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818	Crushed Scoria for Pavement Base and Subbase	April 2011
831	Aggregate for Sprayed Bituminous Surfacing	January 2021
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853	Hot Melt Bitumen Adhesive for Raised Pavement Marker Installation	February 1994
860	Manufacture of Road Signs	August 2019

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SECTION 173 - EXAMINATION AND TESTING OF MATERIALS AND WORK (ROADWORKS)

173.01 GENERAL

This section covers some of the requirements for examination and testing of materials and work associated with road construction. Particular examination and testing requirements are separately specified in the relevant sections of the specification. Unless otherwise specified, the cost of all testing shall be borne by the Contractor.

173.02 LOT TESTING

Unless otherwise specified, acceptance of material and work will be based on testing of the material or work in lots. A lot will consist of a single layer, batch or area of like work which has been constructed or produced under essentially uniform conditions and is essentially homogeneous with respect to material and appearance. Unless otherwise specified, the extent of each lot shall not exceed one day's production. Discrete portions of a lot which are non-homogeneous with respect to material and appearance shall be excluded from the lot and shall be either treated as separate lots, or reworked. Where the areas excluded from a lot as non-homogeneous exceed 10% of the total lot area or at other specified percentages of the total lot area, the whole of the lot shall be rejected.

173.03 TEST ROLLING

(a) General

The Contractor shall submit a test rolling procedure to the Superintendent Council including the method of preparing an area for test rolling, the extent of test rolling and a requirement to provide not less than 24 hours notice of the location and commencement time for the test rolling to the Superintendent Council.

Plant which is nominated for use in test rolling procedures shall comply with the following requirements:

- (i) ~~Static smooth steel wheeled rollers shall have a mass of not less than 12 tonnes and a load intensity under either the front or rear wheels of not less than 6 tonnes per metre width of wheel.~~
- (ii) Pneumatic tyred plant comprising of a loaded tandem truck or filled watercart (ensuring minimum capacity at 75%), which shall have a mass of not less than 20 tonne and shall have a ground contact pressure under either the front or rear wheels of not less than 450 kPa per tyre. The area over which this ground contact pressure shall be applied shall not be less than 0.035 m² per tyre.

Each layer should be test rolled immediately following completion of compaction but if test rolling is carried out at a later time the surface of the layer shall be watered and given a minimum of three passes with the test roller prior to commencement of test rolling.

(b) Compliance

Compliance with the test rolling requirements shall be when an area withstands test rolling without visible deformation or springing.

173.04 COMPACTION AND MOISTURE CONTENT TESTING

(a) General

For the purpose of control of moisture content of material and for determination of compaction procedure the following definitions shall apply:

- (i) material of nominal size 40 mm or less:
material which has 20% or less (by wet mass) retained on a 37.5 mm AS sieve
- (ii) material of nominal size greater than 40 mm:
material which has more than 20% (by wet mass) retained on a 37.5 mm AS sieve.

(b) Definition of Density Ratio for Asphalt and Concrete Pavement

Density ratio is defined as follows:

(i) Asphalt Pavement

The percentage ratio of the field bulk density to the bulk density of the job design mix when compacted in the laboratory.

(ii) Concrete Pavement

The percentage ratio of the field bulk density to the mean bulk density of cylinder specimens taken from the same lot.

(c) Characteristic Value of Density Ratio or Moisture Ratio

The characteristic value of density ratio or moisture ratio of the lot shall be calculated as $\bar{x} - 0.92S$ for six tests per lot where \bar{x} and S are respectively the mean and the standard deviation of the individual density ratio or moisture ratio test values respectively for the lot.

The mean of density ratio or moisture ratio is defined by:

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

The standard deviation of density ratio or moisture ratio test values is defined by:

$$S = \sqrt{\frac{\sum_{i=1}^n (\bar{x} - x_i)^2}{n-1}}$$

where x_i , $i=1, 2, 3, \dots, n$, is the individual density ratio or moisture ratio test value and n is the number of tests per lot.

(d) Testing Small Areas

For earthworks and pavement construction any lot which has a surface area less than 500 m² may be treated as a small area. When testing a small area as a lot and where test requirements are based on characteristic values of density ratio and/or moisture ratio, acceptance of the lot shall be based on the mean values of 3 individual tests. In this case the lot will be accepted as far as compaction is concerned if the mean value of the individual tests exceeds by 2.0% or more the appropriate compaction scale requirement for the characteristic value of density ratio for a lot of six tests.

(e) Samples Containing Oversize Material with a Nominal Size Greater than 40 mm

(i) Assessment Based on Characteristic Density Ratio

If the set of six samples includes no more than two samples having more than the permitted amount of 40 mm nominal size material, the lot will be accepted as far as compaction is concerned if the mean value of the individual tests exceeds the specified characteristic value of density ratio by 2.0% or more. If there are less than 4 valid samples, acceptance shall be based on the adoption of an acceptable compaction procedure and test rolling carried out in accordance with the requirement of this Specification.

(ii) Assessment Based on Mean Density Ratio

If the set of three samples includes one or more samples having more than the permitted amount of material exceeding 40 mm in nominal size, assessment shall be based on the adoption of an acceptable compaction procedure and test rolling carried out in accordance with the requirement of this Specification.

(f) Refilling Test Holes

The Contractor shall backfill test holes with material of similar quality to that removed from test holes during testing. The backfill material shall be compacted in the holes in layers with a suitable compaction device.

(g) Moisture Ratio Determination

For material of nominal size greater than 40 mm, moisture ratio shall be determined on that fraction of the material which passes the 19.0 mm AS sieve.

For material of nominal size 40 mm or less, moisture ratio shall be determined on the whole material, taking into account any adjustment for oversize material as detailed in the relevant test method.

(h) Acceptance Testing

All compaction testing of work carried out under this Contract shall be deemed to be testing for acceptance unless written advice is provided to the Superintendent Council prior to the commencement of the test, that such testing is for in-process monitoring only. Where the Contractor provides prior written advice to this effect, the results of such testing will not be allowable as testing for acceptance.

173.05 TESTING OF SURFACE LEVEL OF EARTHWORKS AND PAVEMENT COURSES (RANDOM LEVEL MEASUREMENT PROCEDURE)

(a) General

The requirements of this clause apply to:

- the top of Type B material in fills
- the Cut Floor Level in cuts where Type A material is specified
- the finished surface of the subgrade
- pavement courses where Scale A and Scale B surface level is specified by the random level measurement procedure in accordance with the VicRoads Test Method.

(b) Measurement of Surface Level

Measurement of surface level will be made using a level accurate to ± 3 mm per 50 m of reading distance, with levels being recorded to the nearest 1 mm.

Within each lot, level measurements shall be compared with the corresponding design levels and individual departures from design, x_i shall be calculated as follows:

the mean of the departures from design level \bar{x} , of n measurements will be determined to the nearest 0.1 mm as follows –

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$$

the standard deviation, S , will be determined as follows -

$$S = \sqrt{\frac{\sum_{i=1}^n (\bar{x} - x_i)^2}{n-1}}$$

where x_i = measured level - design level (mm).

**173.06 TESTING OF SURFACE LEVEL OF EARTHWORKS AND PAVEMENT COURSES
(NON-RANDOM LEVEL MEASUREMENT PROCEDURE)****(a) General**

The requirements of this clause apply to:

- the finished surface of the top of Type B material in fills
- the Cut Floor Level in cuts where Type A material is specified
- the subgrade
- pavement courses where a non-random method of level assessment is permitted or where Scale C level assessment is specified.

(b) Earthwork Formation

The surface level of the finished earthwork formation including:

- table drains
- verges
- the top of Type B material in fills
- the Cut Floor Level in cuts where Type A material is specified
- the prepared subgrade

shall be checked longitudinally for conformity with the specified requirements at intervals not exceeding 20 m. Level measurements shall be taken and recorded at all changes in gradient, at the edges of prepared earthworks surfaces, designated lane lines and at intervals not exceeding 2 m transversely across the prepared surfaces prior to placing Type A material or pavement material.

(c) Pavement Courses

The surface level of each completed pavement course shall be checked longitudinally and transversely for conformity with the specified requirements at intervals not exceeding 20 m in the longitudinal direction. At each location checked for longitudinal level conformity, the surface level shall be checked in the transverse direction at all of the following locations:

- (i) at the edges of the pavement
- (ii) at all changes of gradient across the pavement
- (iii) at intervals not exceeding 2 m across the pavement.

(d) Pavement Layer Thickness

In cases where drawings showing the finished surface level are not provided but the thickness of pavement courses or resheet is specified, the Contractor shall determine the thickness of pavement courses or resheet by taking the difference between the surface level measurements recorded in accordance with the requirements of Clause 173.06(c).

SECTION 175 - REFERENCED DOCUMENTS FOR STANDARD SPECIFICATIONS FOR ROADWORKS AND BRIDGEWORKS

175.01 GENERAL

This section provides a list of current companion documents referenced in the Wyndham City Council Specification. ~~VicRoads Standard Specifications for Roadworks and Bridgeworks~~.

The referenced documents in this section take precedent over any other referenced documents in other Standard Sections.

175.02 VICROADS STANDARD SPECIFICATIONS FOR ROADWORKS AND BRIDGEWORKS SECTIONS

The VicRoads Standard Specification Series referred to in this section are as follows:

- Section 100 Series – General
- Section 200 Series – Formation
- Section 300 Series – Flexible Pavements
- Section 400 Series – Asphalt and Surface Treatments
- Section 500 Series – Concrete Pavements
- Section 600 Series – Bridgeworks
- Section 700 Series – Incidental Construction
- Section 800 Series – Materials

175.03 HIERARCHY OF DOCUMENTS

The following hierarchy of documents shall be used if there is conflict between any referenced documents and the specification whereby the higher listed documents shall take precedence over lower listed documents:

- Acts of Parliament and Regulations (Federal / Victorian)
- ~~Contract Specific Clauses~~
- Standard Section 175
- All other Standard Specification Sections
- VicRoads Codes of Practice and Bridge Technical Notes
- Australian Standards (except test methods)
- VicRoads Test Methods
- Australian Standards Test Methods
- Austrroads Test Methods
- Other Standards and Test Methods
- VicRoads Technical Bulletins
- Austrroads Guideline Documents and Guides
- Other Publications

175.04 APPLICATION AND ACCESS TO REFERENCED DOCUMENTS**Parliamentary Legislative Documents**

These documents shall be obtained through the appropriate level of Government, either Federal or Victorian and are statutory requirements referred in Standard Sections. A copy of the document can be viewed on the relevant Government web site. These documents are referenced in Table 175.051.

Australian Standards

Australian Standards are commonly referenced to reduce the size of the specification document. If only part of the Australian Standard is to apply, the relevant Standard Section will specify particular and/or alternative requirements. Whenever there is conflict between the Australian Standard and the Standard Section, the Standard Section shall take precedent over the Australian Standard. A list of current Australian Standards with a brief description of each can be viewed on the Standards web site <http://www.standards.org.au/>. These documents are referenced in Table 175.061.

Australian Standard Test Methods

Australian Standard Test Methods are also listed in this section and are to be used unless there is an applicable VicRoads Test Method listed. The Contractor is expected to become familiar with relevant Australian Standard Test Methods applicable to particular materials or groups of materials that are referenced by the Australian Standard or VicRoads Codes of Practice. Where there is choice of more than one Australian Standard Test Method, the Test Method to be used is specified in either VicRoads Code of Practice 500.05 or 500.16 or by separate reference within this section.

Australian Standard Test Methods shall be obtained directly from Standards Australia, GPO Box 476, Sydney NSW 2001. A list of current Australian Standard Test Methods with a brief description of each can be viewed on the Standards web site <http://www.standards.com.au/>. These documents are referenced in Table 175.061.

VicRoads Codes of Practice and Bridge Technical Notes

VicRoads Codes of Practice and Bridge Technical Notes are companion documents to the VicRoads Standard Specifications and may or may not be referenced in the Standard Specifications. The Contractor is expected to obtain copies of the Codes of Practice or Bridge Technical Notes to be read in conjunction with the Standard Specifications. The relevant Codes of Practice or Bridge Technical Notes as applicable to each Standard Section are specified in this section.

All current Codes of Practice and Bridge Technical Notes can also be accessed from the VicRoads website <http://www.vicroads.vic.gov.au/>. These documents are referenced in Table 175.071.

VicRoads Test Methods

All Testing Laboratories are expected to become familiar with the contents of the VicRoads Manual of Test Methods. The Test Methods to be used are specified in either VicRoads Code of Practice 500.05 or 500.16 or by separate reference within this section. VicRoads Test Methods, if applicable, shall take precedent over all other Test Methods.

All current VicRoads Test Methods can be accessed from the VicRoads website <http://www.vicroads.vic.gov.au/>. These documents are referenced in Table 175.081.

Austrroads Test Methods

Austrroads has produced a series of Test Methods for Bituminous Products. The Austrroads Test Methods to be used will be either listed in this section or listed in VicRoads Code of Practice 500.16. If there is to be a variation in the Austrroads Method, the variation will be described in Code of Practice 500.16 or in the relevant Standard Specification Section.

The current Austrroads Test Methods can be obtained from the Austrroads Web Site <http://www.austrroads.com.au/>. These documents are referenced in Table 175.091.

VicRoads Technical Bulletins

VicRoads has produced a number of Technical Bulletins. These or parts of these documents may form part of this Specification if referenced in the relevant Standard Section.

VicRoads Technical Bulletins can be accessed from the VicRoads website <http://www.vicroads.vic.gov.au/>. These documents are referenced in Table 175.111.

Austroads Guides and Specification Framework Documents

Austroads has produced a number of specification framework and guideline documents listed in this section. These or parts of these documents may form part of this Specification as specified in the relevant Standard Section.

Austroads Specification Framework and Guideline documents can be purchased from the ARRB Group, 500 Burwood Highway, Vermont South. These documents are referenced in Table 175.121.

Other Documents and International Standards

Other referenced standards, test methods and documents produced by organisations not mentioned above, are also specified in this section, e.g. ASTM, BS, ISO, RTA and APAS.

These documents shall be obtained from Australian Standards or the relevant publishing authority responsible for the document.

These documents are referenced in Table 175.101 (standards and test methods) and Table 175.131 (for other referenced documents).

175.05 PARLIAMENTARY LEGISLATIVE DOCUMENTS

Table 175.051 lists the Parliamentary Legislative Documents that are applicable to the relevant Standard Specification Sections.

All documents listed in this Standard Section shall include all supplements and amendments to the documents, unless otherwise stated within contract specification documents or by Superintendent. Documents that have been reconfirmed are denoted by "R(reconfirmed year)".

Table 175.051 Parliamentary Legislative Documents

Document	Standard Specification Section							
Aboriginal Heritage Act 2006 (Vic)	176 177							
Australian Government Building and Construction WHS Accreditation Scheme	168							
Building and Construction Industry (Consequential and Transitional Provisions) Act 2016	168							
Fair Work (Building Industry—Accreditation Scheme) Regulation 2016	168							
Catchment and Land Protection Act (CALP) (1994)							720 750	
Dangerous Goods (Storage and Handling) Regulations 2012	176 177							
Electricity Safety (Electric Line Clearance) Regulations 2015							752	
Emergency Management Act 2013							750 751 752	
Environment Protection Act 1970 (Vic)	176 177						750 752	
Public Health and Wellbeing Act 2008							750 752	

Table 175.051 Parliamentary Legislative Documents ... continued

Document	Standard Specification Section							
Heritage Act 2017 (Vic)	176 177							
Land Acquisition and Compensation Act 1986	165							
Occupational Health and Safety Act (2004)	168					612 613 614 622 687 688	713 765	
Occupational Health and Safety Regulations (2017)	168					606 608 613 614 631 688	713 751	
Road Safety (Traffic Management) Regulations 2009	160							
Road Management Act 2004	165 166						706 750 752	
Road Management Act 2004 Code of Practice for Management of Infrastructure in Road Reserves (Victoria Government Gazette No. S 117 Thursday 28 April 2016)							706	
Road Management Act 2004 Code of Practice for Operational Responsibilities for Public Roads (Victoria Government Gazette No S 174 30 May 2017)							706	
Road Management Act 2004 Code of Practice for Worksite Safety - Traffic Management (Victoria Government Gazette No S 351 31 August 2010)	160 161 163 166						750 751 752	
Road Management (Works and Infrastructure) Regulations 2015							706	
State Environment Protection Policy (Air Quality Management)	176 177							
State Environment Protection Policy (Groundwaters of Victoria)	176 177							
State Environment Protection Policy (Prevention and Management of Contamination of Land)	163 176 177							
State Environment Protection Policy (Waters of Victoria)	176 177							
Code of Practice for Safe Electrical Work (Low Voltage Electrical Installations) 1997							751	
WorkSafe - Confined Spaces - Shafts, Tunnels and Trenches (May 2003)						606 608		
WorkSafe Compliance Code - Confined Spaces March 2018						606 608		
WorkSafe Compliance Code – Workplace amenities and work environment (September 2008)	160						751	

175.06 AUSTRALIAN STANDARDS

Table 175.061 lists the Australian Standards (including test methods) that are applicable to the Standard Specification Section contained in this Specification.

Table 175.061 Australian Standards (including test methods)

Australian Standard	Standard Specification Section						
AS 1012 (series) : Methods of testing concrete Part 1 : 2014 - Sampling of concrete Part 2 : 2014 - Preparing concrete mixes in the laboratory Part 3.1 : 2014 - Determination of properties related to the consistency of concrete - Slump test Part 3.2 : 1998 (R2014) - Determination of properties related to the consistency of concrete – Compacting factor test Part 3.3 : 1998 (R2014) - Determination of properties related to the consistency of concrete – Vebe test Part 3.4 : 1998 (R2014) - Determination of properties related to the consistency of concrete – Compatibility test Part 3.5 : 2015 - Determination of properties related to the consistency of concrete - Slip flow, T500 and J-ring Part 4.1 : 2014 - Determination of air content of freshly mixed concrete – Measuring reduction in concrete volume with increased air pressure Part 4.2 : 2014 - Determination of air content of freshly mixed concrete – Measuring reduction in air pressure in chamber above concrete Part 4.3 : 2014 - Determination of air content of freshly mixed concrete – Measuring air volume when concrete is dispersed in water Part 8.1 : 2014 - Method of making and curing concrete – Compression and indirect tensile test specimens Part 8.2 : 2014 - Method of making and curing concrete – Flexure test specimens Part 9 : 2014 - Compressive strength tests - Concrete, mortar and grout specimens Part 12.1 : 1998 (R2014) - Determination of mass per unit volume of hardened concrete – Rapid measuring method Part 12.2 : 1998 (R2014) - Determination of mass per unit volume of hardened concrete – water displacement method Part 13 : 2015 - Determination of drying shrinkage of concrete for samples prepared in the field or in the laboratory Part 14 : 2018– Method for securing and testing cores from hardened concrete for compressive strength and mass per unit volume Part 20.1 : 2016 - Determination of chloride and sulphate in hardened concrete and concrete aggregates-Nitric acid extraction Part 20.2 : 2016 - Determination of water-soluble chloride in aggregates and hardened concrete Part 21 : 1999 (R2014) - Determination of water absorption and apparent volume of permeable voids in hardened concrete Part 24 : 2015 - Determination of the tensile bond strength of concrete - Repairs and strengthening systems					503 520 521	607 610 619 683 684 688 689	703 708 711 730
AS 1074 : 1989 - Steel tubes and tubulars for ordinary service							707 733
AS 1101.3 : 2005 (R2018) - Graphical Symbols for General Engineering - Welding and non-destructive examination						630	
AS 1111 (series) : ISO metric hexagon bolts and screws Part 1 : 2015 - Product grade C – Bolts Part 2 : 2015 - Product grade C – Screws						630	707 708 760
AS 1112 (series) : ISO metric hexagon nuts Part 1 : 2015 - Style 1 Product grades A and B Part 2 : 2015 - Style 2 Product grades A and B Part 3 : 2015 - Product grade C Part 4 : 2015 - Chamfered thin nuts - Product grades A and B						630	707 708

Table 175.061 Australian Standards (including test methods) ... continued

Australian Standard	Standard Specification Section							
AS 1141 (series) : Methods for sampling and testing aggregates Part 3.1 : 2012 – Sampling - Aggregates Part 3.2 : 2012 – Sampling – Rock spalls and boulders Part 5 : 2000 (R2016) - Particle density and water absorption of fine aggregate Part 6.1 : 2000 (R2016) - Particle density and water absorption of coarse aggregate – Weighing-in-water method Part 11.1 : 2009– Particle size distribution – Sieving method Part 15 : 1999 (R2018) - Flakiness Index Part 17 : 2014 - Voids in dry compacted filler Part 18 : 1996- Crushed particles in coarse aggregate derived from gravel Part 20.3 : 2000 (R2013) - Average least dimension - Calculation (nomograph) Part 22 : 2008- Wet/dry strength variation Part 23 : 2009 - Los Angeles value Part 25.1 : 2003 (R2013) - Degradation factor - Source rock Part 26 : 2008 - Secondary minerals content in igneous rocks Part 28 : 2014 - Ball mill value Part 30.1 : 2009- Coarse aggregate quality by visual comparison	205 290	307	404 405 407 408 409 410 417 418 421 423 427	503 520	610 619	701 702 703 706 713 715 760	801 802 811 812 815 818 820 831	
AS 1160 : 1996 - Bituminous emulsions for the construction and maintenance of pavements			407 408				802	
AS/NZS 1163 : 2016 - Cold-formed structural steel hollow sections					630	760		
AS/NZS 1170 (series) - Structural design actions Part 1 : 2002- Permanent, imposed and other actions Part 2 : 2011 (R2016) - Wind actions					613			
AS/NZS 1214 : 2016 - Hot-dip galvanized Coatings on threaded fasteners (ISO metric coarse thread series) (ISO 10684:2004, MOD)					630 653	707 708 760		
AS 1237 (series) Part 1 : 2002 (R2015) : Plain washers for metric bolts, screws and nuts for general purposes - General plan Part 2 : 2016 – Tolerances for fasteners - washers for bolts, screws and nuts – product grades A, C, and F					653	707		
AS/NZS 1252 (series) - High-strength steel fastener assemblies for structural engineering - Bolts, nuts and washers Part 1 : 2016 - Technical requirements Part 2 : 2016 - Verification testing for bolt assemblies					630 653			
AS 1275 : 1985- Metric screw threads for fasteners						751		

Table 175.061 Australian Standards (including test methods) ... continued

Australian Standard	Standard Specification Section							
AS 1289 (series) : Methods of testing soils for engineering purposes Part 2.1.1 : 2005 (R2016) – Soil moisture content tests – Determination of the moisture content of a soil – Oven drying method (standard method) Part 2.1.6 : 2005 (R2016) – Soil moisture content tests – Determination of the moisture content of a soil – Hotplate drying method– Part 3.1.1 : 2009 (R2017)– Soil classification tests - Determination of the liquid limit of a soil - Four point Casagrande method Part 3.1.2 : 2009 (R2017)– Soil classification tests - Determination of the liquid limit of a soil - One point Casagrande method (subsidiary method) Part 3.3.1 : 2009 – Soil classification tests - Calculation of the plasticity index of a soil Part 3.6.1 : 2009 – Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving Part 3.7.1 : 2002 (R2013) – Soil classification tests - Determination of the sand equivalent of a soil using a power-operated shaker Part 3.8.1 : 2017 – Soil classification tests - Dispersion - Determination of Emerson class number of a soil Part 4.3.1:1997 – Soil chemical tests - Determination of the pH value of a soil - Electrometric method Part 4.4.1:2017 – Soil chemical tests - Determination of the electrical resistivity of a soil - Method for fine granular materials Part 5.1.1:2017 – Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort Part 5.2.1:2017– Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using modified compactive effort Part 5.4.2:2007 (R2016) – Soil compaction and density tests - Compaction control test - Assignment of maximum dry density and optimum moisture content values Part 5.7.1:2006 – Soil compaction and density tests - Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method) Part 5.8.1:2007 – Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture–Density gauge - Direct transmission mode Part 6.1.1 : 2014 – Soil strength and consolidation tests - Determination of the California Bearing Ratio of a soil - Standard laboratory method for a remoulded specimen Part 6.2.2 : 1998 – Soil strength and consolidation tests - Determination of shear strength of a soil - Direct shear test using a shear box Part 6.7.1 : 2001 (R2013) – Soil strength and consolidation tests - Determination of permeability of a soil Part 6.7.2 : 2001 (R2013) – Soil strength and consolidation tests - Determination of permeability of a soil - Falling head method for a remoulded specimen	204 205 210 290	304 306 307 308 310	407 423	520	610 632 682	701 702 706 712	801 802 811 812 815 818 820	
AS/NZS 1314 : 2003 (R2016) – Prestressing anchorages					612			
AS 1319 : 1994 - Safety Signs for the Occupational Environment					612 622			
AS/NZS 1365 : 1996 (R2016) – Tolerances for flat-rolled steel products						708		
AS 1366.3 : 1992 - Rigid cellular plastics sheets for thermal insulation - Rigid cellular polystyrene – moulded (RC/PS - M)					613 614			

Table 175.061 Australian Standards (including test methods) ... continued

Australian Standard	Standard Specification Section						
AS 1379 : 2007 – Specification and supply of concrete				503	610 619	703 704 705 708 711 760	
AS/NZS 1390 : 1997 - Cup head bolts with ISO metric coarse pitch threads						707	
AS 1391 : 2007 - Metallic materials - Tensile testing at ambient temperature					680	708	
AS 1397 : 2011 – Continuous hot-dip metallic coated steel sheet and strip– Coatings of zinc and zinc alloyed with aluminium and magnesium							860
AS 1443 : 2004 - Carbon and carbon-manganese steel - Cold-finished bars					630	760	
AS/NZS 1477 : 2017– PVC pipes and fittings for pressure applications						733	
AS 1478.1 : 2000 - Chemical admixtures for concrete, mortar and grout – Admixtures for concrete				520	610 619 683 684 689	703 760	
AS 1478.2 : 2005 : Chemical admixtures for concrete, mortar and grout – Methods of sampling and testing admixtures for concrete, mortar and grout					607 612 619 683 689	703 760	
AS/NZS 1554 (series) – Structural steel welding Part 1 : 2014 - Welding of steel structures Part 2 : 2003 - Stud welding (steel studs to steel) Part 3 : 2014 - Welding of reinforcing steel Part 5 : 2014 - Welding of steel structures subject to high levels of fatigue loading Part 6 : 2012 - Welding stainless steels for structural purposes					605 608 611 620 630 632 640	708	
AS 1576.1 : 2010 – Scaffolding – General requirements					613		
AS 1580 (series) – Paints and related materials – Methods of test Part 108.2 : 2004 : Dry film thickness - Paint inspection gauge Part 214.5 : 1997 (R2013) : Consistency – Rotational viscometer Part 301.1 : 2005: Non-volatile content by mass Part 408.4 : 2004 : Adhesion (cross-cut) Part 408.5 : 2006 (R2016) : Adhesion - Pull-off test				520	685 686 691	765	
AS/NZS 1594 : 2002 (R2016) - Hot-Rolled Steel Flat Products					614 630 685	708	
AS 1597 (series) - Precast reinforced concrete box culverts Part 1 : 2010 - Small culverts (not exceeding 1200 mm span and 1200 mm height) Part 2 : 2013 – Large culverts (exceeding 1200 mm span and 1200 mm height and up to and including 4200 mm span and 4200 mm height)					619		
AS 1604 (series) : Specification for preservative treatment Part 1 : 2012 – Sawn and round timber Part 2 : 2012 – Reconstituted wood-based products Part 3 : 2012 – Plywood Part 4 : 2012 – Laminated veneer lumber (LVL) Part 5 : 2012 – Glued laminated timber products						707 765	

Table 175.061 Australian Standards (including test methods) ... continued

Australian Standard	Standard Specification Section							
AS 1627 (series) - Metal finishing Part 1 : 2003 (R2017) - Preparation and pretreatment of surfaces – Removal of oil, grease and related contamination Part 2 : 2002 (R2017) – Power tool cleaning Part 4 : 2005 (R2017)- Preparation and pretreatment of surfaces - Abrasive blast cleaning of steel Part 9 : 2002 (R2017)- Pictorial surface preparation standards for painting steel surfaces						631 685 686 688 689 691	705 708 765	
AS 1646 : 2007 Elastomeric seals for waterworks purposes							701	
AS 1672.1 : 1997 (R2016) : Limes and limestones - Limes for building		290	307 308	407		610	704	815
AS 1683.11 : 2001 - Methods of test for elastomers - Tension testing of vulcanized or thermoplastic rubber							701	
AS 1720 (series) : Timber structures Part 1 : 2010 - Design methods Part 2 : 2006 - Timber properties Part 4 : 2006 - Fire resistance for structural adequacy of timber members					613	708		
AS 1725.1 : 2010 - Chain-link fabric fencing - Security fences and gates – General requirements							707	
AS 1726 : 2017 - Geotechnical site investigations		204				682	711	
AS/NZS 1734 : 1997 - Aluminium and aluminium alloys – Flat sheet, coiled sheets and plate								860
AS 1742 (series) Manual of uniform traffic control devices Part 1 : 2014 General introduction and index of signs Part 2 : 2009 Traffic control devices for general use Part 3 : 2009 Traffic control for works on roads	166						708 714 730 750 751	860
AS 1743 : 2018 - Road signs – Specifications							714	860
AS 1744 : 2015 - Standard alphabets for road signs	160 168							
AS/NZS 1906 (series) Retroreflective materials and devices for road traffic control purposes Part 1 : 2007 - Retroreflective sheeting (available superseded) Part 2 : 2007 - Retroreflective devices (<i>non pavement application</i>) Part 3 : 1992 - Raised pavement markers (<i>retroreflective and non retroreflective</i>) (available superseded)	166						708 709 710 711 712 721	853 860
AS 1988.1 : 2006 - Welding of ferrous castings – Steel castings						675		
AS 2008 : 2013 - Bitumen for pavements			308	407 408 427				802
AS/NZS 2009 : 2006 (R2016) - Glass beads for pavement marking materials							721	
AS/NZS 2041(series) - Buried corrugated metal structures Part 1 : 2011 - Design methods Part 2 : 2011 - Installation Part 4 : 2010 - Helically formed sinusoidal pipes Part 6 : 2010 - Bolted plate structures					632	701 702		

Table 175.061 Australian Standards (including test methods) ... continued

Australian Standard	Standard Specification Section						
AS 2053 (series) : Conduits and fittings for electrical installations Part 1 : 2001 (R2016) - General requirements Part 2 : 2001 (R2016) - Rigid plain conduits and fittings of insulating material Part 3 : 1995 (R2016) - Rigid plain conduits and fittings of fibre-reinforced concrete material Part 4 : 1995 (R2016) - Flexible plain conduits and fittings of insulating material Part 5 : 2001 (R2016) - Corrugated conduits and fittings of insulating material Part 6 : 2001 (R2016) - Profile-wall, smooth-bore conduits and fittings of insulating material Part 7 : 2002 (R2016) - Rigid metal conduits and fittings Part 8 : 1995 (R2016) - Flexible conduits and fittings of metal or composite material						733	
AS 2062 : 1997 - Non-destructive testing - Penetrant testing of products and components					611		
AS 2074 : 2003 - Cast Steels (Withdrawn)					675		
AS 2082 : 2007 (R2017) - Timber - Hardwood - Visually stress-graded for structural purposes						707	
AS 2144 : 2014 - Traffic signal lanterns						751	
AS 2150 : 2005 - Hot mix asphalt - A guide to good practice			407 427				802
AS 2157 : 1997 - Cutback bitumen			408				802
AS 2159 : 2009- Piling - Design and installation					603 604 605 606 607 608 640		
AS 2193 : 2005(R2017) - Calibration and classification of force-measuring systems					612 619 622 680 683		
AS 2205 (series) : Methods for destructive testing of welds in metal Part 4.2 : 2003 (R2018) - Fillet break test Part 5.1 : 2003 (R2018) - Macro metallographic test for cross-section examination					611 630		
AS 2239 : 2003 (R2016) - Galvanic (sacrificial) anodes for cathodic protection					681		
AS 2271 : 2004 (R2016) - Plywood and blockboard for exterior use					603 614		
AS/NZS 2310 : 2002 (R2016) - Glossary of paint and painting terms					631	765	
AS/NZS 2311 : 2017 - Guide to the painting of buildings					685 686	765	
AS/NZS 2312 (series) - Guide to the protection of structural steel against atmospheric corrosion by use of protective coatings Part 1 : 2014 - Paint coatings Part 2 : 2014 - Hot dip galvanizing					631 683 685 686 688 691	765	
AS 2334 : 1980 (R2015) - Steel nails - metric series						707	

Table 175.061 Australian Standards (including test methods) ... continued

Australian Standard	Standard Specification Section						
AS/NZS 2341 (series) : Methods of Testing Bitumen and Related Road Making Products Part 2 : 2015 - Determination of dynamic viscosity by vacuum capillary viscometer Part 3 : 1993 - Determination of kinematic viscosity by flow through a capillary tube Part 4 : 2015 - Determination of dynamic viscosity by rotational viscometer Part 8 : 2016 - Determination of matter insoluble in toluene Part 10 : 2015 Determination of the effect of heat and air on a moving film of bitumen (rolling thin film oven (RTFO) test) Part 12 : 1993 - Determination of Penetration (obsolescent) Part 13 : 1997 (R2013) - Long-term exposure to heat and air Part 18 : 1992 - Determination of softening point (ring and ball method)				408 418 427			
AS 2353 : 2018 - Pedestrian push-button assemblies							751
AS 2423 : 2002 - Coated steel wire fencing products for terrestrial, aquatic and general use							707
AS 2439 (series) : Perforated plastics drainage and effluent pipe and fittings Part 1 : 2007 - Perforated drainage pipe and associated fittings Part 2 : 2007 - Perforated effluent pipe and associated fittings for sewerage applications							702
AS 2700 : 2011 - Colour standards for general purposes				431		631 685 686	765 860
AS 2701 : 2001 (R2015) - Methods of sampling and testing mortar for masonry constructions						607	
AS 2758.1 : 2014 - Aggregates and rock for engineering purposes – Concrete aggregates						610 619	701 703 801
AS 2832 (series) - Cathodic protection of metals Part 1 : 2015 - Pipes and cables Part 2 : 2003 (R2016) - Compact buried structures Part 3 : 2005 (R2016) - Fixed immersed structures Part 4 : 2006 (R2016) - Internal surfaces Part 5 : 2008 (R2018) - Steel in concrete structures						681	
AS 2858 : 2008 - Timber - Softwood - Visually stress-graded for structural purposes							707
AS 2876 : 2000 - Concrete kerbs and channels (gutters) - Manually or machine placed (withdrawn)							703

Table 175.061 Australian Standards (including test methods) ... continued

Australian Standard	Standard Specification Section						
AS/NZS 2891 (series) - Methods of sampling and testing asphalt Part 1.1 : 2013 - Sampling - Loose asphalt Part 1.2 : 2008 - Sampling - Coring method Part 1.3 : 2008 - Sampling - Asphalt from slabs Part 2.1 : 2014 - Sample preparation - Mixing, quartering and conditioning of asphalt in the laboratory Part 2.2 : 2014 - Sample preparation - Compaction of asphalt test specimens using a gyratory compactor Part 3.1 : 2013 - Binder content and aggregate grading - Reflux method Part 3.3 : 2013 - Binder content and aggregate grading - Pressure filter method Part 5 : 2015 - Compaction of asphalt by Marshall method and determination of stability and flow - Marshall procedure Part 7.1 : 2015 - Determination of maximum density of asphalt - Water displacement method Part 7.3 : 2014 - Determination of maximum density of asphalt - Methylated spirits displacement Part 8 : 2014 - Voids and volumetric properties of compacted asphalt mixes Part 9.1 : 2014 - Determination of bulk density of compacted asphalt - Waxing procedure Part 9.2 : 2014 - Determination of bulk density of compacted asphalt - Presaturation method Part 9.3: 2014 - Determination of bulk density of compacted asphalt - Mensuration method Part 10 : 2015 - Moisture content of asphalt Part 11 : 2014 - Degree of particle coating Part 13.1 : 2013 - Determination of the resilient modulus of asphalt - Indirect tensile method Part 14.1.1 : 2013 – Field density tests - Determination of field density of compacted asphalt using a nuclear surface moisture-density gauge - Direct transmission mode Part 14.1.2 : 2013 – Field density tests - Determination of field density of compacted asphalt using a nuclear surface moisture-density gauge - Backscatter mode Part 14.2 : 2013– Field density tests - Determination of field density of compacted asphalt using a nuclear thin-layer density gauge Part 14.3 : 2013 - Field density tests - Calibration of nuclear thin-layer density gauge using standard blocks Part 14.4 : 2013 - Field density tests - Calibration of nuclear surface moisture-density gauge - Backscatter mode Part 14.5 : 2014 – Field density tests - Density ratio and percentage air voids of compacted asphalt			308	404 405 407 409 410 417 418 421 423 427			802 831
AS/NZS 3000 : 2007 - Electrical installations (known as the Australian/New Zealand Wiring Rules)						681 711 733 751	
AS/NZ 3012 : 2010 - Electrical installations – Construction and demolition sites						681	
AS 3568 : 1999 - Oils for reducing the viscosity of residual bitumen for pavements				408			802
AS 3569 : 2010 - Steel wire ropes – Product specification						708	

Table 175.061 Australian Standards (including test methods) ... continued

Australian Standard	Standard Specification Section							
AS 3580 (series) : Method for sampling and analysis of ambient air Part 9.6 : 2015 - Determination of suspended particulate matter - PM10 high volume sampler with size selective inlet - Gravimetric method Part 9.7 : 2009 - Determination of suspended particulate matter - Dichotomous sampler – (PM10 coarse PM and PM2.5) Gravimetric method Part 9.8 : 2008 (R2018) - Determination of suspended particulate matter - PM10 continuous direct mass method using a tapered element oscillating microbalance analyser Part 9.9 : 2017 - Determination of suspended particulate matter – PM10 low volume sampler - Gravimetric method Part 9.11 : 2016 - Determination of suspended particulate matter - PM10 beta attenuation monitors Part 10.1 : 2016 - Determination of particulate matter - Deposited matter - Gravimetric method Part 10.2 : 2013 - Determination of particulate matter – Impinged matter - Gravimetric method	176 177							
AS/NZS 3582 (series) : Supplementary cementitious materials Part 1 : 2016 - Fly ash Part 2 : 2016 - Slag - Ground granulated iron blast-furnace (AS only) Part 3 : 2016 – Amorphous silica			306 307 308	407	520	610 619	703 704	815
AS 3600 : 2009 - Concrete Structures							701 703 704 705 707 708 711 714	
AS 3610.1 : 2010 - Formwork for concrete – Documentation and surface finish (available superseded)						603 613 614 619	703 708 711	
AS/NZS 3678 : 2016 - Structural steel - Hot-rolled plates, floor plates and slabs						608 620 630 682 685		
AS/NZS 3679 (series) : Structural steel Part 1 : 2016 - Hot rolled bars and sections Part 2 : 2016 - Welded I sections					503	611 630 640 682	705	
AS 3705 : 2012 Geotextiles - Identification, marking and general data	205 210			408			702	
AS 3706 (series) : Geotextiles - Methods of test Part 2 : 2012 - Determination of tensile properties - Wide strip and grab method Part 4 : 2012 - Determination of burst strength - California bearing ratio (CBR) - Plunger method Part 5 : 2014 - Determination of puncture resistance - Drop cone method Part 7 : 2014 - Determination of pore-size distribution – Dry-sieving method Part 11 : 2012 – Determination of durability – Resistance to degradation by light, heat and moisture	205 210			408			702	
AS 3743 : 2003 - Potting mixes							720	

Table 175.061 Australian Standards (including test methods) ... continued

Australian Standard						Standard Specification Section		
AS/NZS 3750 (series) : Paints for steel structures Part 6 : 2009 - Full gloss polyurethane (two-pack) Part 9 : 2009 - Organic zinc-rich primer Part 13 : 1997 (R2013) - Epoxy primer (two-pack) Part 14 : 1997 (R2013) - High-build epoxy (two-pack) Part 15 : 1998 (R2013) - Inorganic zinc silicate paint Part 18 : 2002 (R2013) - Moisture cure urethane (single-pack) systems					631	707 708 765		
AS 3799 : 1998 - Liquid membrane-forming curing compounds for concrete				503	610 619 681 689	703 708 711		
AS/NZS 3845 (series) - Road safety barrier system and devices Part.1 : 2015 - -Barrier systems Part 2 : 2017 - Road safety devices	169					708 711		
AS 3894 (series) : Site testing of protective coatings Part 3 : 2002 (R2013) - Determination of dry film thickness Part 4 : 2002 (R2013) - Assessment of degree of cure Part 5 : 2002 (R2013) - Determination of surface profile Part 6 : 2002 (R2013) - Determination of residual contaminants Part 10 : 2002 - Inspection report – Daily surface and ambient conditions Part 11 : 2002 - Equipment report Part 12 : 2002 - Inspection report – Coating Part 13 : 2002 - Inspection report – Daily Part 14 : 2002 - Inspection report – Daily painting					631	765		
AS 3972 : 2010 : General purpose and blended cements		307 308	407	520	607 610 612 619 683	701 703	815	
AS 3978 : 2003 - Non-destructive Testing - Visual Inspection of Metal Products and Components					675			
AS 4049 (series) : Paints and related materials – Pavement marking materials Part 1 : 2005 (R2016) - Solvent-borne paint – For use with surface applied glass beads Part 2 : 2005 (R2016) - Thermoplastic pavement marking materials – For use with surface applied glass beads Part 3 : 2005 (R2016) - Waterborne paint - For use with surface applied glass beads Part 4 : 2006 (R2016) - High performance pavement marking systems			408			721		
AS/NZS 4058:2007 - Precast concrete pipes (pressure and non-pressure)						701 733		
AS 4100 : 1998 (R2016) – Steel Structures					613 630	708		
AS 4115 : 1993 Hand torque tools (withdrawn)					660			
AS 4130 : 2009 - Polyethylene (PE) pipes for pressure applications					683	733		
AS 4133.4.1 : 2007 (R2016) – Methods of testing rocks for engineering purposes – Rock strength tests - Determination of point load strength index	205							
AS 4139 : 2003 - Fibre reinforced concrete pipes and fittings						701		

Table 175.061 Australian Standards (including test methods) ... continued

Australian Standard				Standard Specification Section				
AS/NZS 4233.1 : 2013 - High pressure water jetting systems - Safe operation and maintenance			428					
AS 4373 : 2007 - Pruning of amenity trees						720 750		
AS 4419 : 2003 - Soils for landscaping and garden use						720		
AS 4454 : 2012 - Composts, soil conditioners and mulches						720		
AS/NZS 4455.1 : 2008 – Masonry units, pavers, flags and segmental retaining wall units – Masonry units						713		
AS/NZS 4456 Masonry units, segmental pavers and flags – Methods of test Part.1 : 2003 – Sampling for test Part 4 : 2003 - Determining compressive strength of masonry units						713		
AS 4489.6.1 : 1997 (R2016) - Test methods for limes and limestones - Lime index - Available lime	290	307					815	
AS/NZS 4534 : 2006 (R2017) - Zinc and zinc/aluminium-alloy coatings on steel wire						707		
AS 4663 : 2013 - Slip resistance measurement of existing pedestrian surfaces			431					
AS/NZS 4671 : 2001 - Steel reinforcing materials				503	611 682 683	703 705		
AS/NZS 4672 (series) Steel prestressing materials Part 1 : 2007 - General requirements Part 2 : 2007 - Testing requirements					612 622			
AS 4678 : 2002 - Earth retaining structures					683			
AS/NZS 4680 : 2006 (R2017) - Hot-dip galvanized (zinc) coatings on fabricated ferrous articles				503	611 620 630 631 632 670 671 675 682 683 684	703 705 707 708 714 765		
AS 4738.1 : 2007 - Metal castings – Ferrous sand moulded (withdrawn)					675			
AS/NZS 4791 : 2006 (R2017) : Hot-dip galvanized (zinc) coatings on ferrous open sections, applied by an in-line process						705		
AS/NZS 4792 : 2006 (R2017) : Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process						705		
AS/NZS 4801: 2001 - Occupational Health and Safety – Management Systems – Specification with guidance for use	160							
AS 4848.1 : 2006 - Application specifications for coating systems Single coat inorganic (ethyl) zinc silicate – Solvent-borne					631			

Table 175.061 Australian Standards (including test methods) ... continued

Australian Standard	Standard Specification Section							
AS 5100 (series) : 2017 - Bridge Design Part 1 - Scope and general principles Part 2 - Design loads Part 3 - Foundation and soil-supporting structures Part 4 - Bearings and deck joints Part 5 - Concrete Part 6 - Steel and composite construction Part 7 - Bridge assessment Part 8 - Rehabilitation and strengthening of existing bridges Part 9 – Timber						603 604 605 606 607 608 610 611 612 613 614 619 630 640 652 653 656 660 671 682 683 689	705 715	
AS 5101 (series) – Methods for preparation and testing of stabilized materials Part 3.3 : 2008 (R2017) - Cement content of cement stabilized materials Part 4 : 2008 - Unconfined compressive strength of compacted materials			306 307					815
AS/NZS 5131:2016 – Structural steelwork – Fabrication and erection						760		
AS/NZS ISO 9000:2016 - Quality management systems – Fundamentals and vocabulary	160 161 162 163				630 691			
AS/NZS ISO 9001:2016 - Quality management systems - Requirements	160 161 162 163				630 691			
AS/NZS ISO 14001:2016 - Environmental management systems- Requirements with guidance for use	160							
AS/NZS ISO 19011:2014 - Guidelines for auditing management systems	161 163							

175.07 VICROADS CODES OF PRACTICE AND BRIDGE TECHNICAL NOTES

Table 175.071 lists the VicRoads Codes of Practice and Bridge Technical Notes that are applicable to the Standard Specification Section contained in this Specification.

Table 175.071 VicRoads Codes of Practice and Bridge Technical Notes

VicRoads Codes of Practice	Standard Specification Section							
VicRoads RC 500.00 : December 2012 : Code of Practice for Source Rock Investigations						610		801 812 815 818 820
VicRoads RC 500.01 : December 2018 : Code of Practice for Registration of Bituminous Mix Designs				404 405 407 409 410 417 421 423 427				
VicRoads RC 500.02 : June 2017 : Code of Practice for Registration of Crushed Rock Mix Designs								812 815 820
VicRoads RC 500.05 : June 2017 : Code of Practice for Acceptance of Field Compaction	173	204 205 290	304 306 307 308	407		682	701 706	
VicRoads RC 500.09 : May2018 : Code of Practice for Testing Aggregates for Sprayed Bituminous Surfacing				408				831
VicRoads RC 500.11 : September 2014 : Code of Practice for Surveillance and Testing of Materials and Work	160 161 162 163							
VicRoads RC 500.16 : June 2017 : Code of Practice for Selection of Test Methods for Testing of Materials and Work	160 161 162 163	204 290	304 306 307 308	407	503	610 682	701	801 802 811 812 815 818 820 831
VicRoads RC 500.20 : July 2019 : Code of Practice for Assignment of CBR Strength and Percentage Swell to Earthworks Fill and Pavement Materials		204 290	304			682		811 812 818
VicRoads RC 500.23 : April 2016 : Code of Practice for Lime Stabilised Earthworks Materials – Available Lime Content, Assignment of CBR and Swell		290						

Table 175.071 VicRoads Codes of Practice and Bridge Technical Notes... continued

Bridge Technical Notes	Standard Specification Section							
VicRoads BTN004 : January 2018 - Bridge joints						660		
VicRoads BTN005 : January 2018 - FRP for strengthening of bridge structures						610 688		
VicRoads BTN006 : January 2018 - Bonded anchor						680		
VicRoads BTN007 : January 2018 - Noise attenuation walls						685	765	
VicRoads BTN009 : January 2018 - RC panels for reinforced soil structures						610 611 620 682		
VicRoads BTN015 : January 2018 - Buried corrugated metal structures						610 623		
VicRoads BTN016 : January 2018 - Design of large box culverts						610 611 620 626		
VicRoads BTN023 : January 2018 – AS 5100 Part 3						610		
VicRoads BTN025 : January 2018 – AS 5100 Part 3						610 611		
VicRoads BTN028 : January 2018 – AS 5100 Part 8						688		

175.08 VICROADS TEST METHODS

Table 175.081 lists additional VicRoads Test Methods to be used that are not mentioned in VicRoads Codes of Practice 500.05 or 500.16.

Table 175.081 VicRoads Test Methods

VicRoads Test Method	Standard Specification Section						
VicRoads RC 253.01 : June 2013 - Determination of Aggregate Moisture Content and Estimated Free Water (using microwave or hot plate)					610		
VicRoads RC 301.04 : June 2017 - Lime Stabilised Earthworks Materials – Available Lime, Assigned CBR and Swell	290						
VicRoads RC 316.00 : July 2019 - Density ratio and moisture ratio lot characteristics VicRoads RC 316.10 : March 2018 - Selection of test sites within a test lot (random stratified sampling method)	204 205 290	304 306 308 310	407 431		682		
VicRoads RC 316.14 : June 2013 - Moisture Ratio Determination for Assessment of Dry-Back of Granular Pavement Materials		310					
VicRoads RC 317.01 : October 2012 - Surface Texture by Sand Patch VicRoads RC 317.03 : December 2012 - Stripping of Aggregate from Sprayed Seals			408 427 428 430 431				
VicRoads RC 324.01 : July 2019 – Calculation of Assigned CBR and Assigned Percent Swell	290						
VicRoads RC 326.01 : April 2016 – Weighted Plasticity Index – PI x Percent passing 0.425mm sieve	290						
VicRoads RC 330.01 : December 2012 - Cementitious Binder and Granular Additive Content for the Stabilisation of Pavement Materials VicRoads RC 330.02 : July 2019 - Determination of the Maximum Allowable Working Time for a Cementitious Binder VicRoads RC 330.03 : July 2019 - Decay Correction Factor for Granular Materials Stabilised with Cementitious Binder	290	306 307 308					815
VicRoads RC 370.05: June 2013 - Degradation Factor - Fine Aggregate							801 812 815 820
VicRoads RC 372.01 : October 2016 - Coarse Aggregate Quality by Visual Assessment			407 408 410 423 427	520		701 702	801 802 812 815 818 820 831
VicRoads RC 372.04 : June 2013 - Foreign Materials in Crushed Concrete	204						820
VicRoads RC 374.01 : March 2014 - Polished Stone Value (based on BS EN 1097-8:2009)			407 430 431				801 831
VicRoads RC 376.03 : April 2016 - Potential Aggregate-Silica Reactivity (Accelerated Mortar Bar Method) VicRoads RC 376.04 : June 2013 – Alkali Aggregate Reactivity Assessment using the Concrete Prism Test					610		

Table 175.081 VicRoads Test Methods ... continued

VicRoads Test Method	Standard Specification Section							
VicRoads RC 421.02 : March 2018 - Skid Resistance of a Road Pavement using a SCRIM ® Machine				430 431				
VicRoads RC 422.03 : June 2001 - Pavement Roughness (Inertial Laser Profiler Method) VicRoads RC 422.06 : June 2001 - Pavement Roughness (ARRB TR Walking Profiler Method)	180							
VicRoads RC 423.02 : June 2004 - Measurement of Surface Levels of Pavement Layers VicRoads RC 423.02B : June 2018 - Selection of Random Sites for Surface Levels of Pavement Layers	173	204	304 306 308	407				
VicRoads RC 424.01 : December 2012 - Determination of Retroreflectivity of Pavement Markings (using the Mirolux 30 reflectometer)							721	

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175.09 AUSTRROADS TEST METHODS

Table 175.091 lists Austroads Test Methods to be used that may not be listed in VicRoads Codes of Practice 500.05 or 500.16.

Table 175.091 Austroads Test Methods

Austroads Test Method	Standard Specification Section							
Austroads AGPT/T101 : March 2006 - Method of Sampling Polymer Modified Binders, Polymers and Crumb Rubber				404 407 410 417 421				
AGPT/T103 : June 2006 - Pre-Treatment and Loss of Heating of Bitumen, Multigrade and Polymer Modified Binders (Rolling Thin Film Oven (RTFO) Test)				418				
Austroads AGPT/T143 : December 2010 : Particle Size and Properties of Crumb Rubber				421				
Austroads AGPT/T144 : March 2006- Morphology of crumb rubber – Bulk density test				421				
Austroads AGPT/T221 : May 2018 - Sampling of Bituminous Slurry				427				
Austroads AGPT/T231 : January 2006 - Deformation Resistance of Asphalt Mixes by the Wheel Tracking Test				418				
Austroads AGPT/T232 : January 2007 - Stripping Potential of Asphalt – Tensile Strength Ratio				409				
Austroads AGPT/T235 : June 2006 : Asphalt Binder Drain Off				404 410 417				
Austroads AGPT/T236 : June 2005 : Asphalt Particle Loss				410				
Austroads AGPT/T237 : June 2005 : Binder Film Index				410				
Austroads AGPT/T251 : January 2010 : Ball Penetration Test			310					
Austroads AGPT/T271 : May 2018 : Determination of Set and Cure for Bituminous Slurry (Cohesion Test)				427				
Austroads AGPT/T272 : May 2018 - Determination of Abrasion Loss of Bituminous Slurry (Wet Track Abrasion Test)				427				
Austroads AGPT/T274 : January 2016 - Characterisation of Flexural Stiffness and Fatigue Performance of Bituminous Mixes				418				
Austroads AGPT/T530: May 2015 - Calibration of Bitumen Sprayers – General Introduction and List of Methods Austroads AGPT/T531: November 2012 - Volumetric Calibration of Bitumen Pumps Austroads AGPT/T532: November 2012 - Transverse Distribution by Fixed Pit Facility Austroads AGPT/T533: November 2012 - Transverse Distribution by Field Mat Austroads AGPT/T534: May 2015 - Transverse Distribution by Portable Trough Austroads AGPT/T535: November 2012 - Road Speed Calibration Austroads AGPT/T536: November 2012 - Viscosity of Test Fluid Austroads AGPT/T537: June 2005 - Field Calibration of Aggregate Spreaders				408				

175.10 OTHER STANDARDS AND TEST METHODS

Table 175.101 lists standards and test methods, other than VicRoads, Australian Standards or Austroads, published by other authorities or agencies and which are applicable to the Standard Specification Section contained in the Specification. These include ASTM, BS and RTA Test Methods.

Table 175.101 Other Standards and Test Methods

Document	Standard Specification Section							
American Public Health Association (APHA), American Water Works Association (AWWA) and Water Environment Federation (WEF) : Standard Methods for the Examination of Water and Wastewater, Edition 23 : November 2017 - Part 2510 - Conductivity			306 307					811 812 815 818 820
AS/CA S009 : - Installation requirements for customer cabling (Wiring Rules)							733 751	
Australian Technical Infrastructure Committee (ATIC) ATIC-SP39 : September 2009 - Fasteners for Structural Purposes							765	
Australian Technical Infrastructure Committee (ATIC) ATIC-SP43 : November 2017 - Cementitious Materials for Use with Concrete						610		
Australian Paint Approval Scheme Specifications APAS 0041/2 : October 2015 - Road marking paint, solvent borne APAS 0041/5 : October 2015 - Road marking paint, water borne APAS 0042 : June 2014 - Glass beads for use in pavement marking paints APAS 2908 : November 2003 - Inorganic zinc coating for protection of steel APAS 2911/1 : September 2017 - Polyurethane coating for protection of steel, standard durability APAS 2916/1 : June 2007 - Organic zinc rich coating for protection of steel – primers APAS 2930 : December 2003 - Single pack moisture cure urethane coating for the long term protection of steel APAS 2971 : December 2003 - Epoxy two-pack durable primer for protection of steel in atmosphere APAS 2973 : December 2003 - Medium build two-pack epoxy coating for the long term protection of steel in atmosphere						631	721	
American Concrete Institute (ACI) ACI 440.3R-12 - Test Method B.6 - Accelerated test method for alkali resistance of FRP bars ACI 440.3R-12 - Test Method B.8 - Test method for creep rupture of FRP bars ACI 440.6M-08(17) - Specification for Carbon and Glass Fiber- Reinforced Polymer Bar Materials for Concrete Reinforcement							683	
ASTM A802-95(2015) - Standard Practice for Steel Castings, Surface Acceptance Standards, Visual Examination							675	
ASTM A820/A820M-16 - Standard Specification for Steel Fibers for Fiber-Reinforced Concrete							684	705
ASTM A1059/A1059M-08 (2013) - Standard Specification for Zinc Alloy Thermo-Diffusion Coatings (TDC) on Steel Fasteners, Hardware, and Other Products							683	
ASTM B265-15 - Standard Specification for Titanium and Titanium Alloy Strip, Sheet, and Plate							681	
ASTM C295/C295M-12 - Standard Guide for Petrographic Examination of Aggregates for Concrete							610	
ASTM C603-14 - Standard Test Method for Extrusion Rate and Application Life of Elastomeric Sealants						503		

Table 175.101 Other Standards and Test Methods ... continued

Document	Standard Specification Section							
ASTM C679-15 - Standard Test Method for Tack-Free Time of Elastomeric Sealants					503			
ASTM C793-05(2017) - Standard Test Method for Effects of Laboratory Accelerated Weathering on Elastomeric Joint Sealants					503			
ASTM C794-18 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants					503			
ASTM C940-16 - Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory						683		
ASTM C1116/C1116M-10a(2015) - Standard Specification for Fiber-Reinforced Concrete							705	
ASTM C1399/C1399M-10(2015) - Standard Test Method for Obtaining Average Residual-Strength of Fiber- Reinforced Concrete							705	
ASTM C1609/C1609M-12 - Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading)							705	
ASTM D5/D5M-13 - Standard Test Method for Penetration of Bituminous Materials								853
ASTM D36/D36M-14e1 - Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)								853
ASTM D92-16b - Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester								853
ASTM D146 / D146M-04(2012)e1 - Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing						691		
ASTM D412-16 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension					520			
ASTM D792-13 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement – (Method A)					503 520		705	
ASTM D2171/D2171M-10 - Standard Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer								853
ASTM D2240-15e1 - Standard Test Method for Rubber Property – Durometer Hardness					503 520			
ASTM D2628-91(2016) - Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements					503 520			
ASTM D2669-16 - Test Method for Apparent Viscosity of Petroleum Waxes Compounded with Additives (Hot Melts)								853
ASTM D2835-89(2017) - Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements					503 521			
ASTM D3822/D3822M-14 - Standard Test Method for Tensile Properties of Single Textile Fibers							705	
ASTM D4262-05(2012) - Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces						686		
ASTM D4263-83(2012) - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method						685 686 691		
ASTM D4414-95(2013) - Standard Practice for Measurement of Wet Film Thickness by Notch Gages						685 686 691		

Table 175.101 Other Standards and Test Methods ... continued

Document	Standard Specification Section						
ASTM D5329-16 - Standard Test Methods for Sealants and Fillers, Hot-Applied, For Joints and Cracks in Asphalt Pavements and Portland Cement Concrete Pavements							853
ASTM D7205/D7205M-06 (2016) - Standard Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars					683		
ASTM D7337/D7337M-12 - Standard Test Method for Tensile Creep Rupture of Fiber Reinforced Polymer Matrix Composite Bars					683		
BD 47/99 – Design Manual for Roads and Bridges, Volume 2 Section 3 Part 4 - Waterproofing and Surfacing of Concrete Bridge Decks					691		
BS EN 1109 : 2013 - Flexible Sheets For Waterproofing - Bitumen Sheets For Roof Waterproofing - Determination Of Flexibility At Low Temperature BS EN 1110 : 2010 - Flexible Sheets For Waterproofing - Bitumen sheets for roof waterproofing. Determination of flow resistance at elevated temperature. BS EN 12310-1 : 2000 - Flexible Sheets For Waterproofing - Determination Of Resistance To Tearing (Nail Shank) - Bitumen Sheets For Roof Waterproofing BS EN 12311-1 : 2000 - Flexible sheets for waterproofing. Determination of tensile properties. Bitumen sheets for roof waterproofing					691		
BS 1881-208: 1996 - Testing concrete. Recommendations for the determination of the initial surface absorption of concrete					686		
BS EN 1881: 2006 - Products and systems for the protection and repair of concrete structures. Test methods. Testing of anchoring products by the pull-out method.					686		
BS 6319 (series) - Testing of resin and polymer/cement compositions for use in construction. Part 1 : 1983 - Method for preparation of test specimens Part 2 : 1983 – Method for measurement of compressive strength Part 3 : 1990 – Methods for measurement of modulus of elasticity in flexural and flexural strength Part 7 : 1985 – Method for measurement of tensile strength					687 688 689		
BS 6744: 2016 - Stainless steel bars for the reinforcement of and use in concrete. Requirements and test methods					611		
BS 8006 (series) Part 1 : 2010+A1:2016 - Code Of Practice For Strengthened/Reinforced Soils And Other Fills Part 2 : 2011+A1:2017 - Code of practice for strengthened/reinforced soils. Soil nail design					683		
BS EN 1097-8 : 2009 - Tests for mechanical and physical properties of aggregate. Determination of the polished stone value				430			
BS EN 10088 (series) - Stainless steels Part 1 : 2014 – List of stainless steels Part 2 : 2014 – Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes Part 3 : 2014 – Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes Part 4 : 2009 – Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for construction purposes Part 5 : 2009 – Technical delivery conditions for bars, rods, wire, sections and bright products of corrosion resisting steels for construction purposes					611		

Table 175.101 Other Standards and Test Methods ... continued

Document	Standard Specification Section						
BS EN 14490:2010 - Execution of special geotechnical works. Soil nailing						683	
CSA-S806-12 Annex H - Test methods for creep of FRP Rods Annex M - Test method of alkali resistance of FRP rods						683	
FHWA-NHI-14-007 : 2015 - Geotechnical Engineering Circular No. 7 - Soil Nail Walls						683	
AS/NZS ISO/IEC 17020:2013 – Conformity assessment – Requirements for the operation of various types of bodies performing inspection	160					630	
AS ISO/IEC 17025: 2018 - General requirements for the competence of testing and calibration laboratories ISO 9223:2012 – Corrosion of metals and alloys – Corrosivity of atmospheres – Classification, determination and estimation	160 161 162 163 170					682	765
ISO 6789 (series) - Assembly tools for screws and nuts - Hand torque tools Part 1 - Requirements and methods for design conformance testing and quality conformance testing: minimum requirements for declaration of conformance Part 2 - Requirements for calibration and determination of measurement uncertainty						660	
ISO 3549:1995 - Zinc dust pigments for paints – Specifications and Test Methods ISO 8501(series) - Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness. Part 1 : 2007 - Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings. Part 3 : 2006 - Preparation grades of welds, edges and other areas with surface imperfections. ISO 11127-6 : 2011 - Preparation of steel substrates before application of paints and related products – Test methods for non-metallic blast cleaning abrasives - Determination of water-soluble contaminations by conductivity measurements.						631	
ISO 10319:2015 - Geosynthetics - Wide-width tensile test ISO 10321:2008 - Geosynthetics - Tensile test for joints/seams by wide-width strip method ISO 13431:1999 : Geotextiles and geotextile-related products - Determination of tensile creep and creep rupture behaviour						683	
SAE International AMSS8802D (December 2015) - Sealing Compound, Fuel Resistant, Integral Fuel Tanks and Fuel Cell Cavities					520		
Manufacturers Standardisation Society of the Valve and Fittings Industry ANSI/MSS SP-55-2011: Quality Standard for Steel Castings for Valves, Flanges and Fittings and other Piping Components, Visual Method for Evaluation of Surface Irregularities -						675	
NACE WJ-2:2012/ SSPC-SP WJ 2:2012 – Waterjet Cleaning of Metals – Very Thorough Cleaning						691	

Table 175.101 Other Standards and Test Methods ... continued

Document	Standard Specification Section							
RMS-NSW T534 : November 2012 - Residue on sieving of bituminous material and bitumen emulsion					520			
RMS-NSW T865 : November 2012 - Non-volatile content of concrete admixtures and curing compounds					520			
RMS-NSW T1005 : November 2012 - Recording the infrared spectrum of materials					520			
RMS-NSW T1192 : November 2012 - Adhesion of sealant					503 520			
RMS-NSW T1193 : November 2012 - Accelerated ageing of cured sealant					503			
WTIA TN05(1994) - Flame cutting of steels						630 670		

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175.11 VICROADS TECHNICAL BULLETINS

Table 175.111 lists the VicRoads Technical Bulletins either referenced in the Standard Sections or if not referenced, documents that may be used to obtain additional information.

Table 175.111 – VicRoads Technical Bulletins

VicRoads Technical Bulletin	Standard Specification Section							
VicRoads TB 38 : April 2001 - Guide to Geotextile Reinforced Sprayed Seal Surfacing				408				
VicRoads TB 40 : December 1995 - Pavement Investigation – Guide to Inspection and Testing	160							
VicRoads TB 42 : June 2000 - Curing of Concrete						610	703	
VicRoads TB 45 : April 2004 - Bituminous Sprayed Surfacing Manual				408				
VicRoads TB 46 : November 2003 - Guide to Surveillance of Structural Steelwork	160					611 630 670 671	708	
VicRoads TB 47 : November 2003 - Guide to Surveillance of Precast Concrete	160					620	704	
VicRoads TB 48 : November 2003 - Guide to Surveillance of Protective Coatings of Structural Steelwork	160					630		

175.12 AUSTROADS GUIDES AND SPECIFICATION FRAMEWORK DOCUMENTS

Table 175.121 lists all Austroads Guides and Specification Framework Documents applicable to the Standard Section contained in this Specification and other relevant Austroads Guides for further information.

Table 175.121 Austroads Guides and Specification Framework Documents

Austroads Document	Standard Specification Section							
AGPT04B-14 - Guide to Pavement Technology Part 4B : Asphalt				410				
AGPT/T190-14 - Specification Framework for Polymer Modified Binders				407				
				408				
				410				
				417				
AP-R569-18 – Guidelines and Specifications for Microsurfacing				427				
AP-T68-06 - Update of Austroads Spray Seal Design Method				408				
AP-T236-13 : Update of Double/Double Design for Austroads Sprayed Seal Design Methods				408				
AGRS 06-09 - Guide to Road Safety – Part 6: Road Safety Audit	160							

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175.13 OTHER REFERENCE DOCUMENTS

Table 175.131 lists all other documents applicable to the Standard Specification Section contained in this Specification or required for further information.

Table 175.131 Other Reference Documents

Document	Standard Specification Section						
AASHTO MASH 2:2016 - Manual for Assessing Safety Hardware						711	
AASHTO LRFDLTS 1:2015 - Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals						760	
ABS Catalogue No. 6427.0 - Producer Price Indexes, Table 17, Output of the Construction industries, subdivision and class index numbers - 3101 Road and Bridge Construction Victoria	199						
Standards Australia CCM Volume 1-2007 - Communications Cabling Manual Volume 1 - Handbooks, Codes and Regulations CCM Volume 2-2007 - Communications Cabling Manual Volume 2 - Standards						733 751	
Australian Seed Federation National Code of Practice: September 2013- Labelling and Marketing of Seed For Sowing						720	
Australian and New Zealand Environment and Conservation Council and New Zealand and the Australian and New Zealand Environment and Conservation Council (2000) - Australian and New Zealand Guidelines for Fresh and Marine Water Quality	177						
Country Fire Authority (CFA) - Roadside Fire Management Guidelines (2001)						752	
Department of Sustainability and Environment (June 2006) - Native Vegetation Revegetation planting standards – Guidelines for establishing native vegetation for net gain accounting.	177						
Department of Environment and Primary Industries (September 2013) - Permitted clearing of native vegetation - Biodiversity assessment guidelines	177						
Energy Safe Victoria (ESV) publications and safety alerts						751	
Energy Safe Victoria (ESV) The Blue Book 2017 - The Code of Practice on Electrical Safety for Work on or Near High Voltage Electrical Apparatus						751	
Engineers Australia (2006) - Australian Runoff Quality A guide to Water Sensitive Urban Design	176 177						
EPA Victoria Publication No. 275 - Construction Techniques for Sediment Pollution Control (May 1991)	176 177						
EPA Victoria Publication No. 347.1 - Bunding (October 2015)	176 177						
EPA Victoria Publication No. IWRG701 - Industrial Waste Resource Guidelines -Sampling and analysis of waters, wastewaters, soils and wastes (June 2009)	176 177						
EPA Publication 448 – Classifications of Wastes (May 2007). Replaced by IWRG621 - Soil hazard categorisation and management (2009)	176 177					720	
EPA Victoria Publication No. 464.2 - Guidelines for Environmental Management - Use of Reclaimed Water (November 2003)	176 177						
EPA Victoria Publication No. 480 - Environmental Guidelines for Major Construction Sites (February 1996)	176 177						

Table 175.131 Other Reference Documents ... continued

Document	Standard Specification Section							
EPA Victoria Publication No. 669 - Groundwater Sampling Guidelines (April 2000)	176 177							
EPA Victoria Publication No. 880 - Guideline for Environmental Management: Spraying Bituminous Materials (November 2002)	161							
EPA Victoria Publication No. 960 - Doing it Right on Subdivisions - Temporary environmental protection measures for subdivision construction sites (September 2004)	176 177							
Florabank Guidelines and Codes of Practice http://www.florabank.org.au/						720		
International Erosion Control Association (IECA Australasia) - Best Practice Erosion and Sediment Control (BPESC) document (2008)	176							
Melbourne Water (2005) - Water Sensitive Urban Design Engineering Procedures: Stormwater	176 177							
VicRoads Biodiversity Guidelines	176 177							
VicRoads Contaminated Land (Planning, Construction and Maintenance) Guidelines (September 2013)	176 177							
VicRoads Cultural Heritage Guidelines (2007)	176 177							
VicRoads Integrated Water Management Guidelines June 2013	176 177						812	
VicRoads ITS Group: Standard Drawings and Specifications VicRoads Road Design Guidelines Standard Drawings for Roadworks Final Drawing Presentation Guidelines (2013) VicRoads Supplement to Austroads Guide to Road Design (series)						751 708 711 720		
VicRoads Road Design Note 06-02D (September 2016) – The use of wire rope safety barriers (WRSB)						711		
VicRoads Road Design Note 06-04K (October 2017) – Accepted safety barrier products						708 711		
VicRoads Road Design Note 06-09A (January 2018) – Accepted frangible post systems						714		
VicRoads Road Design Note 06-10C (August 2015) – Accepted guide posts						709		
VicRoads Road Design Note 06-11A (August 2015) – Accepted retro-reflective sheeting materials							860	
VicRoads Road Management Plan (April 2014)						752		
VicRoads Roads Structures Inspection Manual (RSIM) (June 2014)						750		
VicRoads Roadside Handbook See Road Management Act and codes on VicRoads website						752		
VicRoads Safety Requirements for Traffic Devices Works on Traffic Signals and on Road Electrical and Communication Devices						751		
VicRoads Supplement to AS 1742.3:2009 – Manual of uniform traffic control devices (October 2015)	166					750		

Table 175.131 Other Reference Documents ... continued

Document	Standard Specification Section							
VicRoads Sustainability and Climate Change Policy (2015-2020)	176 177							
VicRoads Technical Guidelines - Noise Guidelines - Construction and Maintenance Works 2007	176 177							
VicRoads Temporary Sedimentation Basin Design Tool V1.05	176 177							
VicRoads Traffic Engineering Manual Volume 2 (April 2014)	160						708 709 711 714 721	
Victorian Stormwater Committee Urban Stormwater: Best Practice Environmental Management Guidelines (October 1999), published by CSIRO Publishing	177							
Water Services Association of Australia WSA 05-2013 Version 3.1 – Conduit Inspection Reporting Code of Australia							701	

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SECTION 180 - RIDE QUALITY FOR PAVEMENTS

~~##This section cross references Section 175, which should be included in the specification. If Section 175 is not included in the specification, all references to it should be struck out, ensuring that the remaining text is still coherent.~~

180.01 GENERAL

This section relates to ride quality performance for pavement construction.

~~The locations specified in Table 180.091 are exempt from lot testing under this Contract.~~

180.02 PERFORMANCE REQUIREMENTS

The finished surface of the pavement shall have a smooth longitudinal profile and comply with the minimum ride quality requirements specified. The upper limits for roughness at various locations are specified in Table 180.092.

180.03 DEFINITIONS

Continuous Traffic Lane - A length of traffic lane which can be tested in a single test run uninterrupted by areas exempted from ride quality assessment.

International Roughness Index (IRI_{qc}) - The international measure of ride quality measured and recorded by modern Class 1 profile measuring devices in cumulative metres per kilometre in each wheel path and averaged together. For the purposes of this specification, roughness measurement is to be based on the IRI_{qc} quarter car model.

Individual Lane Roughness Value - The mean value of the two wheel path IRI_{qc} values measured on a 100 m sub-section of a traffic lane.

Mean Lane Roughness Value - The mean of the Individual Lane Roughness Values within the lot as determined by the appropriate test method.

Measuring Device - The device used for measurement of roughness shall be:

- (a) capable of measuring the longitudinal road surface profile along one or both wheel paths at least every 250 mm with a precision in elevation of 0.5 mm over a wave band of 1 to 30 metres;
- (b) calibrated according to the relevant test methods.

180.04 MEASUREMENT AND REPORTING OF RIDE QUALITY

(a) Scope of Testing

Unless noted otherwise in Table 180.091, the surface of all pavement construction shall be tested for ride quality.

(b) Lot Testing

All work shall be tested in lots of continuous traffic lane. A lot shall be defined as the length and width of each continuous traffic lane constructed including any freeway ramps but excluding shoulders and turn lanes. The Contractor shall provide 24 hours notice to the Superintendent Council of when ride quality testing will be undertaken and the limits for each lot.

The maximum length of the lot shall be restricted to 2 km of continuous traffic lane.

The minimum length of the lot shall be the lesser of the total job length or 500 m.

(c) Measurement of Ride Quality

The Contractor shall measure the longitudinal road surface profile of each lot in accordance with the relevant Test Method applicable to the particular test equipment being used ~~as listed in Section 175.~~

Ride quality measurement shall be undertaken within three months after the application of the surfacing.

~~##(strike through if this paragraph not applicable): For contracts with a Defects Liability Period of two years or more, measurement of ride quality shall be repeated no earlier than three months or later than one month before the end of the Defects Liability Period.~~

(d) Reporting of Test Results

Results shall be processed and reported for each 100 m sub-section. Any sub-sections less than 100 m shall be included with the sub-section immediately preceding it and the individual roughness calculated over the longer sub-section. The Contractor shall provide the Superintendent Council with a copy of all test results representing the final roughness survey of completed pavement together with the calculated values of the individual and mean lane roughness for each lot.

180.05 PERFORMANCE STANDARDS

The Contractor shall comply with the requirements for both the Maximum Individual Lane Roughness and Maximum Mean Lane Roughness as follows:

(a) Individual Lane Roughness

Where an Individual Lane Roughness Value in any 100 m sub-section is greater than the specified Maximum Individual Lane Roughness Value specified in Table 180.092, the Contractor shall rectify work within the sub-section to comply with this requirement. The minimum length of rectification work undertaken shall be 100 m.

All rectified 100 m sub-sections shall be re-tested following completion of rectification work.

(b) Mean Lane Roughness

Where the Mean Lane Roughness Value of a lot is greater than the Mean Lane Roughness specified in Table 180.092, the work shall be rectified unless the Superintendent Council agrees to accept the work. ~~at a reduced payment. Where the lot is to be rectified, the minimum length for any rectification work undertaken shall be 100 m. Where the Superintendent agrees to accept the lot at a reduced payment, a deduction to the contract sum shall be made in accordance with Clause 180.06.~~

The Contractor shall re-test the lot following completion of any rectification work.

~~180.06 PAYMENT DEDUCTION PROVISIONS~~

~~Where a deduction in payment is to be made for failure to comply with the specified Maximum Mean Lane Roughness for a lot, the deduction shall be made in accordance with the following formula:~~

$$\text{Deduction to Contract (\$)} = \frac{A \times D \times C}{100}$$

~~Where: A = Area of lot in square metres.~~

~~———— D = Percentage deduction as specified in Table 180.061~~

~~———— C = Unit Cost as specified in Table 180.093~~

Table 180.061 – Percentage Deduction for Failure to Comply with the Specified Maximum Mean Lane Roughness Value

Increase in IRI	% Deduction
0.01 – 0.10	1
0.11 – 0.20	2
0.21 – 0.30	3
0.31 – 0.40	4
0.41 – 0.50	5
0.51 – 0.60	6
0.61 – 0.70	8
0.71 – 0.80	10
> 0.80	Rectify

180.07 – PAYMENT RETENTION

Where the Contractor is required to carry out measurement of ride quality within three months of the end of the Defects Liability Period, retention of payment shall apply.

The amount of retention shall be calculated using the following formula:

$$\text{Retention (\$)} = 0.03 (A_1 \times C_1 + A_2 \times C_2 + \dots) + E$$

where: A_1 = the total area of pavement with the same unit cost as shown in Table 180.093

C_1 = the appropriate unit cost from Table 180.093

E = an amount equal to the value of deductions calculated using Clause 180.06 and the test results at Practical Completion

180.08 – PAVEMENT RECTIFICATION

The Contractor shall bear the full cost of any necessary rectification work including the cost of any additional work required to the underlying or adjacent pavement to comply with this section. All rectification work shall be carried out in accordance with the requirements of the specification.

180.09 SCHEDULE OF DETAILS

(a) The locations shown in Table 180.091 are exempt from ride quality assessment.

Table 180.091 Locations Exempted from Ride Quality Requirement

Serial	Locations exempt from Ride Quality Assessment
##:	##include intersections, widenings etc. exempt from testing (refer to Guide Notes):

(b) The ride quality to be achieved at each location is to be in accordance with Table 180.092.

Table 180.092 Standard of Ride Quality

Location	Maximum Individual Lane Roughness Value for any 100 m Subsection	Maximum Mean Lane Roughness Value for Lot
##insert location:	##refer to Table A of Guide Notes:	##refer to Table A of Guide Notes:

(c) The unit cost (C) to be used for calculation of any payment deduction made in accordance with the deduction provision specified in Clause 180.06 shall be in accordance with Table 180.093.

Table 180.093 Basis of Payment Deduction

Location	Unit Cost \$ per sq m
##specify locations by pavement type:	##refer to Table B of Guide Notes:

SECTION 201 - SITE CLEARING

201.01 DESCRIPTION

This section covers the requirements for site clearing and grubbing and for the management of the materials generated.

201.02 DEFINITION

Clearing and Grubbing

Clearing and grubbing is the removal within specified limits of:

- (a) vegetation such as trees, tree stumps, tree roots, logs, brush, noxious weeds and decayed vegetable matter
- (b) refuse such as pole stumps, rubbish dumps and sawdust piles resting on or protruding from the ground surface
- (c) obstructions such as concrete paving, concrete edgings, drainage pits, foundations, fences and disused structures, but not underground obstructions such as drainage pipes, service conduits and fuel tanks.

201.03 LIMITS OF WORK

Unless otherwise specified, the limits of clearing and grubbing shall be as per the scope of works shown on Drawings and to the satisfaction of Council:

~~(a) the whole length between the following chainages:~~

~~*** ###(restrict this entry to one typed line)-~~

~~(b) the whole width between the outside edges of any batters, including any roundings, together with a further horizontal distance of 1 m beyond the outside edges of batters but not beyond the road reserve boundary or, where catch drains are required, to the outside edges of catch drains~~

~~(c) not more than the width required for completion of the work under the Contract.~~

201.04 CLEARING

Unless otherwise specified, the area within the specified limits shall be cleared of all vegetation, refuse and obstructions down to natural surface. The Contractor shall not undertake any clearing work or any type of disturbance outside of the specified limits of work unless approved by ~~the Superintendent~~ Council.

Trees shall be brought down in such manner as to avoid danger to personnel and traffic or damage to other trees, shrubs, structures or property outside the area being cleared or designated to be retained within the area being cleared.

~~Where the road passes through Crown Land or State Forest, royalties are payable by the Contractor to the Department of Environment, Land, Water and Planning (DELWP) for all timber which in the opinion of the DELWP is suitable for milling or for other commercial use.~~

Tree branches extending over the carriageway shall be trimmed to provide a clearance of at least 6 m above the carriageway surface to the satisfaction of Council. Where whole branches are to be removed, the Contractor shall use the three cut method which requires:

- (a) the under cut
- (b) the upper cut (further away from the trunk than (a) above) to remove the branch
- (c) the final trim cut which is to be cut close to the main trunk but outside the branch collar.

201.05 GRUBBING

In areas where excavation will be made, all vegetation, refuse and obstructions shall be totally grubbed or grubbed to a depth of not less than 0.3 m below the subgrade and batters, whichever is the lesser treatment.

In areas to be covered by embankments ~~fill~~, all vegetation, refuse and obstructions shall be grubbed to a depth of not less than 0.3 m below the stripped surface or not less than 0.6 m below the finished surface of the subgrade, whichever is the lesser treatment. ~~In areas to be covered by embankments exceeding 1 m in height, foundations may remain if located or cut off not more than 0.4 m above the natural surface but not less than 1 m below subgrade.~~

~~Pits which are no longer required shall be completely removed. or broken back to a depth not less than 0.3 m below the finished surface of the subgrade. Remaining pipe openings shall be sealed with concrete. Any remnants of pits shall be backfilled with material and compacted to a density ratio of not less than 95%. The calculation of density ratio shall be based on Standard compactive effort.~~

Holes resulting from grubbing shall be backfilled with material similar to the surrounding material and compacted to the same degree as the surrounding material.

201.06 CLEARING AND GRUBBING AT BRIDGE AND CULVERT SITES

Unless otherwise shown on the drawings, trees and stumps within 10 m of any portion of a proposed bridge, or proposed culvert having a waterway area greater than 6 m², shall be cleared and grubbed.

Clearing and grubbing at bridge and culvert sites shall conform to the other relevant requirements of this section.

201.07 DISPOSAL OF MATERIALS**(a) General**

Unless otherwise specified any salvageable materials shall become the property of the Contractor. Works under the Contract shall be carried out to wherever possible re-use materials generated from clearing and grubbing operations within the works area. Any materials which cannot be re-used on site shall be removed from the site.

~~Disposal of material by burning on site or burying of materials on site shall only be carried out when permitted by the relevant authorities and approved by the Superintendent.~~

(b) Trees

Tree trunks and large branches shall be removed from the site.

Small tree branches, shrubs and leaves, excluding noxious weeds, shall be disposed of by chipping and mulching to form mulch.

(c) Concrete, Bituminous and other Recyclable Materials

The Contractor shall dispose of salvaged concrete, bituminous materials of size greater than 50 mm and other recyclable materials at approved recycling establishments.

201.08 SURVEY MARKS

During clearing and grubbing operations, care shall be taken not to disturb any survey marks.

201.09 DAMAGE TO FENCES

Any damage to fences shall be repaired immediately by the Contractor to a condition at least equal to that existing before damage and no additional payment will be made for this work.

201.10 PROTECTION AND REMOVAL OF EXISTING VEGETATION**(a) Protection of Existing Vegetation**

Prior to commencement of any work, the Contractor and the Superintendent Council shall conduct a joint inspection of the site to identify vegetation to be retained and protected.

HP Existing trees, shrubs, native grasses and groundcovers and other areas of existing vegetation marked as 'to be protected and/or retained' on the Drawings or as directed by the Superintendent Council shall be protected by temporary fencing and incorporated into the works by the Contractor prior to the works.

No earthworks, travel of equipment or storage compounds shall be established within 5 metres of the drip line of mature trees of trunk diameter greater than 200 mm.

Construction of table drains within the drip line of roadside trees shall be undertaken with no disturbance beyond the line of the table drain and no damage to the canopy of the trees.

(b) Protective Fencing

Protective fencing shall consist of, as a minimum, star pickets with three strands of wire (top, middle and bottom) and parawebbing.

(c) Removal of Native Trees

HP Existing native trees 'to be removed' on the Drawings shall be inspected by Council prior to removal.

201.11 SALVAGE OF VEGETATION

The Contractor shall co-operate with Council-VicRoads and its agents by co-ordinating works under the Contract with activities involving the salvage of plants and the collection of cuttings and available seed from areas of native vegetation on the site.

SECTION 204 - EARTHWORKS

~~##This section cross references Sections 173, 175, 205, 210, 290, 304, 702 and 720.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

204.01 DESCRIPTION

This section covers the requirements for forming and grading of earthworks for roadworks and allotments including excavation, placement and compaction of topsoil, Type A, Type B, Type C, permeable, oversize and unsuitable materials, disposal of surplus materials, the trimming of batters, surface drains and formation, and the preparation of the final earthwork surfaces and subgrade.

Rock fills shall be constructed in accordance with Section 205.

Geotextiles in earthworks shall be in accordance with Section 210.

Lime stabilisation of earthworks shall be in accordance with Section 290.

Section 175 details the relevant references to Australian Standards (AS), Test Methods and Codes of Practice referenced in this section.

204.02 DEFINITIONS

Allotments

All areas outside the future road reserve and includes future residential lots, reserves and other areas.

Batter

The uniform side slope of a cut or a fill.

Batter Point

The intersection of the batter with the natural surface disregarding any batter rounding.

Boxing

The space above the subgrade to be occupied by the pavement bounded by the subgrade level and the inside faces of the constructed verges, or unsealed shoulders.

Capping

A Type A material layer of low permeability placed immediately below the pavement subbase or selected material to minimise changes in moisture content in the material below the capping layer. Where a capping layer is provided, the top of this layer will typically be subgrade level.

Catch Drain

An open cut surface drain above a cut batter or below a fill batter to intercept and divert surface water to drainage outlets.

CBR

California Bearing Ratio.

Cut

Excavation below the natural surface level after removal of topsoil.

Cut Floor Level

The theoretical level of the formation in a cut after completion of excavation to the underside of ~~any capping or selected material. Where no capping or selected material is required, the cut floor level is subgrade level and the underside of pavement or fill layer or final topsoil layer.~~

Within the Boxing the Cut Floor Level and Subgrade are the same.

Fill

The compacted embankment placed above natural surface level after removal of topsoil.

Fill Material

Fill material includes:

- **Type A material** – a superior quality material complying with the requirements of Table 204.041 and used principally as capping, selected material, structural material and/or verge material.
- **Type B material** – a medium quality material that does not meet the requirements of Type A material, and is usually specified with a minimum CBR value.
- **Type C material** – a lesser quality material that does not meet the requirements of Type A or Type B material, which may be used in Type C material zones of embankments as indicated on the drawings.
- **Rock Fill material** – a material comprised of larger rock and rock fragments which may be used within Type B and Type C material zones at lower levels of high embankments in accordance with Section 205.
- **Permeable Fill material** – self draining material, typically sand or aggregate.

Formation

The horizontal and vertical extent of the surface of the formed earthworks. The completed formation includes ~~capping~~, selected material, verges, batters, batter roundings and table drains.

Pavement

Pavement shall consist of subbase, base and surfacing courses.

Recycled Material

Various products derived from resource recovery of: construction and demolition waste from building waste; reclaimed asphalt pavement (RAP) from maintenance and rehabilitation activities; and reclaimed glass from the glass disposal industry blended to produce Type A, Type B, and Type C products.

Rock Subgrade

The surface prepared at or below subgrade level by trimming the otherwise undisturbed in situ floor for the full width of the cutting in consistent, medium to high or higher strength rock, as defined in Table A8 of AS 1726 (1993) – Geotechnical Site Investigations, and which is free of soil and loose material.

Areas shall not be considered as a rock subgrade where they do not extend the full width of subgrade and for a continuous length of at least 200 m of a carriageway.

Selected Material

A Type A material layer placed immediately below pavement subbase to provide greater strength to support the pavement.

Silt

A material with properties below the 'A line' on the Plasticity Index (PI) / Liquid Limit (LL) graph per Table A1 in AS 1726 (1993).

Structural Material

A zone of Type A material that is placed at a bridge or a culvert structure or in other areas as specified and/or as shown on the drawings.

Subgrade

Subgrade is the trimmed or prepared portion of the formation on which the pavement (including shoulders) and any paved area (examples including footpath, parking bays and vehicle crossings) is constructed.

Subgrade Level

The level of the prepared subgrade defined as follows:

- **On Fills** – subgrade level is the level of the top of capping and/or selected material or where no capping or selected material is to be placed, the top of Type B material.
- **In Cuts** – subgrade level is the level of the top of capping or selected material or where no capping or selected material is to be placed, the cut floor level and the underside of pavement.

Surface Drain

An open drain to collect and drain surface water to drainage outlets.

Surplus Material

Material which is surplus to the total quantity of material required.

Table Drain

A surface drain adjacent to the shoulder or verge with an invert level designed to be lower than the top of the Type B material or the Cut Floor Level wherever possible.

Topsoil

The layer of fertile, organic soil immediately below natural surface or placed to the finished formation level outside areas to be paved.

Unsuitable Material

Material that is soft, excessively wet, unstable or otherwise not suitable for the specified use.

Verge

The portion of the formation between the outer edge of the shoulder and the start of the batter slope, or as detailed on the drawings.

204.03 CONFORMITY WITH DRAWINGS

Earthworks shall be finished to conform to the levels, lines, grades and cross sections specified or shown on the drawings within the following limits:

(a) Formation Width and Alignment

The widths measured either side of the specified centreline or design line to the tops and toes of cut batters and fill batters shall be not less than the widths specified or shown on the drawings.

(b) Formation Level and Shape (outside subgrade width, excluding batters)

Verges shall be constructed such that they match the finished surface level at the outer edge of shoulder or pavement, or where installed the level of kerb and channel or concrete edgings.

Both prior to and after completion of placement of topsoil, the level at any point on the surface outside those areas to be paved shall not differ by more than 50 mm from the specified level and the surface shall be free from depressions capable of retaining water. No point on these surfaces shall lie more than 25 mm below a 3 m straightedge laid on the surface.

(c) Boxing Width and Alignment

The boxing width shall not be less than specified or shown on the drawings and the edges of boxing shall not deviate by more than 50 mm from the designed offset from the centreline or design line.

(d) Type A Material

The thickness, width and shape of placed Type A material shall not be less than the specified thickness, width and shape at any point.

(e) Type B Material immediately below Capping and/or Selected Material

Where capping and/or selected material is to be placed on Type B material to subgrade level, the level at any point on the surface of Type B material immediately below capping and/or selected material shall not differ by more than 15 mm above or 30 mm below the specified level, unless assessment by random levelling is specified in which case the surface shall comply with Clause 204.03(h) and Table 204.161.

(f) Cut Floor Level

Where capping and/or selected material is to be placed above the Cut Floor Level to subgrade level, the level at any point on the surface of the Cut Floor Level immediately below capping and/or selected material shall not differ by more than 15 mm above or 30 mm below the specified level, unless assessment by random levelling is specified in which case the surface shall comply with Clause 204.03(h) and Table 204.161.

Where capping and/or selected material is not required, the Cut Floor Level shall be prepared to the appropriate tolerance for the subgrade.

(g) Subgrade Level and Shape

The subgrade shall be constructed to the surface level requirements of Scale B unless approved otherwise by Council, in which case Scale A will apply either Scale A, Scale B or Scale C as nominated in Clause 204.16.

Where Scale A or Scale B is approved by Council, nominated, the surface shall be assessed by random levelling and shall comply with the requirements of Clause 204.03(h). Where Scale C is nominated, random levelling is not required; however no point on the subgrade surface shall be more than 10 mm above or 30 mm below the specified level.

For either Scale A, or B or C level tolerances, the level at any point on the subgrade shall not lie more than 20 mm below a 3 m straightedge laid in any direction, except across a crown and water shall not pond at any point. Where the scale of testing has not been specified, Scale A of Clause 204.03(h) shall apply.

(h) Random Level Assessment - Scale A and B Surface Level Requirements

Level measurements shall be taken at random locations over the area of the lot in accordance with Section 173 – Examination and Testing of Materials and Work (Roadworks). The number of measurements taken within each lot shall not be less than the number specified in Table 204.031. Random level assessments of the surface shall be undertaken in lots not exceeding 4000 m².

The mean and standard deviation of the departures from the theoretical surface level within each lot shall meet the requirements of Table 204.031.

Table 204.031 Minimum Number of Level Measurements and Tolerances

Scale of Surface Level Measurement	Minimum Number of Measurements per Lot	Tolerance	
		\bar{x} Range (mm)	Maximum S (mm)
Scale A	80	+5 to -15	12
Scale B	40	+5 to -25	15
Notes: 1. \bar{x} is the mean value of all level readings taken in the lot 2. S is the standard deviation of all level readings taken in the lot 3. A negative value designates a measured departure below the design level and positive value designates a surface level above the design level			

(i) Batter Slope and Shape

At any cross section the batter slope shall be not steeper than the slope specified. The batter face shall be finished to uniform shape.

(j) Batter Line

Cut batters shall be constructed so that the batter point is not more than 10% of the batter height outside the calculated batter line.

Fill batters shall be constructed so that the toe of the batter is not more than 10% of the batter height outside the calculated batter line.

The dimensions of batter rounding shall be within 10% of the dimensions shown on the drawings.

On all sections beneath bridges, and on other sections where it becomes necessary to confine the lateral spread of the earthworks to closer limits due to site constraints, the tops of cut batters and the toes of fill batters shall be not more than 300 mm outside the calculated batter lines.

(k) Surface Drains

Surface drain invert levels and side slopes shall be finished to within 50 mm of the specified level at any point and shall be free from depressions capable of retaining water.

204.04 MATERIALS

Testing of materials shall be undertaken in accordance with VicRoads Code of Practice 500.16.

Materials shall meet the requirements described below:

(a) Topsoil

Topsoil placed on formations and disturbed areas shall be capable of supporting healthy, full cover of grass growth, be friable, contain organic material and unless further defined in Section 740.20, shall be free from subsoil, tree roots, clay balls, stones, rocks, rubbish, contaminants, weeds, pathogens and toxic levels of any element with a pH in the range of 5 to 8.

(b) Type A Material

Type A material shall comply with the requirements of Table 204.041 and shall be free of topsoil, deleterious and/or perishable matter.

HP **Material classified as silt, either before or after compaction, is not acceptable as Type A material without stabilisation to the satisfaction of the Superintendent Council.**

*** **Table 204.041**

Location and Use of Type A Material	Physical Properties			Limits of Grading (% passing by mass) Post Compaction Sieve Size AS (mm)					PI x % passing 0.425 mm Post Compaction (max)	PI Range Post Compaction
	Assigned CBR (min) % (1)	Swell % (1)	Permeability (max) m/s (2)	75.0	37.5	4.75	0.425	0.075		
Capping Layer	##:615	≤ 1.5	5 x 10 ⁻⁹	##:100	##:90-100	##:440-80	##:30-66	##:106-2540	##:1000	##:6-256 - 20
Selected Material	##:6	≤ 1.5	Not Applicable	##:100	##:-	##:40-80	##:-	##:10-40	##:1000	##:6-25
Verge Material	##:6	≤ 1.0	5 x 10 ⁻⁸	##:100	##:-	##:40-80	##:-	##:10-40	##:1000	##:6-25
Structural Material	##:6	≤ 1.5	Not Applicable	##:100	##:-	##:40-80	##:-	##:10-40	##:1000	##:6-25
Other Type A Material	##:610	≤ 1.5	Not Applicable 5 x 10 ⁻⁹	##:100	##:-	##:40-80	##:-	##:108-40	##:101600	##:6-256 - 20
##:										

Notes: (1) The Assigned CBR and percentage swell values are to be determined in accordance with VicRoads Code of Practice RC 500.20. Sampling for CBR testing shall be undertaken after field compaction.

(2) The permeability value is to be determined in accordance with VicRoads Code of Practice RC 500.16. The permeability value is to be determined on specimens manufactured from that fraction of material which passes a 19.0 mm AS sieve, compacted at optimum moisture content and 98% of maximum dry density as determined by testing using standard compactive effort for CBR and swell.

(3) The Assigned CBR for the Capping Layer is 15 minimum unless shown otherwise on the Drawings.

(c) Type B Material

Type B material shall be totally free of organic content, topsoil, deleterious and/or perishable matter such as bricks, concrete, glass, plastic, timber, steel or steel by-products. After compaction Type B material shall have a maximum particle dimension of not more than:

- (i) 150 mm within 400 mm of the top of Type B material; and
- (ii) 400 mm at depths greater than 400 mm below the top of Type B material.

Type B material shall have a minimum Assigned CBR of the subgrade as shown on the drawings###:2%, and Assigned Percent Swell less than 2.5% which has been determined in accordance with VicRoads Code of Practice RC 500.20.

Materials that exhibit swells greater than or equal to 2.5% shall be classified as expansive and shall only be used as Type B material if approved by ~~the Superintendent~~ Council.

Where the highest quality Type B materials are available they shall be reserved for placement in higher levels of the fills being constructed. Material within the top 400 mm of top of Type B material shall have a swell less than 2.5%.

Materials that exhibit swells of 5% or greater are not permitted.

Sampling for CBR testing shall be undertaken after field compaction.

Material classified as expansive or silt, either before or after compaction, shall not be used as Type B material.

(d) Type C Material

Type C material shall be capable of being spread in layers of not more than 500 mm and compacted as specified to achieve a stable condition.

(e) Recycled Materials

Blends of crushed recycled materials such as crushed concrete, crushed brick, reclaimed asphalt pavement (RAP), slag and crushed glass may be used as Type A, B and C materials in earthworks applications.

Any blend of recycled materials proposed for use shall be registered with ~~on~~ VicRoads. ~~contracts shall be registered.~~

The blend of recycled materials shall only be obtained from a VicRoads accredited source and manufactured in a controlled manner which ensures the blended product has consistent physical properties.

The registered blend of recycled materials shall meet all relevant requirements and properties as listed in Clause 204.04.

Low density foreign materials such as plastic, rubber, plaster, clay lumps and other friable material shall not exceed 3% by mass. Wood and other vegetable or decomposable matter shall be limited to a maximum of 0.5% by mass and assessed using test method RC 372.04 'Foreign Materials in Crushed Concrete Products' shown in Section 175.

Crushed glass used in any recycled material blends shall be crushed to a cubic shape and able to pass the 4.75 mm AS sieve.

Any blend of recycled materials shall be able to be classified as 'clean fill' in accordance with Environment Protection Authority, Victoria guidelines.

(f) Permeable Fill Material

Permeable fill material shall be a mixture of hard, durable, clean sand, gravel or crushed aggregate complying with the requirements shown on the drawings of Table 204.042, which is free of clay balls and perishable matter.

Table 204.042 Permeable Fill Material

Location	Type of Permeable Fill Material
##: Against Structures	##: Grade A4, A5 or A6 ⁽⁴⁾
##: Backfill for Open Jointed Pipes	##: Grade A4, A5 or A6 ⁽⁴⁾
##: Drainage Blanket Material	##: Grade A6, B4 ⁽⁴⁾

Note: ~~(1) Grading requirements are specified in Section 702.~~

(g) Oversize Material

Oversize material shall have a maximum particle dimension after compaction not greater than that specified for the type of material and depth of layer being placed.

204.05 STRIPPING OF TOPSOIL

Topsoil shall be stripped for the full area of cut and fill, ~~width of the formation:~~

- ~~(a) defined by the line through batter points extended to include any rounding and any surface and catch drains;~~
- ~~(b) by a means which avoids contamination with subsoil and does not increase the extent of unstable areas; and~~
- ~~(c) placed in stockpile or prepared areas.~~

Unless there is an excess of topsoil to be removed from site, topsoil shall not be removed from the site.

The Contractor shall treat and manage site topsoil before stripping, and after spreading, to remove and/or minimise the spread of weeds and other pathogens and pest organisms throughout the site.

Stockpiles shall be maintained in a neat, well shaped state capable of shedding water. Topsoil shall be re-spread as soon as practicable.

Stripped surfaces shall be graded to an even self-draining surface.

204.06 SITE EXCAVATION

(a) General

Site excavation shall be excavation within the limits of the batters, open and underground drainage and approved borrow areas from within the Site, and shall include the handling of excavated material to the point of disposal.

(b) Catch Drains and Batter Rounding

The Contractor shall construct catch drains where shown on the drawings or where required for the temporary collection and diversion of surface runoff or as otherwise agreed to by ~~the Superintendent~~ Council.

Permanent catch drains and batter rounding at the top of cut batters shall be constructed at the commencement of the cutting excavation.

(c) Material Category

HP Prior to commencing excavation in any area and during excavation work, ~~the Superintendent Council and the Contractor shall inspect each type of material encountered and subject to verification by appropriate laboratory testing, agree on the category of the material in accordance with Clause 204.04.~~

(d) Excavation Operations

The Contractor shall conduct its operations such that the area outside the limits of the excavation is not unduly disturbed. Any falls or slips of material that occur shall be removed and the area treated to prevent recurrence.

If any area on cut batters becomes unstable or unsafe, the Contractor shall install suitable measures to restrict access to the area, e.g. the erection of warning signs and fencing. The affected area shall be inspected and assessed by a geotechnical engineer, and made safe prior to excavation proceeding in the affected area.

Oversize material shall be treated in accordance with Clause 204.08.

(e) Treatment of Cuttings at Cut Floor Level

The material within 400 mm below ~~Subgrade Cut Floor Level~~ shall have an Assigned CBR of not less than ~~the Design CBR for the pavement, that specified for Type B material and shall have a swell less than 2.5%.~~

(i) ~~In situ material below Cut Floor Level having an Assigned CBR less than that specified for Type B material, or a swell of 2.5 % or greater, the Design CBR shown on the Drawings shall be removed to a depth of 400 mm below Cut Floor Level and replaced with conforming Type A/B material as approved by Council to the underside of the capping or selected material layer, or where no capping or selected material is required, to subgrade level.~~

(ii) ~~Where removal and replacement of material below the Cut Floor Level is not required, the surface shall be loosened to a depth of 150 mm and re-compacted to meet the specified requirements.~~

Where the ~~subgrade cut floor~~ on which capping or selected material or pavement is to be placed consists of soil and rocky materials meeting the specification requirements but is too rocky to trim to the tolerances specified in Clause 204.03(f), the material shall be ripped to a minimum depth of 150 mm, loosened and broken down to a maximum particle size of 50 mm. Any rocks or boulders larger than 50 mm shall be removed and any resulting depressions shall be backfilled with Type B material and such backfilling together with the loosened material shall be reworked and compacted as specified to the Cut Floor Level.

(f) Treatment of Rock Subgrade

Where rock exists in a cut below subgrade level ~~but within the designed capping or selected material layer~~, the material shall be excavated to a depth of not less than 150 mm below subgrade level in all areas on which pavement is to be placed and all loose material and soil shall be removed from the rock floor. Any resulting depressions lower than 150 mm below subgrade level shall be cleaned of loose material and backfilled with 20 mm Class 3, 3% cement treated crushed rock and compacted as specified.

A regulating layer of Class 4, 20 mm Crushed Rock shall then be placed above the rock to subgrade level ~~in lieu of the specified capping or selected material~~, in layers not exceeding a compacted thickness of 150 mm in accordance with Section 304.

HP Prior to construction of the regulating layer, the areas of rock subgrade shall be presented to ~~the Superintendent Council~~ for acceptance.

The Contractor shall submit details of any necessary amendments to the subsurface drainage design including transverse subsurface drainage at the interfaces to ~~the Superintendent Council~~ for review.

~~No adjustment to the Contract Sum will be considered for the treatment of a rock subgrade, or for the construction of the regulating layer in lieu of capping or selected material, or for any modifications to the subsurface drainage.~~

(g) Treatment of Cut to Fill Zones

All pavement and verge areas at cut to fill zones shall be excavated to a minimum depth of 600 mm below the Cut Floor Level or top of Type B material, for a distance of not less than 15 m into the cut and 30 m under the fill from the cut-fill line at the upper surface of Type B material earthworks.

In sideling cut areas, the cut shall be excavated to a depth of 600 mm below the Cut Floor Level for the full cut width to be occupied by pavement and verge material.

The above excavations shall be backfilled in layers with Type B material.

(h) Groundwater

HP Where groundwater or seepage is encountered the Contractor shall notify the Superintendent Council and submit the proposed action to be taken to the Superintendent Council for review.

The Contractor shall submit any necessary approvals from relevant authorities for the treatment and disposal of this groundwater.

(i) Surface Finish of Cut and Fill Batters

The surface of cut and fill batters to be topsoiled shall be textured by scarifying or horizontal grooving.

204.07 UNSUITABLE MATERIALS

(a) General

Excavation of unsuitable material shall be undertaken such that the extent of unstable areas is not increased.

Material used to replace excavated unsuitable material shall be Type B material and / or approved by Council.

(b) Cuts

Where in situ material within 400 mm below capping, selected material and/or pavement has an Assigned CBR less than that specified at that level, or has a swell of 2.5% or greater, it shall be treated in accordance with Clause 204.06(e)(i).

Other unsuitable materials below the Cut Floor Level on which pavement subbase, capping or selected material is to be placed shall be either treated in situ or excavated and replaced with Type B material and / or approved by Council. All treated areas or replacement material shall be spread and/or compacted to the specified density in layers not exceeding a compacted thickness of 200 mm.

~~Where material:~~

- ~~—— (i) is unsuitable and does not exceed 150 mm in depth, it shall be treated in situ or excavated and replaced and no additional payment will be made for this work;~~
- ~~—— (ii) is unsuitable and exceeds 150 mm in depth, it shall be treated in situ or excavated and replaced. Separate payment if applicable (i.e. if the Contract is a schedule of rates contract or the work is covered by a Provisional Item under a lump sum Contract) will be made for the volume of material below the Cut Floor Level so treated or excavated and replaced;~~
- ~~—— (iii) has become unsuitable to any depth due to the Contractor's negligence or use of inappropriate methods it shall be treated in situ or excavated and replaced and no additional payment will be made for this work.~~

(c) Areas Upon Which Fill is to be Placed

After completion of clearing, grubbing and stripping of areas upon which fill is to be placed, any unsuitable material immediately below these areas shall be treated in situ or be excavated and replaced with suitable material which shall be spread and compacted as specified.

~~If the Contract is a schedule of rates Contract or the work is covered by a Provisional Item under a lump sum Contract, payment will be made for the full volume of material so treated or excavated and replaced except that, where material has become unsuitable due to the Contractor's negligence or use of inappropriate methods, no additional payment will be made for this work.~~

(d) Treatment of Unsuitable Materials

HP Where unsuitable material is encountered the Contractor shall submit the proposed in situ treatment or extent of excavation to the Superintendent Council for review.

~~(e) Fills~~

~~Unsuitable materials in fills shall be treated in situ or be excavated and replaced at the Contractor's cost.~~

~~(f) Stockpiles~~

~~Material complying with the requirements of Type A, B or C material, which is unsuitable for immediate use due to being over wet, may be stockpiled for later use.~~

~~204.08 SURPLUS EXCAVATED MATERIAL~~

~~No material shall be transported offsite, where such material can be used within the designed earthworks under the Contract.~~

~~Surplus material shall be disposed of off site at the Contractor's cost.~~

204.09 BORROW EXCAVATION

~~Borrow excavation shall be limited to the quantity of material necessary to complete the work under the Contract and will not be permitted where sufficient suitable material is available from within the limits of site excavation. The Contractor shall obtain all necessary permits and approvals for borrow areas outside the road reservation.~~

Borrow excavations within the road reservation will not be permitted without the prior approval of Superintendent Council.

~~Where the Superintendent Council's approval is obtained the Contractor shall be responsible for obtaining all other necessary permits and approvals prior to the commencement of borrow excavation.~~

204.10 FILL CONSTRUCTION

(a) General

Fill construction includes the preparation of areas upon which fills are to be constructed and the selection, placement, and compaction of material.

(b) Areas Upon Which Fills are to be Constructed

Areas upon which fills are to be constructed shall be prepared for test rolling by the Contractor. The surface of the prepared area shall be test rolled in accordance with Clause 204.12. Any unstable areas detected by test rolling shall be rectified.

Where the height of fill to be placed to top of Type B material level over the stripped surface is less than 1.0 m, material immediately below the surface exposed after stripping of topsoil or removal of existing pavements shall be scarified to a depth of not less than 150 mm and re-compacted to the specified density ratio for the location and type of material being placed.

Existing pavements under areas upon which fills are to be constructed, that are not required to be salvaged shall be scarified to a depth of not less than 150 mm and compacted as specified.

If groundwater is encountered, the requirements of Clause 204.06(h) shall apply.

HP The Contractor shall not commence placing any fill on the prepared areas until the area has been reviewed by the ~~Superintendent~~ Council.

(c) Benching

Where a fill is to be constructed on steep sideling ground or against an existing embankment with side slope steeper than 4 horizontally to 1 vertically, benches shall be progressively cut over the full area to be covered by new fill. The width of each bench shall be such as to permit safe and effective operation of plant but shall be not less than 1 m.

Material excavated during benching may be used in construction of fills if it meets the requirements specified in Clause 204.04 for the type of material being placed.

(d) Placing of Fill

(i) General

Fill material shall be placed and spread in uniform layers and shall be compacted to meet the specified requirements for the location and type of material being placed.

Each layer of fill shall be keyed into the layer above by creation of a textured surface.

Any rocky material present in a layer of fill shall be uniformly distributed throughout the layer and the whole shall be compacted to meet specified requirements.

During the placement of fill material the surface of each layer shall be kept generally parallel to the surface of the subgrade. Prior to the cessation of work each day, the top of the fill shall be shaped and compacted to minimise damage resulting from wet weather.

The Contractor shall establish a procedure to verify that compacted layers do not exceed the specified maximum thickness. Verification records must provide evidence of measurements taken at least every three layers in consistent locations across the filled areas, and must be retained with the lot records.

(ii) Filling on Allotments and Reserves

All filling work and subsequent compaction shall be undertaken to Level 1 inspection and testing requirements in accordance with AS 3798 "Guidelines on earthworks for commercial and residential developments".

(iii) Type A Material

Type A material shall be placed in locations shown on the drawings or, if surplus Type A material is available, it may be used in locations specified for Type B material.

Type A material shall be spread and compacted in layers not exceeding a compacted thickness of 200 mm.

Type A structural material shall be placed in accordance with the requirements of Clauses 204.11 and 204.13.

(iv) Type B Material

Type B material shall be placed in locations shown on the drawings, or if surplus Type B material is available, it may be used in locations specified for Type C material. The highest quality Type B materials available shall be reserved for placement in the higher levels of Type B fills being constructed.

Type B material shall be spread and compacted in layers not exceeding a compacted thickness of 200 mm.

Where Type B material contains 25% or more of rock by volume, which will not break down during compaction to meet the maximum particle dimension required for a 200 mm thick layer, the loose thickness of each layer may equal 125% of the typical maximum particle dimension of the rock up to a maximum layer thickness of 500 mm. Any rock with a maximum particle dimension greater than 80% of the loose thickness of the layer shall be removed. The material shall be placed and compacted such that voids are completely filled with fine material.

Type B material containing rock with a particle dimension greater than 150 mm after compaction shall not be placed within 400 mm of the top of Type B and/or Type C material zones.

(v) Type C Material

Type C material shall be placed in locations shown on the drawings or in other areas approved by the Superintendent Council.

Type C material shall be spread and compacted in layers not exceeding a compacted thickness of 300 mm.

Where Type C material contains 25% or more of rock by volume, which will not break down during compaction to meet the maximum particle dimension required for a 300 mm thick layer, the loose thickness of each layer may equal the maximum particle dimension of the rock up to a maximum layer thickness of 500 mm.

Rocks with a maximum particle dimension of less than 800 mm may be placed in Type C material zones as specified, with sufficient spacing between larger rocks to enable full compaction of the Type C material.

The material shall be placed and compacted such that voids are completely filled with fine material.

204.11 FILL AT STRUCTURES

(a) General

This clause covers the requirements for the placement and compaction of fill material adjacent to or preparatory to the construction of structures such as bridge abutments, retaining walls, wing walls, crown units and culverts with an opening height greater than 1200 mm. Such material shall be placed at locations as specified or shown on the drawings.

(b) Fill at Structures

HP No fill shall be placed against or within 3 m of a structure until the foundation for the fill has been reviewed by and approved by the Superintendent Council.

In addition to the placement of Type A material at bridge abutments as structural material, embankment material or backfilling within 3 metres of retaining walls, wing walls, all crown units, and culverts with an opening height greater than 1200 mm, shall be material of at least Type A material quality.

No material shall be placed against concrete within 14 days of casting.

Unless a geocomposite drainage mat is specified as a drainage medium, material to be placed within 300 mm of bridge abutments, retaining walls, wing walls or large culverts shall consist of permeable fill material which meets the requirements of Clause 204.04. The permeable fill material shall be placed in conjunction with the adjacent fill in layers not exceeding 150 mm compacted thickness, and compacted to refusal using hand held mechanical equipment. The bottom of the permeable fill material or any geocomposite drainage mat shall be connected to suitable drainage outfalls by subsurface drainage pipes as shown on the drawings or as otherwise specified.

Material to be placed adjacent to permeable fill material or geocomposite drainage mat within 3 m of the face of structures shall be Type A structural material which meets the requirements of Clause 204.04. Such material shall be spread and compacted as specified in horizontal layers not exceeding 150 mm compacted thickness.

Compaction plant shall not be operated within the minimum distances from structures shown in Table 204.111. These minimum distances apply until the fill reaches the level above the top of the structure corresponding to the relevant specified minimum cover.

The difference in level of any fill being placed on opposite sides of a structure or structural component shall not exceed $H/4$ or 500 mm, whichever is the lesser, where H is the height of the structure.

Table 204.111 Fill at Structures

Non Vibrating Rollers - Static Weight * (tonne)	Vibrating Rollers - Total Applied Force ** (kN)	Minimum Distance from Compaction Plant to Side of Structures (m)	Minimum Distance from Compaction Plant to Abutments, Retaining Walls and Wing Walls (m)	Minimum Cover over Top of-Culverts (m)
Less than 2	Less than 20	0.15	0.15	0.15
2 – 5	21 - 50	0.3	0.3	0.15
6 – 10	51 - 100	1.2	1.2	0.4
11 – 20	101 - 200	2.4	1.2	0.4
21 – 35	201 - 350	2.4 or height of structure (whichever is greater)	1.2 or height of structure (whichever is greater)	0.7
* Includes vibrating rollers operating in non-vibrating mode.				
** Total Applied Force is the sum of the static weight and the vertical component of the centrifugal force.				

(c) Fill Placed Prior to Erection of Structures

Material placed within 3 m of any future structure shown on the drawings shall be Type A structural material.

204.12 TEST ROLLING

Areas upon which fills are to be constructed, all layers of fill, and material within 150 mm of the cut floor level in cuts, shall be test rolled in accordance with Section 173. The Contractor's quality plans and procedures shall include test rolling as a hold point.

HP The Contractor shall provide for the Superintendent Council to be present during all test rolling.

~~The Superintendent Council reserves the right to direct the Contractor to undertake further test rolling on any layer prior to it being covered by a successive layer. No additional payment will be made for any requirement to carry out such further test rolling.~~

204.13 TESTING AND ACCEPTANCE OF COMPACTION AND MOISTURE CONTENT

Fills shall be compacted to either Compaction Scale A, Scale B unless otherwise approved by Council, in which case Scale A will apply, or Scale C as nominated in Clause 204.16. ~~Where the compaction scale has not been specified, Compaction Scale A shall apply.~~ Testing for compaction shall be undertaken in accordance with VicRoads Code of Practice 500.05.

(a) Test Lots

A test lot shall be as defined in Section 173. The lot size for Type A, Type B and Type C material shall be a maximum of 500m² under paved areas or as specified in Table 204.142 in all other areas.

The calculation of density ratio and moisture ratio shall be based on laboratory values determined using standard compactive effort.

For work to be tested for compliance with Scale A or Scale B compaction requirements, the number of tests per lot shall be six, unless the lot is to be treated as a small lot in accordance with Section 173.

For work to be tested for compliance with Scale C compaction requirements, the number of tests per lot shall be three.

(b) Compaction

(i) Material of Nominal Size 40 mm or Less after Compaction

Fill material, and material within 150 mm of the Cut Floor Level having a nominal size after compaction of 40 mm or less shall be compacted to comply with the requirements of Table 204.131.

Each lot to be tested for compaction shall be test rolled in accordance with Section 173. Any unstable areas shall be excluded from the lot and shall be rectified by the Contractor and assessed separately. If the total area of the excluded areas exceeds 20% of the area of the lot, the whole of the lot shall be rejected.

Table 204.131 Compaction Requirements

<u>Location</u>	<u>Material Type and Location</u>	Scale A	Scale B	Scale C
		Minimum Characteristic Value of Density Ratio (%)	Minimum Characteristic Value of Density Ratio (%)	Minimum Mean Value of Density Ratio (%)
<u>Within the Future Road Reserve</u>	All Type A Material	99.0	98.0	100.0
	Type B Material placed within 400 mm of top of Type B Material			
	Ripped and re-compacted material below Cut Floor Level			
	Type B Material placed more than 400 mm below top of Type B Material	97.0	95.0	95.0
	The top 150 mm of areas where fill is to be constructed			
	Type C Material	95.0	93.0	92.0
<u>All Other Areas including Allotments</u>	<u>Type A and Type B Material</u>	<u>95.0</u>	<u>95.0</u>	

(ii) Material of Nominal Size Greater than 40 mm (after Compaction)

All fill material and ripped and re-compacted material in cuts below Cut Floor Level with a nominal size after compaction greater than 40 mm shall be compacted using a grading, mixing, watering and rolling procedure as agreed by the Superintendent Council.

~~The Superintendent Council may require that trial sections be constructed to verify that the proposed compaction routine is acceptable. No additional payment will be made for any requirement to construct trial sections.~~

All fill material and material below the Cut Floor Level shall be compacted at minimum moisture ratio of 80%. The moisture ratio shall be determined using the material which passes the 37.5 mm sieve, where the material contains less than 20% oversize material. If the material contains more than 20% oversize material, the moisture ratio shall be determined using an alternative method in accordance with the appropriate test method or Code of Practice.

Acceptance of work for compaction will be based on compliance with the accepted placement and compaction procedure and test rolling carried out in accordance with Section 173.

Any unstable areas detected by test rolling shall be rectified. Where unstable areas exceed 20% of the area being test rolled, the whole of the area shall be ripped, re-compacted as specified above, and re-presented for test rolling.

(c) Treatment of Expansive Materials

All material with a percentage swell equal to or greater than 2.5% shall be considered as expansive and shall be treated in accordance with Clause 204.06(e)(i) and Clause 204.10(d)(iii).

All layers of Type A material placed over expansive Type B or expansive in situ material, shall be maintained at a characteristic moisture ratio of not less than 90% for the period between completion of compaction and placement of the overlying layer.

Expansive material shall be placed at a characteristic moisture ratio of 90% to 110% during compaction, maintained through test rolling and up to placement of the overlying layer.

The Contractor may nominate a lesser characteristic moisture ratio for agreement of the Superintendent Council if it can demonstrate that complying with the above requirement will result in the material being unstable under a test roll performed in accordance with the requirements of Section 173.

Where the nominal size of material after compaction is greater than 40 mm, the moisture ratio shall be determined on that material which passes the 19.0 mm sieve, otherwise the moisture ratio shall be determined on the material passing the 37.5 mm sieve or 19.0 mm sieve taking into account oversize material as required by the test method.

204.14 FREQUENCY OF TESTING

The Contractor shall carry out testing at a frequency which is sufficient to ensure that the materials and work supplied under the Contract complies with the specified requirements. Notwithstanding this requirement, testing shall be undertaken at either Scale A or Scale B level of testing, at a frequency not less than that specified below. Where the scale of testing has not been specified, Scale A shall apply.

(a) Material Properties Testing - Scale A

(i) CBR and Percentage Swell

Materials shall be tested to demonstrate compliance with the material property requirements specified in Clause 204.04. Where Scale A is specified, the following frequency of testing shall apply.

The initial lot of each material type shall be tested to determine the Assigned CBR (strength) and percentage swell of the material and shall be carried out in accordance with VicRoads Code of Practice RC500.20. Unless otherwise approved by the Superintendent Council sampling for CBR testing shall be undertaken after field compaction of the initial lot. If either the Assigned CBR value or percentage swell value does not meet the requirements specified in Clause 204.04, the lot shall be rejected and all subsequent material from that source will be considered as non-conforming for that use.

Where both the Assigned CBR and percentage swell values meet the requirements of Clause 204.04 the material will be considered to be conforming subject to it complying with other specified requirements, and the Contractor may seek the Superintendent Council's agreement to undertake future testing for CBR and percentage swell at the reduced frequency specified in Table 204.141.

The continued acceptance of Assigned CBR and percentage swell will be assessed against the CBR and percentage swell values of a single CBR test and a single percentage swell test. Provided that the single CBR test value is greater than the specified Assigned CBR value and that the percentage swell value is less than the specified percentage swell value, the lot shall be accepted for CBR and percentage swell.

Should either the single CBR value be less than the specified Assigned CBR or the percentage swell value be greater than the specified swell value, the lot shall be retested for Assigned CBR and percentage swell values.

The values obtained from the new Assigned CBR and percentage swell tests shall comply with the requirements of Clause 204.04 and shall be considered to be the new Assigned CBR and percentage swell values. Subject to compliance to Clause 204.04, single test verification of the Assigned CBR and percentage swell shall continue at the reduced testing frequency.

Should either the verification tests for the Assigned CBR and/or percentage swell value not comply with the requirements of Table 204.041, the material from that source will be considered as non conforming and the lot and any subsequent lots from that source will be rejected.

(ii) Gradings, PI, LL, Permeability and Particle Dimension

Testing for grading, PI, LL, permeability and maximum particle dimension shall be undertaken at the initial testing frequency specified in Table 204.141 until three consecutive lots of like material and work have achieved the specified requirements. After satisfying this requirement, the Contractor may seek the ~~Superintendent~~ Council's agreement to reduce the frequency of testing of subsequent lots to the reduced testing frequency specified in Table 204.141.

If the Contractor has obtained the ~~Superintendent~~ Council's agreement to reduce the frequency of testing and any lot fails to achieve the specified requirements, all testing of all subsequent lots shall be undertaken in accordance with the initial testing frequency in Table 204.141 until three consecutive lots of like material and work have achieved the specified requirements in the first test. After satisfying this requirement, the Contractor may again reduce the frequency of testing to the reduced testing frequency specified in Table 204.141.

If a material source changes, or the properties of a material differ from the material initially tested, a new testing regime shall be established in accordance with this clause.

Table 204.141 Frequency of Testing for Material Properties

Material Properties	Material	Initial Testing	Reduced Testing Frequency (minimum)
CBR and percentage swell	Type A Material	1 Lot Test to determine Assigned CBR and swell	Single CBR test to confirm Assigned CBR and swell per every ## 2 lots
	Type B Material	1 Lot Test to determine Assigned CBR and swell	Single CBR test to confirm Assigned CBR and swell per every ## 8 lots
	In situ material in cuts within 400 mm below Cut Floor Level	1 Lot Test to determine Assigned CBR and swell	Single CBR test to confirm Assigned CBR and swell per every ## 4 lots
Grading	Type A Material	1 Test for each lot tested for compaction	1 test for every second lot tested for compaction
	Permeable Fill Material	1 Test per lot	1 Test per every ## 2 lots
PI and calculation of PI x % Passing 0.425 mm	Type A Material	1 Test per 2 lots	1 test per every ## 4 lots
LL and comparison of PI against LL, (identification of silt)	Type A Material Type B Material	1 Test per 2 lots	1 test per every ## 4 lots
Permeability	Capping and Verge Materials and Other Type A Material	1 Test per 2 lots	1 test per every ## 4 lots
Maximum Particle Dimension ¹	Type A Material,	Every lot	Every lot
	Type B and Type C Material containing rock greater than 150 mm	Every lot	Every lot
Note: ¹ Visual inspection, assessment and measurement of larger rock particles.			

(b) Material Properties Testing - Scale B

Where Scale B is specified in Table 204.161, the first lot of each material type shall be tested to demonstrate compliance with the material property requirements specified in Clause 204.04.

Where the first lot of each material type satisfies the material property requirements in Clause 204.04 as applicable to that material type, no further testing will be required for that material except where changes to the physical properties of the material are observed or where directed by the Superintendent Council.

Where the first lot of each material type does not satisfy the material property requirements in Clause 204.04 as applicable to the material type, the lot will be rejected.

(c) Compaction and Moisture Content Testing Frequency

Every lot shall be tested initially to demonstrate compliance with the requirements for compaction and moisture content. ~~Testing of every lot shall continue until three consecutive lots of like material and work have achieved the specified requirements in the first test. After satisfying this requirement and establishing a compaction procedure to the satisfaction of the , the Contractor may seek the Superintendent's agreement to reduce the frequency of testing of subsequent lots to the minimum requirements specified in Table 204.142.~~

~~If the Contractor has obtained the Superintendent's agreement to test for compaction and moisture content at the minimum testing frequency and any lot fails to achieve the specified requirements, testing of all subsequent lots shall be undertaken until three consecutive lots of like material and work have achieved the specified requirements in the first test. After satisfying this requirement, the Contractor may submit changes to the compaction procedure for the Superintendent's review and may again seek approval to reduce the frequency of testing to the minimum requirements.~~

For the purposes of this sub-clause, small areas as defined in Section 173 shall not be included in the initial consecutive lots tested for compliance, nor any subsequent set of consecutive lots.

Table 204.142 Minimum Frequency of Testing for Compaction and Moisture Content

Material	Acceptable Lot Size in a Single Layer of Work	Minimum Testing Frequency
Type A Material	One day's production or 5,000 m ² , whichever is the lesser	Every second lot of like material and work
Type B Material		
• ripped and re-compacted below Cut Floor Level	One day's production or 10,000 m ² , whichever is the lesser	Every second lot of like material and work
• placed within 400 mm of top of Type B Material	One day's production or 10,000 m ² , whichever is the lesser	Every second lot of like material and work
• placed more than 400 mm below top of Type B material	One day's production	Every third lot of like material and work
Type C Material	One day's production	Every sixth lot of like material and work

204.15 PREPARATION AND MAINTENANCE OF FINAL EARTHWORK SURFACES AND SUBGRADE

The top of the Type B material, Cut Floor Level and subgrade surfaces shall be prepared to level and shape within the tolerances specified in Clause 204.03(g) to produce a smooth, hard, tightly bound surface, free from depressions capable of holding water.

Material within 150 mm of subgrade shall be maintained such that its moisture content is not less than 70% of optimum moisture content prior to the placement of any pavement layer.

204.16 SCHEDULES FOR TOLERANCES, MATERIAL PROPERTIES AND COMPACTION TESTING

Table 204.161 nominates the level of testing required for acceptance of Surface Level Measurement as specified in Clause 204.03, for acceptance of material properties as specified in Clauses 204.04 and 204.14, and for acceptance of compaction as specified in Clause 204.13.

Table 204.161 Schedule for Surface Tolerance, Material Properties and Compaction Testing

Road Name	Chainage / Location	Scale of Surface Level Measurement (A, B or C)	Scale of Material Property Testing (A or B)	Scale of Compaction (A, B or C)
##:Freeway M Roads	Within Limits of Works	A	A	A
##:Arterial A Roads	Within Limits of Works	A	B	A
##:Arterial B Roads	Within Limits of Works	B	B	B
##:Arterial C Roads	Within Limits of Works	C	Not Applicable	C

Note: Where no level of testing is nominated, Scale A applies.

204.17 TOPSOILING

Topsoiling shall not be placed over cut and fill areas until the Contractor has verified that such areas comply with the requirements in Clause 204.03

All unpaved cut and fill areas within the limits of the batters, including batter roundings but excluding cut batters steeper than 1.5 to 1 (horizontal to vertical), and any other area disturbed by the Contractor's operations, shall be topsoiled to the following thicknesses measured normal to the slope:

- (a) batters with slopes of 2 to 1 (horizontal to vertical) or steeper - 50 mm minimum
- (b) tree and shrub plantation bed areas other than (a) above - 100 mm minimum
- (c) verges: In areas without kerb and channel or concrete edging strips the depth of topsoil shall vary uniformly from 50 mm deep at the outside edge of verge to 20 mm deep within 100 mm of the edge of seal or asphalt surface treatment
- (d) all other areas - ~~75~~100 mm minimum.

Topsoil shall be placed and levelled but not compacted except for verge areas, which shall be compacted. Topsoil on batters shall be placed so as to prevent rilling.

The surface level of topsoil shall match the finished surface level, or level of back of kerb or concrete edging, as appropriate.

SECTION 205 - ROCK FILL

205.01 DESCRIPTION

This section covers the requirements for the use of rock fill in embankment construction. This section should be used taking into account the requirements of Section 204.

205.02 DEFINITIONS

Fill:

The compacted embankment placed above natural surface level after removal of topsoil.

Rock Fill:

A material comprised of larger fragments of hard, sound durable rock containing only a small amount of fine particles, which when placed and compacted produces an embankment deriving its stability from the mechanical interlock of the coarser rock particles and not from the compaction of finer material.

205.03 MATERIALS

(a) Rock Fill Material

Material for rock fill embankment construction shall be obtained from excavations within the works.

Rock fill shall be comprised of sound rock fragments having not less than two broken or angular faces. Not less than 10 individual, randomly selected, rock samples, with dimensions greater than 100 mm, shall be tested for each nominated point load test. Not less than 90% of rock fragments with dimensions greater than 100 mm shall have a Point Load Strength ($I_{S(50)}$) of 2.0 MPa or greater.

Prior to placement, rock fill material shall have no particle dimension exceeding 500 mm and minimal fine material.

After placement and compaction, rock fill material, including Rock Fill cover layer material, shall comply with post-compaction gradings in Table 205.031.

Table 205.031 Post-Compaction Grading of Rock Fill Material

Rock Fill Type	Limits of Grading (% passing by mass) Post Compaction AS Sieve Size (mm)				
	500	300	150	75	37.5
Maximum Particle Size 500 mm	100	10-25	0-10		
Maximum Particle Size 300 mm		100	10-25	0-10	
Maximum Particle Size 150 mm			100	10-25	0-10
Maximum Particle Size 75 mm				100	10-25
Maximum Particle Size 37.5 mm					100

(b) Geotextile Fabric

Geotextile fabric required for the construction of rock fills shall have a G robustness rating of greater than 3000 and shall be supplied, handled and placed in accordance with the requirements of Section 210.

205.04 SITE EXCAVATION**(a) General**

Site excavation of rock fill material shall be within the limits of batters, open and underground drainage and approved borrow areas from within the Site, and shall include the handling of excavated material to the point of disposal.

(b) Material Category

Prior to the use of excavated rock material as rock fill, the Superintendent Council and the Contractor shall inspect the material encountered and subject to verification by appropriate testing, agree on the suitability of the material for rock fill as described in Clause 205.03.

(c) Excavation Operations

If excavated rock is to be used in the construction of rock fill embankment, the working methods employed in the excavation of cuttings must be adjusted so as to produce rock fill material of the size and grading and rock strength specified in Clause 205.03. Such working methods generally must include screening and, if necessary, secondary processing.

(d) Oversize Rock

Oversize rock produced as a consequence of rock fill production shall be used or disposed of only in areas specified or shown in the drawings or approved by the Superintendent Council.

HP The Superintendent Council's approval shall be obtained to the use or disposal of oversize rock with a maximum particle dimension greater than the requirements for Type B fill material in Type C fill areas in accordance with Section 204.

205.05 ROCK FILL EMBANKMENT CONSTRUCTION**(a) Areas Upon Which Rock Fills are to be Constructed**

Areas upon which fills are to be constructed shall be prepared in accordance with the requirements of Section 204. Topsoil and material classified as silt shall be removed prior to construction of any rock fills.

Where a rock fill is to be constructed on steep sideling ground or against an existing embankment with side slope steeper than 4 horizontally to 1 vertically, benches shall be progressively cut over the full area to be covered by new fill. The width of each bench shall be such as to permit safe and effective operation of plant but shall be not less than 1 m.

Material excavated during benching may be used in construction of earthworks in accordance with Section 204.

Foundations under rock fills must be shaped to ensure that drainage is maintained and treated to ensure that erosion of the foundation will not occur.

(b) Placement and Compaction of Rock Fill

Prior to placement of the first layer of rock fill, a geotextile fabric shall be placed as a separation layer.

The rock fill material shall be placed and compacted in layers in accordance with the accepted placement and compaction procedure and Table 205.051.

Rock fill shall be placed and compacted to ensure rock particle to particle contact between coarser rock particles is maintained and to achieve stability of the layer.

Interlock between successive rock fill layers shall be ensured by limiting the placement of finer particles over the surface of the rock fill layer to that necessary to achieve interlock between the courser rock particles.

Where earthworks fill material is to be placed over or adjacent to a rock fill, cover layers of rock fill material shall first be placed in accordance with Table 205.051. A geotextile separation fabric with a G robustness rating of greater than 3000 shall then be placed over the top of the rock fill layers, and extended to cover the longitudinal edge of the top layer. A minimum layer of 200 mm of Type B fill material with a maximum particle dimension of 75 mm shall then be placed on top of the geotextile fabric, above which the earthworks fill layer can then be constructed.

Table 205.051 Thickness of Rock Fill Material Layers

Rock Fill Type	Maximum Thickness of each Compacted Layer	Minimum Distance Below Subgrade Level	Thickness of Rock Fill Cover Layers			
			Bottom Layer Maximum Particle Size 150 mm	Middle Layer Maximum Particle Size 75 mm	Top Layer Maximum Particle Size 37.5 mm	Total Thickness of Rock Fill Cover Layers
Maximum Particle Size 500 mm	600 mm	2.0 m	300 mm	200 mm	100 mm	600 mm
Maximum Particle Size 300 mm	400 mm	1.2 m	Not Required	200 mm	100 mm	300 mm
Maximum Particle Size 150 mm	300 mm	800 mm	Not Required	Not Required	100 mm	100 mm
Maximum Particle Size 75 mm	200 mm	400 mm	Not Required	Not Required	100 mm	100 mm

(c) Rock Fill around Structures

At structures, including abutments, retaining walls, wingwalls and culverts, rock fill and rock fill cover material shall not be placed within any specified Type A fill zone or within 2 m of any structure.

(d) Level Control

Each layer of rock fill including cover layers shall be surveyed to confirm that placement is in accordance with the following tolerances:

Intermediate layers of rock fill shall be placed to a tolerance of +/- 100 mm.

The surface level tolerance of the top of final layer of rock fill or zone shall be finished to a tolerance of:

+0 mm / -100 mm.

205.06 ACCEPTANCE OF PLACEMENT AND COMPACTION

The first lot shall be placed as a trial section for review by the ~~Superintendent Council~~. The Contractor shall then develop a material grading, mixing, watering and rolling routine based on the construction and testing of trial section for review by the ~~Superintendent Council~~.

As a minimum, trial sections shall be carried out both for the initial layer of rock fill over in situ material and then for the subsequent (second) layer of rock fill and each trial section shall:

- have an area of not less than 1000 m²
- be thoroughly watered prior to applying roller passes
- be compacted by the application of not less than 15 roller passes or more, if consolidation is still occurring
- be surveyed for level changes in surface levels after each roller pass at not less than 20 pre-determined monitoring points
- be assessed to determine the point at which effective refusal occurs
- be inspected and tested for compliance with this Section 205.

Where any monitoring point has been, in the opinion of ~~the Superintendent~~ Council, destroyed or significantly damaged by crushing or rock break down, the survey level result for that point shall be disregarded for that roller pass and a replacement monitoring point established for monitoring of subsequent roller passes.

The accepted compaction routine shall provide not less than three additional passes of the compaction plant above the number of passes identified from the compaction trials as having no further consolidation of rock particles and the compactive effort shall be not less than the equivalent of 6 passes of a vibrating pad foot roller which can transmit a minimum force to the ground through the surface of the drum of 50 kN per metre of drum length, when operated at the maximum frequency of vibration. The frequency of vibration of the roller shall be between 16 and 25 Hz, and the travel speed shall not exceed 1 m for every three seconds.

~~The Superintendent~~ Council may require that further trial sections be constructed to verify that the proposed placement and compaction routine is acceptable where there is a change in the type or quality of the material being placed.

Assessment of placement and compaction will include visual inspection of inspection trenches excavated to the full depth of the rock fill layer and test rolling carried out in accordance with Clause 205.07.

Assessment of placement and compaction shall also include monitoring the level of rock particles at the surface of the layer to identify the point at which no further consolidation of the rock particles occurs when subject to three additional passes of the compaction plant. The number and location of monitoring sites shall be to the satisfaction of ~~the Superintendent~~ Council but shall not be less than 12 locations for each lot monitored.

Acceptance of work for compaction will be based on compliance with the accepted placement and compaction procedure, testing and inspection as specified and the confirmation by survey level monitoring that effective refusal has been achieved for the rock fill layer. For the purpose of this clause, effective refusal is where the average cumulative deflection over the last three roller passes is no greater than 5 mm.

205.07 TEST ROLLING

All layers of rock fill shall be test rolled in accordance with Section 173.

Prior to any layer being covered by a successive layer, ~~the Superintendent~~ Council may require further test rolling to confirm that the layer is stable.

Any unstable areas detected by test rolling shall be rectified.

205.08 MINIMUM FREQUENCY OF TESTING**(a) Material Properties**

Materials shall be tested to demonstrate compliance with the material property requirements specified in Clause 205.03. Testing shall be undertaken at the frequency specified in Table 205.081.

Table 205.081 Minimum Frequency of Testing for Material Properties

Material Properties	Minimum Frequency of Testing
Rock Strength – Point Load Index – $I_{S(50)}$	Each source prior to the commencement of work and every 500 m ³ of production.
Grading Prior to Compaction	Prior to the commencement of work and at other times when in the opinion of the Contractor or the Superintendent Council, the nature and/or physical properties of the material have changed.
After Compaction Grading	For each trial section and for every third lot, and at other times when in the opinion of the Contractor or the Superintendent Council, the nature and/or physical properties of the material have changed.
Consolidation Measurement of Rock Fill Layers	Survey monitoring for all trial sections and each layer of rock fill including cover layers.
Test Rolling	All layers of rock fill including cover layers.

(b) Compaction

The Contractor shall initially test each trial section to verify the adequacy of placement and the compaction procedure to the satisfaction of the Superintendent Council.

Once a placement and compaction routine is established, each lot shall be placed in accordance with this procedure.

Every layer shall be tested for stability by test rolling and every third lot shall be monitored to verify that no further consolidation is occurring. Should the rock fill in any layer be found to be continuing to consolidate within the past three roller passes, the placement and compaction procedure shall be reviewed to the satisfaction of the Superintendent Council.

205.09 AS-CONSTRUCTED RECORDS

The location and extent of all rock fill zones and cover layers constructed shall be surveyed and shown in As-Constructed Drawings.

SECTION 210 - GEOTEXTILES IN EARTHWORKS

~~##This section cross references Sections 160 and 204.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

210.01 GENERAL

This section covers the requirements for the supply, handling and placing of geotextiles as listed below or used as a separation layer, or as a separation and filtration layer, in earthworks at locations shown on the drawings or specified.

- (a) Woven Geotextile
- (b) Non-woven Geotextile

210.02 SUPPLY OF MATERIALS

The Contractor shall supply the geotextiles ~~as specified in Clause 210.07 and~~ as shown on the drawings. The physical and mechanical properties of the geotextiles shall be provided in accordance with Clause 210.03.

After delivery of the geotextiles to site, the Contractor shall ensure that the geotextiles are kept clean and undamaged and stored away from direct sunlight until covered. Any damaged or improperly stored geotextiles shall be replaced by the Contractor.

210.03 PROPERTIES OF GEOTEXTILES

- (a) General

The geotextile shall consist of woven or non-woven fabric manufactured from synthetic fibres of a long chain polymer such as polypropylene, polyethylene, polyester or similar.

Woven geotextiles shall have filaments interlaced in two sets, mutually at right angles. One set shall be parallel to the longitudinal direction of the geotextile.

Non woven geotextiles shall have filaments bonded by needle punching, heat or chemical bonding processes.

- (b) Robustness

The geotextile shall have a robustness (Geotextile Strength Rating - G) complying with the requirements of Table 210.031.

Table 210.031

Classification	Robustness (G)
Moderately Robust	900 - 1350
Robust	1350 - 2000
Very Robust	2000 - 3000
Extremely Robust	Greater than 3000

Determination of robustness (G) shall be in accordance with VicRoads Test Method RC 381.01 *Calculation of Robustness of Geotextile Material*, as listed in Section 175.

(c) Equivalent Opening Size

Where specified in Clause 210.07 as a separation/filtration material, both woven and non-woven geotextiles shall have an equivalent opening size between 85 and 230 microns. The equivalent opening size determination shall be carried out in accordance with AS 3706.7 *Determination of pore size distribution - Dry sieving method*, as listed in Section 175.

(d) UV Radiation Stabilisation

The geotextile shall be stabilised against deterioration due to ultra-violet radiation such that when tested in accordance with AS 3706.11, the geotextile must have retained strength of at least 50% after 28 days of test exposure. After forming, the geotextile shall be processed so that the fibres retain their relative positions with respect to each other. The geotextile shall be free from defects or flaws which adversely affect its physical and mechanical properties.

(e) Testing

Laboratories that perform tests required by this VicRoads Standard Specification Section shall meet the requirements of AS ISO/IEC 17025. All test reports shall be endorsed in accordance with the AS ISO/IEC 17025 accreditation for that laboratory. Testing laboratories shall comply with the resource requirements for competent testing personnel and appropriate supervision as required by AS ISO/IEC 17025. (Test reports may be called test certificates.)

NOTE: Accreditation bodies which are signatories to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) for testing laboratories can offer accreditation against the requirements of AS ISO/IEC 17025. A listing of ILAC signatories is available from the ILAC website (www.ilac.org). In Australia, the National Association of Testing Authorities (NATA, <https://www.nata.com.au>) is a signatory to the ILAC MRA.

Test certificates shall be in the English language.

Sampling shall be in accordance with AS 2490, and testing shall be in accordance with the relevant part of AS 3706, including the determination of the material properties specified in Clause 210.03(b), (c) and (d).

Test certificates shall be submitted for each delivery of geotextile supplied to the works. Test certificates for the same material produced and tested within 12 months prior to the proposed use will be accepted, except for geotextile material used in structural applications, as detailed in Table 201.032, below.

Where no test certification is provided, test samples from each roll of geotextile shall be selected and the test results reported in accordance with the relevant part of AS 3706. Tests shall include the determination of the material properties specified in Clause 210.03(b), (c) and (d) of the geotextile for the consignment delivered.

Table 210.032 Frequency of Testing for Geotextile Material Properties

Geotextile Use	Test	Test frequency
General use	AS 3706.1 AS 3706.2 AS 3706.3 AS 3706.4 AS 3706.5 AS 3706.7 AS 3706.9 AS 3706.11 RC 381.01	Annual
Geotextile used in structural fill applications	AS 3706.1 AS 3706.2 AS 3706.3 AS 3706.4 AS 3706.5 AS 3706.7 AS 3706.9 RC 381.01	Test results on the test certificate shall include at least one set of results for each month of geotextile manufacture.
	AS 3706.11	Annual

210.04 PREPARATION

Prior to placing any geotextiles the Contractor shall excavate the surface material to the depth shown on the drawings or specified. The area shall then be trimmed to provide a uniform surface freely draining to points clear of the road formation.

Where the surface having been trimmed becomes unstable for whatever reason, the Contractor shall treat in situ or remove and replace the unstable material to the condition that the surface has the required strength to support the weight of construction traffic and plant and no additional payment shall be made for this work.

210.05 PLACING GEOTEXTILES AND BACKFILLING

HP The placement of geotextile is not permitted without the written approval of the Superintendent Council.

(a) General

The Contractor shall place the specified geotextile to the limits as shown on the drawings or specified. The geotextile shall be subject to a visual inspection by the Contractor's geotechnical consultant during placing. A certificate of compliance shall be provided by the Contractor's geotechnical consultant to verify that the coverage and ground preparation for placement of the geotextile have been executed in accordance with the drawings and this specification.

The geotextile shall be placed without punctures or tears and, if these occur, they shall be rectified or the entire roll of geotextile replaced prior to covering. Any rolls with imperfections shall not be used. Geotextiles used in subsurface drains shall be placed to conform approximately to the shape of the excavation. The geotextile shall fully envelop the drainage material in the excavation. All joints shall be overlapped or sewn in accordance with requirements specified in Clause 210.07. Geotextiles shall be covered by filling within 48 hours of placement.

(b) Type B Material

The Contractor shall supply and place over the geotextile Type B material of maximum particle size of not more than 150 mm and moisture ratio of not less than 85% as determined by test using the Standard compactive effort. The initial layer of Type B material shall be placed and compacted to the maximum density practicable without causing further instability in the underlying materials upon which the geotextile has been placed. Subsequent layers of Type B material shall also be placed to the maximum density practicable until stability is achieved and a layer satisfies the test rolling requirements specified in Section 204 as applicable. Any remaining layers of fill to be placed above the stable layer shall be placed and compacted in accordance with the requirements of Section 204 as applicable.

(c) Permeable Fill Material

Where shown on the drawings or specified, the Contractor shall supply and place permeable fill material of the depth specified in Clause 210.07 over the geotextile. The geotextile shall be of the type of filtration and separation classification. The permeable fill material shall comply with the requirements of Clause 210.06 and have a moisture content compatible with achieving maximum density practicable. The initial layer of permeable fill material shall be placed and compacted to the maximum density practicable without causing further instability or loss of shape to the trimmed surface upon which the geotextile has been placed. Any subsequent layers of permeable fill material shall also be placed to the maximum density practicable until the full depth of permeable fill material specified has been placed.

Following placement of the specified depth of permeable fill material, a second layer of geotextile (filtration and separation) shall be placed as specified to completely enclose the permeable fill material before placement of Type B material commences.

210.06 SUPPLY OF PERMEABLE FILL MATERIAL ~~##(strikethrough (a) or (b)):~~

For the purpose of this section, permeable fill material shall:

- (a) comply with the requirements of Section 204;
- (b) consist of hard, durable and clean sand or gravel, or crushed stone from a source rock with a Los Angeles Abrasion Loss of not more than 45;
- (c) have maximum particle size not exceeding 19 mm and a permeability not less than 10^{-4} m/sec when compacted to a density ratio value of 100% based on Standard compactive effort.

210.07 SCHEDULE OF DETAILS

~~*** (a) Supply of Geotextiles (Clause 210.02)~~

	Classification	Overlap Requirements	Type
(i) Separation Only	##:	##: mm	##:
(ii) Separation/Filtration	##:	##: mm	##:

~~*** (b) Permeable Fill Material (Clause 210.05(c))~~

~~Depth ##: m~~

SECTION 290 - LIME AND/OR CEMENTITIOUS STABILISATION OF EARTHWORKS MATERIALS

~~##This section cross-references Sections 173, 175 and 204. These sections must be included in the specification.~~

290.01 DESCRIPTION

This section covers the requirements for lime and/or cementitious stabilisation of earthworks materials. The requirements relate to preparation of the formation to be stabilised, quality of lime and cementitious binders, spreading, mixing, and compaction of the stabilised earthworks material.

This section shall be read in conjunction with Section 204 - *Earthworks*, and includes the requirements for stabilisation of earthworks materials, that are in addition to or override the requirements of Section 204.

290.02 STANDARDS

Table 290.021 Design and Material Standards, Test Methods and Codes of Practice

Australian Standards	
AS 1289.3.3.1	<i>Methods of testing soils for engineering purposes Soil classification tests - Calculation of the plasticity index of a soil</i>
AS 1672.1	<i>Limes and limestones Part 1 Limes for building</i>
AS 2350.12	<i>Methods of testing portland, blended and masonry cements - Preparation of a standard mortar and moulding of specimens</i>
AS 3582.1	<i>Supplementary cementitious materials for use with portland and blended cement – Fly ash</i>
AS 3582.2	<i>Supplementary cementitious materials – Slag - Ground granulated blast-furnace</i>
AS 3972	<i>General Purpose and blended cements</i>
AS 4489.6.1	<i>Test methods for limes and limestones Lime index - Available lime</i>
AS 5101.4	<i>Methods for preparation and testing of stabilized materials - Unconfined compressive strength of compacted materials</i>
VicRoads Test Methods	
RC 301.04	<i>Lime Stabilised Earthworks Materials - Available Lime, Assigned CBR and Swell</i>
RC 316.00	<i>Density Ratio and Moisture Ratio - Lot Characteristics</i>
RC 324.01	<i>Calculation of Assigned CBR and Assigned Percent Swell</i>
RC 326.01	<i>Weighted Plasticity Index – $PI \times \text{Percent passing } 0.425 \text{ mm sieve}$</i>
VicRoads Codes of Practice	
RC 500.16	<i>Selection of Test Methods for Testing of Materials and Work</i>
RC 500.20	<i>Assignment of CBR and Percent Swell to Earthworks Fill and Pavement Materials</i>

Section 175 details the revision dates of the relevant references to Australian Standards (AS), VicRoads Test Methods and Codes of Practice referenced in this section.

290.03 DEFINITIONS

Available Lime

The amount of Calcium Oxide (CaO) or Calcium Hydroxide (Ca(OH)₂) contained in Quicklime or Hydrated Lime respectively.

Available Lime Index (ALI)

The Calcium Oxide or Calcium Hydroxide content of quicklime or hydrated lime respectively, expressed as a percentage of the total mass of lime determined in accordance with AS 4489.6.1.

Cement

A cementitious material that complies with AS 3972 for general purpose (GP) and blended (GB) cements.

Cementitious Binder

A cementitious material capable of being uniformly mixed into a material to bind the particles together to increase its strength. Cementitious binders includes cement, or a blend of fly ash (AS 3582.1), ground granulated blast furnace slag (AS 3582.2), hydrated lime (AS 1672.1), alkali activated slag or other pozzolanic material supplied in accordance with this specification.

Design Distribution Rate of Available Lime

The spread rate of pure Calcium Oxide or Calcium Hydroxide.

Fly Ash

A fine powder of pozzolanic material extracted from the flue emissions produced from the burning of black coal.

Lime

Lime is either Hydrated Lime (Calcium Hydroxide) or Quicklime (Calcium Oxide).

Hydrated Lime

Hydrated lime is a powdered form of lime consisting primarily of calcium hydroxide, also referred to as slaked lime.

Lime Spreading Rate

The required spread rate of lime determined from the Design Distribution Rate of Available Lime corrected for the ALI of the lime to be used.

Maximum Allowable Working Time for Cementitious Binder

The maximum allowable working time for a cementitious binder as determined in accordance with the relevant VicRoads Test Method or Code of Practice, applicable to earthworks material.

Pozzolan

A siliceous or aluminosiliceous material when finely ground can be mixed with lime or cement to form a cementitious material.

Quicklime

Quicklime is a fine granulated powder consisting primarily of Calcium Oxide that can be readily slaked by the application of water after it has been evenly spread to form Calcium Hydroxide.

Slag (Ground Granulated Blast Furnace Slag)

Ground Granulated Blast Furnace Slag (GGBFS) is a pozzolan produced by fine grinding of slag produced as a by-product from the smelting of iron ore.

Slaking

The addition of water to quicklime, with the purpose of fully hydrating the quicklime.

Stabilising Binder

Lime, cementitious binder or a blend of binders used for the stabilisation of earthworks.

Working Time

The time required to mix, fully compact and trim the stabilised layer after the addition of the stabilising binder.

290.04 CONFORMITY WITH DRAWINGS

Further to the requirements of Section 204 stabilised layers shall be finished to conform within the following limits to the levels, lines, grades, thicknesses and cross sections specified or shown on the drawings:

(a) Depth of Stabilisation

The depth of stabilised material shall not at any point be less than the depth specified in ~~Clause 290.17(a) or (b).~~

(b) Alignment

Stabilised earthworks carried out in a boxed formation shall extend to the full width of the boxing. If there is no boxed formation, the edges of the stabilised material shall not be inside the specified offset from centreline or design line.

(c) Width

The width of the stabilised material shall not be less than the specified width.

290.05 MATERIALS

Materials supplied under the Contract shall comply with the following properties:

(a) Lime

Quicklime and hydrated lime shall meet the requirements of AS 1672.1.

All quicklime and hydrated lime supplied to the job shall be provided with delivery dockets showing an assigned ALI at the start of each production week. The assigned ALI shall be determined by averaging the six most recent test results for ALI. A test certificate for determination of the ALI shall be made available on request

Lime shall be stored in a moisture free environment and shall be re-tested for compliance with AS 1672.1 if stored for more than 14 days after receipt from the manufacturer.

(b) Cementitious Binders**(i) Cement**

The Contractor shall nominate the type, brand and source of cement proposed. GP or GB cement complying with AS 3972 may be used.

(ii) Slag/Lime Blends

Slag and hydrated lime may be used in blended combination as a stabilising binder. The requirements for hydrated lime shall be as specified in Clause 290.05(a). Slag shall be Ground Granulated Blast Furnace Slag (GGBFS) meeting the requirements of AS 3582.2. The Contractor shall nominate the type, brand and source of the GGBFS to be used

Slag/lime shall be blended uniformly in the ratio of 85% slag to 15% hydrated lime unless laboratory testing indicates that superior strength of the stabilised mixture is achieved by using a different ratio. If the blend is to be varied, the proportion of lime shall not be less than 10%. The Contractor shall provide evidence that the blend ratio has been met for all material supplied to the job.

The slag/lime blend shall have a 7 day compressive strength of 10 MPa and 28 day compressive strength of 16 MPa. The test shall be the same test specified in AS 5101.4. The cement to water ratio shall be adjusted to match the consistency of mortar produced for the compressive strength test for GB cement in accordance with AS 2350.12.

(iii) Other Blends

Other cementitious blends nominated by the Contractor for use may be considered by the ~~Superintendent~~ Council.

(c) Water

Water added to the material shall be potable water.

290.06 SELECTION OF STABILISING BINDER

The use of cementitious binders in capping layer or verge material is not permitted.

Unless otherwise specified, the stabilising binder shall be selected in accordance with Table 290.061.

Table 290.061 Permitted Stabilising Binder

Particle Size	More than 25% Passing 0.075 mm			Less than 25% Passing 0.075 mm		
Plasticity Index (PI) ¹ Weighted PI (WPI) ²	PI ≤ 10	10 < PI < 20	PI ≥ 20	PI ≤ 6 WPI ≤ 60	PI ≤ 10	PI > 10
Stabilising Binder Type						
Lime	Not Permitted	Permitted		Not Permitted		Permitted
Cementitious binders	Permitted	Not Permitted		Permitted		

Notes on Table 290.061

1 – PI is to be determined in accordance with AS 1289.3.3.1

2 – WPI is to be determined in accordance with RC 326.01

290.07 INVESTIGATION AND DETERMINATION OF STABILISING BINDER DESIGN SPREADING RATE**(a) General**

If stabilisation of earthwork material is proposed to provide Type A material, the requirements specified in Table 204.041 shall apply. If stabilisation of earthwork material is proposed to provide Type B material, the requirements specified in clause 204.04(c) shall apply.

The determination of the stabilising binder rate, Assigned CBR and Assigned Swell shall be in accordance with clauses 290.07(b), (c) and (d), as appropriate.

(b) Lime

If the Design Distribution Rate of Available Lime is not specified in clause 290.17(b), the Contractor shall carry out site investigation and perform laboratory testing to determine the Design Distribution Rate of Available Lime in accordance with RC 301.04. The Design Distribution Rate so determined shall satisfy all the requirements for the stabilised material as specified in clause 290.07(a) or clause 290.17(a) as appropriate to achieve the required CBR and Assigned Swell.

(c) Cementitious Binder

If the design distribution rate of the cementitious binder is not specified in clause 290.17(b), the Contractor shall carry out site investigation and perform laboratory testing to determine the Design Distribution Rate of the Cementitious Binder to meet the requirements of clause 290.07(a) or clause 290.17(a), as appropriate. The Assigned CBR and Assigned Swell shall be determined in accordance with RC 324.01. The design distribution rate of cementitious binder shall be the greater of 1.5% or that determined to achieve the required Assigned CBR and Assigned Swell.

(d) Lime and Cementitious Binder Stabilisation

Stabilisation of earthworks material with lime followed by stabilisation using a cementitious binder is allowed where the lime stabilised material has been shown to meet the requirements of Table 290.061 permitting the use of cementitious binder. If the design distribution rate of the cementitious binder is not specified in clause 290.17(b), the Contractor shall carry out site investigation and perform laboratory testing to determine the Design Distribution Rate of the Cementitious Binder to meet the requirements of clause 290.07(a) or clause 290.17(a) as appropriate. The Assigned CBR and Assigned Swell shall be determined in accordance with RC 324.01. The design distribution rate of cementitious binder shall be the greater of 1.5% or that determined to achieve the required Assigned CBR and Assigned Swell.

290.08 COMMENCEMENT OF WORK

- HP** The Contractor shall not commence work until all mix design details including the stabilising binder spreading rates have been presented to the Superintendent Council for review. If the Contractor is required to determine the Design Distribution Rate of the stabilised binder(s), evidence shall be produced to show that the material properties specified in clause 290.07(a) or clause 290.17(a) as appropriate have been met.

290.09 CONSTRUCTION PLANT

The Contractor shall provide and operate sufficient spreading, mixing, watering and compaction plant to complete the work in accordance with the requirements of this section.

(a) Spreader

A purpose built mechanical spreader capable of accurately regulating the discharge of the stabilising binder directly to the roadbed shall be used such that the Design Distribution Rate of the stabilising binder is uniformly met in accordance with the requirements of clause 290.13(a).

The spreader must have calibrated load cells and be capable of uniformly spreading the stabilising binder using a fixed bulk bin feeding a mechanical or hydraulic driven spreading rotor to varying widths.

(b) Mixing Machine

A purpose built mixing machine designed for in situ stabilisation of roadworks shall be used to pulverise and uniformly mix the earthworks formation material with water and the stabilising binder for the specified depth of stabilisation. The mixing machine must have a centrally mounted mixing chamber, a water system capable of varying the total flow rate and an ability to control individual water jets for variable materials or mixing overlaps. The stabilising machine shall be capable of mixing the stabilising binder uniformly throughout the layer within its enclosed mixing chamber.

Rotary hoes and other types of agricultural machinery, including skidsteer machines with attachments shall not be used. Mixing with a grader blade or tynes is not permitted.

After pulverisation and mixing, all stabilised material shall be capable of passing a 37.5 mm sieve, other than isolated hard rock particles up to a nominal size of 75 mm.

(c) Watering Plant

Watering plant or any purpose designed watering system incorporated within the mixing machine shall be capable of uniformly distributing sufficient water to hydrate quicklime and if required add more water to increase the moisture content to aid compaction of the stabilised material.

(d) Compaction Plant

Compaction plant shall be of such mass and configuration as to be capable of compacting the stabilised layer to the minimum density ratio throughout the entire depth of the stabilised layer.

290.10 CONSTRUCTION**(a) General**

Construction includes the preparation of the earthworks formation, spreading of the stabilising binder, slaking of quicklime, mixing, compaction, trimming and curing of the stabilised material.

The construction methodology shall include provision for how the requirements of clause 290.04 will be achieved.

Unless otherwise specified, stabilisation work undertaken each day shall be completed across the full pavement width.

Stabilisation operations may continue during light rainfall if the moisture content of the in situ pavement material can be maintained below standard optimum moisture content.

If it is proposed to stabilise the earthworks material with both lime and cement, simultaneous mixing of the stabilising binders is not permitted. Each stabilising binder shall be mixed in accordance with the specified requirements. The lime stabilised material shall be rolled with a smooth drum or wheeled roller to protect it from adverse weather, prior to it being cementitiously stabilised. The requirements of Clause 290.10(h) shall also apply.

HP If Type GP is proposed, the ~~Superintendent~~ Council shall be first notified and evidence provided to show that the earthworks material can be mixed and compacted to the specified density within the Maximum Allowable Working Time for Type GP Cement.

(b) Pre-treatment of Earthworks

The material to be stabilised shall be pre-treated by scarifying or pulverising to the specified depth to provide an even surface capable of being trimmed to meet the requirements of clause 290.04. Any hard rock particles larger than 75 mm shall be removed from the scarified material.

(c) Spreading of Stabilising Binder

The spreading of the stabilising binder shall not be carried out at times when the binder could become air borne or dispersed in such a way as to become a nuisance or a hazard to persons, property or livestock.

If the required spreading rate for the stabilising binder exceeds 15 kg/m², it shall be spread in two equal spreading runs with material from the first spreader run being fully mixed into the material prior to the second spreading run being undertaken.

Immediately following the completion of spreading of the stabilising binder, the Contractor shall check and record the Average Spreading Rates and the Uniformity of Spread in accordance with clause 290.13.

(d) Spreading of Lime

Lime shall be spread uniformly over the prepared surface at the Lime Spreading Rate calculated using the appropriate formula (i) or (ii) below.

- (i) If hydrated lime has been used in the laboratory testing to determine the Design Distribution Rate of Available Lime and it is proposed to use quicklime at the job site, the Lime Spreading Rate shall be determined from:

$$\text{Lime Spreading Rate} = 0.76 \times \frac{\text{Design Distribution Rate of Available Lime}}{\text{ALI of Lime to be Used (\%)}}$$

- (ii) If the same type of lime (hydrated lime or quicklime) is to be used at the job site as has been used in the laboratory tests to determine the Design Distribution Rate of Available Lime, the Lime Spreading Rate shall be determined from:

$$\text{Lime Spreading Rate} = \frac{\text{Design Distribution Rate of Available Lime}}{\text{ALI of Lime to be Used (\%)}}$$

The minimum Design Content of Available Lime shall be 1.5% by mass as determined under RC 301.04. The 1.5% by mass minimum design content of Available Lime only applies when a design strength is being targeted and does not apply when lime stabilisation is being undertaken to only dry back material.

(e) Slaking of Quicklime

Quicklime shall be slaked with sufficient water to allow full hydration to take place. Full hydration will be deemed to have been achieved when all quicklime that has been spread has changed from a cream coloured granulate to a fine white powder and there is a cessation of rising vapours.

(f) Mixing of Lime Stabilised Material

If quicklime is used, mixing shall not commence until full hydration has been achieved.

All lime shall be mixed to the specified depth within six hours of spreading regardless of the number of spreading and mixing runs required. If lime stabilised material contains non-friable wet clay lumps with a nominal size in excess of 75 mm after the initial mixing run, the lime stabilised material shall be allowed to stand for up to 72 hours to allow sufficient time for clay lumps to dry out and react with the lime.

Once the lime stabilised material is friable it shall be remixed prior to compaction. Remixing shall proceed until all stabilised material other than isolated hard rock particles up to a nominal size of 75 mm, is capable of passing a 37.5 mm sieve and a minimum of at least 60% is capable of passing a 9.5 mm sieve when shaken without forcing material through the openings. The stabilised material shall be visually inspected for uniform mixing by excavating test holes for the full depth of the loose material at six random locations within each compaction test lot as defined in clause 290.14(a).

The number of mixing runs undertaken after the completion of the spreading of lime shall not be less than two

(g) Spreading and Mixing of Cementitious Stabilised Material

The cementitious binder shall be spread uniformly over the prepared surface at the Design Distribution Rate of the cementitious binder.

Mixing shall commence as soon as practical after spreading of the cementitious binder and shall continue until all the earthwork material and cementitious binder are uniformly blended throughout the full depth of the stabilised earthworks.

The moisture content of the earthworks material prior to addition of the cementitious binder shall be within the range 80% to 100% of the optimum moisture content. Additional water shall be added to hydrate the cementitious binder.

If it is proposed to stabilise the earthworks material with both lime and cement, simultaneous mixing of the stabilising binders is not permitted. Each stabilising binder shall be mixed in accordance with the specified requirements.

The number of mixing runs undertaken after the completion of the spreading of the cementitious binder shall not be less than two.

(h) Cementitious Stabilisation of Lime Stabilised Material

Cementitious stabilisation of a lime stabilised material is permitted to commence the next calendar day after the completion of the mixing of the lime into the earthworks material.

Prior to the addition of cementitious binder, the requirements of clause 290.10(b), (c), (d), (e) and (f) shall be met. Spreading and mixing of the cementitious stabilised material shall be undertaken in accordance with clause 290.10(g).

The number of mixing runs undertaken after the completion of the spreading of the cementitious binder shall not be less than two.

(i) Compaction

Compaction of the stabilised layer shall commence immediately after mixing, but only after the requirements of clause 209.10(f) or (g) or (h), as appropriate, have been met.

Compaction equipment shall work as close as practicable behind the mixer to maximise the time available for compaction. Compaction and trimming shall be carried out in a continuous operation.

All compaction shall be completed within the times specified in Table 290.101 after addition of the stabilising binder.

If necessary during compaction, the Contractor shall water the material to maintain the moisture content within 80% to 100% of the stabilised material's optimum moisture content.

Table 290.101 Maximum Allowable Working Time after Mixing for Various Stabilising Binders

Binder Type	Maximum Allowable Working Time (hours)	
	Construction between October and April	Construction between May and September
Lime		
Hydrated Lime and Quicklime	12	24
Cementitious		
Medium Setting Type GB Cements	3	5
Rapid Setting Type GP Cement	2	3

(j) Maximum Layer Thickness

The maximum compacted layer thickness for any stabilised material shall not exceed 250 mm, unless otherwise approved by the Superintendent Council.

(k) Trimming

The surface may be further trimmed before or during compaction to meet the requirements of clause 290.04(a) and (c).

On completion of initial rolling, the stabilised material shall be trimmed to the specified surface tolerances. Light applications of water may be applied during this operation to replace evaporated moisture and to assist in rapid achievement of a tightly knit surface.

All surface irregularities which do not conform to the requirements of clause 290.04 shall be rectified by the Contractor within the maximum working time for the stabilising binder used as specified in Table 290.101.

The material trimmed off shall be either cut to waste and if necessary, removed from site or, alternatively it may be transported to another location to be incorporated into a stabilised layer.

290.11 PRELIMINARY TRIAL

If specified in clause 290.17(c), the Contractor shall carry out a preliminary trial of the proposed stabilising operation.

The trial shall determine the:

- (a) effectiveness of the construction plant
- (b) number of passes of the stabilisation machine necessary to achieve uniform pulverisation and mixing
- (c) field moisture content required to achieve the specified compaction requirements
- (d) rolling routine required to meet the specified compaction requirements
- (e) uniformity of mixing of six random test holes.

The trial section shall be located within the Works area. If there are multiple earthwork material types being stabilised and/or different stabilising binders, separate trials will be required for each combination of material and stabilising binder.

The length of each trial section shall be between 100 and 200 metres over the full width of the area proposed for stabilisation, or other length as approved by the Superintendent.

HP Stabilisation shall not proceed outside the trial sections until the Superintendent has reviewed all aspects of the work. If the Specification requirements are not met for the trial, the Superintendent may direct that another trial be undertaken or that the work be re-stabilised and presented for re-assessment.

290.12 TEST ROLLING

All stabilised material shall be test rolled in accordance with Section 173 of the Specification. Any unstable areas detected by test rolling shall be rectified by the Contractor.

If the ~~Superintendent~~ Council considers that a completed stabilised earthworks layer has been affected by rain or damaged in some way before a successive layer is placed, further test rolling shall be carried out by the Contractor on the layer immediately prior to being covered by a succeeding layer.

290.13 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF STABILISING BINDER SPREADING RATE**(a) Mat or Tray System**

The average spreading rate of stabilising binder shall be ascertained by dividing the mass of the binder used by the area over which the binder has been spread. If the average spreading rate is less than specified, additional binder shall be spread over the surface to bring the average spreading rate up to at least the specified rate. The Contractor shall check the uniformity of the spreading of the binder at the frequency specified in Table 290.151.

The following procedure shall be used to determine the uniformity of the spreading rate:

- (i) place a minimum of three mats or trays with a plan area not less than 1 m² in total, in the path of the spreading vehicle at an equal spacing of not less than 25% of the length of the spreading run;
- (ii) divide the mass of binder deposited on each mat or tray by the plan area of the mat or tray;
- (iii) if the binder spreading rate so determined for any mat or tray is less than the specified rate by more than 10%, additional binder shall be spread over the part or all of the area over which the binder has been spread.

The Contractor shall check the uniformity of the spreading of lime at the frequency specified in Table 290.131 by placing a minimum of three mats or trays with a plan area not less than 1 m² in the path of the spreading vehicle at an equal spacing of not less than 25% of the length of the spreading run. The Lime Spreading Rate over each mat or tray shall be calculated by dividing the mass of lime deposited on each mat or tray by the plan area of the mat or tray. Where the Lime Spreading Rate so determined for any mat or tray is less than the specified rate by more than 10%, additional lime shall be spread over the part or all of the area over which the lime has been spread.

(b) Continuous Weighing System

The mass of the stabilising binder spread over the surface may be measured and recorded by a spreader fitted with a fully calibrated computerised electronic weigh scale system capable of continuously measuring and recording the mass of binder at intervals of not more than 100 m of forward travel. If requested by the ~~Superintendent~~ Council, the Contractor shall produce the print out of the actual binder spreading rate.

The Contractor shall have a current certificate of calibration for the computerised spreading equipment and shall produce evidence of the actual running spread rate when requested by the ~~Superintendent~~ Council.

290.14 REQUIREMENTS FOR ACCEPTANCE OF COMPACTION AND MATERIAL**(a) Lot Testing Requirements**

If Scale A or B compaction standard is specified in Table 290.171, compaction is to be accepted by density testing in lots of similar material and work. Unless otherwise specified, the maximum lot size shall be the area of work completed on the same day up to 4,000 m² provided that the whole of the lot is essentially a uniform material similar to material used for the relevant mix design applicable to the lot.

If the maximum binder working time requires a lot to be completed over multiple days, each daily sub-section shall be treated as a separate lot.

If the material is too variable to be able to assign a single maximum dry density for the lot, a separate reference density shall be determined for each test site.

~~If a compaction scale is not specified in Table 290.171, the Scale C compaction procedure shall be adopted.~~

The calculation of density ratio determined in accordance with RC 316.00 shall be based on Standard compactive effort of the laboratory prepared sample for reference density containing the design rate of the stabilising binder.

The work shall be assessed for compliance with ~~Scale A, B or C~~ requirements for testing and acceptance of compaction as specified in clauses 290.14(b) or (c).

For work to be tested for compliance with Scale A or Scale B requirements, the number of randomly selected test sites per lot shall be six, unless the option of clause 173.04(d) for testing of small areas is applicable.

Sampling for CBR testing shall be undertaken after field compaction, including samples for grading and PI.

(b) Lime Stabilised Material

For stabilised earthworks incorporating lime only, density testing shall be undertaken within 24 hours after completion of compaction. Unless otherwise directed by ~~the Superintendent~~ Council, remoulding of compacted specimens for determination of the laboratory reference density at each test site shall be completed within 24 hours after extraction of samples from the stabilised material.

The calculation of the characteristic or mean density ratio shall be based on Standard compactive effort. Lime stabilised material shall be compacted to comply with the requirements of Table 290.141.

For lime stabilised material, if the characteristic density ratio is not achieved, the material shall be immediately reworked and/or re compacted as specified in clause 290.10 to meet specification requirements.

Table 290.141 Lime Stabilised Material Compaction Requirements

Stabilised Material Type	Scale A	Scale B	Scale C
	Minimum Value of Characteristic Density Ratio (%)		
Lime Stabilised Material	99.0	98.0	Acceptance of work will be based upon on compaction plant to be used, compaction routine and a density monitoring procedure using a nuclear gauge (with three tests per lot to have a minimum mean value of 98.0%) and proof rolling as specified or agreed between the Superintendent and the Contractor.

(c) Cementitious Stabilised Material

(i) General

For stabilised earthworks incorporating any cementitious binders, density testing shall be undertaken within two hours after completion of compaction. The remoulding of extracted samples of stabilised material at each test site shall be completed within 12 hours after extraction from the stabilised layer.

The calculation of the characteristic or mean density ratio shall be based on Standard compactive effort. Cementitiously stabilised material shall be compacted to comply with the requirements of Table 290.142.

For cementitiously stabilised material, if the characteristic density ratio is not achieved, the Contractor shall submit a proposal to rectify the works, to the satisfaction of ~~the Superintendent~~ Council.

Table 290.142 Cementitious Stabilised Material Compaction Requirements

Stabilised Material Type	Scale A	Scale B	Scale C
	Minimum Value of Characteristic Density Ratio (%)		
Cementitious Stabilised Material	97.0	95.0	Acceptance of work will be based upon on compaction plant to be used, compaction routine and a density monitoring procedure using a nuclear gauge (with three tests per lot to have a minimum mean value of 95.0%) and proof rolling as specified or agreed between the Superintendent and the Contractor.

(ii) Determination of the Density Ratio

The determination of the reference density for the test site shall be within 24 hours of the time of addition of the cementitious binder and shall be in accordance with RC 316.00, utilising the appropriate Density Decay Correction Factors from (A) or (B) below.

The following procedure shall be used to determine the Density Ratio for each test site:

1. measure field density on completion of compaction
2. extract samples and transport to an offsite laboratory
3. determine the reference density for the laboratory compacted samples as soon as practicable but not exceeding 24 hours after addition of cementitious binder
4. calculate a density ratio at time t (DR_t) based on the results of items 1 and 3
5. determine the test site Density Ratio (DR) from:-

$$DR = DR_t \times DDCF$$

Where:

DR_t = Density Ratio calculated using the reference density determined at time (t)

DDCF = Density Decay Correction Factor determined from (A) or (B) below, as appropriate

- (A) For individual jobs using cementitious stabilisation of more than 20,000 m² where Type A material properties are required, or 50,000 m² where Type B material properties are required, the Contractor shall determine and apply a job specific DDCF determined in accordance with the relevant Test Method specified in RC 500.16.
- (B) For individual jobs using cementitious stabilisation of less area than (A) above, the Contractor shall select and apply the appropriate Density Decay Correction Factor from Table 290.143 corresponding to time (t), the binder type and the time of year that construction is being undertaken.

Table 290.143 Density Decay Correction Factors

Time (t) from Addition of Binder to Completion of Laboratory Compaction (hours)	Cementitious Binder (construction between October and April)		Cementitious Binder (construction between May and September)	
	Medium Setting	Rapid Setting	Medium Setting	Rapid Setting
1 to 2	1	1	1	1
2 to 4	1	0.994	1	1
4 to 6	0.982	0.987	1	0.988
6 to 10	0.954	0.964	0.969	0.967
10 to 18	0.932	0.946	0.963	0.952
18 to 24	0.910	0.931	0.957	0.938

(d) Material CBR Requirements

The initial lot of the stabilised material shall be tested to determine the Assigned CBR in accordance with RC 500.20. Unless otherwise approved by the Superintendent Council, sampling for CBR testing shall be undertaken after field compaction of the initial lot.

290.15 MINIMUM TESTING FREQUENCY

(a) General

The Contractor shall carry out testing at a frequency which is sufficient to ensure that the materials and work supplied under the Contract complies with the specified requirements but which is not less than that shown in Table 290.151.

(b) Frequency of Density Testing for Assessment of Compaction

The Contractor shall initially test every lot for acceptance of compaction in accordance with the requirements of the Specification. ~~Density testing of every lot shall continue until three consecutive lots of like material or work have achieved the specified standard when tested for the first time. The Contractor shall reduce the frequency of density testing to the minimum testing requirements specified after satisfying the above requirement.~~

~~If the Contractor has satisfied the above requirement and is density testing lots at the minimum test frequency and any lot fails to achieve the specified standard, the Contractor shall test all subsequent lots until three consecutive lots of like material or work have achieved the specified standard, at which time the frequency of density testing shall again be reduced to the minimum frequency.~~

For the purposes of this sub-clause, acceptance of compaction for small areas as defined in Section 173 will not be regarded as satisfying the initial testing requirements stated above.

Table 290.151 Frequency of Testing

Test	Clause	Minimum Frequency of Testing
Available Lime / Available Lime Index for Lime	290.05(a)	One test per production day at the point of manufacture.
Uniformity of Mixing	290.11(e)	For each compaction lot – visual inspection of six random test holes excavated for the full depth of the loose material after mixing of the binder prior to commencement of compaction.
Uniformity of Spreading Rate	290.13(a)	A mat or tray test (minimum of three mats or trays as specified in Clause 290.13(a) for each separate continuous spreading run except where calibrated load cell computerised spreading devices are fitted with a system to continuously monitor the binder spreading rate every 100 m.
Average spreading rate for stabilising binder	290.13(b)	Each continuous spreader run with no breaks or pauses in spreading.
Characteristic or Mean Density Ratio	290.14(b) and (c)	Every second compaction lot subject to the qualifying period as defined in Clause 290.14(b) or (c), as appropriate.
CBR of stabilised material (Sampled after stabilising binder has been added then re-compacted in the laboratory within working times specified in Clause 290.10(i))	290.14(d)	Every second compaction lot or a minimum of one per 8,000 m ² of stabilised earthworks. First lot to set assigned value, needs 6 tests.

290.16 CURING AND PROTECTION OF COMPACTED LAYERS

The surface of the compacted layer shall be kept continually moist, and free from contamination until the succeeding layer is placed.

- *** If the stabilised material overlies an expansive material with a percentage swell exceeding 2.5%, the stabilised material shall be maintained at a minimum characteristic moisture ratio of ##:90%.

290.17 SCHEDULE OF DETAILS

- *** (a) ~~Job Details and Design Requirements ##(strikethrough this clause if the design distribution rates of available lime and design spreading rate for cementitious binder if applicable are to be specified in Clause 290.17(b)):~~

~~Job details and design requirements are shown in Table 290.171.~~

Table 290.171 Job Details (Contractor Design) ##(delete all # symbols. Limit after # symbol may be changed or deleted if not required):

Road	Location		Minimum CBR Strength	Maximum Swell %	Maximum Permeability m/sec	Minimum Depth of Stabilisation (mm)	Compaction Assessment (Scale A, B or C)
	From	To					
##:	##:	##:	##:	##:1.5%	##:5 × 10 ⁻⁹	##:	##:

- *** (b) ~~Job Details and Design Distribution Rates ##(strikethrough this clause if the contractor is to determine the design distribution rate of available lime or cement or cementitious binder, as applicable, from the job details and design requirements specified in Clause 290.17(a) above):~~

~~Job details and Design Distribution Rates of Available Lime are shown in Table 290.172.~~

Table 290.172 Design Distribution Rates of Stabilising Binder (VicRoads Design) ##(insert values as appropriate and delete all # symbols):

Road	Location		Design Distribution Rate of Available Stabilising Binder (kg/m ²)	Minimum Depth of Stabilisation (mm)	Compaction Assessment (Scale A, B or C)
	From	To	## Binder Type to be Nominated*		
##:	##:	##:	##:	##:	##:

* For lime, this figure is to be used to determine the Lime Spreading Rate in the formula given in Clause 290.10(d) once the Available Lime Index of the lime to be used on the job is known.

— In the paragraph below, strikethrough inapplicable word(s)

—— In the table, nominated binder type as required:

- *** (c) A preliminary trial ##is/: is not required.

SECTION 304 - UNBOUND FLEXIBLE PAVEMENT CONSTRUCTION

~~##This section cross-references Sections 173, 175, 180, 204, 801, 811, 812, 818 and 820.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent:~~

~~## (include the option to use crushed concrete as a specified alternative to the use of Class 3 or Class 4 pavement materials manufactured from virgin rock, shown on the drawings as necessary):~~

304.01 DESCRIPTION

This section covers the requirements for the placement of gravel, sand, soft or ripped rock, crushed rock, ~~crushed scoria~~ or crushed concrete pavement materials, for the construction of unbound flexible pavement layers.

304.02 DEFINITIONS

Unbound Flexible Pavement

A pavement consisting of an unbound granular base and subbase materials, with a thin asphalt or sprayed bituminous seal surfacing.

Pavement Course

For the purpose of this specification, the pavement base, upper subbase and lower subbase shall each be termed a pavement course. A pavement course may comprise one or more layers.

Base

One or more layers of material usually constituting the uppermost structural element of a pavement on which the surfacing may be placed, which may be composed of crushed rock, or other materials as specified in Clause 304.03. Typically, base is the top 200 mm of the pavement or the pavement base thickness as specified or shown on the drawings.

Subbase

The pavement material constructed on the subgrade to the underside of the base either for the purpose of making up the additional pavement thickness required, or to provide a working platform. The subbase may be constructed of the same material type or may comprise two different material types as follows:

- (a) Upper Subbase - the better quality material immediately below the base; and
- (b) Lower Subbase - the lower quality material immediately above the subgrade.

If only a single layer of subbase is specified or shown on the drawings, the specified requirements for subbase material shall conform to the requirements of an upper subbase material.

Subgrade

Subgrade is the trimmed or prepared portion of the formation on which the pavement including shoulders is constructed.

Segregated Area

An area of a pavement layer, which does not comply with the grading requirements of Clause 304.10. Typically this is where the finer material is either not present or has settled to the bottom of the layer leaving the coarser materials at the surface.

304.03 MATERIALS

The Contractor shall be responsible for the procurement of sufficient specified material to complete the work. The Contractor shall supply details demonstrating compliance of the materials with Section 801 and the following sections as relevant: ~~##(strike through whichever is not relevant):~~

Section 811 Gravel, Sand and Soft or Ripped Rock for Pavement Base and Subbase

Section 812 Crushed Rock for Pavement Base and Subbase

~~Section 818 Crushed Scoria for Pavement Base and Subbase~~

Section 820 Crushed Concrete for Pavement Subbase and Light Duty Base.

Where a crushed product is specified in accordance with Sections 811, 812, ~~818~~ and 820, mixes registered by VicRoads as 'General' may be used in the construction of roadworks. Mixes registered as 'Conditional' may be used provided the conditions are complied with and written approval of Council has been obtained. Mixes registered as 'Experimental' shall only not be used ~~with the written permission of the Superintendent.~~

Water added to the pavement material shall be clean and substantially free from detrimental impurities such as oils, salts, acids, alkalis and vegetable substances. Water shall contain a maximum of 1000 mg/L of suspended solids. Water supplied from sources where dissolved salts are known or likely to be present shall be tested for electrical conductivity prior to use. The electrical conductivity shall not be more than 3500 µS/cm. Water sources classified by the relevant Water Authority as potable water shall be exempt from this requirement.

304.04 SUBGRADE PREPARATION

Prior to placing subbase material, the subgrade shall meet the requirements of Section 204.

304.05 DELIVERY DOCKETS

~~Where material is scheduled for measurement by loose volume in delivery vehicles or by mass, a delivery docket for each load shall be issued to the Superintendent at the point of delivery.~~

~~Where material is measured by other means and for Lump Sum Contracts, the~~ The Contractor shall make delivery dockets available for inspection on request by the Superintendent Council.

Delivery dockets shall show:

- (a) name of the supplier, and location of quarry, pit or plant;
- (b) docket number;
- (c) name of user;
- (d) project name and location (or contract number);
- (e) registered number or fleet number of the vehicle;
- (f) date and time of loading;
- (g) nature and source of material;
- (h) empty and loaded masses of the vehicle (where material is scheduled for measurement by mass);
- (i) loose volume in delivery vehicle (where material is scheduled for measurement by loose volume);
- (j) supplier's stockpile identification number if applicable; and
- (k) legible signature of person receiving the material at the point of delivery.

304.06 CONFORMITY WITH DRAWINGS

All pavement courses shall, after compaction, be finished to smooth and uniform surfaces, free of segregated areas, and conforming to the limits for level, line, grade, thickness and cross section shown on the drawings or as specified.

Any material that has been compacted and then trimmed from the compacted surface to conform to the correct level or thickness as shown on the drawings shall not be re-used in the pavement construction without the approval of the Superintendent Council.

(a) Width and Alignment

The width of each side of the pavement shall not be less than the specified offset width or more than 50 mm outside the specified offset width when measured at right angles from the centre line or design line.

(b) Surface Level of Pavement Courses

The surface level of the pavement courses shall be measured in accordance with the requirements of Section 173 and every test lot, ~~plus one test in each intersection and court bowl~~ shall meet either Scale A, B or C requirements as specified in ~~Clause 304.12~~ Table 304.064 or as otherwise specified on Drawings.

The maximum lot size for measurement and assessment of surface level shall be ~~4000~~ 500 m² but may be increased to match the maximum lot size for assessment of compaction specified in ~~Table 304.111~~.

Where pavement is to be constructed to the lip level of kerb and channel, it shall be constructed flush with the lip of the channel or not more than 5 mm above.

(i) Scale A and B Surface Level Requirements

Each level measurement shall be taken at random locations over the area of the lot in accordance with the VicRoads Test Method and the number of measurements taken within each lot shall not be less than the number specified in Table 304.061.

The mean and standard deviation of the departures from the design surface level for the pavement courses at their respective levels within each lot shall meet the requirements of Table 304.062.

Table 304.061 Minimum Number of Level Measurements per Lot

Scale of Surface Level Measurement	Minimum Number of Measurements Per Lot
Scale A	80
Scale B	40

Table 304.062 Surface Level Tolerances for the Pavement Courses

Scale of Level Measurement	Lower Subbase		Upper Subbase		Base	
	\bar{x} Range (mm)	Max. S (mm)	\bar{x} Range (mm)	Max. S (mm)	\bar{x} Range (mm)	Max. S (mm)
Scale A	+6 to -10	10	+4 to -8	8	± 5	8
Scale B	+8 to -16	15	+ 6 to -12	13	± 8	10
Notes: <ol style="list-style-type: none"> \bar{x} is the mean value of all level readings taken in the lot S is the standard deviation of all level readings taken in the lot A negative value designates a measured departure below the design level and positive value designates a surface level above the design level 						

Where the surface does not meet the relevant surface tolerance in Table 304.062, the Contractor shall undertake further work to bring the surface into the specified tolerance and shall re-survey the test lot in accordance with this clause. The Contractor shall accept all costs associated with the necessary additional works and survey.

For Scale A and Scale B level requirements, the Superintendent may agree to accept a lot which does not conform with the limits of Table 304.062 at a reduced payment subject to the lot not exceeding either of the limits specified in Table 304.063. Where the Superintendent agrees to accept the lot, payment for the work will be reduced as shown in Table 304.063. The value of the lot of work shall be reduced as calculated from the percentages specified in Table 304.063 and the unit rates for pavement construction as specified in Clause 304.12(b).

Table 304.063 Payment Deduction for Surface Level

Variation	Payment Reduction
Mean (\bar{x}) exceeding the specified limit up to a maximum of 25% of the permitted range	8% plus 4% reduction for each 1 mm of \bar{x} outside the tabulated limit
Standard Deviation (S) exceeding the specified limit up to a maximum of 35% of the permitted range	8% plus 4% reduction for each 1 mm of S greater than the tabulated limit
If both \bar{x} and S vary by more than the specified limit, the payment reduction shall be the sum of the payment reductions for both \bar{x} and S.	

(ii) Scale C Surface Level Requirements

Surface level measurement shall be undertaken in accordance with the procedure specified in Section 173.

The surface level of the pavement courses shall comply with the requirements of Table 304.064.

Table 304.064 Level Tolerances at the Surface of Pavement Courses

Lower Subbase (mm)	Upper Subbase (mm)	Base (mm)
+ 15 to – 25	+ 10 to - 25	± 10 ± 5

(c) Thickness of Pavement Layers

In addition to complying with pavement layer surface tolerances specified in Clause 304.06(b), the following tolerances shall apply to the thickness of any pavement layer:

- (i) the subbase course shall be not less than the specified thickness by more than 15 mm;
- (ii) the base course shall be not less than the specified thickness by more than 10 mm and the average thickness of base over every 100 m section, over the full carriageway width, shall be not less than the specified thickness;
- (iii) the combined thickness of subbase and base courses shall be not less than the specified thickness by more than 15 mm.

~~Where the Contract does not require design finished surface level control but specifies a pavement composition or a minimum resheet thickness only, the Contractor shall construct the pavement to comply with the requirements of thickness of each pavement layer as specified in this sub-clause. The tolerance requirements of Clause 304.06(b) shall not apply.~~

(d) Shape

No point on the surface of any pavement layer shall vary by more than 8 mm from a 3 m straight edge, or 10 mm from a 6 m straight edge, placed in any direction.

At no location shall water pond on the surface of any pavement layer.

~~*** (e) Rideability ##(Note to specification author – include this clause and Section 180 where Rideability targets are required – Note that if a rideability requirement is included, the tolerance requirements of Clause 304.06(b) may not apply and can be struck out):~~

~~— In addition to the above requirements for surface tolerance, the finished surface shall satisfy the requirements specified in Section 180.~~

304.07 JOINTING

The layout of joints shall conform to the following requirements:

- (a) material shall be spread in such a manner as to minimize the number of joints;
- (b) for all pavement layers, transverse joints in adjoining paver runs shall be offset by not less than 2 m;
- (c) transverse joints shall be offset from one layer to the next by not less than 2 m;
- (d) longitudinal joints shall be offset from one layer to the next by not less than 150 mm;
- (e) longitudinal joints shall be located within 300 mm of the planned position of traffic lanes lines or within 300 mm of the centre of a traffic lane.

The exposed end of each lot and the exposed edges of any part width construction shall be kept moist until spreading and compaction has been completed over the entire layer.

304.08 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF COMPACTION

(a) General

Pavement lots shall be tested for compliance with the specified compaction scale at the frequency specified in Clause 304.11, using the appropriate test methods listed in Section 175 and VicRoads Code of Practice RC500.05.

Material during compaction shall have a moisture content of not less than 85% of optimum. After completion of compaction of a layer, the moisture content of the material in the layer shall be maintained at a moisture content of not less than 85% of optimum until test rolling has been completed. All segregated areas shall be rectified as construction proceeds, prior to the completion of compaction and in such a way as to mitigate the potential for segregation to re-occur.

(b) Material of Nominal Size 40 mm or Less

Material shall be spread and compacted such that the material is properly mixed both transversely and longitudinally to produce a homogeneous material for each lot.

Material having a nominal size after compaction of 40 mm or less shall be compacted to comply with the following requirements:

- (i) The calculation of density ratio shall be based on tests performed using Modified compactive effort. The work shall be assessed for compliance with ~~Scale A, Scale B or Scale C~~ requirements for testing and acceptance of compaction as specified in ~~Clause 304.12 and as provided in Tables 304.081. and 304.082.~~
- (ii) A lot shall consist of a single layer of work ~~and its size shall not exceed that given in Table 304.144.~~
- (iii) For work to be tested for compliance with Scale A or Scale B requirements, the number of tests per lot shall be six. For work to be tested for compliance with Scale C requirements, the number of tests per lot shall be three.
- (iv) All pavement layers shall be compacted to withstand rolling and shall be test rolled in accordance with Section 173, prior to acceptance of the layer. For pavement construction, any lot that has a surface area less than 500 m² may be treated as a small area and tested in accordance with Section 173.

The Contractor shall provide for the Superintendent Council to be present during all test rolling.

- (v) The maximum thickness of any pavement base layer shall not exceed 150 mm and the maximum thickness of any subbase layer shall not exceed 200 mm.
- (vi) The minimum thickness of any pavement layer shall be 4 times the nominal size of the material.

Table 304.081 Acceptance Limits for Scale A and Scale B Standards of Compaction

Compaction Scale	Characteristic Density Ratio % (six tests)			
	Lower Subbase Layers	Upper Subbase Layers	Base Layers	
			Layer directly beneath the Bituminous Surfacing	Other Layers
A	Not less than 98.0	Not less than 98.0	Not less than 100.0	Not less than 99.0
B	Not less than 97.0	Not less than 97.0	Not less than 98.0	Not Less than 98.0

Table 304.082 Acceptance Limits for Scale C Standard of Compaction

Compaction Scale	Mean Value of Density Ratio % (three tests)	
	Subbase Layers	Base Layers
C	Not less than 98.0	Not less than 100.0

- (c) Material of Nominal Size Greater than 40 mm

The first lot shall be placed as a trial section. Following acceptance of the trial section, the Contractor shall then confirm the moisture control and compaction procedure and submit the procedure to the Superintendent Council for review and record.

~~The Superintendent Council may require that further trial sections be constructed to verify that the proposed compaction routine is acceptable. No additional payment will be made for any such request.~~

Acceptance of work as far as compaction is concerned will be based on compliance with the accepted moisture control, compaction procedure and test rolling carried out in accordance with Section 173.

HP

The Contractor shall provide for the Superintendent Council to be present during all test rolling.

Unstable areas identified by test rolling shall be rectified by the Contractor.

Prior to any layer being covered by a successive layer, ~~the Superintendent Council~~ may require further test rolling to confirm that the layer is sound.

304.09 MAINTENANCE OF COMPACTED LAYERS

The surface of any compacted pavement layer or prepared subgrade shall be maintained in such a way as to minimise dust, prevent ravelling, erosion, deformation or any other damage to the layer resulting from environmental conditions, traffic or construction activities. The layer shall be kept free from contamination until any subsequent pavement work under the Contract is commenced or ~~the Superintendent Council~~ accepts and takes responsibility for that part of the Works.

304.10 POST COMPACTION REQUIREMENTS FOR PAVEMENT MATERIAL

~~If specified in Clause 304.10(c) or Clause 304.10(d), the following completion of compaction Council may request testing, material shall be tested for post-compaction grading or Plasticity Index (PI), at the frequency specified in Clause 304.11 for the appropriate Scale of Testing specified in Clause 304.12(a).~~

The test samples to be used for post-compaction grading and PI tests shall be a combined sample made up from six randomly selected increments extracted from the lot of pavement construction being assessed.

(a) Assessment of Post-compaction Grading

Assessment of post-compaction grading shall be based on a sieve analysis on a sub-sample of the combined sample. The post-compaction grading shall comply with the requirements of Tables 304.101. or 304.102.

(b) Assessment of Post-compaction Plasticity Index (PI)

The assessment of post-compaction PI shall be based on the mean value of a pair of test results determined from two single results from separate sub-samples taken from the combined sample. The mean PI shall comply with the limits on PI specified in Table 304.103 or such value as approved by the Superintendent Council to meet the permeability requirement specified in Section 812.

in (c) and (d) below, delete # symbols and strikethrough inappropriate phrases:

*** (c) Post-compaction grading testing ##is required: ##is not required: (refer to Clause 304.11(c))

Where post-compaction grading testing is required, the sample shall be taken from the same sample site as the compaction testing.

*** (d) Post-compaction Plasticity Index testing ##is required: ##is not required: (refer to Clause 304.11(c))

Where post-compaction Plasticity Index testing is required, the sample shall be taken from the same sample site as the compaction testing and the post-compaction grading testing (if required).

Table 304.101 Post-Compaction Grading Requirements for Crushed Materials

Sieve Size (mm)	Post-Compaction Grading Limits (% Passing by Mass)		
	Class 1 or Class 2 Crushed Rock Crushed Scoria Base Class CC2 Crushed Concrete	Class 3 Crushed Rock Crushed Scoria Upper Subbase Crushed Concrete Class CC3	
	Nominal Size (mm)	Nominal Size (mm)	
	20	20	40
53.0	-	-	100
37.5	-	-	95 - 100
26.5	100	100	75 - 95
19.0	95 - 100	95 - 100	64 - 90
13.2	78 - 92	75 - 95	-
9.5	63 - 83	60 - 90	42 - 78
4.75	44 - 64	42 - 76	27 - 64
2.36	30 - 49	28 - 61	20 - 51
0.425	14 - 23	14 - 29	10 - 24
0.075	6 - 12	6 - 14	6 - 13

*** **Table 304.102 Post-compaction Grading Requirements for Gravel, Sand, and Soft or Ripped Rock Base and Subbase Materials**

in the table below, delete all # symbols, even where no value is to be specified:

Sieve Size (mm)	Post-compaction Grading Limits (% Passing by Mass)			
	Base		Upper Subbase	
	Natural Sands or Gravel	Ripped Rock	Natural Sands or Gravel	Ripped Rock
75.0				##:
53.0				-
37.5		##:		##:
26.5	##:	-	##:	-
19.5	##:	-	##:	-
9.5	##:	-	##:	-
4.75	##:	##:	##:	##:
2.36	##:	-	##:	-
1.18	##:	-	##:	-
0.425	##:	##:	##:	##:
0.075	##:	##:	##:	##:

*** **Table 304.103 Post-Compaction Requirements for Plasticity Index**

in the table below, delete all # symbols - Limits after # symbols may be changed if required:

Material	Plasticity Index	
	Minimum	Maximum
Class 1 Crushed Rock	2	6
Class 2 Crushed Rock	0	6
Class 3 Crushed Rock	0	10
Gravel, Sand or Ripped Rock Base Material	2	##:6
Gravel, Sand or Ripped Rock Upper Sub-base Material	2	##:12

304.11 MINIMUM FREQUENCY OF TESTING

(a) General

The Contractor shall carry out compaction density testing and post-compaction grading and PI testing at a frequency sufficient to ensure that work performed under the Contract complies with the specified requirements and / or to Council satisfaction, ~~but shall not be less than that shown in Table 304.111.~~

~~The minimum test frequency specified in Table 304.111 shall not apply to small areas as defined in Section 173. In this case, every lot shall be tested separately for compliance with the specified requirements.~~

If the nature of material in any lot being placed has visibly altered when compared to previous lots placed, ~~the Superintendent~~ Council may require additional testing to be undertaken to confirm that the lot complies with the specified requirements for post-compaction grading and PI. ~~No additional payment will be made for this testing.~~

(b) Compaction

The Contractor shall undertake compaction testing at a rate of one lot test for every 500m² or part thereof of work, plus one additional test in each intersection and court bowl.

~~The Contractor shall initially test every lot for acceptance of compaction in accordance with the requirements of the Specification. Testing of every lot shall continue until three consecutive lots of like material and/or work have achieved the standards specified in Clauses 304.08 and 304.10 when tested for the first time. The Contractor may reduce the frequency of compaction testing to the minimum test frequency as specified in Table 304.111 after satisfying this requirement.~~

- ~~— The Contractor may continue to test at the minimum frequency until such time as a lot fails to achieve the specified requirements. All subsequent lots shall be tested until three consecutive lots of like material and work have achieved the specified standard, at which time the frequency of testing may revert to the minimum test frequency.~~
- ~~— If the Contractor is testing at the minimum frequency and any test lot does not meet specification requirements, the Superintendent may require any previous untested lots between the last lot to be tested and the failed lot to be tested. This testing shall be carried out at no additional cost to VicRoads.~~

(c) ~~Post-compaction Grading and Plasticity Index (PI)~~

~~— (i) Scale A Requirements for Post Compaction Grading and PI Testing~~

- ~~— Where testing is specified in Clause 304.10(c) or (d) and Clause 304.12 requires it to be Scale A, all pavement layers shall be tested for post-compaction grading and PI at the frequency specified in Table 304.111.~~

- ~~— The first lot of each pavement layer shall be tested for post-compaction grading and PI. If the lot satisfies the requirements specified in Clause 304.10(a) and (b) as applicable, the Contractor may test at the minimum frequency as specified in Table 304.111. The Contractor shall immediately notify the Superintendent of any lot that does not meet the specified requirements and any subsequent lot shall be tested as if it were the initial lot. If any lot meets the specified requirements but is reworked to comply with the specified compaction requirements, it shall be retested for compliance with specified requirements.~~

- ~~— If the Contractor is testing at the minimum frequency and any test lot does not meet specification requirements, the Superintendent may require the testing of the post-compaction grading and PI of all lots constructed after the last tested lot. This testing shall be carried out at no additional cost to VicRoads.~~

~~— (ii) Scale B Requirements for Post Compaction Grading and PI Testing~~

- ~~— Where testing is specified in Clause 304.10(c) or (d) and Clause 304.12 requires it to be Scale B, the first lot of each pavement course shall be tested for post-compaction grading and PI.~~
- ~~— If the first lot each pavement course satisfies the specified post compaction requirements in Clause 304.10(a) and (b), as applicable, no further post-compaction testing will be required for that pavement course.~~

- ~~— **If the first lot does not meet the requirements specified in Clause 304.10(a) and (b), the Contractor shall then seek approval from the Superintendent before work proceeds.**~~

~~— (iii) Scale C Requirements for Post Compaction Grading and PI Testing~~

- ~~— Post compaction grading and PI testing is not required.~~

*** **Table 304.111 Maximum Lot Size and Minimum Frequency of Testing for Compaction, Post-compaction Grading and PI (after passing the minimum number of qualifying lots)**

in the table below, the limit after # symbol may be changed if required

in the table below, at the * symbol, strikethrough if further PI testing is not required after the first lot is accepted for PI:

Pavement Layer	Maximum Allowable Lot Size for a Single Layer of Work	Minimum Frequency of Testing for Compaction	Minimum Frequency of Testing for Scale A Post-compaction Grading	Minimum Frequency of Testing for Scale A Post-compaction PI
Upper Base Layer	The lesser of ##:4000 m ² or one day's production	One per ##:2 lots	One per ##:2 lots	One pair per ##:4 lots
Lower Base Layer	The lesser of ##:4000 m ² or one day's production	One per ##:2 lots	One per ##:2 lots	* One pair per ##:8 lots
Upper Subbase	The lesser of ##:4000 m ² or one day's production	One per ##:2 lots	One per ##:4 lots	* One pair per ##:8 lots
Lower Subbase	The lesser of ##:4000 m ² or one day's production	One per ##:2 lots		

304.12 SCHEDULES OF DETAILS

*** (a) Requirements for Testing and Acceptance of Surface Level Measurement, Compaction and Post-compaction Gradients and PIs (Clauses 304.06, 304.08, 304.10 and 304.11)

in the table below, delete all # symbols and insert required information:

Table 304.121 Testing Levels

Roadway	Road Chainage / Location	Scale of Surface Level Measurement (A, B or C)	Scale for Assessment of Compaction (A, B or C)	Scale for Assessment of Post-Compaction Grading and PI (A, B or C)
##:	## to ##:	##:	##:	##:

Where for any location a specific scale has not been nominated, Scale A shall apply.

*** (b) Basis for Price Reduction for Departure from Specified Surface Level (Clause 304.06(b)(i))

in the table below delete all # symbols and insert required information:

Table 304.122 Rates for Price Reduction

Location	Pavement Course	Unit Price \$/m ²
##:	Upper Subbase	##:
	Lower Subbase	##:
	Base	##:
##:	Upper Subbase	##:
	Lower Subbase	##:
	Base	##:

SECTION 306 - CEMENTITIOUS TREATED PAVEMENT SUBBASE

~~##This section cross-references Sections 173, 175 and 815.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent. DELETE THIS NOTE FROM FINAL DOCUMENT.~~

~~###Include the option to use crushed concrete as a specified alternative to the use of Class 3 or Class 4 pavement materials manufactured from crushed rock. Show on the drawings as necessary. DELETE THIS NOTE FROM FINAL DOCUMENT:~~

306.01 DESCRIPTION

This section covers the requirements for the delivery, spreading and compaction of plant mixed crushed rock and recycled crushed concrete for the construction of pavement subbase, treated with cementitious binder to produce a modified or bound subbase. This section is to be read in conjunction with Section 815 *Cementitious Treated Crushed Rock for Pavement Subbase*.

306.02 DEFINITIONS

Cementitious Binder

A cementitious material capable of being uniformly mixed into a granular pavement material to bind the particles together to increase its strength. Cementitious binders include Portland cement Type GP or blended cement Type GB, hydrated lime, quicklime, or a blend of ground granulated blast furnace slag (GGBFS), hydrated lime, fly ash, alkali activated slag or other pozzolanic material supplied in accordance with this specification.

Maximum Allowable Working Time

The maximum allowable working time for the cementitious binder as specified or as determined in accordance with the relevant Test Method or Code of Practice.

Pavement Design Modulus

The presumptive modulus used as the basis for the mechanistic design of a bound pavement with a bound cementitious treated crushed rock or crushed concrete subbase.

Working Time

The time required to transport, place, compact and trim the pavement layer after the cementitious binder is added at the mixing plant.

306.03 CONFORMITY WITH DRAWINGS

Pavement subbase shall be finished to a smooth and uniform surface and shall, after compaction, conform within the following limits to the levels, lines, grades, thicknesses and cross sections as specified or shown on the drawings.

(a) Width and Alignment

The width of pavement measured on each side of the centreline or design line shall not deviate by more than 50 mm from the designed offset when measured at a right angle.

(b) Surface Level of Subgrade and Pavement

The surface level of the subgrade and pavement courses shall be measured in accordance with the requirements of Section 173 and every test lot, plus one test in each intersection and court bowl shall meet ~~either~~ Scale A, B or C requirements as specified in Clause 306.12 or as otherwise specified on Drawings.

The maximum lot size for measurement and assessment of surface level shall be ~~4000~~ 500 m².

–(i) Scale A and B Surface Level Requirements

Each level measurement shall be taken at random locations over the area of the lot in accordance with the VicRoads Test Method and the number of measurements taken within each lot shall not be less than the number specified in Table 306.031.

The mean surface level and the variation in surface level for the subgrade, and pavement courses within each lot shall meet the requirements of Table 306.032.

Table 306.031 Minimum Number of Level Measurements per Lot

Scale of Surface Level Measurement	Minimum Number of Measurements Per Lot
Scale A	80
Scale B	40

Table 306.032 Average Surface Level Tolerances for the Subgrade and Cementitious Treated Subbase

Scale of Level Measurement	Subgrade		Cementitious Treated Subbase	
	\bar{x} Range (mm)	Max. S (mm)	\bar{x} Range (mm)	Max. S (mm)
Scale A	+5 to –15	12	+4 to -8	8
Scale B	+5 to –25	15	+6 to -12	13
Notes: <ol style="list-style-type: none"> \bar{x} is the mean value of all level readings taken in the lot S is the standard deviation of all level readings taken in the lot A negative value designates a measured departure below the design level and positive value designates a surface level above the design level. 				

~~For Scale A and Scale B level requirements, the Superintendent may accept a lot which does not conform with the limits of Table 306.032 at a reduced payment, in which case payment for the work will be reduced as shown in Table 306.033. The value of the lot of work shall be calculated from the unit rates for pavement construction as specified in Clause 306.12(b).~~

Table 306.033 Payment Deduction for Surface Level

Variation	Payment reduction
Mean (\bar{x}) exceeding the specified limit up to a maximum of 25%	8% plus 4% reduction for each 1 mm of \bar{x} outside the tabulated limit
Standard Deviation (S) exceeding the specified limit up to a maximum of 35%	8% plus 4% reduction for each 1 mm of S greater than the tabulated limit
Note: If both \bar{x} and S vary by more than the specified limit, the payment reduction shall be the sum of the payment reductions for both \bar{x} and S.	

(ii) Scale C Surface Level and Thickness Requirements

Surface level measurement shall be undertaken in accordance with the procedure specified in Section 173 - Examination and Testing of Materials and Work (Roadworks).

The surface level of the subgrade and subbase shall comply with the requirements of Table 306.034.

Table 306.034 Level Tolerances at the Surface of Subgrade and Subbase

Subgrade (mm)	Subbase (mm)
+ 15 to – 25	+ 10 to - 25

(c) Shape

No point on the prepared surface of the subgrade shall lie more than 12 mm below a 3 metre straight edge placed on the pavement in any direction.

No point on the surface of the cementitious treated subbase layer shall vary by more than 8 mm from a 3 metre straight edge, or 10 mm from a 6 metre straight edge, placed in any direction.

Water shall not pond on the surface of the cementitious treated subbase.

306.04 MATERIALS

The Contractor shall supply all materials required to construct the cementitious treated pavement subbase. The supply of Cementitious Treated Crushed Rock or Cementitious Treated Crushed Concrete shall comply with the requirements of Section 815.

306.05 MOISTURE CONTENT

The moisture content of the material at the time of spreading and compaction, expressed as a percentage by mass, shall be within plus 0.5% and minus 1.0 % from the Modified optimum moisture content.

306.06 WATER

Except for the purpose of curing, no water shall be added to the cementitious treated material.

Water shall be clean and substantially free from detrimental impurities such as oils, salts, acids, alkalis and vegetable substances. Water sources shall be tested for electrical conductivity and pH, in accordance with the current Australian Standards as listed in Section 175 *Referenced Documents for Standard Specifications for Roadworks and Bridgeworks* prior to use. The electrical conductivity shall not be more than 3500 $\mu\text{S}/\text{cm}$ and pH within the range of 6 to 10 unless otherwise approved. Water sources classified by the relevant water authority as potable water shall be exempt from this requirement. Water sources shall be tested at a maximum of twelve monthly intervals or when the nature of the water source has changed. The use of reclaimed water will require the approval of the Superintendent Council and shall conform to the VicRoads guidelines for reclaimed water as listed under other referenced documents in Section 175.

306.07 DELIVERY

(a) Delivery Vehicles

Delivery vehicles shall have bodies fitted with covers of a suitable material to prevent loss of moisture during transport. Vehicles used for delivery of material to the hoppers of pavers shall have bodies or discharge equipment which will enable the load to be discharged direct into the hopper without spillage and in such a way that segregation will be minimised.

(b) Delivery Dockets

Delivery dockets shall show:

- (i) name of the supplier, and location of plant;
- (ii) docket number;
- (iii) name of user;
- (iv) project name and location (or contract number);
- (v) registered number or fleet number of the vehicle;
- (vi) date and time of loading;
- (vii) nature and source of material;
- (viii) empty and loaded masses of the vehicle (where material is scheduled for measurement by mass);
- (ix) loose volume in delivery vehicle.

~~Where material is scheduled for measurement by loose volume in delivery vehicles or by mass, a delivery docket for each load shall be issued at the point of delivery.~~

~~Where material is measured by other means and for Lump Sum Contracts, the~~ The Contractor shall make delivery dockets available for inspection on request.

306.08 JOINTING

The layout of joints shall conform to the following requirements unless otherwise approved by the ~~Superintendent~~ Council:

- (a) material shall be spread in such a manner as to minimise the number of joints;
- (b) in any layer, transverse joints in adjoining paver runs shall be offset by not less than 2 m;
- (c) transverse joints shall be offset from one layer to the next by not less than 2 m;
- (d) longitudinal joints shall be offset from one layer to the next by not less than 150 mm;
- (e) longitudinal joints shall be located within 300 mm of the planned position of traffic lane lines or within 300 mm of the centre of a traffic lane.

If approval is given to depart from the joint location specified in 306.08(a) to (e), the Contractor shall record of the location of these joints.

The edge of any paver run shall be kept moist until spreading and compaction have been completed in adjacent paver runs.

Longitudinal and transverse joints shall be made where specified, or at the end of each day's work, or where spreading operations have been halted for a period in excess of the maximum allowable working time for the binder as specified in Clause 306.09 and Table 306.091. If the binder is not one of the binders listed in Table 306.091 the allowable working time for the binder shall be determined in accordance with the VicRoads Test Method.

Joints shall be made in a careful manner and shall be prepared immediately prior to the recommencement of spreading operations by cutting back the edge of previously laid material to a clean vertical face in compacted material of the full specified layer thickness. Longitudinal joints shall be constructed parallel to the centre line of the carriageway and transverse joints at right angles to the centre line.

Material cut during the preparation of joints shall be removed from site.

The faces of all joints shall be thoroughly wetted immediately before spreading new material.

The level and shape of the surface at all joints shall be within the limits specified in Clause 306.03.

306.09 COMPACTION PROCEDURE AND REQUIREMENTS FOR TESTING AND ACCEPTANCE**(a) General**

The cementitious treated subbase material shall be placed, trimmed to level and fully compacted within the maximum allowable working time specified in Table 306.091 depending on the binder type and the time of year the subbase is being placed.

HP If the Contractor proposes to use an alternative cementitious binder to those included in Table 306.091, laboratory test results shall be produced to the Superintendent Council showing that the binder satisfies the required working time determined in accordance with the VicRoads Test Method. In addition, the cementitious treated material using the alternative binder shall meet specified strength requirements.

Table 306.091 Maximum Allowable Working Time after Mixing for Common Cementitious Binders

Cementitious Binder	Maximum Allowable Working Time (hours)	
	Construction between October and April ⁽¹⁾	Construction between May and September
Rapid Setting Type GP Cement	2	3
Medium Setting Type GB Cements Cement/Slag blend (50% to 60% cement content) Cement/Fly ash blend (70% to 80% cement content) Cement/Slag/Fly ash blend (55% to 65% cement content)	3	5
Slow Setting Slag/Lime Blend and other slow setting Supplementary Cementitious Blends	8	12
Note 1: If the ambient temperature within the period from October to April on any day is less than 15°C, the May to September maximum allowable working times may be applied.		

On completion of compaction, any segregated areas shall be rectified.

The calculation of density ratio shall be based on Modified compactive effort.

The work shall be assessed for compliance with Scale A or Scale B requirements for testing and acceptance of compaction as specified in Clause 306.12 and as provided in Clauses 306.09(b) and (c).

For work to be tested for compliance with Scale A requirements, the number of tests per lot shall be six.

For work to be tested for compliance with Scale B requirements, the number of tests per lot shall be three.

A lot shall consist of a single layer of pavement material placed on the same day and all lots shall be tested for compliance with the requirements of this section. The maximum lot size shall not exceed 4000 500 m².

(b) Scale A Requirements for Testing and Acceptance of Compaction

The work represented by the lot will be accepted as far as compaction is concerned if the characteristic value of density ratio of the lot is not less than 96% or as otherwise specified on Drawings.

If the characteristic value of density ratio of the lot is less than 96.0% but greater than or equal to 92% the work represented by the lot may be accepted but the method of rectification or redesign of the pavement shall be approved by the Superintendent. Alternatively, the Superintendent may accept the work at a reduced payment calculated using the formula:

$$P = 4R_c - 284$$

in which R_c is the characteristic value of density ratio of the lot and P is the percentage of the value of work represented by the lot that will be paid provided that the value of P shall not exceed 100. For the application of this formula, the value of work represented by the lot shall be calculated from the unit rate of payment specified in Clause 306.12(b).

If any small lot less than 500 m² is to be assessed under Section 173 of this specification where only three tests are required to be undertaken and assessed on the basis of meeting a Mean Density Ratio of 98%, the reduced payment shall be calculated using the formula:

$$P = 4R_m - 292$$

(c) Scale B Requirements for Testing and Acceptance of Compaction

The work represented by the lot will be accepted as far as compaction is concerned if the mean density ratio for the lot is not less than 96.0% or as otherwise specified on Drawings.

If the mean of the individual density ratio test values for the lot is less than 96.0%, but greater than or equal to 92% the work represented by the lot may be accepted but the method of rectification and/or redesign of the pavement shall be approved by the Superintendent. Alternatively, the Superintendent may accept the work at a reduced rate calculated using the formula:

$$P = 4R_m - 284$$

in which R_m is the mean of the individual density ratio test values for the lot and P is percentage of the value of work represented by the lot that will be paid provided the value of P shall not exceed 100. For the application of this formula the value of work represented by the lot shall be calculated from the unit rate of payment specified in Clause 306.12(b).

306.10 TEST ROLLING

Test rolling must ~~may~~ be carried out in accordance with the requirements of Section 173 on the cementitious treated pavement subbase layer within the maximum allowable working time for the relevant binder and time of year as specified in Table 306.091.

306.11 CURING AND PROTECTION OF COMPACTED LAYERS

Unless there are special design and construction conditions specified for placing of multiple layers, cementitious treated subbase with a pavement design modulus exceeding 500 MPa shall be placed in a single layer. The minimum compacted thickness shall be not less than 100 mm and the maximum compacted thickness shall be no more than 180 mm and constructed within the tolerances specified in Clause 306.03.

(a) Pavement Design Modulus of 500 MPa or where no Pavement Design Modulus is Specified

The surface of each compacted layer shall be kept moist for a period of seven days unless covered at an earlier stage with the succeeding layer or with an approved curing membrane.

Construction or other traffic shall not use a compacted layer within 24 hours of placement without the approval of ~~the Superintendent~~ Council.

The subbase shall be kept in good order and condition and free from contamination.

(b) Pavement Design Modulus of 2000 MPa

In addition to meeting the requirements of Clause 306.11(a) above, the Contractor shall:

- (i) cure the cementitious treated subbase by maintaining the surface in a moist condition for seven days;
- (ii) prevent construction plant from using the pavement during the seven day curing period apart from that required to maintain and cure the surface; and
- (iii) after the seven day curing period, restrict all construction traffic to vehicles with a maximum axle group load of 4 tonnes until asphalt base and intermediate courses are placed (priming, primersealing and asphalt placement activities excepted).

(c) Pavement Design Modulus of 3500 MPa

In addition to meeting the requirements of Clause 306.11(a) above, the Contractor shall:

- (i) apply a size 7 CRS standard grade emulsion primerseal at a rate of application of 1.5 litres per square metre (0.9 litres per square metre of residual binder) to the cementitious treated subbase within 12 to 24 hours after completion of compaction. If after 24 hours ambient conditions are such the material has not dried back to less than 80% of the modified optimum moisture content, the primerseal shall be delayed until such time as the moisture content has reduced below 80% of optimum.

Subject to approval by the Superintendent Council and if weather conditions during the period from October to April inclusive suit priming, a light or very light cut back bitumen primer may be applied to the surface of the cementitious treated material in lieu of the emulsion primerseal. The rate of application of primer shall be a minimum of 0.6 litres per square metre and shall deliver a minimum of 0.3 to 0.4 litres per square metre of residual bitumen to the surface.

HP Requests by the Contractor to vary the rates of application shall be submitted in writing to the Superintendent Council for review.

Primersealing shall not be carried out within 12 hours of forecast rain and priming, if approved for use, shall not be carried out within 24 hours of forecast rain.

HP The Contractor's Environmental Management Plan shall include procedures to minimise all risks of damage to the environment associated with priming and primersealing.

- (ii) allow the cementitious treated subbase to cure for seven days without trafficking (except for the application of a prime or primerseal);
- (iii) prevent construction plant from using the pavement during the seven day curing period apart from that required to maintain and cure the surface; and
- (iii) after the seven days curing period, restrict construction traffic to vehicles with a maximum axle group load of 4 tonnes until asphalt base and intermediate courses are placed (priming, primersealing and asphalt placement activities excepted).

306.12 SCHEDULE OF DETAILS

*** (a) Requirements for Testing and Acceptance of Compaction (Clause 306.09)

Location and Chainage	Pavement Design Modulus (MPa)	Scale of Surface Level Measurement (A, B or C)	Compaction Scale (A or B)
##:	##:	##:	##:

*** (b) Unit rate of payment to be used to calculate the value of the work represented by the lot for application of payment deduction formulae specified in Clauses 306.03(b)(i), 306.09(b) and 306.09(c) shall be \$##:/m³.

SECTION 310 - PREPARATION OF GRANULAR PAVEMENTS FOR BITUMINOUS SURFACING

~~##This section cross-references Section 175.~~

~~If Section 175 is relevant, it should be included in the specification.~~

~~If Section 175 is not included in the specification, all references to it should be struck out, ensuring that the remaining text is still coherent. DELETE THIS NOTE FROM FINAL DOCUMENT:~~

310.01 DESCRIPTION

This section covers the requirements for preparation of unbound granular pavements, including in situ cementitious and bituminous stabilised pavements, for sprayed bituminous surfacing or asphalt surfacing.

310.02 PAVEMENT PREPARATION

The Contractor shall prepare for bituminous surfacing the lengths, widths and areas specified or shown on the drawings for bituminous surfacing plus an additional 0.3 m on sides where there is no concrete edging. The surface of the shoulders and verges shall be matched to the finished surface of the prepared pavement.

Construction practices that produce a slurry or pasting of fine material at the surface are not permitted.

The addition of fine material to the surface is not permitted.

~~Where the Superintendent Council considers the prepared surface to have excessive fines, the pavement layer shall be rectified to a condition acceptable to the Superintendent Council.~~

The pavement shall be prepared to produce a surface that is:

- (a) constructed to meet specified shape and level requirements
- (b) homogenous and consistent with the material in the pavement base layer
- (c) uniform in texture
- (d) free of tearing and scabbing
- (e) free of lamination on or within 75 mm of the finished surface
- (f) level with adjacent sealed areas and edgings at the joints
- (g) a hard dense and tight surface capable of being swept with a rotary road broom or similar
- (h) free of loose and foreign materials
- (i) dried back to the moisture content and embedment requirements specified in Clause 310.03.

~~Any imperfections as listed above shall be corrected in a manner acceptable to the Superintendent Council. Where this involves the re-working of the material, the full layer depth shall be re-worked.~~

~~The total area of the work shall be presented to the Superintendent Council for acceptance for surfacing as one lot.~~

310.03 DRYING BACK OF PAVEMENT BASE PRIOR TO BITUMINOUS SURFACING

(a) Pavement Dryback

The uppermost pavement layer after preparation of the surface and prior to priming or primersealing shall be allowed to dry back so the moisture content of the layer meets the requirements of Table 310.031 for each test lot.

The mean Moisture Ratio shall be determined from six randomly selected sites as a percentage of the optimum moisture content based on Modified compactive effort, and determined in accordance with VicRoads Test Method RC 316.14 - *Moisture Ratio Determination for Assessment of Dry-Back of Granular Pavement Materials*, as listed in Section 175.

(b) Pavement Embedment

Pavement embedment shall be assessed by Ball Penetration testing when required as detailed in Table 310.031. Ball Penetration testing shall be undertaken on the prepared surface in accordance with Austroads test method AG:PT/T251 - Ball Penetration Test at six randomly selected sites. No individual test result shall exceed the maximum penetration detailed in Table 310.031.

Table 310.031 Requirements for Pavement Dryback and Embedment

Testing Scale	Pavement Dryback		Pavement Embedment
	Mean Moisture Ratio	Maximum of any individual result	Ball Penetration Maximum individual result
A	Less than 60%	70%	3 mm
B	Less than 60%	70%	Not required
	Less than 65%	70%	3 mm
C	Less than 65%	70%	Not required

(c) Testing Schedule

The Contractor shall carry out testing for pavement dryback and embedment in accordance with Table 310.031340.032.

The maximum lot size to be presented for testing under this provision shall be 4000 m², and testing shall be undertaken no more than 24 hours before priming or primersealing. Test sites for assessing conformance with Table 310.031 shall be selected in accordance with VicRoads Test Method RC316.10 – *Selection of Test Sites* as listed in Section 175. Where both dryback and embedment testing are required, both tests shall be undertaken at the same test site within the same square metre.

Where the pavement moisture content has increased during the period between dryback testing and the proposed time of bituminous surfacing, the Superintendent Council may require pavement dryback and embedment to be reassessed in accordance with this clause.

*** ~~Table 310.032 Testing Schedule for Pavement Dryback and Embedment~~ ## complete table below and delete all # symbols – refer to guide notes for appropriate levels:

Road	Location/Chainage	Testing Scale
##:	##: to ##:	##:

310.04 MAINTENANCE PRIOR TO BITUMINOUS SURFACING

Following the acceptance of the prepared surface and until bituminous surfacing is completed, the Contractor shall maintain the pavement in the accepted condition until surfacing works are completed. Should the pavement condition deteriorate before surfacing works are completed, the Contractor shall re-prepare the pavement and re-present the pavement for acceptance.

SECTION 402 - REMOVAL OF PAVEMENT BY COLD PLANING

~~##This section cross references Section 407.~~

~~If Section 407 is relevant, it should be included in the specification.~~

~~If Section 407 is not included in the specification, all references to it should be struck out, ensuring that the remaining text is still coherent:~~

402.01 GENERAL

This section covers the requirements for removal of pavement by cold planing including the cleaning up, removal and disposal of the excavated materials.

402.02 COLD PLANING

Cold planing shall be carried out in a manner as to leave a uniform surface on a plane parallel with the ultimate finished surface of the pavement as shown on the drawings.

Cold planing machines have the following cutting drum characteristics:

- standard cutting drum with cutting tool spacing of 15 mm horizontally; and
- fine tooth drum with a cutting tool spacing of 8 mm (or less) horizontally.

The nominal depth and width of pavement to be removed shall be as specified in Clause 402.06. After planing, no point on the planed surface shall lie more than 15 mm below a 3 m straightedge placed on the planed surface in any direction.

In locations where removal and replacement of asphalt or pavement is required on the same day, the rate of cold planing including clean up shall be at a rate consistent with the asphalt replacement process to minimise the pavement area closed to traffic.

402.03 CLEANING UP AND DISPOSAL OF EXCAVATED MATERIAL

The planed surface shall be swept clean of all loose material prior to either diverting traffic onto the planed surface or placing asphalt.

The excavated material removed from the road shall either become the property of VicRoads, or the property of the Contractor, as specified in Clause 402.06.

~~If the material becomes the property of VicRoads, the Contractor shall load, transport and stockpile material into a neat pile at the nominated stockpile area as specified in Clause 402.06(d).~~

~~If the material becomes the property of the Contractor, The Contractor shall remove all such material from the site.~~

Prior to opening to traffic, placing asphalt, or leaving the site, the Contractor shall present a clean planed surface.

402.04 ASPHALT REPLACEMENT

Where work under the Contract includes replacement of excavated material with asphalt supplied and placed under Section 407, the following requirements shall apply:

- Exposed granular pavement material shall be watered, re-compacted and, where specified, primed or heavily tack coated, or for larger areas, given a bitumen emulsion primerseal prior to placing asphalt.
- Prior to opening to traffic, excavated areas shall be filled with hotmix asphalt. All transverse and longitudinal joints shall be constructed as cold joints in accordance with Clause 407.17 and new asphalt shall be compacted flush with the existing pavement in accordance with the requirements of Clause 407.22(a).

- (c) In the event of a breakdown in the supply or placing of asphalt in areas to be opened to traffic, the Contractor shall temporarily backfill or ramp down the cold planed area with cold mix asphalt or other suitable material which will support traffic loading and provide for the safe passage of traffic. Material so placed shall be removed prior to placing new asphalt as specified and the placing and removal of temporary backfilling shall be at the expense of the Contractor. Temporary ramping shall be carried out to the standards specified in Clause 402.05.

402.05 TEMPORARY RAMPING

(a) Longitudinal Edges

Any exposed longitudinal edges within the trafficked area shall be ramped down at a slope no steeper than 5 horizontal to 1 vertical by constructing a temporary wedge of hot mixed or cold mix asphalt.

(b) Transverse Edges

Any exposed transverse edges within the trafficked area shall be ramped down by constructing a temporary wedge of hot or cold mix asphalt. Temporary ramping shall not be steeper than 20 horizontal to 1 vertical for traffic speeds of more than 75 km/h or 10 horizontal to 1 vertical for traffic speeds of 75 km/h or less.

(c) Removal of Temporary Ramping

Before asphalt replacement, all temporary ramping shall be removed by cutting back along a straight line to expose a vertical face of fully compacted asphalt at the specified layer depth.

~~402.06 SCHEDULE OF DETAILS~~ ~~###[strikethrough items below which are not applicable]:~~

~~(a) Type of Work~~

- ~~—— (i) Removal of asphalt with a ###standard/fine tooth (strikethrough inappropriate option): cold planer~~
- ~~—— (ii) Cutting of tapered longitudinal chases against kerb and channel, median openings, and side streets~~
- ~~—— (iii) Cutting of tapered transverse chases~~
- ~~—— (iv) Excavation of granular pavement material~~
- ~~—— (v) Profiling of concrete pavement~~
- ~~—— (vi) Removal and replacement of asphalt in accordance with Section 407 of this specification~~

~~*** (b) Nominal area and depth of removal: ###: m² ###: mm (Clause 402.02)~~

~~*** (c) Nominal width of removal: ###: m (Clause 402.02)~~

~~*** (d) Planed material shall become the property of VicRoads and be stockpiled at ##: (Clause 402.03).~~

~~*** (e) Planed material shall become the property of the Contractor and shall be removed from the site (Clause 402.03).~~

SECTION 404 - STONE MASTIC ASPHALT

~~##This section cross-references Section 407. Section 407 should be included in the specification.:~~

404.01 GENERAL

This section shall be read in conjunction with Section 407 Hot Mix Asphalt and covers special requirements for Stone Mastic Asphalt (SMA) that are in addition to or override the requirements of Section 407. The section covers four types of SMA mixes; Normal Duty Size 7 mm (SMA7N), Normal Duty Size 10 mm (SMA10N), Heavy Duty Size 7 mm (SMA7H) and Heavy Duty Size 10 mm (SMA10H).

SMA is a coarse graded asphalt containing a high proportion of binder and added filler with the addition of cellulose fibre.

404.02 CELLULOSE FIBRE ADDITIVE

Cellulose fibre additive shall be nontoxic and manufactured from raw cellulose.

Cellulose fibre shall be supplied in bags of equal mass suitable for metered plant mixing and shall be handled in accordance with the manufacturer's specifications.

Cellulose fibre additive may be supplied in loose or pelletised form and may be incorporated with a binding agent. The binding agent can be either bituminous or non-bituminous.

404.03 AGGREGATES

Unless otherwise specified, properties of the aggregates used in all SMA mixes shall comply with the requirements for Type H asphalt as specified in Clause 407.03.

Further to Clauses 407.03 and 407.09, no Reclaimed Asphalt Pavement (RAP) shall be added to SMA.

404.04 BINDER

The binder used in SMA7N and SMA10N shall be either Class A25E, A20E, A15E or A10E PMB.

The binder used in SMA7H and in SMA10H shall be Class A10E PMB.

All PMB binders shall comply with the requirements of the Austroads Specification Framework for Polymer Modified Binder as listed in Section 175.

404.05 MIX DESIGN

The mix to be used shall be a VicRoads registered mix and shall comply with the requirements of Clause 407.06.

HP The Contractor shall only use asphalt mixes that are registered by VicRoads as 'General' mixes at the time of placement, unless otherwise approved by the Superintendent Council.

The Contractor shall also provide the following information:

- (a) Marshall Stability to meet the requirements of Clause 404.06(d)
- (b) the results of the Binder Drain Off tests meeting the requirements of Clause 404.06(e) and the selected maximum mixing temperature to avoid excess binder drain off
- (c) the Indirect Tensile Modulus of the mix. The sample shall be prepared at $5 \pm 0.5\%$ air voids.

404.06 MIX DESIGN REQUIREMENTS

- (a) The grading limits in the job mix shall lie within the limits specified in Table 404.061 below:

Table 404.061 Grading Limits for Aggregates (including any filler)

Sieve Size AS (mm)	Percentage Passing (by mass)		
	SMA10N	SMA10H	SMA7N SMA7H
19.0	100	100	100
13.2	100	100	100
9.5	90-100	90-100	100
6.70	45-65	25-45	85-100
4.75	30-50	18-32	35-55
2.36	21-31	15-30	17-35
1.18	16-25	13-24	16-28
0.600	14-22	12-21	12-24
0.300	12-19	10-18	10-20
0.150	9-15	9-15	8-16
0.075	8-12	8-12	8-13

- (b) The proportions of mineral matter, bitumen and cellulose fibre additive shall lie within the limits shown in Table 404.062 below:

Table 404.062 Proportions of Mineral Matter, Binder and Cellulose Fibres

Material	Percentage (by total mass of mix)		
	SMA10N	SMA10H	SMA7N SMA7H
Mineral Matter	93.4 - 92.4	93.7 - 92.7	93.4 - 92.4
Bitumen	6.5 - 7.5	6.0 - 7.0	6.5 - 7.5
Cellulose Additive	0.3	0.3	0.3

- (c) Further to the requirements of 407.04 and 407.06, the mix shall contain a minimum of 8% added filler for SMAN. The minimum proportion of added filler shall be 6% for SMAH.
- (d) The Marshall cylinder test properties (50 blows each face at the temperature outlined in AS/NZS 2891.5 using the specified production binder) shall meet the requirements in Table 404.063.
- (e) The Asphalt Binder Drain off test shall be performed at the design binder content and shall not exceed 0.3% of the total mass of the sample at the maximum nominated production temperature.

Table 404.063 Marshall Properties, Air Voids and Voids in Mineral Aggregate

Mix Size (mm)	Stability (kN) Minimum	Air Voids (%)		Voids in Mineral Aggregates Minimum
		Minimum	Maximum	
SMA10N	5.5	3.5	5.0	18
SMA10H	5.5	4.8	5.2	18
SMA7N SMA7H	5.5	2.5	5.0	19

404.07 STORAGE OF CELLULOSE FIBRE AT THE MIXING PLANT

Packaged cellulose fibre products shall not be stored in the open or exposed to direct sunlight unless protected by a waterproof UV resistant covering. Any product that has become wet shall not be used.

404.08 MIXING PLANT

Batch pug mill type mixing plant may be used to produce SMA. Pressed packs of cellulose fibre shall only be used in batch mixing plants.

~~The Superintendent~~ Council may allow drum type mixing plants to produce SMA where the drum plant can incorporate the filler and fibre in a dedicated mixing chamber remote from the burner and the flow of exhaust gases from the plant. The Contractor shall provide information to show the asphalt plant is able to produce a well-mixed and uniform SMA that can be successfully placed and produces a material comparable to SMA from batch plants.

Where any mixing plant has not yet proven its ability to produce conforming and consistent SMA, ~~the Superintendent~~ Council may require a trial of about 50 tonnes to assess the SMA.

404.09 MIXING SEQUENCE

Batch Mixing Plants

Unopened cellulose fibre press packs shall be added to the mixer during the metered addition of the hot aggregates. Dry mixing shall continue for a maximum of 15 seconds after the last Cellulose Fibre press pack has been added. Cellulose fibre press packs shall not be added to the mixer before the aggregates are added.

Binder shall be added after completion of the dry mixing as specified and mixing shall continue for a minimum of 20 seconds or longer period required to ensure that coarse aggregate particles are fully coated with bitumen and the Cellulose fibres are distributed homogeneously through the mix.

Drum Mixing Plants

The mixing sequence shall be determined by the Contractor and in accordance with fibre manufacturer's recommendations.

404.10 MIXING AND MIXING TEMPERATURES

The temperature of aggregates before mixing shall not exceed 190°C. The temperature of asphalt at discharge from the mixing plant shall not exceed 175°C.

404.11 FREQUENCY OF INSPECTION AND TESTING AT THE MIXING PLANT

The production tolerances on the grading aim of the mix before compaction shall be as specified for Size 10 mm in Table 407.071. Notwithstanding the requirements of Clause 407.11, a reduced frequency is not permitted.

Further to Table 407.111 the minimum frequency for Binder Content and Full Sieve Analysis of Asphalt (full extraction test) shall be one test per 150 tonnes or part thereof of the asphalt plant production on a representative sample taken from a delivery truck. The Binder Content and Full Sieve Analysis of Asphalt and fibre content results shall be provided to ~~the Superintendent~~ Council.

404.12 CONDITIONS FOR PLACING STONE MASTIC ASPHALT

The Contractor should note SMA may be adversely affected by traffic during hot weather, and within 48 hours of placement. It is the Contractor's responsibility to ensure SMA is placed at such times that hot weather and traffic shall not affect the SMA by reducing the texture of the surface, or cause rutting of the surface. Detouring traffic shall not be used a method of managing risk of damage to the new surface.

404.13 COMMENCEMENT OF PLACING

- HP** The placement of SMA shall not commence until approval is obtained from the ~~Superintendent~~ Council.

404.14 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF COMPACTION

After placement, the SMA shall be immediately compacted to meet the requirements for testing and acceptance of compaction as detailed in Clause 407.21, except:

- work shall be tested for compaction density on a lot basis regardless of the quantity of material placed
- work represented by a lot of six tests shall be assessed as shown in Table 404.141
- work represented by either four or five cores shall be assessed as shown in Table 404.142.

Table 404.141 Limits for Characteristic Density Ratio (Six Tests)

For layers less than 50 mm thickness	
Characteristic Value of the Density Ratio (Rc)	Assessment
96.0% or more	Accept lot
93.0% to 95.9%	Lot may be accepted at a reduced rate calculated by $P = 10 R_c - 860$

Table 404.142 Mean Density Ratio (less than six cores)

For layers less than 50 mm thickness	
Mean Value of the Density Ratio (Rm)	Assessment
97.5% or more	Accept lot
94.5% to 97.4%	Lot may be accepted at a reduced rate calculated by $P = 10 R_m - 875$

Vibratory rollers may be used for a maximum of two passes only. Use of vibration shall be discontinued immediately if any breakdown of surface aggregate occurs. Pneumatic tyred rollers shall not be used.

- HP** The Contractor shall not place traffic on the SMA until the ~~Superintendent~~ Council has agreed the temperature of the asphalt is less than 40°C and is trafficable.

404.15 ACCEPTANCE OF COMPACTION ON A PROCEDURAL BASIS

Where the specified layer thickness is less than 25 mm acceptance of work for compaction can, where approved by the ~~Superintendent~~ Council, be based on the adoption of approved placing procedures as outlined in the contractor's quality plan, inspection and test plan as well as industry best practice documents including AS 2150 – Hot mix asphalt.

SECTION 405 - REGULATION GAP GRADED ASPHALT

~~##This section cross-references Section 407-~~

~~If Section 407 is relevant, it should be included in the specification.~~

~~If Section 407 is not included in the specification, all references to it should be struck out, ensuring that the remaining text is still coherent.~~

405.01 GENERAL

This section shall be read in conjunction with Section 407 - Hot Mix Asphalt and covers special requirements for Regulation Gap Graded Asphalt (RGG) that are in addition to or override the requirements of Section 407.

405.02 AGGREGATES

The properties of the aggregates used in RGG shall comply with the requirements for Type H asphalt as specified in Clause 407.03. Reclaimed Asphalt Pavement (RAP) may be recycled by adding it to new asphalt during the mixing process subject to meeting the requirements specified in Clause 407.09(a). The use of RAP in this asphalt mix is permitted however it is limited to the addition of up to 10% RAP.

405.03 BINDER

Binder used in RGG shall be Class 320 bitumen in accordance with Section 407.

405.04 MIX DESIGN

The mix to be used shall be a VicRoads registered mix and shall comply with the requirements of Clause 407.06. The Indirect Tensile Modulus of the mix is not required to be submitted.

405.05 MIX DESIGN REQUIREMENTS

(a) The grading limits in the job mix shall lie within the limits specified in Table 405.051 below:

Table 405.051 Grading Limits for Aggregates (including any filler)

Sieve Size Australian Standards (mm)	Percentage Passing (by mass)
9.5	100
6.7	90 - 100
4.75	72 - 84
2.36	39 - 49
1.18	27 - 37
0.600	21 - 31
0.300	17 - 23
0.150	9 - 15
0.075	6 - 12

- (b) The proportions of bitumen, air voids and aggregates and filler shall lie within the limits shown in Table 405.052 below:

Table 405.052 Proportions of Bitumen and Air Voids

Material	Percentage (by mass)
Binder Content	5.7 – 6.3
Air Voids	2 – 5

405.06 FREQUENCY OF INSPECTION AND TESTING AT THE MIXING PLANT

The production tolerances on the grading aim of the mix before compaction shall be as specified for Size 7 mm in Table 407.071. The frequency of inspection and testing at the mixing plant shall be in accordance with Clause 407.10.

405.07 CONDITIONS FOR PLACING

RGG shall be placed in accordance with Clause 407.12 for Wearing Courses.

HP The placement of RGG shall not commence until approval to proceed is obtained from the Superintendent Council.

405.08 COMPACTION

Compaction shall be achieved using not less than 3 passes with steel wheeled rollers with a minimum overall mass of 6 tonnes. The Contractor may use a multi-wheel roller for secondary rolling however multi-wheel rolling shall be discontinued if it results in any damage to the surface of the new asphalt mat. The Contractor shall use a multi-wheel roller for compaction of small areas where the steel wheeled roller is unable to compact the newly placed mix.

SECTION 407 - DENSE GRADED ASPHALT

~~##This section cross references Sections 160, 173, 175, 402, 404, 405, 417, 418, 421, 422, and 801, and these sections should be included in the specification. If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent:~~

407.01 GENERAL

This section covers the requirements for the manufacture and placement of dense graded asphalt, including quality of materials, mix design, supply and placing of the asphalt.

The following supplementary VicRoads Standard Sections shall be read in conjunction with this section where mixes other than dense graded asphalt are required:

Stone Mastic Asphalt	Section 404
Regulation Gap Graded Asphalt	Section 405
Open Graded Asphalt	Section 417
High Modulus Asphalt (EME2)	Section 418
High Binder Crumb Rubber Asphalt	Section 421
Light Traffic Crumb Rubber Asphalt	Section 422

If any cold planing is undertaken in association with placing of asphalt, Section 402 shall apply.

407.02 STANDARDS

Documents referred to in this section are listed in Table 407.021.

Table 407.021: Referenced Documents

Australian Standards	
AS 1141.3.1	Methods for sampling and testing aggregates Sampling - Aggregates
AS 1141.5	Methods for sampling and testing aggregates - Particle density and water absorption of fine aggregate
AS 1141.6.1	Methods for sampling and testing aggregates Particle density and water absorption of coarse aggregate - Weighing-in-water method
AS 1141.6.2	Methods for sampling and testing aggregates Particle density and water absorption of coarse aggregate - Pycnometer method
AS 1141.8	Methods for sampling and testing aggregates - Method 8: Water-soluble fraction of filler
AS 1141.11.1	Methods for sampling and testing aggregates – Particle Size Distribution Sieving Method
AS 1141.15	Methods for sampling and testing aggregates – Flakiness Index
AS 1141.17	Methods for sampling and testing aggregates Voids in dry compacted filler
AS 1160	Bituminous emulsions for the construction and maintenance of pavements
AS 1289.3.3.1	Methods of testing soils for engineering purposes Soil classification tests - Calculation of the plasticity index of a soil
AS 1672.1	Limes and limestones Limes for building
AS 2008	Bitumen for pavements
AS 2150	Hot mix asphalt - A guide to good practice
AS 2341.2	Determination of dynamic viscosity by vacuum capillary viscometer
AS/NZS 2891.11	Methods of sampling and testing asphalt Degree of particle coating
AS/NZS 2891.3.3	Methods of Sampling and Testing Asphalt: Binder Content and Aggregate Grading - Pressure Filter Method

Table 407.021 continued on next page

Table 407.021: Referenced Documents (continued)

Australian Standards	
AS/NZS 2891.7.1	Methods of Sampling and Testing Asphalt – Determination of Maximum Density of Asphalt, Water Displacement Method
AS/NZS 3582.1	Supplementary cementitious materials: Fly ash
AS 3582.2	Supplementary cementitious materials: Slag - Ground granulated blast-furnace
AS 3972	General purpose and blended cements
AS 4489.8.1	Test methods for limes and limestones - Free moisture - Convection oven
Austroroads	
ATS 3110	Austroroads Technical Specification - Supply of Polymer Modified Binders
AGPT/T192	Characterisation of the Viscosity of Reclaimed Asphalt Pavement (RAP) Binder Using the Dynamic Shear Rheometer (DSR)
AGPT/T193	Design of Bituminous Binder Blends to a Specified Viscosity Value
AGPT/T234	Asphalt Binder Content (Ignition Oven Method)
VicRoads	
RC 211.01	Moisture Content of Mixed Asphalt Products
RC 212.01	Recovery of Bituminous Binder from Asphalt for Measurement of Viscosity
RC 370.05	Degradation Factor – Fine Aggregate
RC 372.01	Coarse Aggregate Quality by Visual Assessment
RC 500.01	Registration of Bituminous Mix Designs
RC 500.05	Acceptance of Field Compaction
RC 500.16	Selection of Test Methods for Testing of Materials and Work

Section 175 details the revision dates of the relevant references in this section.

407.03 DEFINITIONS

Added Filler

A fine material, the majority of which passes the 0.075 mm sieve that forms part of the final aggregate grading and is added to the combined asphalt aggregate derived from crushed rock or other similar material. Typical materials include hydrated lime, fly ash, cement, ground limestone. It excludes the natural component of the combined aggregate passing the 0.075 mm sieve.

Asphalt

Asphalt is a designed and controlled mixture of coarse and fine aggregates, filler, binder and other additives which is mixed, spread and compacted to a uniform layer while hot.

Asphalt Base Course

Asphalt base course is that part of an asphalt pavement supporting the intermediate and wearing courses. It rests on the subgrade or pavement subbase.

Asphalt Course

An asphalt course comprises one or more layers of a single asphalt type.

Asphalt Intermediate Course

Asphalt intermediate course is that part of the asphalt pavement immediately under the wearing course. It rests on the asphalt base course.

Asphalt Layer

An asphalt layer comprises a single uniform application of asphalt placed in a single pass of the paver.

Asphalt Pavement

Asphalt pavement comprises the combined thickness of all asphalt courses.

Asphalt Regulating Course

Asphalt regulating course is an asphalt course of variable thickness applied to the road surface to adjust the shape prior to the wearing course or any other bituminous surfacing or re-surfacing.

Asphalt Types (Dense Graded)

Dense graded mixes are designated by a letter indicating their intended use and key materials. Dense graded asphalt types L, N, V and H series mixes are used for wearing courses, and Type S series mixes are used as structural mixes for intermediate and base courses. A brief description for the various types of dense graded asphalt is shown in Table 407.031.

Table 407.031: Types of Dense Graded Asphalt

Mix Designation	Description
L	A light duty Size 7 or 10 wearing course with low air voids and higher binder content for use in very lightly trafficked pavements.
N	A light to medium duty Size 7, 10 or 14 wearing course or regulating course for use in light to moderately trafficked pavements.
H	A heavy duty Size 7, 10 or 14 asphalt wearing course or regulating course for use in most heavily trafficked pavements.
V	A heavy duty Size 10 or 14 asphalt wearing course for heavily trafficked intersections.
HP	A high performance Size 10 or 14 heavy duty wearing course asphalt incorporating a Polymer Modified Binder (PMB) where a high resistance to deformation and flexural cracking is required.
VP	A high performance Size 14 heavy duty wearing course asphalt incorporating a PMB for very heavily trafficked intersections where a high resistance to deformation and flexural cracking is required.
SI	A multi-purpose Size 14 or 20 structural asphalt for intermediate course in heavy duty pavements or base course in medium duty pavements.
SF	A fatigue resistant Size 20 structural base course asphalt for heavy duty asphalt pavements with a total asphalt thickness (excluding Open Graded Asphalt) of at least 175 mm.
SP	A high performance heavy to very heavy duty Size 20 structural intermediate course asphalt incorporating a PMB for high resistance to deformation and flexural cracking.
SS	A very stiff Size 20 structural intermediate course asphalt used to increase pavement deformation resistance and increase mix stiffness for very large scale heavy duty asphalt pavements.

Asphalt Wearing Course

Asphalt wearing course is the final part of the pavement upon which the traffic travels except for Open Graded Asphalt (OGA) where the wearing course is the layer beneath the OGA.

Assigned Polished Stone Value

The assigned Polished Stone Value (PSV) is a friction rating derived from PSV tests undertaken by the Department of Transport, which is assigned to each source.

Binder

Binder is bitumen or polymer modified binder (PMB) used to hold a mixture of aggregates together as a cohesive mass.

Binder Film Index

Binder film index is an empirical calculation of theoretical thickness of the binder film around each aggregate particle within the asphalt mix having regard to the aggregate grading, surface area of the aggregates and binder content.

Bulk Density

Bulk density is the mass per unit volume of the compacted mix including the air voids.

Coarse Aggregates

Coarse aggregates are those retained on the 4.75 mm sieve and higher.

Cold Joints

Cold joints are where asphalt is placed against the exposed edge of an existing asphalt mat, where the existing mat has cooled below 95°C for asphalt containing bitumen and, or less than 110°C for asphalt containing PMBs.

Compaction Aid

A chemical additive used to allow compaction of asphalt at low temperatures or improve the workability of mixes.

Density Ratio

The percentage ratio of the field bulk density to the assigned bulk density of the approved laboratory mix design.

Filler

Filler is the portion of aggregates passing the 0.075 mm sieve. It includes the combined mass of crusher dust, any added recycled fines from the asphalt plant dust extraction filters and any added filler.

Fine Aggregates

Fine aggregates are aggregates passing the 4.75 mm sieve and retained on the 0.075 mm sieve.

Glass Fines

Glass fines are fine aggregate material generally passing the 4.75 mm AS sieve produced by crushing recycled glass to a cubic shape.

Hot Joint

A hot joint is a longitudinal joint between two mats that are generally paved in echelon which are compacted simultaneously before the asphalt edge in both mats has cooled below 95°C for asphalt containing bitumen and 110°C for asphalt containing PMBs.

Hot Mix Asphalt (HMA)

Hot Mix Asphalt is asphalt that has been produced at conventional hot mix temperatures, typically above 165°C.

In situ Air Voids

In situ air voids represents the air voids in the field compacted mix. It is based on a ratio of field density to maximum density.

Longitudinal Edge Strip

A longitudinal edge strip is the area of the asphalt layer within 200 mm of a longitudinal edge of the asphalt layer.

Maximum Density (Void free density)

The maximum density is the density that could be achieved in a sample of asphalt if it were possible to compact it to exclude all air voids between coated aggregate particles.

Natural Sand

Natural sand is a fine aggregate material passing the 4.75 mm sieve extracted from natural sand deposits.

Particle Density

Particle density is the mass of a dry particle of aggregate in air divided by volume of the particle of aggregate excluding permeable voids.

Placing

Placing is the spreading and compacting of asphalt, including all necessary ancillary operations.

Reclaimed Asphalt Pavement (RAP)

Reclaimed asphalt pavement is asphalt removed from an existing asphalt pavement/plant returns that is re-processed by crushing and/or screening for recycling into new asphalt.

RAP Level

RAP level describes the range of RAP contents that can be used in a mix and the associated testing required at each level.

Registered Mix

A registered mix is an asphalt mix which has been placed on the VicRoads Asphalt Mix Design Register under a General or Conditional status.

Rejuvenating Agents

Rejuvenating agents are materials added to RAP mixes to restore the virgin binder and RAP binder blend viscosity to the required level.

Warm Mix Asphalt (WMA)

Warm Mix Asphalt is asphalt which contains an additive, or uses a manufacturing process, that allows the asphalt mix to be produced and placed at temperatures at least 20°C lower than HMA.

407.04 ASPHALT QUALITY PLAN

In addition to meeting the requirements of Section 160, the Contractor shall provide an asphalt quality plan that addresses the following requirements:

- sourcing, handling and storage of constituent materials
- RAP Management plan
- asphalt production and process control
- asphalt loading and transportation to minimise segregation and achieve adequate mix temperature on delivery to site
- measuring and recording of pavement temperature, wind speed and weather conditions
- achieving a uniform application of tack coat
- achieving uniform asphalt placement including determination of paving speed and paving plans
- determination of appropriate compaction equipment, number of rollers and rolling patterns required to achieve density
- procedures to maximise density at joints.

407.05 ADDITIVES

(a) Warm Mix Additive

The maximum proportion of warm mix additive shall comply with the limits in Table 407.051

Table 407.051: Maximum Proportion of Warm Mix Additive

Additive Type	Maximum Proportion by Mass of Binder %
Wax	1.5
Chemical surfactants	1.0
Water (applied directly or in the form of crystals containing water)	3.0

407.06 AGGREGATES

(a) General

The combined aggregate mixture shall include coarse aggregate, fine aggregate, filler, and any RAP permitted under Clause 407.12.

(b) Source Materials

Source materials including source rock shall comply with the requirements of Section 801.

(c) Coarse Aggregates

- (i) Coarse aggregates shall be a mixture of separate sized crushed aggregate fractions.
- (ii) The minimum assigned PSV shall comply with the requirements of Section 801.
- (iii) The Flakiness Index of each separate sized coarse aggregate fraction, with a nominal size of 10 mm or larger, when tested in accordance with AS 1141.15, shall comply with Table 407.061.
- (iv) The unsound and marginal rock of each separate sized aggregate fraction excluding any RAP, shall not exceed the relevant percentages specified in Table 407.061 when tested in accordance with RC 372.01.
- (v) The particle density of each separate sized aggregate fraction shall be tested in accordance with AS 1141.6.1 or AS 1141.6.2 and provided by the source quarry.

Table 407.061: Quality of Coarse Aggregates

Type of Asphalt	Flakiness Index (%) (max)	Total of Marginal and Unsound Rock (% by mass) (max)	Unsound Rock (% by mass) (max)
H and V Series	35	8	3
L, N, and S Series	35	10	5

(d) Fine Aggregates

- (i) For wearing course mixes fine aggregates shall be a mixture of one or more sands and crushed aggregates which shall be free from lumps and aggregations.
- (ii) The particle density of each separate sized aggregate fraction shall be tested in accordance with AS 1141.5 and provided by the source quarry.

- (iii) Fine crushed aggregate shall comply with the relevant requirements specified in Table 407.062 and tested in accordance with RC 370.05 and AS 1289.3.3.1.

Table 407.062: Fine Crushed Aggregate Components

Test Value	
Degradation Factor (min)	Plasticity Index (max)
60	3

Sand extracted from natural sand deposits shall consist of clean, hard, durable grains free from lumps, clay, mica and organic or harmful matter.

Where a washed natural sand is used in the registered mix, the Sand Equivalent Value of any such sand supplied for asphalt production shall not be less than 45.

Where unwashed natural sand is used in the registered mix, the Plasticity Index of any sand supplied for asphalt production shall not be more than 3.

(e) Glass Fines

Glass fines are permitted as a replacement for natural sand but shall be limited to intermediate and base course layers.

Glass fines shall:

- (i) consist of a uniformly graded product, manufactured by crushing recycled glass
- (ii) contain no more than 2% by mass of contaminants such as paper, corks, metals, and other harmful materials; glass shall be primarily container glass and shall not include glass from ceramics, cathode ray tubes, fluorescent light fittings and laboratory glassware.
- (iii) comply with the grading limits specified in Table 407.063 when tested in accordance with AS 1141.11.1
- (iv) be cubical in shape, not sharp edged or elongated.

Table 407.063: Glass Fines

Sieve Size AS (mm)	Percentage Passing (by mass)
6.70	100
4.75	97 – 100

407.07 FILLER

(a) Dry Compacted Voids

The dry compacted voids for the total combined filler (all filler in the mix including added filler) passing 0.075 mm sieve shall not be less than 38% when tested in accordance with AS 1141.17.

(b) Added Filler

Added filler shall comply with the requirements of Tables 407.071 and 407.072.

If any of the following added fillers are used, they shall comply with the corresponding requirements below:

- (i) hydrated lime complying with AS 1672.1
- (ii) cement kiln dust complying with the requirements of Tables 407.071 and 407.072

- (iii) ground limestone complying with the requirements of Tables 407.071 and 407.072
- (iv) ground granulated blast furnace slag (GGBFS) complying with AS 3582.2 and the requirements of Table 407.072
- (v) portland cement complying with AS 3972 and the requirements of Table 407.072
- (vi) fly ash produced from the combustion of black coal complying with Grade 1 limits in AS/NZS 3582.1.

Table 407.071: Grading Limits for Cement Kiln Dust and Ground Limestone

Sieve Size (mm)	Percentage Passing by Mass
0.600	100
0.300	95 – 100
0.075	75 – 100

Table 407.072: Additional Test Requirements for Added Filler

Added Filler Type	Test	Test Limit (%)
Cement Kiln Dust Ground Limestone GGBFS Portland Cement	Moisture Content ¹	3 (Max)
Cement Kiln Dust	Water Soluble Fraction ²	20

Notes on Table 407.072

1. Tested in accordance with AS 4489.8.1
2. Tested in accordance with AS 1141.8

407.08 BITUMINOUS MATERIALS**(a) General**

The Contractor shall comply with the following requirements for supply and handling of bituminous binders:

- (i) material shall be handled in accordance with the manufacturer's requirements
- (ii) a product quality certificate and test report from the manufacturer shall be obtained for each delivery of material
- (iii) material shall be transported and stored in such a manner to avoid contamination and in accordance with the manufacturer's recommendations
- (iv) on request a binder sample shall be supplied to the Superintendent Council, from the point of binder manufacture/supply, in accordance with the supplier's sampling procedures and the labelling requirements of AS 2008 Bitumen for pavements
- (v) for asphalt types with no RAP or those containing RAP in accordance with RAP Level 1 as specified in Table 407.121, the class of binder shall comply with Table 407.081.

Table 407.081: Class of Binder

Asphalt Type	Binder Class
L	C170
N	C170 ¹ , C320 ²
H, V, SI and SF	C320
HP, VP and SP	A10E ³
SS	C600

Note on Table 407.081

1. For mixes containing C170, up to 20% RAP may be used
2. For mixes containing C320, up to 10% RAP may be used
3. A10E shall be used unless otherwise specified in Clause 407.30(e).

(b) Bitumen

All bitumen shall comply with AS 2008.

The viscosity of bitumen recovered from a sample of mixed asphalt prior to placement or from the pavement after compaction shall comply with the requirements specified in Table 407.082 and tested at the frequency specified in Table 407.151. Testing shall be in accordance with RC 212.01.

Table 407.082: Viscosity Range of Bitumen Recovered from Mixed Asphalt

Class of Bitumen	Viscosity Range at 25°C (kPa.s)		
	Wearing Course	Intermediate Course	Base Course
170	200 - 600	-	-
320	500 - 1600	500 - 2300	500 - 3000
600	-	800 - 5500	800 - 5500

(c) Polymer Modified Binder (PMB)

All PMBs shall comply with the requirements specified in ATS 3110. Where alternative binders have been permitted through the asphalt mix design approval, the binders shall conform to the requirements set out in that asphalt mix approval.

PMBs stored longer than the manufacturer's recommended holding times shall not be used as a modified binder.

(d) Tack Coat

Tack coat shall consist of a bituminous based binder.

Bitumen emulsion used for tack coating shall be a cationic rapid setting type complying with AS 1160. Emulsion diluted with water shall have a bitumen content of not less than 30%.

Proprietary grades of bituminous tack may also be used where it can be demonstrated they will provide an equivalent or better bond between pavement layers compared to an emulsion tack and can be applied in a uniform distribution at the residual rates specified in Clause 407.19.

Bituminous tack shall contain no more than two parts of cutter or other hydrocarbon solvent.

From 1 July 2022 only trackless tack coat will be permitted.

HP The Contractor shall submit the details of the trackless tack coat proposed to be used in the works

407.09 MIX DESIGN

All asphalt mixes proposed for use in the works shall be registered in accordance with RC 500.01.

All mix designs registered with Department of Transport are issued a status according to compliance as:

General	Complies with the requirements of RC 500.01.
Conditional	Mixes which do not comply in some respects with the requirements of RC 500.01, but which are considered appropriate for use subject to conditions attached to the registration.
Expired	Previously registered mixes which have exceed the registration period. Details are retained in Department of Transport mix registration system for record purposes.
Withdrawn	Mixes which are no longer available for use. Details are retained in the Department of Transport mix registration system for record purposes.

HP All asphalt mixes proposed for use in the works shall have a mix design registered by Department of Transport as 'General', unless otherwise approved by the Department of Transport. The registration for all mixes incorporated into the works shall be current at the time of their use. The Contractor shall submit documentation to the Superintendent Council nominating the asphalt mixes to be supplied no less than 7 days prior to their use.

Approval of a registered mix for use under the Contract does not guarantee the handling properties or performance of the mix nor relieve the Contractor from contractual obligations in regard to rectification of defects.

If a registered mix has unsatisfactory handling or field performance, the Contractor or Superintendent Council may not accept the use of this material. request the mix be de-registered and listed as Withdrawn in accordance with RC 500.01.

407.10 TOLERANCES ON MIX PRODUCTION

The tolerance on the binder content in the mix shall be $\pm 0.3\%$ of the total mix by mass when tested in accordance with AS/NZS 2891.3.3 or AGPT/T234.

The production tolerances on the registered mix design target grading before compaction shall be as specified in Table 407.101.

Table 407.101: Production Tolerances for Mix Grading

Sieve Size AS (mm)	Tolerance on Percentage Passing (by mass)			
	Size 7	Size 10	Size 14	Size 20
37.5	Nil	Nil	Nil	Nil
26.5	Nil	Nil	Nil	Nil
19.0	Nil	Nil	Nil	± 6
13.2	Nil	Nil	± 6	± 6
9.5	Nil	± 6	± 6	± 6
6.70 - 4.75	± 6	± 6	± 6	± 6
2.36 - 0.600	± 5	± 5	± 5	± 5
0.300 - 0.150	± 3	± 3	± 3	± 3
0.075	± 1.0	± 1.0	± 1.0	± 1.0

Notes on Table 407.101

1. Gradings to be undertaken in accordance with AS 2891.3.3 or AGPT/T234.
2. Tolerances apply to all mix types unless otherwise specified in the relevant standard section.
3. If post compaction grading is checked by binder extraction and sieve analysis after placement, the positive tolerances shall be increased by one percentage point.

407.11 PRODUCTION OF ASPHALT

(a) Temperatures

The temperature of binder and aggregates at the asphalt plant and the temperature of the asphalt as it is discharged from the asphalt plant shall not exceed the limits specified in Table 407.111. Asphalt manufactured at temperatures in excess of the limits specified in Table 407.111 shall not be used.

Table 407.111: Maximum Material Storage, Mixing and Asphalt Discharge Temperatures

Material	Temperature °C (max)
Binder plant storage	185 ¹
Aggregates before binder is added	200
Asphalt at discharge from asphalt plant	175

Note on Table 407.111

1. This limit may vary in accordance with the binder supplier's recommendations.

(b) Mixing

The mixing period shall be such that at least 95% of the coarse aggregate particles are fully coated with binder. Where requested by the Superintendent Council, testing for particle coating shall be undertaken in accordance with AS/NZS 2891.11.

After completion of mixing, the moisture content of the mix shall not exceed 0.5% when tested in accordance with RC 211.01.

(c) Hot Storage of Mixed Asphalt

Asphalt types with PMB, C600 and EME binders shall not be stored in hot bins for more than 8 hours prior to use. All other asphalt types shall not be stored in hot bins for more than 18 hours prior to use, unless otherwise approved by the Department of Transport.

(d) Warm Mix Asphalt (WMA)

All mixes shall comply with the requirements of Clause 407.09. The mix identification number for WMA shall include the suffix 'W'.

Production, storage, discharge and compaction temperature ranges for warm mix asphalt shall be included in the Contractor's asphalt quality plan.

(e) Assigned Maximum Density

The Assigned Maximum Density of an asphalt mix for a lot shall be the mean maximum density of the days production from the plant that supplied the asphalt mix to that lot. Maximum density shall be measured in accordance with AS/NZS 2891.7.1

Should a single maximum density result for the production mix vary by more than $\pm 35 \text{ kg/m}^3$ of its 6-point rolling average then a check design on the mix volumetrics shall be completed.

Where the check design indicates a significant change to volumetric properties, a re-design shall be undertaken.

407.12 ASPHALT INCORPORATING RAP**(a) General Requirements**

No RAP shall be added to mixes containing Polymer Modified or EME2 binders.

RAP may be added to other asphalt types subject to the following:

- (i) the requirements of Clause 407.13 are met
- (ii) the RAP content by mass does not exceed the limits shown in Table 407.121 at the designated RAP level
- (iii) for mixes registered at RAP Level 2, RAP binder characterisation and binder blend viscosity adjustments are undertaken in accordance with Clause 407.13(e).

Table 407.121: Permitted RAP Content

Asphalt Type	Permitted RAP Content (% by mass)	
	RAP Level 1	RAP Level 2
L	Up to 25	-
N	Up to 10 ¹ Up to 20 ²	-
H	Up to 15	16 to 20
SI, SS	Up to 15	16 to 30
V	Up to 10	11 to 15
SF	Up to 15	16 to 40

Notes on Table 407.121

1. For Type N mixes using C320 binder
2. For Type N mixes using C170 binder

407.13 RAP MANAGEMENT

The Contractor shall have a detailed Department of Transport approved RAP management plan and inspection and test plan which at a minimum addresses the following areas:

(a) RAP Stockpile Management

- (i) RAP sourcing and inspection: RAP shall only consist of plant returns and milled or excavated asphalt. RAP shall be free of foreign material such as granular base, concrete, brick, geotextiles, tar or other contaminants.
- (ii) RAP processing: RAP materials used for asphalt production shall be processed by blending, crushing and screening to produce a material that is free flowing and homogenous. Processes to manage RAP which are sourced from plant returns and rejected loads shall be outlined.
Processed RAP that has segregated or formed lumps shall be re-processed and re-tested for grading.

- (iii) RAP stockpiling: RAP shall be transported and stored to minimise the impact of moisture and prevent compaction, segregation and contamination from other material sources including virgin aggregates, other processed RAP lots and unprocessed RAP.

RAP shall be stored in a manner that ensures materials removed are representative of the cross section of the processed RAP stockpile.

Processed RAP shall be stockpiled in lots not exceeding 1000 tonnes. Each lot shall be clearly identified and marked including its testing status.

Once the processed RAP stockpile has been assessed for compliance there shall be no more processed RAP added to that stockpile.

(b) RAP Sampling and Testing

- (i) Sampling: Stockpiles shall be sampled in accordance with AS 1141.3.1.
- (ii) General Testing: RAP shall be tested for moisture content, grading, and binder content at the frequency specified in Table 407.151.
The Contractor shall outline the method that will be used to monitor aggregate density.
- (iii) RAP Binder Viscosity Characterisation: For mixes registered at RAP Level 2, characterisation of the viscosity of the RAP lot binder shall be undertaken in accordance with AGPT/T192, at the frequency specified in Table 407.151.
- (iv) The RAP management plan shall include grading, binder content and recovered binder viscosity results for three separate samples from a 1000 tonnes lot produced within 3 months of the submission date of the RAP Management plan.

(c) RAP Process Control

The Contractor shall have documented processes to monitor and manage fluctuations in the aggregate density, moisture content, grading, binder content and binder viscosity of the RAP lot to ensure that the requirements of the specification are met.

- (i) RAP Grading and binder content: A target grading and binder content shall be established for each RAP component. RAP shall be then produced within the tolerances outlined in Table 407.131.
- (ii) RAP Moisture content: The maximum moisture content acceptable for an individual asphalt plant shall be nominated by the Contractor.
- (iii) RAP compliance data: The Contractor shall maintain an ongoing system of process control demonstrated by data that shows the RAP processing facility is able to produce RAP to the requirements of the specification and the Contractor's quality plan. This analysis shall be based on 25 continuous data points for asphalt manufacturers seeking registration of mixes at RAP Level 1 and 50 continuous data points for asphalt manufacturers seeking registration of mixes at RAP Level 2.
- (iv) Allowable deviation from tolerances: the number of test results which constitute a non-conformance for binder content and on each individual sieve for grading that are outside of the permitted tolerances are outlined in Table 407.131.

Table 407.131: RAP Grading and Binder Tolerances

Description	Tolerance	Allowable number of results outside of tolerance
Passing 26.5 mm sieve and larger	± 10	1 out of 5 consecutive results
Passing 4.75 mm to 19.0 mm sieve	± 8	1 out of 5 consecutive results
Passing 1.18 mm and 2.36 mm	± 6	1 out of 5 consecutive results
Passing 0.300 mm and 0.600 mm	± 5	1 out of 5 consecutive results
Passing 0.150 mm	± 3	1 out of 5 consecutive results
Passing 0.075 mm	± 2	1 out of 10 consecutive results
Binder Content (%)	± 0.5	1 out of 10 consecutive results

(d) RAP Traceability

Each RAP lot shall be traceable through to asphalt production.

(e) RAP Binder Blend Viscosity

For RAP Level 2 mixes the blend of virgin and RAP binder shall be designed to have a viscosity at 60°C that falls within the viscosity range in Table 407.132 for the binder specified in the nominated mix type. The components of the binder blend shall be determined according to AGPT/T193.

To achieve the targeted binder blend viscosity in the asphalt mix, the Contractor may use a virgin binder class one grade lower than that specified in Table 407.081.

The viscosity of the virgin binder class used in the binder blend calculation may be determined using either AGPT/T192 or AS 2341.2.

Table 407.132: Binder blend Viscosity Range for the Specified Binder Class

Specified Binder Class	Binder Blend Viscosity Range (Pa.s @ 60°C)
C170	170 – 240
C320	320 – 500
C600	600 – 880

(f) Asphalt Plant Capability

Evidence shall be provided that the manufacturing process allows for the controlled addition and mixing of RAP into a plant that has been specifically designed to produce the registered mixes, as governed by the plant manufacturer's specification.

At the asphalt plant the processed RAP shall be stored in stockpiles or cold aggregate storage bins that are covered with a permanent roof and protected from the direction of prevailing weather by permanent walls.

Heating of materials shall be undertaken in such a way to prevent damage to the RAP and virgin binder, but which will ensure binder in the processed RAP is activated. The difference in temperatures between the binder and the aggregate (including RAP) shall be maintained so that it does not exceed 30°C.

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No asphalt containing RAP shall be supplied until the Department of Transport approved RAP Management Plan has been submitted at least 14 days prior to the asphalt works commencing and approval to proceed is given by the Superintendent Council.

407.14 RED ASPHALT

Where the works include the provision of red asphalt at the sites as listed in Clause 407.30(j) red asphalt shall conform to the following:

(a) Mix Design and Registration

Mixes shall be designed and registered as per the requirements of Clause 407.09.

(b) Aggregate

Further to Clause 407.06 pink coarse aggregate for the red asphalt shall be obtained from the quarry sources included in Table 407.141.

Table 407.141: Allowable Sources of Pink Aggregate

Source Name	Location
Granite Rock Quarry	Bairnsdale, Victoria
Bald Hills Quarry	Holbrook, NSW

Alternative aggregate sources may be considered by the Department of Transport depending on the aggregate meeting the requirements of Section 801, and the ability of the aggregate to provide red coloured asphalt to the satisfaction of the Superintendent Council.

(c) Binder

The binder for the red asphalt shall be that specified for the mix type as per Clause 407.08.

(d) Red Oxide Pigment

A minimum of 1% by mass of the binder of red oxide shall be used to colour the binder. Other pigments may be considered by the Superintendent Council.

The Contractor shall provide coloured asphalt samples for approval by the Superintendent Council and these shall be used as the reference to assess the colour of the completed mat. Asphalt samples shall be treated to remove the binder film from the surface aggregate.

407.15 FREQUENCY OF INSPECTION AND TESTING

The frequency of inspection and testing shall not be less than that shown in Table 407.151.

The test frequency for Grading, Degradation Factor, Plasticity Index, Sand Equivalent and Particle Density may be halved where the most recent ten successive test results meet the specified requirements. If any subsequent test result fails, another test shall be immediately undertaken. If the second test fails, the test frequency shall revert to that specified in Table 407.151 and shall not return to half the test frequency until a further ten successive test results comply with the specified requirements.

Table 407.151 Frequency of Inspection and Testing

Checks Required	Minimum Frequency
Aggregates and Fillers	
Particle size distribution of each aggregate and sand component	Certification of compliance against asphalt manufacturers nominated particle size distribution is received for each delivery to the asphalt plant.
Particle size distribution glass fines	1000 tonnes
Unsound and marginal rock content	On each day, one per 500 tonnes or part thereof
Degradation Factor of fine aggregate components	2 500 tonnes
Plasticity Index of fine aggregate and natural sand supplied as unwashed sand	2 500 tonnes
Sand Equivalent of natural sand supplied as washed sand	2 500 tonnes
Flakiness Index of coarse aggregate 10 mm and larger	2 500 tonnes
Particle Density of all coarse and fine aggregate components	10 000 tonnes
Added fillers	2 500 tonnes
Binders	
Compliance against AS 2008 for bitumen	<p>Certification of specification compliance for each delivery of bitumen supplied to the asphalt plant.</p> <p>Testing of viscosity at 60°C, at weekly intervals where bitumen has been stored above 150 °C for more than 28 days without the storage tank being topped up by more than 50% of its capacity.</p> <p>In cases where two or more bitumen classes are blended together at the asphalt plant, a viscosity test at 60°C shall be undertaken prior to use.</p>
Compliance against ATS 3110 for PMBs	Certification of specification compliance for each delivery of PMB supplied to the asphalt plant.
RAP	
RAP Levels 1 and 2: Grading, Binder Content, & Moisture content	One set of tests on a representative sample of RAP for each 500 tonnes of RAP.
RAP Level 2 mixes: RAP binder viscosity characterisation	One test on representative sample of RAP for each 1000 tonnes lot of RAP.
Asphalt	
Scrutiny for segregation, uncoated particles, separated binder, excess binder or overheating before dispatch from the plant	Each loaded truck.
Degree of particle coating	As directed by the Superintendent Council
Temperature of asphalt before dispatch from the plant	Each loaded truck or at intervals of 15 minutes if more than one truck is dispatched in 15 minutes.
Binder Content and Full Sieve Analysis of Asphalt (full extraction test)	On each production day: One test per 250 tonnes or part thereof of the asphalt plant production on a representative sample taken from a delivery truck.
Maximum Density	On each production day
Viscosity of Recovered Bitumen at 25 °C	As directed by the Superintendent – the The average of three tests where any asphalt mix containing unmodified bitumen is reasonably suspected of being over-heated or over-mixed.

The Contractor shall make available all completed work sheets, checklists and test reports for inspection at the asphalt plant.

407.16 RATE OF DELIVERY

Asphalt shall be placed at a rate that matches the plant and asphalt delivery capacity and ensures continual paving.

407.17 AMBIENT CONDITIONS FOR PLACING**(a) General Requirements**

The surface on which asphalt is to be placed shall be essentially dry and free from surface water. Asphalt shall not be placed when the pavement surface is wet, or rain is imminent.

Asphalt shall not be placed when the majority of the area to be paved has a surface temperature less than that detailed in Table 407.171.

Table 407.171: Minimum Pavement Temperatures Prior to Laying Asphalt

Asphalt Type	Intermediate or Base Courses	Wearing Course
C170, C320	5°C	10°C
C600, PMBs	10°C	15°C

(b) Cold Weather Placement

Where approved by the ~~Superintendent~~ Council placement of dense graded asphalt in layers 35 mm or greater may take place at pavement temperatures up to 5°C below the minimum temperatures specified in Table 407.171 provided that the:

- (i) The asphalt manufacturer agrees that the requirements of the specification can be met.
- (ii) Asphalt is produced using a warm mix technology based on a wax or chemical surfactant as a compaction aid. Evidence shall be supplied of the ability of the process to facilitate compaction at lower temperatures.
- (iii) Prevailing wind speeds are less than 30 km/h.
- (iv) Asphalt is transported using insulated/heated or double skinned delivery trucks with tight fitting covers.
- (v) Minimum temperature of asphalt at the time of discharge into the paver is 145°C for asphalt containing PMBs and 135°C for other mixes.
- (vi) Minimum temperature of the asphalt mat at completion of initial breakdown rolling is 110°C for PMBs and 95°C for other binders.
- (vii) Additional density testing is undertaken for lots greater than 2,000 m². The lot shall be split into two equal sub-lots, representing the first 50% of the lot laid and the last 50% of the lot laid. Compaction testing as per Clause 407.27 shall be undertaken on each sub-lot.
- (viii) A job specific inspection and Test Plan ITP is developed which addresses the modified procedures to be used.
- (ix) Contractor personnel are present full time on site to specifically monitor and manage the cold weather paving process.

~~The Superintendent~~ Council may require a placement trial as detailed in Clause 407.22 to demonstrate that the Contractor's cold weather placement procedures will meet the requirements of this specification.

(c) Cold Weather Placement Management Plan

The cold weather placement management plan shall include as a minimum:

- (i) Monitoring frequency of pavement temperature, asphalt temperature at discharge into paver and mat temperature after initial rolling.
- (ii) Measures to mitigate risk during the construction process including but not limited to:
 - a. Asphalt delivery – planning to avoid delays and use of the quickest route to the site, enough trucks to allow continuous paving and avoiding trucks waiting for lengthy periods.
 - b. Paving – determination of paving width and speed to match roller capacity, measurement of mix temperature prior to discharge, use of material transfer vehicles where practical and a process to cease works where pavement temperatures fall below the minimum requirement.
 - c. Compaction - modified rolling procedures, additional rollers for surfacing mixes, use of joint compaction devices, monitoring of compaction and mat temperature during laying.
- (iii) Quality Records
 - a. Monitoring of the above measures including method of measurement and frequency of testing.

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Prior to commencing cold weather placement of asphalt, the Contractor shall submit a job specific cold weather placement management plan to the Superintendent Council for review.

~~The Superintendent Council may prohibit cold weather placement at any stage during the works where the Superintendent Council has deemed that the Contractor has not adopted satisfactory measures or demonstrated satisfactory implementation of the cold weather placement plan.~~

407.18 SURFACE PREPARATION AND RAISING OR LOWERING OF MANHOLE AND VALVE COVERS

Prior to tack coating and placing of asphalt, the Contractor shall remove all loose and deleterious material and sweep clean the area upon which asphalt is to be placed.

Where specified in Clause 407.30(d), all manhole and valve covers shall be raised or lowered to the new surface level. Where directed by the Superintendent Council temporary ramping around each cover shall be provided and removed in accordance with the requirements of Clause 407.21(f).

407.19 APPLICATION OF TACK COAT

A tack coat shall be applied to all asphalt, concrete or sprayed seals on which asphalt is to be placed.

The tack coat shall achieve an effective bond between the asphalt and the underlying layer.

The application rate for the tack coat shall be 0.15 to 0.30 L/m² of residual bitumen (except for joints and chases where rates shall be doubled).

The tack coat shall be:

- applied only to a clean, essentially dry surface, free from surface water
- applied uniformly over the entire road surface
- intact at the time of placing the asphalt.

Photographic evidence that includes an identifiable landmark relevant to the lot, shall be supplied to show that tack has been applied uniformly over the lot.

Before asphalt is placed, sufficient time shall be allowed for emulsion based tack coats to break.

Any tack coat not covered by asphalt shall be covered with clean grit or sand before the road is opened to traffic.

Where asphalt is to be spread over a clean, un-trafficked, freshly laid asphalt, over a clean primed surface, or on a granular material where the overall asphalt depth is 150mm or greater the Contractor may omit the tack coat.

407.20 DELIVERY OF ASPHALT**(a) General**

Delivery of asphalt shall only be made during the hours listed for possession of site.

Asphalt delivered to the site, which is segregated, has been overheated, is too cold, contains separated binder, uncoated particles or which does not comply with the Specification shall be removed from the site.

(b) Delivery Dockets

Delivery dockets shall show:

- (i) name of supplier and location of plant
- (ii) docket number
- (iii) name of user
- (iv) project name and location (or contract number)
- (v) registered number or fleet number of the vehicle
- (vi) date and time of loading
- (vii) mix or product identifier traceable to the mix registration number
- (viii) size and type of asphalt
- (ix) empty and loaded mass of the vehicle, or the total of the electronically measured batch weights printed on the docket
- (x) class of binder, and proprietary name of modified binder
- (xi) temperature of load at the asphalt plant when dispatched.

~~Where asphalt is scheduled for measurement by mass, a copy of the delivery docket for each load shall be provided at the point of delivery or delivered to the Superintendent at the end of each shift.~~

~~Where asphalt is measured by other means and for Lump Sum Contracts, the~~ The Contractor shall make delivery dockets available for inspection on request by ~~the Superintendent Council.~~

407.21 JOINTS AND JUNCTIONS**(a) General**

The location of all joints shall be planned before work commences to achieve the specified offsets between layers and the final position of joints in the wearing course.

The number of joints shall be minimised by adopting good asphalt paving practices. If requested by ~~the Superintendent Council,~~ the Contractor shall produce drawings showing the location of longitudinal joints of asphalt layers in respect to the traffic lane lines.

All joints shall be well bonded and sealed and the surface across the joint shall meet the requirements of Clause 407.29

All cold joints and abutting concrete edges shall be tack coated as per Clause 407.19.

Where cold joints are constructed, any loose or poorly compacted existing asphalt on the exposed edge shall be trimmed back to produce a face of fully compacted asphalt along the exposed edge before fresh asphalt is placed.

(b) Transverse Joints

All transverse joints shall be offset from layer to layer by not less than 2 m.

(c) Longitudinal Joints

- (i) Longitudinal joints in the wearing course shall coincide with the location of intended traffic lane lines.
- (ii) Longitudinal joints in intermediate and base courses shall be offset from layer to layer by not less than 150 mm and shall be within 300 mm of the traffic lane line or the centre of traffic lane. Where new pavement abuts an existing full depth asphalt pavement, the existing pavement shall be removed in steps to achieve an offset from layer to layer of not less than 150 mm.

At the wearing surface where the new and existing pavement join, a hot applied bituminous crack sealant shall be applied.

- (iii) Longitudinal joints shall be parallel to the traffic lanes.

Subject to approval by the ~~Superintendent~~ Council, a longitudinal joint in the wearing course may be located up to 150 mm from the traffic lane line, or 150 mm from the centre of a traffic lane.

(d) Joints Against a Granular Pavement

Asphalt joints against a granular pavement shall not be offset between layers but shall form a vertical flush joint.

A tack coat as per Clause 407.19 shall be applied to the vertical surface of the existing pavement.

At the wearing surface where the new and existing pavement join, a hot applied bituminous crack sealant shall be applied.

(e) Junctions at Limits of Work

At junctions where the new asphalt mat is required to match the level of existing pavement surface at the limits of work, chases shall be cut into the existing pavement by cold planing as specified in Section 402.

The chase shall be cut by removal of a wedge of asphalt tapering from zero to a depth of 2.5 times the nominal size of the asphalt from the existing pavement to the minimum length as follows:

- (i) at side streets and median openings – 600 mm
- (ii) on through carriageways with a speed limit of 80 km/h or less – 3 m
- (iii) on through carriageways with a speed limit of more than 80 km/h – 6 m.

(f) Treatment of Exposed Edges under Traffic

On completion of each day's work and prior to opening to traffic, the following treatment of exposed edges shall be adopted for asphalt work.

- (i) Longitudinal Edges

All longitudinal joints within the trafficked area shall be matched up between paver runs except for a short section required to achieve the minimum offset between transverse joints, unless otherwise approved by the ~~Superintendent~~ Council. Any exposed longitudinal edges within the trafficked area shall be ramped down at a slope of not steeper than 5 horizontal to 1 vertical by constructing a temporary wedge of dense graded or cold mixed asphalt. In unusual situations such as the sudden onset of inclement weather, a longer length of longitudinal joint may be exposed provided it is ramped down as specified and appropriately signed.

(ii) Transverse Edges

At the end of the paving run in the transverse direction, the new asphalt mat shall be squared up to a straight line and ramped down by constructing a temporary wedge of dense graded or cold mixed asphalt. Temporary ramping shall not be steeper than shown in Table 407.211.

Table 407.211: Maximum Grade of Temporary Ramping

Posted Speed Limit (km/h)	Maximum Ramp Grade (Horizontal to Vertical)
40	20 to 1
60	30 to 1
80	40 to 1
> 80	50 to 1

(iii) Removal of Temporary Ramping

Before commencement of each day's work, all temporary ramping shall be removed by cutting back along a straight line to expose a vertical face of fully compacted asphalt at the specified layer depth.

407.22 PLACEMENT TRIAL

Where specified in Clause 407.30(h), the mix, plant, procedures and personnel proposed for the placement of asphalt shall be subjected to a placement trial conforming with the following:

- (a) each mix nominated shall be subjected to a separate placement trial
- (b) each placement trial may be located within the Works
- (c) the size of each placement trial shall be limited to one lot.

The Contractor shall design the trial to implement all the procedures described in the Contractor's quality plan and demonstrate conformance with the Specification.

The Contractor shall submit a copy of the completed inspection and test plan and all relevant test results and records from the placement trial. Prior to further placement the Superintendent Council shall review the outcomes of the placement trial for approval.

In the event of a nonconformance in the placement trial, or when the Superintendent Council determines that a previous trial is not representative of the materials, asphalt mix proportions, asphalt temperature, ambient condition, plant and method of placement, a new trial shall be undertaken prior to placement resuming.

407.23 COMMENCEMENT OF PLACEMENT

- HP The placement of asphalt on the sub-base or granular base for a new pavement or for an overlay of an existing bituminous surfaced pavement shall not commence until approval to proceed is obtained from the Superintendent Council.**

407.24 REGULATING COURSE

A regulating course of asphalt of the type and size specified shall be placed for correction of longitudinal and transverse pavement shape so that the resulting surface is parallel with the finished surface.

407.25 PAVING OF ASPHALT**(a) General**

Asphalt shall be spread in layers at the compacted thicknesses shown on the drawings or specified.

(b) Level Control

Asphalt paver screed levels shall be controlled by a suitable combination of manual and automatic controls operating from fixed or moving references.

(c) Spreading by Paver

All asphalt shall be spread with a purpose designed asphalt paving machine to form a uniformly smooth asphalt mat complying with the requirements of Clause 407.29 without segregation, tearing or gouging. In areas that are not accessible by a paver placement of asphalt by other means is permitted.

The width of a single paving run shall not exceed 6 metres unless paving in echelon is proposed or procedures are in place to ensure that a uniform asphalt layer free of segregation can be achieved.

The Contractor shall conduct spreading operations to ensure that the paver speed matches the rate of supply so that stoppages are minimised.

If the paver is required to stop and asphalt in front of the screed cools to below 120°C, a transverse joint shall be constructed.

For asphalt work carried out on a road to be opened for traffic at the completion of work each day, each layer of asphalt shall cover the full width of the trafficked area. The requirements of Clause 407.21(f) shall be followed in respect of the treatment required for exposed edges.

(d) Spreading by Hand

Hand spreading shall only be used for small areas where it is not practical to use a paver.

(e) Echelon Paving

Where specified in Clause 407.30(g) two or more pavers in echelon shall be used in locations where a full carriageway wider than 6 m is available clear of traffic.

When paving in echelon the longitudinal joints shall be constructed as hot joints.

407.26 COMPACTION

Asphalt shall be uniformly compacted to the standards specified in Clause 407.27. Compaction shall not commence until the asphalt has cooled sufficiently to support the rollers without undue displacement.

Vibratory rolling shall not be used to compact asphalt on bridge decks.

407.27 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF COMPACTION**(a) General**

Work shall be tested and accepted for compaction on either a test lot basis as provided in Clause 407.27(b) or on an approved procedural basis as provided in Clause 407.27(c).

Where the total quantity of the particular size and/or type of asphalt supplied under the contract exceeds 300 tonnes, compaction shall be tested and accepted on a test lot basis.

Acceptance of compaction for all other asphalt work may be on a procedural basis.

(b) Testing and Acceptance of Compaction on a Lot Basis

(i) Test requirements

The density of extracted cores for the purposes of determining the bulk density for acceptance purposes or to check or assign offsets to a nuclear gauge shall be undertaken in accordance with RC 500.05 and RC 500.16.

A lot presented for testing shall consist of an asphalt layer which is placed in one shift under uniform conditions and is essentially homogeneous in respect to placement methods, materials and appearance.

Sites for density testing for acceptance of the lot (excluding longitudinal edge strips) shall be selected on a random basis as per RC 500.16 provided that no site shall be selected within 200 mm of a joint constructed against a cold edge.

For lots exceeding 500 m² density testing of the longitudinal edge strips for wearing courses shall be undertaken and results reported and submitted separately. Sites for this testing shall be selected as follows:

- The length of all the longitudinal edge strips within a lot shall be added and treated as a continuous length. Six test sites shall be selected so that they are evenly spaced along this length.
- Sites shall not be located within 2 m of a transverse joint.
- Where density is measured using a nuclear gauge, testing shall be undertaken so that the gauge is parallel to the direction of paving and the centre of the nuclear gauge shall be located within ± 50 mm of the centre of the longitudinal edge strip at the selected test location.

For core sample tests, the layer thickness is the mean thickness of the core samples and for nuclear gauge tests, the layer thickness is the nominated layer thickness.

The assigned maximum density of the asphalt shall be determined in accordance with Clause 407.11(e).

(ii) Lot size

For lots with an area less than 50 m² acceptance of compaction shall be based on procedures outlined in the contractor's asphalt quality plan.

Lots between 50 and 500 m², the test procedure specified for small areas in Section 173.04 shall apply.

For lots greater than 500 m² compaction shall be assessed using the characteristic value of density ratio. Asphalt Density Ratio is defined as the percentage ratio of the characteristic field bulk density to the assigned bulk density of the approved laboratory mix design.

(iii) Characteristic Density Ratio Calculation

The characteristic field bulk density ratio is the calculated value of $\bar{x} - 0.92S$ for six tests per lot where \bar{x} and S are respectively the mean and standard deviation of the individual density ratio test values for the lot.

(iv) Compaction requirements

The work (excluding longitudinal edge strips) represented by a lot of six tests shall be assessed as shown in Table 407.271.

Table 407.271: Limits for Characteristic Density Ratio (Six Tests)

For layers less than 50 mm thick		For layers 50 mm thick or greater	
Characteristic Value of the Density Ratio (R _c)	Assessment	Characteristic Value of the Density Ratio (R _c)	Assessment
95.0% or more	Accept lot subject to no other nonconformances raised for the lot.	96.0% or more	Accept lot subject to no other nonconformances raised for the lot.
94.9% to 93.0%	Lot may be accepted at a reduced rate calculated by $P = 15 R_c - 1325$	95.9% to 94.0%	Lot may be accepted at a reduced rate calculated by $P = 15 R_c - 1340$
92.9% or less	Remove and replace asphalt	93.9% or less	Remove and replace asphalt

Notes: (R_c) is the Characteristic Value of the density ratio for the lot and (P) is the percentage of the relevant scheduled rate to be paid which shall not be greater than 100%.

Where the Contract is a lump sum Contract the relevant scheduled rate will be that shown in the 'Rates for Variation Purposes' schedule accompanying the lump sum tender. If no such rate is provided a variation will be considered in accordance with the General Conditions of Contract.

The Characteristic Value of the Density Ratio determined for the longitudinal edge strips within the lot shall be submitted for report only.

Where one or more individual core thicknesses are less than the relevant values shown in Table 407.272, they shall be discarded, and the acceptance assessment modified in accordance with Table 407.273 provided that there remain at least four test values.

Table 407.272: Minimum Thickness of Cores Extracted from the Pavement

Size of Asphalt	Individual Core Thickness (mm) min
7	20
10	25
14	35
20	50

Table 407.273: Mean Density Ratio (less than six cores)

For layers less than 50 mm thickness		For layers 50 mm thickness or greater	
Mean Value of the Density Ratio (R _m)	Assessment	Mean Value of the Density Ratio (R _m)	Assessment
96.5% or more	Accept lot subject to no other nonconformances raised for the lot.	97.0% or more	Accept lot subject to no other nonconformances raised for the lot.
94.5% to 96.4%	Lot may be accepted at a reduced rate calculated by $P = 15 R_m - 1348$	95.0% to 96.9%	Lot may be accepted at a reduced rate calculated by $P = 15 R_m - 1355$
94.4% or less	Remove and replace	94.9% or less	Remove and replace

(R_m) is the mean of the individual density ratios for the lot and (P) is the percentage of the relevant scheduled rate to be paid which shall not be greater than 100%.

(v) In situ Air Voids and Characteristic In situ Air Voids

In situ Air Voids and Characteristic In situ Air Voids shall be reported for each lot.

Percentage In situ Air Voids is defined as the ratio of In-situ Air Voids to the Maximum Density of asphalt. Percentage In situ Air Voids represents the Air Voids of the compacted asphalt as placed onsite, and shall be determined as follows:

$$\text{In situ Air Voids} = \frac{\text{Assigned Maximum density} - \text{field bulk density}}{\text{Assigned Maximum density}} \times 100$$

The Characteristic Value of In situ Air Voids is the calculated value of $\bar{x} + 0.92S$ for six tests per lot where \bar{x} and S are the mean and standard deviation of the individual In situ Air Void test values for the lot, respectively.

(c) Acceptance of Compaction on a Procedural Basis

Where a procedural basis is to be used, the Contractor is required to develop a compaction procedure that has been validated against density testing for the mix placed. Acceptance of work for compaction shall be based on the adoption of these approved placing procedures and a density test check plan that provides for a minimum test frequency of 5% of relevant lots to be tested. The test check plan shall provide for additional testing to demonstrate correction of non-conformance. Placing procedures shall be in accordance with AS 2150.

407.28 TRAFFICKING OF ASPHALT AND PAVING OF MULTIPLE LAYERS

Trafficking of asphalt or placement of asphalt over freshly laid asphalt layer is not permitted unless the majority of the asphalt has a surface temperature lower than that specified in Table 407.281.

Table 407.281: Maximum surface temperature of mixes before trafficking or placement

Mix Type	Maximum Surface Temperature (°C)
SF	50

Where trafficking results in deformation of the asphalt, further trafficking shall cease until such time that the asphalt has adequately cooled to allow trafficking without further damage.

407.29 SURFACE FINISH AND CONFORMITY WITH DRAWINGS

(a) General

For all asphalt works the following requirements shall apply for conformance with shape, location, alignment and width.

(i) Surface Finish

The finished surface of any asphalt course shall be of uniform appearance, free of dragged areas, cracks, open textured patches and roller marks.

(ii) Kerb and Channel

Where asphalt is placed against kerb and channel the surface at the edge of the wearing course shall be either flush with or not more than 5 mm above the lip of the channel.

(iii) Shape

No point on the finished surface of the wearing course shall lie more than 4 mm below a 3 m straight edge laid either parallel to the centreline of the pavement or, except on crowned sections, at right angles to the centreline. For intermediate and base course layers, the distance below the straight edge shall not exceed 6 mm and 10 mm respectively.

(iv) Alignment

Where asphalt pavement is not placed against a concrete edging, the edge of asphalt layers shall not be more than 50 mm inside nor more than 100 mm outside, the designed offset from centreline or design line. Within these tolerances, the rate of change of offset of the edge of layer shall not be greater than 25 mm in 10 m.

(v) Width

Where asphalt pavement is not placed against a concrete edging, the width of asphalt layers shall not be less than the design or specified width of layer by more than 50 mm or greater than the design or specified width by more than 100 mm. The average width over any 300 m shall not be less than the design or specified width.

(b) Conformity with Drawings for New Pavements and Major Pavement Rehabilitation Projects

For pavement works where design drawings show the finished surface level and thickness of each pavement course, the surface level of each asphalt course shall be measured in accordance with the requirements of Section 173. Every test lot shall meet either a Scale A, B or C requirement as specified in Clause 407.30(b).

Unless otherwise specified in Clause 407.30(f), the maximum lot size for measurement and assessment of surface level shall be 4,000 m².

(i) Scale A and B Surface Level Requirements

- a. Each level measurement shall be taken at random locations over the area of the lot in accordance with the relevant Test Method and the number of measurements taken within each lot shall not be less than the number specified in Table 407.292.
- b. The mean surface level and the variation in surface level for the base, intermediate and wearing courses within each lot shall meet the requirements of Table 407.293.

Table 407.292: Minimum Number of Level Measurements per Lot

Scale of Surface Level Measurement	Minimum Number of Measurements Per Lot
Scale A	80
Scale B	40

Table 407.293 Mean Surface Level Tolerances for the Sub-base and Pavement Courses

Scale of Surface Level Measurement	Granular or Cement Treated Subbase		Asphalt Layers	
	\bar{x} Range (mm)	Max. S (mm)	\bar{x} Range (mm)	Max. S (mm)
Scale A	+4 to -8	8	± 5	8
Scale B	+6 to -12	13	± 8	10

Notes on Table 407.293

\bar{x} is the mean value of all level readings taken in the lot (a negative value designates a measured departure below the design level and positive value designates a surface level above the design level)

S is the standard deviation of all level readings taken in the lot.

For Scale A and Scale B level requirements, the Superintendent may agree to accept a lot which does not conform with the limits of Table 407.293 at a reduced payment, in accordance with Table 407.294. The value of the lot of work shall be calculated from the unit rates for pavement construction as specified in Clause 407.30(c).

Where the surface level tolerances exceed the allowable variation in Table 407.294 rectification of the surface levels shall be undertaken

HP ~~Rectification of surface levels shall not commence until approval to proceed is obtained from the Superintendent.~~

Table 407.294: Payment Deduction for Surface Level

Variation	Payment reduction
Mean (\bar{x}) outside the specified limit up to a maximum of 25% of the limit	8% plus 4% reduction for each 1 mm the mean value extends outside the tabulated limit
Standard Deviation (S) exceeding the specified limit up to a maximum of 35% of the limit	8% plus 4% reduction for each 1 mm the Standard Deviation extends outside the tabulated limit

Note to Table 407.294

If both (\bar{x}) and (S) vary by more than the specified limit, the payment reduction shall be the sum of the payment reductions for both (\bar{x}) and (S).

(ii) Scale C Surface Level and Thickness Requirements

Surface level and thickness measurements shall be taken in accordance with the procedure specified in Section 173.

The level of the top of each asphalt course shall not differ from the specified level by more than 15 mm for intermediate and base courses and 10 mm for wearing course.

Where a uniform thickness of new asphalt pavement construction is specified, the mean thickness of a lot of asphalt shall not be less than the combined thickness of all asphalt courses specified in Clause 407.30 or shown on the drawings. For the purpose of this clause, the maximum lot size shall not be more than 4,000 m² of pavement area.

(c) Asphalt Overlays

Where a minimum average or nominal thickness of overlay is specified, and no existing pavement or finished levels are available, the average thickness of the overlay shall be calculated by:

$$T = \frac{M}{D \times A} \times 1000$$

Where:

T is the thickness of overlay in millimetres

A is the area of the job in square metres

D is the mean field density of placed asphalt in tonnes/m³

M is the mass of asphalt used in tonnes

The average thickness of the overlay shall not be less than the specified thickness.

407.30 SCHEDULES OF DETAILS***** (a) Asphalt Requirements (Clause 407.09)**

Course	Layer	Nominal Size of Asphalt (mm)	Type of Asphalt	Specified Layer Thickness (mm)
Wearing and Regulation	Open Graded (Section 417)	##:	##:	##:
	Wearing	##:	##:	##:
	Regulation	##:	##:	##:
Intermediate	Intermediate 1	##:	##:	##:
	Intermediate 2	##:	##:	##:
	Intermediate 3	##:	##:	##:
Base		##:	##:	##:
Combined Thickness of Asphalt Pavement (less the Open Graded Asphalt Layer)				##:

***** (b) Scale of Level/Thickness Control (Clause 407.29)**

Road Name	Location	Scale for Level/Thickness Control
##:		

Note to Table: Scale A shall be used unless otherwise approved by the Superintendent.

***** (c) Basis for Determining the Value of the Lot to be used for Price Deduction for Departure from Specified Density Requirements and Surface Level (Clauses 407.27 and 407.29).**

Location	Layer	Unit Price \$/m ²
##:	##:	##:

- *** ~~(d) Schedule of Manhole and Valve Covers to be Raised or Lowered to the New Finished Level Prior to Asphalt Overlay~~

Location or Chainage	Direction or Carriageway	Lane	Cover Type (Manhole or Valve)
##:			

- ~~(e) Polymer Modified Binder if different to Class A10E (Clauses 407.08) ##[strikethrough if 'default' Class A10E is to be used]:~~

*** ~~The class of PMB required in the ##: course shall be Grade ##:.~~

- ~~(f) Maximum Size of Test Lots if different to 4,000 m² (Clause 407.29b(ii)) ##[strikethrough if the maximum lot size is to be 4,000 m²]:~~

*** ~~The maximum size of test lot for assessment of compaction under Clause 407.27 and if applicable, compliance drawings under Clause 407.29 shall be ##: m².~~

- ~~(g) Paving in Echelon (Clause 407.25(e))~~

*** ~~Two pavers in echelon shall be used on the through carriageways from ##: to ##:~~

- ~~(h) A placement trial is required for mix type ## (strikethrough if a placement trial is not required)~~

- ~~(i) Joint testing required over 10% of lots with a minimum of 1 lot ## (strikethrough if not required).~~

- ~~(j) Locations where red asphalt to be placed~~

Location or Chainage	Direction or Carriageway	Lanes
##:		

SECTION 408 - SPRAYED BITUMINOUS SURFACINGS

~~##This section cross references Sections 166, 175, 310, 801, 831 and 832.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

408.01 GENERAL

This section covers the requirements for materials, design and application of sprayed bituminous surfacings including primes and sprayed seals of various types.

408.02 STANDARDS

Table 408.021 Referenced Documents

AAPA Health and Safety Guide	
AAPA HSE Guide No.8	Environmental management when spraying bituminous materials
Australian Standards	
AS 1160	Bituminous emulsions for the construction and maintenance of pavements
AS 2008	Bitumen for pavements
AS/NZS 2106.1	Methods for the determination of the flash point of flammable liquids (closed cup) Abel closed cup method
AS 2106.2	Methods for the determination of the flash point of flammable liquids (closed cup) Determination of flash point - Pensky-Martens closed cup method
AS 2157	Cutback bitumen
Austroads	
AGPT4K	Guide to Pavement Technology: Part 4K: Selection and Design of Sprayed Seals
AGPT-T530	Calibration of Bitumen Sprayers: General Introduction and List of Methods
AGPT-T531	Calibration of Bitumen Sprayers: Volumetric Calibration of Bitumen Pumping Systems
AGPT-T532	Calibration of Bitumen Sprayers: Transverse Distribution by Fixed Pit Facility
AGPT-T533	Calibration of Bitumen Sprayers: Transverse Distribution by Field Mat
AGPT-T534	Calibration of Bitumen Sprayers: Transverse Distribution by Portable Trough
AGPT-T535	Road Speed and Distance Calibration
AGPT-T536	Viscosity of Calibration Fluid
ATS-3110	Austroads Technical Specification: Supply of Polymer Modified Binders
ASTM International Standards	
ASTM D86	Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure
ASTM D93	Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
ASTM D276	Standard Test Methods for Identification of Fibers in Textiles
ASTM D445	Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D1298	Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
ASTM D3828	Standard Test Methods for Flash Point by Small Scale Closed Cup Tester
ASTM D4052	Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
ASTM D6140	Standard Test Method to Determine Asphalt Retention of Paving Fabrics used in Asphalt Paving for Full-Width Applications
VicRoads Test Methods	
RC 317.01	Test Method for Surface Texture by Sand Patch
RC 317.03	Test Method for Stripping of Aggregate from Sprayed Seals

Section 175 details the revision dates of the relevant references in this section.

408.03 DEFINITIONS

Adhesion Agent

A wetting agent designed to promote adhesion of binder to aggregate.

Aggregate Retention

Retention of aggregate particles by the binder under traffic. The degree of aggregate stripping is measured to assess aggregate retention.

Effective Spray Width

The width that the full design binder application rate is achieved. This width can vary depending on the type of end nozzles used. Where EAN18 end nozzles are used the effective width is considered to be 100 mm outside of the end nozzles.

Final Seal (FS)

The application of a sprayed seal treatment to a surface previously treated with an Initial Treatment.

Forward Aggregate Discharge Plant

Any item of plant or device approved by the Superintendent Council that loads aggregate into a vehicle/truck or hopper for the use in the process of forward aggregate spreading.

Forward Aggregate Spreading Plant

Any item of plant or device approved by the Superintendent Council that uniformly spreads aggregate on to the road surface at a predetermined rate and width while the vehicle is travelling in a forward direction and the operator/driver of the vehicle is facing in the direction of travel.

Polymer Modified Binder (PMB)

A bituminous binder with modified properties achieved by the addition of a polymer or crumb rubber.

Prime

An Initial Treatment comprising of the application of a bituminous primer to a prepared granular pavement base or concrete surface without cover aggregate.

Initial Seal (IS)

An Initial Treatment involving the application of a bituminous binder and covered with aggregate to a prepared basecourse which has not been primed to provide a temporary bituminous surfacing.

Initial Treatment

The application of a bituminous treatment to a prepared granular pavement base either as a prime or Initial Seal.

Reseal (R)

The application of a sprayed seal treatment over an existing bituminous surfacing.

Residual Binder

The volume of bituminous binder at 15°C including the volume of any polymer, crumb rubber but does not include the volume of any cutter, water, emulsifier or adhesion agent.

Reverse Aggregate Spreading Plant

Any item of plant or device that uniformly spreads aggregate at a predetermined rate and width while the vehicle is operating in a reverse direction (e.g. tip trucks with box spreaders attached).

Sprayed Seal

The sprayed application of bituminous binder to a previously primed or sealed surface followed by an application of aggregate to form an all-weather skid resistant road surfacing.

Types of sprayed seals include:

- Conventional (C), where the bituminous binder is generally Class 170 bitumen.
- High Stress Seal (HSS), where the bituminous binder is a lightly modified PMB (S10E, S35E) or has 9% (10 parts) of crumbed rubber added to aid aggregate retention on heavily trafficked roads. HSS seals may be applied as a single/single application (HSS1) or as a double/double application (HSS2).
- Extreme Stress Seal (XSS), is a double/double treatment where the bituminous binder is a heavily modified binder (S20E, S45R, S15RF), to accommodate extreme stresses imposed by heavy traffic volumes and high proportions of heavy vehicles or difficult service conditions.
- Strain Alleviating Membrane (SAM), where the bituminous binder is a heavily modified PMB (S20E, S45R, S15RF), to treat cracked pavements.
- Strain Alleviating Membrane Interlayer (SAMI), where the bituminous binder is a very heavily modified PMB (S25E, S18RF) to inhibit cracks reflecting through to an overlying surface.
- A Geotextile Reinforced Seal (GRS), where the bituminous binder is reinforced by the inclusion of a geotextile fabric to treat extensively cracked pavements. It is a form of SAM or SAMI where enhanced crack suppression is required.
- A Fibreglass Reinforced Seal (FRS) is a seal where the bituminous binder is reinforced by the inclusion of chopped fibreglass strands to treat cracked pavements. It is a form of SAM or SAMI where enhanced crack suppression is required but where a GRS cannot be placed.

Surface Enrichment (SE)

A light application of cutback bitumen or bitumen emulsion to an existing highly textured bituminous surfacing in very low or non-trafficked areas to extend the life of an existing sprayed seal or asphalt surface.

Surface Pre-Treatments

Surface pre-treatments include any sprayed bitumen, aggregate, combination of sprayed bitumen and aggregate, High Pressure Water Retexturing (HPWR), or other treatment approved by the Superintendent Council that is applied prior to the specified sprayed seal.

Surface Texture

The mean height of aggregate particles above the level of the binder as determined by VicRoads Test Method RC 317.01.

408.04 COMMENCEMENT OF WORK

(a) Periodic Resurfacing and Maintenance Works

~~Within 2 weeks of the Date of Award of Contract the Contractor shall submit to the Superintendent for review the sealing program for the whole of the works.~~

~~During the period of the Contract works, the Contractor shall submit by the preceding Thursday to Council a detailed program of planned sealing jobs for the following week for review by the Superintendent, including planned dates for each sealing job.~~

(b) Construction Projects

The Contractor shall include details of all sprayed bituminous surfacing works on the Construction Program.

~~During the period of the Contract works, the Contractor shall submit by the preceding Thursday to Council a detailed program of planned sprayed bituminous surfacing works for the following week for review by the Superintendent, including the planned sprayed bituminous surfacing works for each day.~~

HP Prior to the works being carried out, the Contractor shall provide written confirmation of the works that will be undertaken the following day and obtain agreement from the Superintendent Council to any variation in the design rates of application to those provided under clause 408.13(a).

HP Work shall not commence until the Contractor and the Superintendent Council have agreed that the road or pavement surface is fit and ready for surfacing no more than 24 hours prior to the works occurring. For Periodic Resurfacing and Maintenance Works this includes patching and other preparatory works, and for Initial Seals on Construction Projects the requirements of Standard Section 310 shall be satisfied.

408.05 LIMITS OF WORK

~~Where the Job Items are detailed in Table 408.191, the~~ The limits of work at the start and finish chainages plus the limit in any side road that have been marked on the pavement surface.

The Works shall include all existing tapers, bell mouths at intersecting roads, pavement widenings (turn lanes), traffic lanes and sealed shoulders, unless otherwise specified.

~~The Superintendent Council may increase or decrease the limits of work for Job Items listed in Schedule 1. The Contractor will be notified in writing prior to works commencing of such adjustments to the limits of work for any job. The Contract Sum shall be adjusted on a pro-rata basis using the Item price tendered in Schedule 1 and the difference in area of the revised works.~~

~~The areas for items listed in Table 408.191 are accurate to $\pm 5\%$.~~

408.06 INCLUSION AND DELETION OF JOB ITEMS

~~The Superintendent may cancel any work, subject to notice of cancellation being given at least one week prior to the proposed commencement date.~~

~~The Contractor will be notified in writing of such deletion and the Contract Sum adjusted by the price tendered in Schedule 1 for the job item/s deleted.~~

~~No additional payment will be made as a result of the deletion of any job item. However, where the deletion of job items results in a Contract Sum reduction of more than 20% of the original Contract Sum, the deletion of job items in excess of this amount will be treated as a variation in accordance with the Contract.~~

~~In the event of aggregate having been delivered to a job site and the job is deleted in accordance with this clause, the cost of the removal of the aggregate and any loss of aggregate shall be treated as a variation in accordance with the Contract.~~

~~The Superintendent may request the Contractor to undertake additional sealing works at sites not listed in Schedule 1. These works will be treated as a variation in accordance with the Contract.~~

408.07 CALIBRATION OF BITUMEN SPRAYERS

All sprayers used for application of bituminous materials shall have a current Certificate of Calibration showing compliance with Austroads test methods AGPT-T530 through to AGPT-T536. The Certificate of Calibration shall be renewed every 12 months. If any sprayer has its spray equipment overhauled or replaced, it shall be calibrated and issued with a new Certificate of Calibration prior to use.

408.08 BITUMINOUS MATERIALS**(a) Bitumen**

Unless otherwise specified, bitumen shall be Class 170 complying with the requirements of AS 2008. The value for the long-term effect of heat and air shall be not be less than nine days.

Bitumen incorporating up to 5% (five parts) of crumb rubber shall be considered to be an unmodified bituminous binder. Bitumen incorporating manufactured polymers that provide a similar level of modification may also be considered to be unmodified binders, subject to the approval of ~~the~~ Superintendent Council.

(b) Bitumen Emulsion

Bitumen emulsion shall comply with the requirements of AS 1160.

The use of any non-standard proprietary classes of bitumen emulsion shall be subject to the Contractor providing evidence that the product has demonstrated satisfactory field performance for a period of at least three years. Restricted use of untried products on a trial basis shall be subject to the approval of ~~the Superintendent Council.~~

(c) Cutback Bitumen

Cutback bitumen shall comply with the requirements of AS 2157. An equivalent product may be used subject to the Contractor providing evidence satisfactory to the Superintendent Council that the proprietary product has demonstrated acceptable field performance for a period of at least three years. Restricted use of untried products on a trial basis shall be subject to the approval of the Superintendent Council.

(d) Polymer Modified Binder (PMB)

The class of PMB shall comply with the requirements of Austroads Technical Specification ATS-3110.

Alternative or 'ungraded' PMBs which do not comply with the specified test requirements of ATS-3110 shall not be used without approval by the Superintendent Council and will be subject to the Contractor providing evidence that the product has delivered satisfactory field performance for a period of at least three years. Restricted use of untried products at nominated trial sites shall be subject to the approval of the Superintendent Council.

(e) Primer

The primer shall be cutback bitumen complying with the requirements of clause 408.08(c) and shall be water resistant, of uniform appearance and capable of providing a strong bond between the bituminous surfacing and the pavement. Proprietary classes of bitumen emulsion may be accepted by the Superintendent Council as an alternative to cut back bitumen if evidence is provided to show that the emulsion product meets the same functional requirements.

408.09 OTHER MATERIALS

(a) Adhesion Agent

Adhesion agent may be added to the aggregate precoat or binder to promote adhesion to the cover aggregate and/or pavement surface. The type of adhesion agent and the percentage to be used shall be subject to the Contractor providing evidence that the proprietary product has satisfactory field performance. When adhesion agent is added to the binder, the total volume of adhesion agent and diluent shall not exceed 1% by mass of the binder.

(b) Aggregate Precoating Material

Aggregate precoating material shall be a distillate, distillate-based product, cutback bitumen, emulsion or proprietary product subject to the Contractor providing evidence that the proprietary product has demonstrated satisfactory field performance for a period of at least three years. Restricted use of untried products on a trial basis shall be subject to the approval of the Superintendent Council.

(c) Crumb Rubber

Crumb rubber must be sourced from waste tyres generated in Australia and processed by a Tyre Stewardship Australia accredited supplier and shall be free from cord, wire, fluff and other deleterious material.

(d) Cutter

All cutters shall comply with the properties in the Table 408.091.

Table 408.091 Properties of Cutter

Property	Cutter ⁽¹⁾		Method of test
	Requirement		
	Min.	Max.	
Appearance	Clean, bright and visually free from solid matter and undissolved water at ambient temperature		—
Flash point (°C)	61.5	—	AS/NZS 2106.1 or AS 2106.2 or ASTM D93 or ASTM D3828 ⁽²⁾
Distillation range			ASTM D86
Initial boiling point (IBP) (°C)	140	—	
Final boiling point (FBP) (°C)	—	300	
Viscosity at 40°C (mm ² /s)	0.7	2.5	ASTM D445
Density at 15°C (kg/m ³)	Report		ASTM D1298 or ASTM D4052

Notes to Table 408.091

1 Cutter shall be completely miscible with bitumen and no precipitation shall occur.

2 Whichever of the listed test methods that is applicable for the flash point range of the material.

Other cutters which do not comply with the requirements of Table 408.091 but have a flash point of 61.5°C or higher, or other methods of temporarily lowering the viscosity of the binder may be used subject to the Contractor providing evidence that such methods or products have demonstrated satisfactory field performance for a period of at least three years.

Restricted use of untried products or processes on a trial basis shall be subject to the approval of the Superintendent Council.

(e) Geotextile Fabric

Unless otherwise specified or approved by the Superintendent Council, all geotextile fabric used for geotextile reinforced seals shall be a non-woven needle punched fabric. The mass of the fabric shall be a minimum of 135 g/m² for seals of nominal maximum size of 14 mm and under, and 175 g/m² for seals of nominal maximum size of larger than 14 mm. The geotextile fabric shall have a melting point when determined in accordance with ASTM D276 at least 10°C above the maximum binder spraying temperature. The binder retention allowance shall be determined in accordance with ASTM D6140 with a C170 bitumen.

408.10 BINDERS FOR TREATMENT TYPES

(a) Initial Seal Binder

The binder to be used in Initial Seals shall be a suitable cutback bitumen, bitumen emulsion or a 9% (10 parts) crumb rubber modified binder. Other modified binders may be used subject to approval of the Superintendent Council.

The Initial Seal shall be waterproof and capable of adhering to the pavement surface while retaining sufficient binder on the surface to hold the aggregate in place.

(b) Final Seal and Reseal Binders

Unless otherwise specified in Table 408.191, one of the following binder classes and seal sizes outlined in Table 408.101 shall be used.

Table 408.101 Binder Class for Treatment Types

Treatment Type	Binder Class	Seal Type	Typical Aggregate Sizes
Conventional	C170, C240, C320	Single/single Double/double	7,10,14 10/5, 10/7, 14/7, 20/7
HSS	S10E, S35E 10 parts rubber	Single/single Double/double ⁽¹⁾	7, 10, 14 10/5, 10/7, 14/7, 20/7
XSS	S20E, S15RF S45R	Double/double ⁽¹⁾	14/7, 20/7
SAM	S20E, S15RF, S45R	Single/single Double/double ⁽¹⁾	10, 14 10/5, 10/7, 14/7, 20/7
SAMI	S25E, S18RF	Single/single Double/double ⁽¹⁾	10, 14 10/5, 10/7, 14/7
GRS SAM	C170, C240, C320	Double/double	14/7, 20/7
GRS SAMI	C170, C240, C320	Single/single Double/double	10, 14 10/5, 10/7, 14/7

Notes to Table 408.101

(1) These treatments may incorporate a geotextile fabric layer where specified.

408.11 AGGREGATE**(a) Aggregate Specification**

Aggregate shall comply with the following Standard Specification Sections:

- 801 - Source Rock for the Production of Crushed Rock and Aggregates
- 831 - Aggregate for Sprayed Bituminous Surfacing
- 832 - Sands for Sprayed Bituminous Surfacing.

(b) Aggregate Precoating

The Contractor shall provide either plant precoated aggregate or field precoated aggregate.

Aggregate precoating shall be undertaken using a purpose-built item of plant to apply the precoating material in a controlled manner that produces a uniform coating

408.12 USE OF STACKSITES**(a) General**

~~Department of Transport stacksites available for use by the Contractor for stockpiling of aggregate prior to placement are shown in Table 408.192.~~

~~The available stacksites are not guaranteed as suitable for the Contractor's operations or that they are of sufficient capacity to accommodate any or all of the quantities needed by the Contractor.~~

~~Any stacksites used by the Contractor during the Contract shall be cleaned and returned to their original condition within four weeks of completion of the use of that stacksite for works under the Contract. Where the Contractor does not clean any stacksite used as specified, the Superintendent may arrange for it to be done by others at the Contractor's expense.~~

No stacksites are to be constructed on the road reserve.

The use of stacksites on ~~other~~ road reserves (such as municipal stacksites), or on other public or private land require the approval of the relevant authority or owner ~~prior to use for items under the Contract.~~

Aggregate stored at stacksites shall be managed to avoid contamination from other materials on the stacksite or from other sources such as vegetation, debris etc.

(b) Placement of Stacks

The following requirements shall apply to the placement of aggregate and materials:

- (i) stacks shall be placed so they do not unduly reduce sight distance at locations such as intersections and curves
- (ii) stacks shall not be placed under or immediately adjacent to power lines and shall comply with all "No-Go Zones" and the relevant requirements for electrical spotters
- (iii) stacks shall not be placed at locations where any sealing operations, including aggregate delivery will interfere with trees or structures
- (iv) stacks shall be placed clear of the road formation, drains, gateways and side tracks
- (v) for aggregate placed on roadside stacksites, stacks shall be placed within the limits of the existing cleared area at the stacksite.

~~(c) Safe Work Method Statement~~

~~Prior to using any stacksite, the Contractor or relevant parties shall submit a Safe Work Method Statement addressing the requirements of the SWMS Checklist in Appendix ##:~~

408.13 APPLICATION OF BITUMINOUS MATERIAL, AGGREGATE AND GEOTEXTILES**(a) Design Rates of Application**

The Contractor shall determine the design rates of application for primer, binder, surface pre-treatments, remedial works and aggregate in accordance with the procedures set out in the Guide to Pavement Technology (Austroads): Part 4K. The design calculation shall clearly show how design rates have been determined including all traffic and EHV allocations to each lane, voids factors, allowances, assumptions and any supporting data.

All rates of application of bituminous material shall be expressed in L/m². In the case of binder, rates of application shall refer to residual binder at 15°C.

All rates of application of aggregates shall be expressed in m²/m³ and rates of application of precoat shall be expressed in L/m³.

Traffic data and default rates of application for bituminous material are specified in Table 408.191.

HP

~~At least one week prior to the commencement of work, the~~ The Contractor shall submit the initial design rates of application for bituminous material, aggregate, and rates for pre-treatment for review by the Superintendent Council.

Final design rates for primer, binder, surface pretreatments, remedial works and aggregate may be varied at any time prior to the application of the treatment where notification of any such adjustments are provided to the Superintendent Council in writing.

(b) Surface Pre-treatment

Surface pre-treatments to correct variable surface texture shall be allowed for by the Contractor and carried out as part of the works to meet the requirements of Surface Texture and Aggregate Retention specified in Tables 408.152 and 408.153. Where the Superintendent Council has included a requirement for pre-treatment in Table 408.191 this does not limit the Contractor's responsibility for pre-treatments on all jobs. ~~The cost of surface pre-treatments shall be included in the lump sum works.~~

The acceptance criteria for Surface Texture and Aggregate Retention shall apply as specified in Tables 408.152 and 408.153 unless these requirements are waived in Table 408.191.

(c) Geotextile Fabric Sprayed Seals

Geotextile fabric shall be fixed to the pavement surface free of wrinkles and/or folds. Transverse joints shall be butt jointed.

Longitudinal joints shall be overlapped by approximately 150 mm and be located along lane lines. The Contractor shall make an allowance for additional binder to be applied along the joint so that both geotextile layers are adequately saturated with bitumen. This allowance shall be included in the Contractor's seal design.

Bond coats shall be applied so that the effective width of the bond coat extends approximately 100 mm beyond the width of the fabric being placed.

(d) Minimum Temperature

Unless otherwise approved by the Superintendent Council, the Contractor shall not apply any sprayed bituminous treatments unless the air and pavement temperature are above those listed in Table 408.131 and rising. The minimum temperature shall not apply for Strain Alleviating Membrane Interlayer (SAMI) treatments which will not be trafficked, prior to the SAMI being overlaid.

In addition to Table 408.131 priming and initial sealing shall only be undertaken when the prevailing weather conditions, when assessed in accordance with *AAPA HSE Guide No.8 – Environmental management when spraying bituminous materials*, have a risk rating of 'low' or less and appropriate work practices to minimise risks are in place.

Table 408.131 Minimum Temperatures for Spraying Bituminous Materials

Treatment Type	Minimum air and pavement Temperature (°C)
Initial Treatments	
Primes	10
Initial seals (single/single)	15
Initial seals (double/double)	10
Reseal Treatments	
C170 and crumb rubber modified PMBs	15
Other PMBs	20
Geotextile Reinforced seals	20

(e) Aggregate Spreading

The Contractor shall include in their quality plan a method to measure and assess the aggregate spread rates applied.

(f) Forward Aggregate Spreading

~~Forward aggregate spreading is encouraged but not mandatory for sealing works delivered prior to 1 July 2022.~~

Where forward moving aggregate spreading plant is used, no aggregate spreading or discharge from that item of plant will be permitted in a reverse direction. This includes plant items which discharge into self-propelled aggregate spreaders.

Forward aggregate spreading and discharge plant shall require that the operator of that plant is facing in the direction of travel. Vehicles or devices may include synchronised bitumen spraying and aggregate spreading or independent aggregate spreading only.

The combination of both forward and reverse aggregate spreading techniques will be accepted on the same section of road and sprayer run during the transition period.

HP Where the Contractor proposes to use forward aggregate spreading plant, written approval is required from the Superintendent Council prior to use., unless written approval has been previously provided by the Department of Transport.

~~(g) Additional Payment for Forward Aggregate Spreading~~

~~Contractors who use forward aggregate spreading techniques prior to 1 July 2022 shall be entitled to additional payments for completed seal treatments above the Contract Sum as follows:~~

- ~~—— (i) a value recognition for the use of forward aggregate spreading techniques of an additional payment of 50 cents per square metre sealed; and~~
- ~~—— (ii) an early adopter's incentive for the use of forward aggregate spreading technique of a further additional payment of 20 cents per square metre sealed for all sealing works delivered prior to 1 July 2020.~~

~~For all sealing works delivered after 1 July 2022, the forward aggregate spreading requirement shall be mandatory for all sprayed sealing works and all associated costs shall be deemed to have been incorporated into the Contract Sum.~~

~~If a combination of forward and reverse spreading or discharge plant or devices are used on the same works or section of road, a pro-rata rate will be used to determine any additional payment. (e.g. if one forward spreading vehicle and two reverse spreading vehicles are being used, the additional payment shall be paid on one third of the total square metres sealed for that part of the Contract provided that the forward aggregate spreading plant has undertaken a commensurate amount of aggregate spreading for the works).~~

~~For sprayed seals consisting of multiple application of aggregates, payments as described in this clause shall only be applicable to the area of the completed sprayed seal treatment.~~

~~For multiple year contracts the additional payments shall only be applicable to the years as specified in this clause.~~

(h) Rolling of Aggregate

Rolling of aggregate shall:

- (i) be undertaken over the full width of the pavement being sealed including any untrafficked areas
- (ii) be undertaken by static rubber tyred rollers or rubber coated steel drum rollers unless otherwise specified or approved by the Superintendent Council.

~~Rolling of aggregate using rollers where the operator faces in the direction of travel of the roller at all times is encouraged but not mandatory for sealing works delivered prior to 1 July 2030.~~

~~From 1 July 2030 the only rollers that shall be used for sealing works will, at all times, have the operator facing in the direction of travel of the roller.~~

~~There shall be no additional payment for forward facing rollers prior to 1 July 2030.~~

(i) Sweeping of road surface prior to application of a seal treatment

All surfaces shall be inspected prior to the application of a sprayed seal treatment to ensure that a clean surface is available for sealing works that is free from dirt, loose aggregate and other detritus.

HP

For multiple application treatments, intermediate sprayed seal layers shall be thoroughly swept to ensure that loose aggregate particles are removed prior to the application of the subsequent sprayed seal layers. This includes areas where an overlap of aggregate has occurred during the spreading operation.

408.14 REMOVAL OF LOOSE AGGREGATE

After the completion of a sprayed seal treatment, the Contractor shall remove and dispose of all loose aggregate within the maximum time limits as specified in Table 408.141. This includes loose aggregate on all trafficked areas, and areas where loose aggregate has been swept, or moved by traffic onto sealed shoulders or non-trafficked areas, or into other areas such as concrete channels, traffic islands, medians, open drains, drainage pits, footpaths, nature strips, or verges.

Table 408.141 Maximum Time Limit for Removal of Loose Aggregate

Traffic Volume (AADT) *	Maximum Time Limit
>5000 and all Freeways	Within 8 hours of sealing
>2000 to 5000	Within 24 hours of sealing
>500 to 2000	Within 48 hours of sealing
<500	Within 5 days of sealing

* Annual Average Daily Traffic - refer to Table 408.191 for AADT for each Job Item

Until loose aggregate is removed from the sealed surface, traffic speed shall be controlled by signing and installation of road works speed limits in accordance with Standard Specification Section 166.

Loose aggregate shall not be removed until the aggregate has properly bedded down into the binder by either trafficking or rolling. Any damage to the sprayed seal resulting from removal of loose aggregate shall be repaired by the Contractor.

Rotary brooms and/or suction sweepers are permitted to remove loose aggregate from the trafficked areas, unless otherwise specified.

~~Loose aggregate may be temporarily stored at the stock sites nominated in Table 408.192.~~

For seals of nominal size 10 mm and over, including multiple application seals:

After the removal of loose aggregate and at any time during the Defects Liability Period, no more than 40 loose stones in any square metre of pavement shall remain. This includes stones that have originated from the area sealed under the Contract and which have accumulated on adjacent sealed areas such as intersections, additional traffic lanes (in either direction), shoulders and flanks.

On job items where 40 loose stones or more are measured, warning signs shall be erected within eight hours, and the site shall be re-swept, or the loose stones removed within 48 hours of measurement.

For seals of nominal size 7 mm and under:

After the removal of loose aggregate and at any time during the Defects Liability Period, no more than 60 loose stones in any square metre of pavement shall remain. This includes stones that have originated from the area sealed under the Contract and which have accumulated on adjacent sealed areas such as intersections, additional traffic lanes (in either direction), shoulders, and flanks.

On job items where 60 loose stones or more are measured, warning signs shall be erected within eight hours, and the site shall be re-swept, or the loose stones removed within 48 hours of measurement.

408.15 ACCEPTANCE OF WORK

(a) Rates of Application for Binder

The Contractor shall produce evidence to show that the actual rate of application for a Job Item, or segments of a Job Item with different design rates of application, complies with the final submitted design rates of application. Variation between the actual rates and the design rates will be assessed in accordance with Table 408.151.

~~If a payment deduction or rectification is required in respect of unsatisfactory surface texture or aggregate loss as specified in parts (b) and (c) of this clause, deductions under Table 408.151 will not be applied.~~

Table 408.151 Variation in Rates of Application of Bituminous Material

Variation from the Design Rates of Application for Bituminous Material (L/m ²) *	Assessment
< 0.1 L/m ² below the design rate of application	Accept
≥ 0.1 L/m ² to 0.2 L/m ² below the design rate of application	Works to be rectified. Deduct \$0.75/m² for the affected area provided that minimum texture and aggregate retention requirements are met
> 0.2 L/m ² below the design rate of application	Works to be rectified. Deduct \$1.50/m² for the affected area provided that minimum texture and aggregate retention requirements are met

* The variation from the Design Rate of Application for SAM seals or SAMIs may be increased by 0.05 L/m².

Acceptance or otherwise of the criteria specified in Table 408.151 shall not relieve the Contractor from its obligations under the Contract.

(b) Surface Texture

Acceptance of work for surface texture and surface enrichment shall be based on visual assessment. However, in marginal cases the Superintendent Council may request that nominated areas be tested in accordance with VicRoads Test Method RC 317.01 and assessed in accordance with Table 408.152. The test lot size shall not be less than 100 m of single traffic lane or more than 600 m of single traffic lane. For any testing undertaken on areas other than within traffic lanes, the minimum lot size shall be not less than 400 m² or more than 2500 m².

Table 408.152 Surface Texture Requirements

SINGLE/SINGLE TREATMENTS						
Treatment	Mean Texture Depth (mm)				Action Required	
	Size 5	Size 7	Size 10	Size 14		
Seals (All Types) ⁽¹⁾	1.0 to 1.6	1.3 to 1.8	1.5 to 2.5	2.0 to 4.0	Accept	
	0.8 to 1.0 or 1.6 to 1.8	1.2 to 1.3 or 1.8 to 2.0	1.3 to 1.5 or 2.5 to 3.0	1.7 to 2.0 or 4.0 to 4.5	Work to be rectified. The Superintendent may require rectification of the works or elect to reduce payment for the lot by \$1.00/m ²	
	< 0.8 or > 1.8	< 1.2 or > 2.0	<1.3 or > 3.0	< 1.7 or > 4.5	Work to be rectified	
Initial Seals ⁽²⁾	N/A	1.0 to 2.0	1.2 to 3.0	N/A	Accept	
	N/A	< 1.0 or > 2.0	< 1.2 or > 3.0	N/A	Work to be rectified	
Surface Enrichment ⁽¹⁾	N/A		0.8		Accept	
	N/A		< 0.8		Work to be rectified	
DOUBLE/DOUBLE TREATMENTS						
Treatment	Mean Texture Depth (mm)					Action Required
	Size 10/5	Size 10/7	Size 14/5	Size 14/7	Size 20/7	
Seals (All Types) ⁽¹⁾	1.3 to 2.1	1.3 to 2.2	1.3 to 2.4	1.3 to 2.4	1.4 to 2.5	Accept
	1.2 to 1.3 or 2.0 to 2.3	1.2 to 1.3 or 2.1 to 2.4	1.2 to 1.3 or 2.4 to 2.7	1.2 to 1.3 or 2.4 to 2.7	1.3 to 1.4 or 2.5 to 2.8	Work to be rectified. The Superintendent may require rectification of the works or elect to reduce payment for the lot by \$1.00/m ²
	<1.1 or >2.3	<1.1 or >2.4	<1.2 or >2.7	<1.2 or >2.7	<1.3 or >2.8	Work to be rectified
Initial Seals ⁽²⁾	1.0 to 2.0	1.0 to 2.0	N/A	N/A	N/A	Accept
	< 1.0 or > 2.0	< 1.0 or > 2.0	N/A	N/A	N/A	Work to be rectified

Notes: (1) Surface texture measurements for sprayed seals and surface enrichment may be undertaken at any time during the Defects Liability Period, but final acceptance of works is not affected until the end of the Defects Liability Period.

(2) Surface texture measurements for initial seals shall be undertaken between 10 and 15 weeks after placement. If tests are not undertaken in this period and later test results require the works to be rectified, the later test results are to be used for acceptance of the works.

(c) Aggregate Retention

Acceptance of work for aggregate retention shall be based on visual assessment. However, in marginal cases the Superintendent Council may request that nominated areas be tested in accordance with the VicRoads Test Method RC 317.03 and assessed in accordance with Table 408.153. Depending on the measured Degree of Aggregate Stripping, the Contractor shall take action as specified in Table 408.153. The test lot size shall not be less than 100 m of single traffic lane or more than 600 m of single traffic lane. For any testing undertaken on areas other than within traffic lanes, the minimum lot size shall be not less than 400 m² or more than 2500 m².

Table 408.153 Assessment of Aggregate Retention

Degree of Aggregate Stripping	Action Required
0 to 2	Accept
3 to 5	Work to be re-tested within one month prior to the end of the Defects Liability Period. If the Degree of Aggregate Stripping has increased since it was last tested, the work shall be rectified before the end of the Defects Liability Period.
Greater than 5	Work shall be rectified within 5 days.

Note: Aggregate retention measurements may be undertaken at any time during the Defects Liability Period, but final acceptance of works is not affected until the end of the Defects Liability Period.

(d) Visual Uniformity

The Contractor shall provide a surface with uniform colour and texture to provide a consistent appearance for each job item. Any aggregate used for repairs and/or remedial works shall be supplied from the same source.

408.16 MAINTENANCE OF SEALS

The Contractor shall be responsible for the monitoring and maintenance of seals from the time of application until the end of the Defects Liability Period. Monitoring of seals shall include regular and timely inspection of work, management of traffic and monitoring of any deterioration in the surface condition.

The Contractor shall carry out any work necessary to protect and maintain the seal or to effect repairs to any seal failure. Such failures include but are not limited to emulsification, flushing, bleeding, fatty areas, significant areas of bitumen on kerb and channel, excess bitumen without aggregate cover, aggregate stripping, non-uniform aggregate spreading and streaking of binder but do not include pavement failures or events beyond the reasonable control of the Contractor.

HP The Contractor shall advise the Superintendent Council in writing of the proposed treatment to affect the above work before undertaking the work.

HP The Contractor shall obtain the agreement of the Superintendent Council of the proposed treatment before undertaking the work.

The Contractor shall undertake the protection or repair work within 48 hours of notification by the Superintendent Council. The Contractor shall be responsible for the installation and maintenance of appropriate traffic management as approved by the Superintendent Council until the repairs are completed.

For urgent repairs, the Contractor shall take action to preserve the work and make the road safe within 48 hours of being notified or becoming aware of the defect.

~~Payment will be made for the cost of repairs undertaken by the Contractor and approved by the Superintendent for damages that are the result of incidents outside the Contractor's control, including but not limited to, damage caused by others involving oil spills, accidents, vehicle fire or tearing due to heavy braking and skidding.~~

408.17 RECORDS

The Contractor shall forward to the Superintendent Council a Job Completion Report (Sealing) using the proforma included as Attachment A to this Section 408, or an equivalent proforma as approved by the Superintendent Council, for each job item in Schedule 1. The completed form shall be submitted within seven days of completion of sealing each job.

The Contractor shall ensure that where a representative of the Superintendent Council is on site during the works, that officer validates the works as provided on the Job Completion Report (Sealing).

The Contractor shall carry out at least two inspections of each job during the Defects Liability Period and provide a condition report to the Superintendent Council. The condition report shall detail the condition of the seal, any defects and the proposed corrective action.

408.18 DEFECTS LIABILITY PERIOD

All defects shall be rectified ~~six months~~ prior to the conclusion of the Defects Liability Period, to an agreed corrective action. This does not limit the Contractor's responsibility to undertake protection or urgent repair works under clause 408.16. ~~The Defects Liability Period for repaired work shall recommence on the date of repair in accordance with the provisions of the Contract.~~

408.19 SCHEDULE OF DETAILS**Table 408.191 Schedule of Details**

Job Item (refer Sch 1)	Freeway, Highway or Road Name	Map Ref VicRoads/ Melway Directories		Chainage km	Approx Length m	Approx Width m	Approx Area m ²	Treat- ment Type (2)	Treat- ment Descrip- tion (3)	Single or Two Appli- cation (4)	Agg Sizes mm	Min Agg Class (A, B or C)	Traffic Data			Default Binder Rates of Appli- cation L/m ²	Pre-treat Y/N?	Other Requirements
		Road No. (and Linking Victoria Classification)	Map & Ref (1) or GPS Coordinates. (1)										24 hr AADT (5)	% EHV	24 hr AADT/ Lane (6)			
## Note to author - The following items are examples only. Change text to suit your specification - DELETE THIS ROW BEFORE PRINTING:																		
1	Birchip-Rainbow Road	5432 (C243)	100-G7	7.00-8.00	1000	7.4	7400	FS	C	S	10	B	1400	15	700	1.3		
2	Western Highway	2520 (A8)	150-B6	161.0-162.0									12000	15	see under			
	2.1 Lane 1 (slow lane)			161.0-162.0	1000	3.7	3700	R	GRS	D	14/7	A			4500	2.4		Min. PSV of ##: is required for aggregate
	2.2 Lane 2 (passing lane)			161.0-162.0	1000	3.7	3700	R	SAM	S	14	A			1500	1.8		PMB Class ##: is required
	2.3 Lane 3 (reverse direction)			161.0-162.0	1000	3.7	3700	R	HSS	S	10	A			6000	1.5		
	2.4 Shoulders x 2			161.0-162.0	1000	2 x 2.4	4800	R	SE	S	N/A	N/A			≤50	0.8		
3	Mallee Highway	2650 (B12)	11-C3	120-121	1000	7.4	7400	R	SAM	S	14	B	1000	10	500	1.6		

If any space is left blank it shall be read as "Not Applicable".

Notes on Table 408.191

- (1) The map references refer to either the Melway Street Directory or the VicRoads Country Directory. GPS Coordinates refer to the start of the section travelling in the direction of increasing road chainage.
- (2) Treatment Type - Prime Only (PO), Initial Seal (IS), Prime and Seal (P&S), Final Seal (FS), Reseal (R) Surface Enrichment (SE).
- (3) Treatment Description - Conventional (C), Single/Single High Stress Seal (HSS1), Double/Double High Stress Seal (HSS2), Extreme Stress Seal (XSS), Strain Alleviating Membrane (SAM), Strain Alleviating Membrane Interlayer (SAMI), Geotextile Reinforced Seal (GRS), Fibreglass Reinforced Seal (FRS).
- (4) Single or Two Application - Single(S) or Double Application (D) of Binder and Aggregate.
- (5) AADT is the Annual Average Daily (24 hr) Traffic and % EHV is the percentage of the AADT calculated from number of heavy vehicles and large heavy vehicles.
- (6) AADT / lane is the Average Annual Daily (24 hr) Traffic for the traffic lane being considered. Where this is not given it shall be proportioned by the Contractor from the AADT figures.
- (7) Typical 'Other Requirements' include: Specific PMB Class (Cl. 408.08 & Cl 408.10), Aggregate PSV >48 (Section 831), If plant precoated aggregate is specifically required (Cl. 408.11), Need for gritting of trafficked areas for Prime Only treatments (PO), Notification to abutting landowners, Placement of variable message boards or other additional advisory signs, suction sweeper required (Cl. 408.12), Specific programming requirements.

Table 408.192 Stacksite Locations

Stacksite ID.	Map Reference ⁽¹⁾			Location and General Description	Additional Restrictions on Use and Cleaning Up of Stacksites
	Map No.	Grid Ref.	GPS Coord.		
##Note to author. The following items are examples only. Change text to suit your specification. DELETE THIS ROW BEFORE PRINTING:					
1	100	G8		Birchip-Rainbow Road approx. 9.0 km / north side	Powerlines exist on site, Vehicles not to enter no go zones and to leave protective earth bund in place when cleaning site.
N/A				Contractor to obtain approval to selected stacksite	Remnant aggregate shall be removed from the stacksite within 2 weeks rather than 4 weeks.

Notes to Table 408.192

(1) The Map References refer to either the Melway Street Directory or the VicRoads Country Directory.

(2) GPS coordinates where provided refers to Stacksite entrance.

CONTRACT No.

DELINEATION	Existing RRPMS	Removed	Yes / No	Date:		
	TRRPMS	Installed	Yes / No	Date:	Spacings:	m
		Uncovered	Yes / No	Date:		
	Reinstatement	Pavement Markings - 1 st Coat		Specified Date Due:		
				Actual Date Done:		
		Pavement Markings - 2 nd Coat		Specified Date Due:		
				Actual Date Done:		
		RRPMS		Specified Date Due:		
				Actual Date Done:		
	Weather Delays to Linemarking: days					

..... /

(Superintendent/Council's Representative, signed)

SECTION 409 - WARM MIX ASPHALT

~~##This section cross-references Section 407.~~

~~When Section 409 is included in the specification, Section 407 must also be included:~~

409.01 GENERAL

These clauses cover special requirements for Warm Mix Asphalt (WMA) that are in addition to, or override, the requirements for Section 407 – Hot Mix Asphalt.

409.02 DEFINITION

Warm Mix Asphalt (WMA)

Warm Mix Asphalt (WMA) is asphalt which contains an additive, or uses a manufacturing process, that allows the asphalt mix to be produced and placed at lower temperatures than Hot Mix Asphalt (HMA).

409.03 BINDERS

The class of binder for each asphalt type shall comply with the requirements of Clause 407.05.

409.04 MIX DESIGN

All mixes shall comply with the requirements of Clause 407.06.

HMA mix designs registered as 'General' can be used as the basis of WMA mix designs. The mix identification number for WMA shall include the suffix 'W'.

409.05 ADDITIONAL PERFORMANCE TESTING FOR WMA

- (a) Representative samples of production asphalt shall be taken and tested at a frequency not less than that specified in Table 409.051.
- (b) Test specimens for the tests shall be compacted to an air voids content as specified in VicRoads Code of Practice RC500.01.

Table 409.051 Frequency of Testing for WMA

Test Required	Minimum Frequency
Moisture Sensitivity (Minimum Wet Strength and Tensile Strength Ratio)	One per 10,000 tonnes or part thereof.
Indirect Tensile Modulus*	One per 2,000 tonnes or part thereof.

* Modulus testing is only required for the approved WMA mixes produced by using the sequential aggregate coating method with two different binder grades.

SECTION 421 - HIGH BINDER CRUMB RUBBER ASPHALT

~~##This section cross-references Standard Section 407 and it must be included in the specification:~~

421.01 GENERAL

This section is a supplement to Standard Section 407 - Asphalt and covers special requirements for High Binder Crumb Rubber Asphalt (HBCRA) that are in addition to or override the requirements of Section 407.

421.02 DESCRIPTION

HBCRA is asphalt which contains crumb rubber obtained from waste tyres and a high binder content to improve flexural and elastic recovery properties and to delay reflective cracking.

421.03 STANDARDS

Standard Section 175 details the relevant references to Australian Standards (AS), Austroads Standards and Codes of Practice referenced in this section. These references are summarised in Table 421.031.

Table 421.031 Standards, Specifications and Codes of Practice

Australian Standards	
	<i>Nil</i>
Austroads Documents	
AGPT/T190	<i>Specification Framework for Polymer Modified Binders</i>
VicRoads Codes of Practice	
RC 500.01	<i>Registration of Bituminous Mix Designs</i>
RC 500.16	<i>Selection of Test Methods for Testing of Materials and Work</i>
VicRoads Test Method	
RC 200.01	<i>Design of Asphalt Mixes (Marshall Method)</i>

421.04 AGGREGATES

Unless otherwise specified, properties of the aggregates used in HBCRA shall comply with the requirements specified in clause 407.03. Size 10 mm and Size 14 mm HBCRA mixes must use aggregates that comply with the Type H requirements of clause 407.03. Size 20 mm HBCRA mixes must use aggregates that comply with the Type S series requirements of clause 407.03.

421.05 FILLER

The added filler shall be hydrated lime.

421.06 CRUMB RUBBER

Crumb rubber must:

- comply with the requirements of AGPT/T190; the use of uncured or devulcanized rubber is not permitted; an alternative grading for the crumb rubber will be considered subject to evidence being provided that demonstrates the alternative graded crumb rubber has no adverse impact on asphalt performance

- (b) be processed from waste tyres generated in Australia and processed by a Tyre Stewardship Australia accredited supplier
- (c) be a uniform material consisting of synthetic rubber or natural rubber from car or truck tyres, or a mixture of both, and shall be free from cord, wire, fluff and other deleterious material.

A certificate of compliance may be requested to demonstrate that all crumb rubber requirements have been met.

421.07 BINDER

The bitumen shall be Class 320 complying with the requirements of AS 2008.

421.08 RECLAIMED ASPHALT PAVEMENT (RAP)

The use of RAP is not permitted in HBCRA.

421.09 WARM MIX ASPHALT ADDITIVE

Warm mix asphalt additive may be included in the asphalt mix to reduce the asphalt manufacturing and placement temperatures or to aid compaction.

421.10 MIX DESIGN REQUIREMENTS

- (a) Mix Design

The asphalt mix shall be registered in accordance with clause 407.06 and RC 500.01 and designed in accordance with RC 201.01.

- (b) Grading

Unless otherwise specified, the grading of aggregate with added filler after mixing but before compaction, and the proportions of aggregate, added filler, granular crumb rubber and bitumen in the mix shall comply with Tables 421.101 and 421.102.

Table 421.101 Grading of Aggregate with Added Filler

Sieve Size (mm)	Percentage Passing (by Mass)		
	Mix Size 10	Mix Size 14	Mix Size 20
19.0	-	100	90 - 100
13.2	100	90 - 100	75 - 85
9.5	90 - 100	65 - 75	60 - 70
6.7	64 - 74	40 - 50	38 - 46
4.75	36 - 46	30 - 40	24 - 36
2.36	20 - 30	15 - 25	12 - 23
1.18	12 - 22	10 - 19	8 - 17
0.600	8 - 17	7 - 15	6 - 14
0.300	6 - 11	5 - 10	4 - 10
0.150	4 - 8	4 - 8	3 - 8
0.075	3 - 5	3 - 5	3 - 5

Note: For purposes of grading, the grading of the aggregates includes the added filler and excludes the crumb rubber.

Table 421.102 Proportions of Aggregate, Added Filler, Crumb Rubber and Bitumen

Sieve Size (mm)	Percentage Passing (by Mass) Mix Sizes 10, 14 and 20 mm
Aggregate	86 – 89
Added Filler	1.0 - 2.0
Crumb Rubber	2.5 - 3.0
Bitumen	7.5 - 9.0

(c) Volumetric Test Properties

The volumetric test properties of the mix shall comply with Table 421.103

Table 421.103 Volumetric Test Properties (Mix Sizes 10, 14 and 20 mm)

Air Voids (%)	Voids in Mineral Aggregates (Minimum %)	Binder Film Thickness (microns)
5.0 - 6.5	23	19 - 25

- Notes: 1. For purposes of calculation of Voids in Mineral Aggregates, the crumb rubber is to be considered as part of the binder.
2. Binder film thickness shall be calculated as bitumen distributed over the surface of the aggregates including crumb rubber.

(d) Performance Test Properties

The following performance test properties shall be submitted for information only.

Table 421.104 Performance Test Properties

Performance Test	Mix Size		
	10 mm	14 mm	20 mm
Mean Indirect Tensile Modulus @ 25 ^C (MPa)	For information only		
Min Wet Tensile Strength (kPa)			
Min Wet to Dry Tensile Strength (%)			
Max Wheel Tracking Depth @ 60 ^C (mm)			

- Notes: 1. All testing shall be undertaken in accordance with RC 500.16
2. Modulus test limits apply to gyratory compacted specimens compacted to 5% air voids within a tolerance of $\pm 0.5\%$ air voids.
3. Wet tensile strength and tensile strength ratio test specimens shall be prepared using gyratory compaction to 8% air voids $\pm 1\%$ air voids.
4. Wheel track test specimens shall be compacted to 5% air voids $\pm 1\%$ air voids.

421.11 MIXING AND MIXING TEMPERATURES

The temperature limits shall be in accordance with clause 407.08.

Following discharge of aggregate and filler into the mixer, the required quantity of crumb rubber shall be added and dry mixed for a minimum period of 10 seconds.

Following the addition of bitumen, the whole mixture shall be mixed for a minimum of 60 seconds or until the whole of the mix is homogeneous and proper digestion of the crumb rubber into the bitumen has occurred.

421.12 AMBIENT CONDITIONS FOR PLACING

The asphalt mix shall not be placed when the majority of the area to be paved has a surface temperature less than 15°C.

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SECTION 431 - COLOURED SURFACE TREATMENTS

~~##This section cross-references Sections 175 and 721.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

431.01 GENERAL

This section covers the requirements for the supply and placement of coloured surface treatments.

431.02 DEFINITIONS

The following definitions apply to the coloured surface treatment clauses:

Accelerant

Accelerant refers to any material used to reduce the curing time of the binder.

Aggregate

Aggregate refers to any natural or synthetic particles used as a cover material applied to the binder, to provide a coloured and textured skid resistant surface.

Aggregate Coating

Aggregate coating includes all materials used to cover and/or colour aggregate.

Aggregate Retention

Aggregate retention refers to the ability of the binder to adhere and retain the aggregate under traffic and maintenance activities.

Binder

Binder refers to any resin used to bond the aggregate to the existing road surface.

Cleaning Agents

Cleaning Agents include all materials used to remove dirt, grime, fuel, oil and other materials from the existing surface.

Coloured surface treatment

Coloured surface treatments provide a trafficable surface that is coloured for enhanced delineation for specific road uses. The treatment consists of a coloured binder applied to the existing road surface, and coloured aggregate spread over the binder surface. A coloured surface treatment may include an additional layer of coloured binder or protective sealer over the aggregate layer.

Delamination

Delamination refers to failure of the binder and aggregate to adhere to the existing pavement surface.

Polished Stone Value

The Polished Stone Value (PSV) of an aggregate is a friction rating derived from test results. Measure of the aggregate's resistance to polishing shall be determined in accordance with VicRoads Test Method RC374.01.

Priming Material

Priming material refers to any substance used to clean and prepare the existing road surface for the application of binder and improve the adhesion of the binder to the existing roadway.

Protective Sealer

Protective sealer refers to any substance used to protect and seal the coloured surface treatment.

Sideways Force Coefficient (sfc)

Sideways force coefficient, also called sideways friction coefficient, is a general term for the ratio of the resistance to sideways motion to the normal component of force between the tyres of a vehicle and the road surface when using sideways force test equipment.

Skid Resistance

Skid resistance is the friction between the vehicle tyre and the pavement surface. Skid resistance shall be measured using one of the following methods:

- (a) with a Sideways Force Coefficient Routine Investigation Machine (SCRIM ®), tested in accordance with VicRoads RC421.02; or
- (b) a portable pendulum friction tester, tested in accordance with AS 4663 – Wet method.

Note: SCRIM ® is a registered trademark of WDM Limited.

Surface Texture

The mean height of aggregate particles above the level of the binder as determined by the VicRoads test for surface texture testing as listed in Section 175.

Test Lots

Acceptance of work and materials shall be based on testing of the work or material in lots. A lot will consist of a single batch or area of like work which has been constructed under uniform conditions and is essentially homogeneous with respect to material and appearance. A lot shall be the lesser of either one day's production or each 500 m².

431.03 MATERIALS**(a) Binder**

The binder shall be:

- (i) resistant to fuel and oils spills from traffic
- (ii) non flammable after placement and curing on road surface
- (iii) able to be swept using a mechanical broom and cleaned with high pressure water without damage
- (iv) free from lead and other heavy metals
- (v) Stable in UV light
- (vi) capable of providing strong adhesion between the existing surface and the aggregate to achieve a uniform surface.

Thermoplastic and paint binders are not permitted.

The following primer and binder details shall be provided to the Superintendent Council at least 14 days prior to the start of works:

- (i) priming materials type and source
- (ii) binder type and source
- (iii) manufacturer's recommendations/instructions for priming material supply and placement
- (iv) manufacturer's recommendations/instructions for binder mix quantities and tolerances on mixing components
- (v) manufacturer's recommendations/instructions for mixing of binder and components

- (vi) manufacturer's recommendations/instructions for pot life of binder, i.e. time of mixing to time of spreading
- (vii) manufacturer's recommendations/instructions for placement of binder including application rates and tolerances and placement temperatures
- (viii) manufacturer's recommendations/instructions for curing
- (ix) manufacturer's recommendations/instructions for accelerants (if applicable)
- (x) manufacturer's recommendations/instructions for supply and placement of protective sealers
- (xi) type of coloured pigment.

(b) Aggregate

The aggregate shall be clean, free from dirt, clay and organic matter, of uniform shape and quality, resistant to fuel and oils spills from traffic, able to withstand traffic stresses without damage, and able to be swept using a mechanical broom and cleaned with high pressure water equipment without damage.

The aggregate may be pigmented to provide a colour match of the final product.

The following aggregate details shall be provided to ~~the Superintendent~~ Council at least 14 days prior to the start of works:

- (i) aggregate type, source and gradation
- (ii) manufacturer's or Contractor's recommendations/instructions for placement of aggregate including spread rate
- (iii) Polished Stone Value (PSV) – aggregates shall have a minimum PSV of 54.

431.04 PRODUCT PERFORMANCE

Documented evidence of satisfactory performance over at least 5 years for the coloured surface treatment in a heavy urban traffic environment shall be provided with the Tender. The documentation may include references from clients, details of sites with the coloured surface treatment, evidence of texture with time, evidence of skid resistance with time, evidence of colour retention with time, evidence of durability with time.

~~The Superintendent~~ Council may request additional information regarding performance of the proposed coloured surface treatment and shall determine if the documented evidence is satisfactory. Only products with satisfactory documented evidence will be considered for award of the works.

~~The Superintendent~~ Council may require a sample of the material to be provided. The sample shall be a minimum size of 300 mm x 300 mm which is representative of the material to be applied.

Acceptance of the documented evidence and acceptance of the proposed coloured surface treatment does not guarantee the performance of the coloured surface treatment, and does not relieve the Contractor from any performance requirements.

Restricted use of untried products on a trial basis shall be subject to the approval of ~~the Superintendent~~ Council.

431.05 OFFENSIVE ODOUR

The coloured surface treatment shall not emit offensive odours after opening to traffic. ~~The Superintendent~~ Council shall determine if the coloured surface treatment is producing offensive odours.

Any coloured surface treatment which is deemed to be unacceptable shall be rectified with the agreement of ~~the Superintendent~~ Council.

431.06 MATERIAL SAFETY DATA SHEETS

Copies of Material Safety Data Sheets (MSDS) for priming materials, binders, aggregate coatings, protective sealers and any other work materials shall be provided to ~~the Superintendent~~ Council prior to the start of works. Any requirements for environmental protection measures as recommended by the material manufacturer shall be undertaken.

All materials shall be used and stored in accordance with the manufacturer's instructions, and MSDSs.

431.07 SITE PREPARATION

All loose material, grit, stones, vegetative matter, and rubbish shall be removed from the area of works prior to placement of the coloured surface treatment.

The site may be further cleaned and prepared as required. Cleaning and preparation shall not cause structural damage to the pavement. All cleaning agents and collected material shall be removed from site and disposed in accordance with Environment Protection Authority (EPA) Victoria requirements for the type of waste generated.

Existing pavement markings shall be masked to ensure the coloured surface treatment is not applied to the markings.

All Raised Reflective Pavement Markers (RRPMs) shall be removed from the area of works prior to any coloured surface treatment being placed. New RRPMs shall be reinstated after the application of the coloured surface treatment.

Service pits and valve covers less than 0.03 m², and drainage grates and frames shall also be masked. Larger pit and valve covers shall be covered with the coloured surface treatment. All lifting mechanisms and joints between the lid and frame shall be masked and protected such that the coloured surface treatment does not impede lifting and replacing lids.

Any damage caused to the surface by the removal of pavement markings and RRPMs shall be repaired prior to placement of the coloured surface treatment.

HP ~~The Superintendent~~ Council shall agree to the method of removal and any pavement repairs for pavement markings and RRPMs prior to these works occurring.

All pavement markings covered by the application of coloured surface treatments shall be reinstated in accordance with Section 721. This shall also apply to any pavement markings or RRPMs which are covered partially or wholly by the coloured surface treatment due to inadequate masking.

431.08 PLACEMENT

Coloured surface treatments shall be applied to produce a visually uniform coloured and textured surface. The edges of the work shall provide a neat and clean line onto the adjacent surface.

HP Coloured surface treatments shall not be placed until Council agrees that the prepared road surface is ready for surfacing.

(a) Priming Materials

Priming materials where used shall be applied uniformly over the site. The application rate for each lot of material shall be determined by mass or volume divided by the area and result recorded. All application rates for the work shall be provided to ~~the Superintendent~~ Council.

(b) Binder

Binder shall be spread to provide a uniform coverage and thickness over the site and in accordance with the manufacturer's recommendations. The spread rate for each lot of material shall be determined by mass or volume divided by the area, and the result recorded. All application rates for the work shall be provided to ~~the Superintendent~~ Council.

(c) Aggregate

Aggregate shall be spread to provide a uniform thickness over the site. The spread rate for each lot of material shall be determined by mass or volume divided by the area, and the result recorded. All application rates for the work shall be provided to the ~~Superintendent~~ Council.

(d) Temperature

The pavement temperature of the site shall be measured and recorded at least every 2 hours during the works. The temperature shall be measured using an infrared temperature gauge accurate to $\pm 2^{\circ}\text{C}$. The temperature results shall be provided to the ~~Superintendent~~ Council. All materials shall be placed within any temperature limits recommended by the manufacturer.

(e) Accelerants

Accelerants may be used to reduce the time of curing for the coloured surface treatment. The application rate for each lot of material shall be determined by mass or volume divided by the area, and the result recorded. All application rates for the work shall be provided to the ~~Superintendent~~ Council.

431.09 SCHEDULE OF DETAILS

The details for each site of works for coloured surface treatments are shown in the drawings detailed in Table 431.091.

*** **Table 431.091 Schedule of Details**

Job No	Road Name	Map Ref	Location	Approx Area (m ²)	24-hr AADT	Other requirements
##:	##:	##:	##:	##:	##:	##:

No additional payment or deduction shall be made where the measured total area of each job falls within 2.5% of the listed area.

431.10 CLEAN-UP

All excess material shall be removed from the site and disposed in accordance with EPA requirements.

All masking shall be removed prior to opening the site to traffic.

Excess aggregate shall be removed from the finished surface prior to opening the site to traffic. Excess aggregate shall be removed from the roadway, kerb and channel, driveways and any adjacent trafficked and un-trafficked areas prior to opening to traffic.

HP ~~The Superintendent~~ Council shall agree the site is neat, tidy and free of excess aggregate prior to opening to traffic.

All material which becomes loose after the initial clean-up shall be removed at 24 hours, 3 days and 14 days after placement.

431.11 ACCEPTANCE OF WORK

Coloured surface treatments shall provide a visually uniform surface with uniform aggregate retention, and be free from delamination, stripping and areas of wear/scuffing.

Any work that fails to meet the minimum requirements shall be rectified.

Acceptance of work shall be on a lot basis. Discrete portions of a lot which are non-homogeneous with respect to material and appearance shall be excluded from the lot and either treated as separate lots, or replaced. Where the areas excluded from a lot as non-homogeneous exceed 20% of the total lot area, the whole of the lot shall be rejected.

(a) Surface Texture

Acceptance of work for surface texture shall be based on visual assessment, however in marginal cases ~~the Superintendent~~ Council may request that nominated areas be tested in accordance with the test method for assessment of surface texture testing as listed in Section 175.

A lot will consist of a single batch or area of like work which has been constructed under uniform conditions and is essentially homogeneous with respect to material and appearance. A lot shall be the lesser of one day's production or each 500 m².

The surface texture of each test site within the lot shall be a minimum of 0.6 mm.

(b) Skid Resistance

~~The Superintendent~~ Council may require that the work be tested and assessed for skid resistance using one of the following methods:

(i) SCRIM ®

The length of the entire site shall be tested using SCRIM ® in the left and right wheel paths in every through traffic lane of the site. The site shall be tested within 4 weeks of initial placement, and within 8 weeks prior to the end of the defects liability period. Council may undertake additional skid resistance testing of the site at any time during the defects liability period.

The skid resistance of the coloured surface treatment shall be a minimum of 0.55 sfc at any time during the defects liability period.

(ii) Portable Pendulum Friction Tester

The coloured surface treatment shall be tested using a pendulum friction tester in accordance with AS 4663 – Wet method. Each lot shall have 5 randomly selected test locations selected in accordance with VicRoads test method RC316.10 – Selection of test sites within a lot.

Each lot shall achieve a minimum mean British Pendulum Number (BPN) of 55 with no individual test location having a BPN of less than 50 at any time during the defects liability period.

The method selected to assess skid resistance shall be the most practical for the extent and size of work. ~~The Superintendent~~ Council may require testing at any time prior to the end of the defects liability period.

Skid resistance testing will be undertaken at the ~~Superintendent's~~ Contractor's cost.

(c) Colour

The colour of the finished surface shall be a Rating 3 Approximate Match (or better) with one of the following Australian Standard 2700 - 2011 colours as listed in Table 431.111.

The initial colour shall be measured in accordance with Australian Standard 1580.601.1:1995. Each lot of material shall be tested within 2 days of placement. Testing shall be undertaken onsite and under daylight conditions only. Each lot of coloured surface treatment shall provide a Rating 3 Approximate Match (or better) with adjacent lots.

Table 431.111 Colour Requirements

Use	AS2700S - 2011 Colour
Bus Lanes (Nominally Red)	Preferred Colour R54 – Raspberry Acceptable Alternatives R14 – Waratah R15 - Crimson
Bicycle Lanes (Nominally Green)	Preferred Colour G13 – Emerald Green Acceptable Alternatives G16 – Traffic Green G23 - Shamrock

The same consistent colour shall be used along a continuous route or within a given locality.

431.12 MAINTENANCE AND REPAIRS

The Contractor shall be responsible for monitoring and maintenance of the coloured surface treatment from the time of placement, until the end of the defects liability period.

The Contractor shall carry out any works necessary to protect and maintain the surface, and repair all surface failures, including loss of aggregate, bleeding, fatty areas, flushing, loss of skid resistance, and delamination from the existing surface.

The Contractor is not responsible for defects caused by either settlement or failure of the existing pavement, or for damage (including gouging and vehicle fire) and repairs to the surface caused by traffic incidents.

Areas of delamination less than 0.01 m² are not required to be repaired, unless the total of defective areas exceeds 1% of the total area. Areas of defect shall be agreed with the Superintendent Council. Defective areas of coloured surface treatment shall be squared-up and removed and replaced.

Repairs shall be undertaken within 4 weeks of notification by the Superintendent Council. Urgent repairs shall be started onsite within 24 hours of notice by the Superintendent Council.

HP The Contractor shall advise the Superintendent Council in writing of the proposed treatment for any repairs before undertaking the work.

431.13 EXCLUDED AREAS

The following areas are excluded from the limits of work:

- all service pits and valve covers less than 0.03 m²
- traffic detector loops
- pedestrian crossings – the white pavement markings and designated travel path of pedestrians.

SECTION 610 - STRUCTURAL CONCRETE

~~##This section cross-references Sections 175, 204, 606, 611, 613, 614, 680, 684, 686, 687, 689, 691, 703 and 801.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

610.01 GENERAL

This section specifies the requirements for durability, strength and surface finish for structural concrete including the requirements for mix design, supply and delivery of concrete, sampling and testing, placing, compaction, finishing, curing and protection.

Additional requirements for concrete for post-tensioned, pre-tensioned, precast, sprayed concrete and other types of concrete construction are specified in the relevant sections. Requirements for general non-structural concrete paving Works are specified in Section 703.

Concrete using general purpose portland cement Type GP or blended cement Type GB shall comply with the requirements of AS 3972 *General purpose and blended cements*. In addition, blended cement Type GB shall consist of a specified minimum quantity of portland cement in combination with any one or two of Ground Granulated Blast Furnace Slag (Slag), Fly Ash (FA) or Amorphous Silica (AS) and as specified in this section.

All concrete shall be special class performance concrete in accordance with Appendix B of AS 1379 *Specification and Supply of Concrete* and the requirements of this section.

Structural concrete shall be designed and constructed in accordance with the requirements of this specification to prevent the occurrence of nonconforming drying shrinkage and cracking, alkali-aggregate reactivity, soluble salts, inadequate cover, curing and compaction and to provide the required protection against exposure to the specified in-service conditions.

610.02 STANDARDS

Australian Standards and VicRoads Codes of Practices are referenced in an abbreviated form (e.g. AS 1379 and RC 500.00).

(a) Australian Standards

AS 1012	Methods of testing concrete
AS 1141	Methods of sampling and testing aggregates
AS 1379	Specification and supply of concrete
AS 1478	Chemical admixtures for concrete, mortar and grout – Admixtures for concrete
AS/NZS 2425	Bar chairs in reinforced concrete – Product requirements and test methods
AS 2758.1	Aggregates and rock for engineering purposes - Concrete aggregates
AS 3582	Supplementary cementitious materials for use with portland and blended cement
AS 3582.1	Part 1 : Fly ash
AS 3582.2	Part 2 : Slag - Ground granulated iron blast-furnace
AS 3582.3	Part 3 : Amorphous silica
AS 3799	Liquid membrane-forming curing compounds for concrete
AS 3972	General purpose and blended cements
AS 5100	Bridge Design

(b) VicRoads Codes of Practices

Code of Practice RC 500.00 Code of Practice for Source Rock Investigations.

Code of Practice RC 500.16 Code of Practice for Selection of Test Methods for the Testing of Materials and Work.

(c) VicRoads Test Methods

RC 253.01 Determination of aggregate moisture content and estimated free water (using microwave or hot plate)

RC 376.03 Accelerated Mortar Bar Test - Alkali-Silica reactivity of aggregate

RC 376.04 Alkali Aggregate Reactivity Assessment - using the Concrete Prism Test.

(d) Additional Test Methods

ASTM C295/C295M Standard Guide for Petrographic Examination of Aggregates for Concrete.

(e) Additional Referenced Specifications

ATIC-SPEC SP43 – Cementitious Materials for Concrete published by ATIC (Australian Technical Infrastructure Committee)

Section 175 details the relevant references to these documents.

610.03 DEFINITIONS

Batch: One load or charge of a transit concrete mixer or agitator.

Blended Cement: General purpose blended cement Type GB complying with the requirements of AS 3972 and as specified in this section.

Cement: Material complying with the requirements of AS 3972 and as specified in this section.

Cementitious Material: Portland cement or a mixture of portland cement with one or more supplementary cementitious materials **or in combination with other supplementary material as approved by the Superintendent Council.**

Concrete Cover: Distance between the outside of the reinforcing steel and the nearest permanent surface of the concrete member excluding any surface finishing material.

Water/Cementitious Material (W/C) Ratio: The ratio of the amount of water to the total amount of cementitious materials by mass in a freshly mixed cubic metre of concrete. The water shall be the total free water contained in the batch aggregates in excess of their saturated surface-dry condition.

Concrete Grade: A grade of concrete with a specified minimum cementitious material content, a maximum W/C ratio and a minimum compressive strength at 3, 7 and 28 days. It is designated by the letters VR (VicRoads) followed by a three digit number indicating the minimum cementitious material content in kg/m³ and a two digit number indicating the specified minimum compressive strength at 28 days.

Exposure Classifications: Designation indicative of the most severe environment to which a concrete member is to be subjected during its design life, in accordance with the exposure classifications A, B1, B2, C1, C2 and U, as stated in Table 4.3 of AS 5100.5, and which are used to determine the concrete quality requirements.

Intense compaction: Compaction of the fresh concrete using external vibrators attached to steel forms in conjunction with the use of internal vibrators.

Marine and other saline environments: Environmental exposure of surfaces of concrete members exposed to sea water, brackish water, coastal zone and saline soils as represented by the relevant exposure classifications B2, C1 and C2 in accordance with Table 4.3 of AS 5100.5.

Portland Cement: General purpose portland cement Type GP complying with the requirements of AS 3972.

Sample: A portion of fresh concrete drawn from a batch and from which test cylinders and other test specimens are made, and from which other concrete testing is undertaken as required. All sampling is carried out in accordance with AS 1012.

Self Compacting Concrete (SCC): Concrete that is able to flow and consolidate under its own weight, completely fill the formwork or bore hole even in the presence of dense reinforcement, whilst maintaining homogeneity and without the need for additional compaction, and which complies with the requirements of Table 610.131. Also called self-consolidating concrete or super-workable concrete.

Standard compaction: Compaction of the fresh concrete using internal vibrators with or without the use of vibrating screeds as specified.

Supplementary Cementitious Material: Fly Ash (FA), Ground Granulated Blast Furnace Slag (Slag), or Amorphous Silica (AS) complying with the requirements of AS 3582.1, AS 3582.2 and AS 3582.3 respectively.

Triple Blend: Blended cement Type GB consisting of a minimum quantity of portland cement in combination with any two Supplementary Cementitious Materials (i.e. any two of Fly Ash, Slag or Amorphous Silica).

VPV: % Apparent Volume of Permeable Voids as determined by test method AS 1012.21.

610.04 DURABILITY

Durability requirements with respect to exposure classification as detailed in AS 5100.5 Bridge design – Concrete and concrete grade shall be as shown on the drawings and as specified in this section.

The durability requirements for concrete in exposure classification U shall be as shown on the drawings and this specification.

The concrete shall be designed, manufactured and delivered, sampled and tested, placed, compacted, finished and cured in accordance with the requirements of this section to achieve a service life of at least 100 years in the specified in-service exposure conditions with minimal maintenance.

610.05 MINIMUM COMPRESSIVE STRENGTH

The minimum compressive strength requirements for each concrete grade are shown in Table 610.051.

Table 610.051

Concrete Grade	Minimum Compressive Strength (MPa)		
	3 days	7 days	28 days
VR330/32	14	20	32
VR400/40	17	26	40
VR450/50	23	35	50
VR470/55	25	40	55
VR520/60	27	45	60
VR535/65	29	48	65
VR550/70	31	52	70
VR580/80	34	60	80
VR610/90	38	67	90
VR640/100	42	75	100

The 3 day minimum compressive strength requirement shall not apply to concrete mixes containing supplementary cementitious materials which exceed the cement replacement values stated in clause 610.07(f).

610.06 MAXIMUM VPV VALUES AT 28 DAYS

The maximum VPV values at 28 days for each concrete grade for both test cylinders and concrete test cores cut from cast in situ and sprayed concrete shall be as shown in Table 610.061.

Table 610.061

Concrete Grade	Maximum VPV Values at 28 days (%)		
	Test Cylinders (compacted by vibration)	Test Cylinders (compacted by rodding)	Test Cores
VR330/32	14	15	17
VR400/40	13	14	16
VR450/50	12	13	15
VR470/55	11	12	14
VR520/60	11	12	14
VR535/65	10	11	13
VR550/70	10	11	13
VR580/80	9	10	12
VR610/90	9	10	12
VR640/100	9	10	12

For the purpose of satisfying the requirements of this clause, VPV test results may be rounded down to the nearest whole number for the corresponding concrete grade.

610.07 CONCRETE MIX DESIGN**(a) General**

The Contractor shall be responsible for the mix design of all concrete, including any other nominated requirements, so that the specified durability, strength and other requirements of the hardened and plastic concrete are achieved.

The Contractor shall ensure that arrangements for the supply of concrete are made with the concrete supplier at the commencement of the Works, to ensure that a fully compliant concrete mix design which is supported with all required test results meets the specified time frames of this section.

(b) Mix Design Details**HP**

The Contractor shall submit the concrete mix design details for review by the Superintendent Council not less than 4 weeks prior to the placement of concrete. Concrete shall not be placed until the mix design has been reviewed by the Superintendent Council, and allocated a registration number on the Register of VicRoads approved concrete mixes.

Concrete mix designs shall remain valid for 12 months from the date of registration, unless constituent materials and material proportions cease to comply with the specified requirements.

The concrete mix design details shall include the following:

- (i) the source, type and proportions of the constituent materials
- (ii) the Cementitious Material Registration Scheme (CMRS) registration number(s) for the cementitious material(s) used in the mix as specified in clause 610.08(c)
- (iii) aggregate gradings, water absorption and saturated surface-dry densities
- (iv) chemical admixtures details and manufacturer's recommended dosage rates and method of use

- (v) the nominated slump and where a superplasticiser is used the final slump
- (vi) for self compacting concrete (SCC) additional details as specified in clause 610.07(m)
- (vii) the maximum water content and maximum W/C ratio
- (viii) level of control, accuracy and method of determination of both the coarse and fine aggregate moisture content, consistent with the requirements of clause 610.13(d)
- (ix) documentary evidence of previous performance and relevant test results which shall not be more than 12 months old including -
 - (1) 3, 7 and 28 day compressive strengths complying with the minimum compressive strength requirements given in Table 610.051 and clause 610.05
 - (2) VPV values at 28 days complying with the requirements given in Table 610.061 and clause 610.07(l)
 - (3) drying shrinkage test results as specified in clause 610.07(j)
 - (4) soluble salts content as specified in clause 610.07(k)
- (x) alkali aggregate reactivity test results as specified in clause 610.11(e) and which shall not be more than 3 years old in accordance with the minimum frequency of testing as stated in Table 610.121
- (xi) the method of placement and the member(s) of the structure in which the concrete is to be placed
- (xii) full details of concrete curing methods as specified in clause 610.23
- (xiii) a unique identification number for the concrete mix design to satisfy the requirements of clause 610.15.

Concrete mix designs not complying with the requirements of this section will require the approval of the Superintendent Council.

The concrete mix design shall be strictly adhered to by the Contractor. In the event of changes to the agreed concrete mix design, the Contractor shall submit a new concrete mix design to the Superintendent Council for review or approval as appropriate.

~~(e) Trial Mix~~

~~In the absence of recent documentary evidence that the concrete mix design complies with the requirements of this section, a trial mix shall be undertaken in accordance with AS 1012.2.~~

~~**The test results of the trial mix and the associated concrete mix design details indicating compliance with the specified requirements shall be submitted for review by the Superintendent.**~~

(d) Mix Constituents

The concrete shall consist of a mixture of cementitious material, fine aggregate, coarse aggregate and water.

The concrete may also contain chemical admixtures, details of which shall be submitted with the mix design.

If the coarse aggregate or fine aggregate is composed of more than one material or size of material, the mix proportions for each shall be specified separately.

(e) Cementitious Material Content and Water/Cementitious Material (W/C) Ratio

The minimum mass of total cementitious material per cubic metre of finished concrete and the corresponding maximum W/C ratio shall be as shown in Table 610.071.

Table 610.071

Concrete Grade	Cementitious Material Content (min) (kg/m ³)	W/C Ratio (max)
VR330/32	330	0.50
VR400/40	400	0.45
VR450/50	450	0.40
VR470/55	470	0.36
VR520/60	520	0.35
VR535/65	535	0.34
VR550/70	550	0.34
VR580/80	580	0.33
VR610/90	610	0.33
VR640/100	640	0.32

The cementitious material content of concrete to be placed under water shall not be less than 400 kg/m³, with a maximum W/C ratio of 0.45.

The W/C ratio of the proposed concrete mix design shall not be less than 0.26 for both concrete cast in situ works and for concrete utilised in precast works.

(f) Minimum Portland Cement Content

The minimum mass of portland cement in concrete mixes containing Slag, Fly Ash or Amorphous Silica shall be 60%, 75% or 90% respectively, of the total mass of cementitious material in the concrete mix. The inclusion of Slag, Fly Ash or Amorphous Silica in concrete mixes shall only be in single or double combination with portland cement. In a triple blend concrete mix, the portland cement content shall be a minimum of 60% and the individual contribution of Slag, Fly Ash or Amorphous Silica shall be a maximum of 40%, 25% or 10% respectively, of the total mass of the cementitious material in the concrete mix.

~~Other cementitious materials may be used subject to approval by the Superintendent.~~

(g) Concrete Structures in Marine and other Saline Environments

Concrete structures located in marine and other saline environments shall be constructed in accordance with the minimum compliant cementitious material options as shown in Table 610.072.

Where proportioning of cementitious material in concrete mixes uses higher replacement levels of supplementary cementitious materials than those stated in Table 610.072, the Contractor shall submit for review by the Superintendent Council a supporting documented detailed methodology addressing potential lower early strength development, longer formwork removal times and development of lower lifting strengths to ensure compliance with the specification.

Additional protective measures for concrete structures constructed in marine and other saline environments are covered in clause 610.29.

(h) Concrete Structures Subject to Sulphate and Chemical Attack

Concrete structures subject to sulphate and chemical attack represented by an acidity of pH of 5 and higher shall be constructed in accordance with the minimum compliant cementitious material options as shown in Table 610.072, provided that the mobility of any groundwater if present is in an approximately static condition. For pH lower than 5.0, the environment shall be assessed as exposure classification U and be subject to special consideration in accordance with clause 610.30.

Where proportioning of cementitious material in concrete mixes uses higher replacement levels of supplementary cementitious materials than those stated in Table 610.072, the Contractor shall submit for review by the Superintendent Council a supporting documented detailed methodology addressing potential lower early strength development, longer formwork removal times and development of lower lifting strengths to ensure compliance with the specification.

Table 610.072

Concrete Members	Exposure Classification	Concrete Grade	W/C Ratio (max)	Proportioning of Cementitious Material (% mass) in concrete mixes
Piles Fender/keeper walls Wing walls Head walls Above Deck (Parapets etc) Base slabs	C1, C2	VR450/50	0.40	<ul style="list-style-type: none"> 90% GP / 10% AS; or Higher replacement levels of: <ul style="list-style-type: none"> at least 30% FA; or 30%GP / 60% Slag / 10% AS; or 65% Slag / 35% GP
Pile Caps Pier Columns Pier Crossheads Abutment Crossheads	C1, C2	VR470/55	0.36	
Deck slab Approach slab	B2	VR400/40	0.45	Moderate replacement levels in accordance with clause 610.07(f)
Beams Crown Units	C1, C2	VR470/55	0.36	90% GP / 10% AS; or 80% GP / 20% FA
Where required concrete grades higher than those stated in this table may be used.				

(i) Use of Supplementary Cementitious Materials for Special Applications

Supplementary cementitious materials requirements for other special applications shall be as specified in the drawings and specification.

(j) Limitations on Drying Shrinkage

One sample per trial mix shall be taken. Each sample shall consist of 3 specimens tested in accordance with AS 1012.13. The shrinkage strain of each sample, as determined from the average value of the 3 specimens, shall not exceed 550 microstrain and 750 microstrain after 21 days and 56 days of drying respectively.

For concrete grades with minimum 28 day compressive strength in the range of 60 MPa to less than 80 MPa the shrinkage strain shall not exceed 500 microstrain and 700 microstrain after 21 days and 56 days of drying respectively.

For concrete grades with minimum 28 day compressive strength in the range of 80 MPa to 100 MPa the shrinkage strain shall not exceed 400 microstrain and 600 microstrain after 21 days and 56 days of drying respectively.

Drying shrinkage requirements for special applications shall be as specified in the drawings and specification.

(k) Soluble Salts

(i) Chloride-ion Content

The maximum acid-soluble chloride-ion content of concrete as placed, expressed as the percentage of the total mass of cementitious material in the concrete mix shall not be greater than:

- 0.1% for prestressed concrete
- 0.15% for reinforced concrete
- 0.07% for all mortars and grouts, including post-tensioning grout.

(ii) Sulphate Content

The sulphate content of concrete as placed, expressed as the percentage by mass of acid-soluble SO₃ to the total cementitious material in the concrete mix shall not be greater than 5%.

Notwithstanding the requirements of this clause the sulphate content for steam and heat accelerated cured concrete, expressed as the percentage by mass of acid-soluble SO₃ to the total cementitious material in the concrete mix shall not be greater than 4%.

Sulphate and chloride-ion content shall be determined by testing of hardened concrete in accordance with AS 1012.20.1.

(l) Testing and Acceptance of Concrete Mix Design on the Basis of 28 Day VPV Value

Test cylinders shall be cured in accordance with AS 1012. A minimum of 2 cylinders per sample per trial mix shall be taken. Each cylinder shall be tested for VPV at 28 days in accordance with test method AS 1012.21. The specification will be satisfied if the VPV value for each sample, as determined from the average value of the test cylinders, is not greater than the specified maximum 28 day VPV value in Table 610.061.

Should the VPV value of any one sample representing the concrete exceed the specified maximum 28 day VPV value as shown in Table 610.061, the Contractor shall take steps to modify the concrete mix design and re-test to ensure that the maximum specified VPV value is not exceeded.

(m) Mix Design for Self Compacting Concrete (SCC)

The mix design requirements for SCC shall be as specified in this clause and clause 610.13(b), except that the nominated slump requirements as stated in clause 610.07(b)(v) shall not apply for SCC.

Further to the requirements of clause 610.07(b), mix design details of SCC shall include the nominated slump flow, T500 (measure of viscosity) and passing ability which shall comply with the requirements for SCC given in Table 610.131.

Notwithstanding the requirements of clause 610.07(f), higher amounts of fly ash and slag may be used in SCC mixes where further optimisation of the mix is required to comply with this section, including the required cohesiveness, workability, flowability and self-compactability of the concrete, without segregation.

SCC shall be used only for the manufacture of precast concrete members and the construction of bored piles as specified in clause 610.18(c).

610.08 CEMENT, FLY ASH, SLAG AND AMORPHOUS SILICA

(a) Cement

Cement shall comply with the requirements of AS 3972 and ATIC-SPEC SP43. Cement per batch of concrete shall be from one manufacturer and of one brand, type and grind. Cement more than 3 months old shall not be used in the Works unless it is re-tested to demonstrate compliance with the requirements of AS 3972 and ATIC-SPEC SP43.

(b) Fly Ash, Slag and Amorphous Silica

Fly Ash, Slag and Amorphous Silica shall comply with the requirements of AS 3582.1, AS 3582.2 and AS 3582.3 respectively and ATIC-SPEC SP43 and shall be from one manufacturer and of one brand, type and fineness.

(c) Pre-Registration and Testing of Cementitious Materials

Cementitious materials used in the works shall be pre-registered under the Cementitious Material Registration Scheme (CMRS) in accordance with ATIC-SPEC SP43.

The CMRS registration number(s) for the cementitious material(s) used in the Works shall be submitted as part of the concrete mix design review as specified in clause 610.07.

In addition to the information required as part of routine quality control, test certificates endorsed in accordance with the AS ISO/IEC 17025 accreditation for the testing laboratory demonstrating compliance with the requirements of this section shall be submitted for review by the ~~Superintendent Council~~.

Summaries of cementitious material test data shall be submitted for review by the ~~Superintendent Council~~. The data shall be traceable to the concrete supplier's batching plant(s).

610.09 WATER

The quality of water to be used in the concrete mix and for the curing of concrete shall comply with the requirements of clause 2.4 of AS 1379. However, the amounts of chloride in the water shall be not greater than 0.03% (300 ppm). The amount of sulphate (as SO₄) in water shall not be greater than 0.04% (400 ppm).

In addition, recycled water used in the concrete mix shall have total dissolved solids of not greater than 1700 milligrams per litre.

Sources of recycled water containing differing levels or other contaminants shall be subject to approval by the ~~Superintendent Council~~ on the basis of predetermined test results and evidence of previous performance.

Recycled or non-potable water shall be sampled and tested as a minimum at six monthly intervals to demonstrate compliance with the requirements of this clause and AS 1379.

610.10 CHEMICAL ADMIXTURES

Chemical admixtures shall comply with the requirements of AS 1478 unless otherwise specified in this section. They shall be used in accordance with the requirements of clause 2.5 of AS 1379 and the manufacturer's recommended method of use and shall not reduce the strength of concrete below that specified. Chemical admixtures shall be accurately measured by means of dispensers which are subject to regular maintenance and are calibrated as a minimum at three monthly intervals.

Chemical admixtures shall not contain calcium chloride, calcium formate, chlorine, sulphur, sulphides or sulphites. Where two or more chemical admixtures are proposed for incorporation in a concrete mix, their compatibility shall be certified by the manufacturers.

Air entraining admixtures shall not be used unless approved by the ~~Superintendent Council~~.

Where the use of air entraining admixture is approved, the Contractor shall determine the air content of the freshly mixed concrete at the point of discharge in accordance with AS 1012.4 and clause 5.4 of AS 1379, and it shall not exceed the nominal value of 5%.

The concrete represented by a sample taken in accordance with clause 610.16 shall be deemed to comply with the approved air content if the measured air content is within 1.5% of the approved air content.

610.11 AGGREGATES**(a) General**

Fine and coarse aggregate for concrete shall comply with the requirements of AS 2758.1.

The maximum amount of water absorption for fine aggregate, coarse aggregate, combined coarse aggregate and combined fine aggregate shall not exceed 2.5%.

Aggregates shall be stored in such a manner that they will not segregate, become contaminated by foreign matter, or become intermixed. Stockpiles shall be arranged to prevent entry of adjacent surface or ground water and allow free drainage of rain water.

(b) Fine Aggregate**(i) Description**

The fine aggregate shall consist of clean, hard, durable, naturally occurring sands, or a combination of naturally occurring sands and manufactured sands, and shall be free from clay, dust, lumps, soft or flaky particles, shale, salt, alkali, organic matter, soil or other deleterious substances. Any manufactured sands used as fine aggregate shall be crushed from rock that produces aggregate complying with the requirements of clause 610.11. Manufactured sands produced from any igneous or metamorphic rock shall have a Degradation Factor - Crusher Fines of not less than 60.

A maximum of 25% of manufactured sand from a source approved by the Superintendent Council will be permitted.

Consideration may be given by the Superintendent Council to approve the use of up to a maximum of 50% of manufactured sand if objective documented evidence is provided that concrete made with such higher amount of manufactured sand complies with all other requirements of this section both in the fresh and hardened state, including evidence of acceptable performance regarding tendency for segregation, bleeding, plastic shrinkage, satisfactory compaction and finishing properties.

(ii) Testing for Impurities

Fine aggregate shall be tested for impurities in accordance with AS 1141.

The clay and fine silt levels of natural sands shall be monitored as a routine quality control measure and records shall be available for review by the Superintendent Council. Action shall be taken where levels exceed normal consistency limits derived from routine quality control testing.

(iii) Grading of Fine Aggregate

Fine aggregate shall be uniformly graded and shall comply with the limits in Table 610.111 when tested with standard sieves.

If required fine aggregates can be combined in such proportions that the resulting fine aggregate mix shall comply with the grading requirements.

Table 610.111

Sieve Size AS (mm)	Percentage Passing (by mass)
9.5	100
4.75	90 - 100
2.36	75 - 100
1.18	50 - 90
0.6	30 - 75
0.3	10 - 50
0.15	2 - 15
0.075	0 - 5

(iv) Consistency of Grading

The grading of fine aggregate shall not deviate from the submitted grading by more than $\pm 5\%$.

Consideration may be given by the Superintendent Council to approve the use of fine aggregate with grading outside the specified limits if objective documented evidence is provided that concrete made with such fine aggregate grading complies with all other requirements of this section both in the fresh and hardened state, including evidence of acceptable performance regarding tendency for segregation, bleeding, plastic shrinkage, satisfactory compaction and finishing properties.

(c) Source Rock

Source rock shall comply with the requirements of Section 801.

(d) Coarse Aggregate

(i) Description

Coarse aggregate shall consist of clean, hard, durable angular rock fragments of uniform quality. It shall be free from clay, clay lumps, salt, organic matter or other substances deleterious to concrete or steel.

(ii) Testing Requirements for Coarse Aggregate.

Coarse aggregate shall not contain:

- (1) more than 5% by mass of unsound rock; or
- (2) more than 10% total by mass of unsound rock plus marginal rock.

The flakiness index of the coarse aggregate shall not exceed 35%.

(iii) Grading of Coarse Aggregate

Coarse aggregate size ranges, when tested by means of standard sieves, shall have a maximum nominal size between 10 and 20 mm and shall comply with the requirements of AS 2758.1.

(iv) Effective Size of Coarse Aggregate

Concrete in various parts of the structure shall contain coarse aggregate with the following effective maximum sizes:

Joint and pedestal concrete	14 mm
Precast concrete	14 mm for minimum cover of 25 mm 20 mm for minimum cover greater than 25 mm
All other concrete	20 mm

The effective minimum size will be 10 mm for crushed material and 5 mm for rounded materials.

(v) Use of Pebble Aggregate

Notwithstanding the requirements of clause 610.11(d) and Section 801, pebble aggregate may be used in the manufacture of structural concrete including concrete intended for use in pre-stressed and post-tensioned members subject to the following requirements:

- (1) where the LA of pebble aggregate or blended aggregate containing pebbles is greater than 35 but equal to or less than 45 the Wet and Dry Strength variation shall be equal to or less than 25 and the Sodium Sulphate Soundness shall be equal to or less than 8
- (2) pebble aggregate or blended aggregate containing pebbles with an LA greater than 45 shall not be used in the works
- (3) the minimum frequency of testing for Wet and Dry Strength and Sodium Sulphate Soundness shall be in accordance with the requirements of Table 610.121.

(e) Alkali Aggregate Reactivity

Unless otherwise approved by the Superintendent Council, all aggregates shall be assessed and tested for alkali reactivity as follows:

(i) Petrographic Examination

Aggregates shall be assessed for any unstable silica minerals by petrographic examination in accordance with ASTM Test Method C295.

(ii) Potential Alkali Silica Reactivity

The potential alkali silica reactivity of the coarse and fine aggregates shall be determined using either the VicRoads accelerated mortar bar test method RC 376.03 or the VicRoads concrete prism test method RC 376.04 as described in the VicRoads Code of Practice RC 500.16.

(1) Accelerated Mortar Bar Test Method (RC 376.03)

Coarse and fine aggregates shall be deemed to be non-reactive if the average expansion of the mortar bars made with the proposed aggregates and General Purpose portland cement Type GP does not exceed 0.1% at 21 days in the case of coarse aggregates and 0.15% at 21 days in the case of fine aggregates. Individual results shall not differ from the mean by more than 15%.

Should the average expansion of the mortar bars exceed 0.1% at 21 days in the case of coarse aggregates and 0.15% at 21 days in the case of fine aggregates, the aggregates will be classed as reactive and either new aggregates shall be proposed for use and re-tested for compliance, or if it is proposed to use aggregates that have been classed as reactive, all of the following requirements shall be satisfied:

- the concrete mix be designed such that the alkali content does not exceed 2.8 kg/m³ (Na₂O equivalent)
- a blended cement be used in the concrete mix that satisfies the minimum requirements of Table 610.112. Concrete mixes containing the minimum proportions of supplementary cementitious material as shown in Table 610.112 shall be deemed to comply with this clause.

(2) Concrete Prism Test Method (RC 376.04)

Aggregates shall be classified reactive when the average expansion at 12 months is greater than 0.03%, and non reactive when it is equal to or less than 0.03%.

Aggregates classified as reactive by the concrete prism test method in a concrete mix design, shall not be used in that particular concrete mix design. Alternative aggregates and/or alternative concrete mix designs shall be used subject to compliance with the requirements of this specification.

Table 610.112

Supplementary cementitious material	Minimum proportion of supplementary cementitious material in single combination with portland cement in the concrete mix to mitigate alkali aggregate reactivity (%)	Minimum proportion of supplementary cementitious material in double combination with portland cement in the concrete mix to mitigate alkali aggregate reactivity (%)		
		Fly Ash	Slag	Amorphous Silica
Fly Ash	20	-	-	-
Slag	50	-	-	-
Amorphous Silica	8	-	-	-
Fly ash + Slag	-	15	15	-
Fly Ash+ Amorphous Silica	-	15	-	5
Slag + Amorphous silica	-	-	40	5

Where blended aggregates are used, the aggregates from different sources shall be tested individually.

Notwithstanding the requirements of this clause when fine and coarse aggregates are procured from the same source, only one alkali silica reactivity evaluation per source shall be undertaken.

Any proposed blended cement deviations from the minimum blended cement requirements of Table 610.112 shall demonstrate compliance with both the maximum mortar bar and concrete prism expansion limits stated in this clause, and as determined by both the VicRoads accelerated mortar bar test method RC 376.03 and the VicRoads concrete prism test method RC 376.04.

610.12 MINIMUM TESTING REQUIREMENTS FOR AGGREGATES

Aggregates shall be tested at a frequency which is sufficient to ensure that concrete complies with the specified requirements. The frequency shall not be less than that shown in Table 610.121. Where the Contractor has implemented a system of statistical process control and can demonstrate that a lower frequency can assure the quality of the product, the Superintendent Council may agree to a lower frequency than that shown in Table 610.121.

Table 610.121

Test	Minimum Frequency of Testing
Grading of Fine Aggregates	On each day one per 500 tonne or part thereof
Grading of Coarse Aggregates	On each week one per 1500 tonne or part thereof
Water Absorption of Fine and Coarse Aggregates	At 3 monthly intervals
Unsound Rock Content	On each day one per 500 tonne or part thereof
Flakiness Index of Coarse Aggregate 10 mm and Larger	At monthly intervals
Degradation Factor of Crusher Fines	At monthly intervals
Organic Impurities other than sugar	At monthly intervals
Alkali Reactivity of Aggregate Sources	At 3 yearly intervals
Wet and Dry Strength and Sodium Sulphate Soundness for Pebble Aggregates	At 3 monthly intervals

610.13 MANUFACTURE AND DELIVERY OF PREMIXED CONCRETE

(a) General

The Contractor shall be responsible for the manufacture and delivery of all concrete which shall comply with the approved or registered concrete mix design and the requirements of AS 1379.

The minimum quantity of a load of premixed concrete in the mixer or agitator delivered to site shall be 1 m³. The quantity of concrete delivered in any mixer or agitator shall not exceed the rated capacity of the agitator drum.

Concrete shall not be mixed when the air temperature is lower than 5°C or greater than 35°C.

Water may be added to the freshly mixed concrete prior to commencement of discharge provided no more than 60 minutes have elapsed from the time of adding cement to the aggregate and a means of accurately measuring the volume of water is available to ensure that the maximum design amount of water and the agreed maximum W/C ratio are not exceeded. In addition, concrete samples shall be taken after the water has been added, in accordance with clause 610.16(b). The consistency of the concrete shall be measured by a slump test after the water has been added, in accordance with clause 610.16(c).

No water shall be added after the commencement of discharge of concrete.

Concrete which has begun to stiffen shall not be used in the works.

Concrete which has been dried-out after leaving the mixing plant shall not be used in the works. Notwithstanding this requirement concrete may be dried-out after leaving the mixing plant provided the site of intended discharge is located within a close proximity to the mixing plant, to ensure the maximum discharge time of 60 minutes as stated in clause 610.13(f) from the time of original mixing of the concrete is not exceeded and quality documentation is provided to verify that the affected load of concrete fully complies with this section.

Prior to the discharge of concrete at the site, the mixer or agitator shall be operated at mixing speed until the concrete achieves the required uniformity but for not less than a period of three minutes. Where superplasticisers or other admixtures are added to the concrete on site, the concrete shall be mixed for a period of not less than five minutes prior to the discharge at the site

(b) Self Compacting Concrete (SCC)

Further to the requirements of clause 610.07, SCC shall incorporate the various cementitious materials, coarse and fine aggregate and any additional fine materials, water and chemical admixtures in proportions to achieve the rheological characteristics of flow and self-compaction. SCC shall be produced using High Range Polycarboxylate Type Water Reducers which include a viscosity modifying capability that impart pseudoplastic or thixotropic behaviour upon the concrete in order to inhibit segregation.

Conventional superplasticisers may be used provided a viscosity modifying admixture is also used and it is clearly demonstrated that the required flow is being achieved without segregation.

SCC shall not be vibrated or subjected to any physical disturbance after deposition.

The slump flow, T500 time (measure of viscosity) and passing ability of the self compacting concrete (SCC) shall be determined in accordance with the AS 1012.3.5. The slump flow, T500 time and passing ability of the SCC shall comply with the requirements of Table 610.131.

Sampling and testing for SCC shall be in accordance with the requirements of clause 610.16(n).

Table 610.131

Properties of SCC	Measurement	Observations
Slump Flow	550 – 800 mm spread	The aggregate shall be evenly distributed throughout the concrete paste within the spread and shall not exhibit signs of segregation
T ₅₀₀ time (measure of viscosity)	Achieve a spread of 500 mm within 1 to 5 seconds	The final spread shall not exceed 800 mm in diameter
Passing Ability	≤ 10 mm	The concrete shall not exhibit signs of segregation

(c) Highly Workable Concrete

Highly workable concrete shall be superplasticised with a nominated slump of between 160 mm and 220 mm and shall be compacted in accordance with this section. Highly workable concrete placed under water shall contain an anti-dispersing admixture.

Sampling and testing for highly workable concrete shall be in accordance with clause 610.16, including the requirements for superplasticised concrete as stated in clause 610.16(c).

(d) Moisture Content of Aggregates

The moisture content of the fine and coarse aggregates shall be determined prior to concrete production for the day and whenever conditions change or fresh aggregates are delivered. Corresponding corrections shall be made to the mass of all aggregates and the volume of water used in the mix.

The moisture content of the fine and coarse aggregates shall be determined to constant mass in accordance with the VicRoads aggregate moisture content test method RC 253.01 as described in the VicRoads Code of Practice RC 500.16. Moisture meters or other equivalent devices may also be used provided they are calibrated as a minimum, on a monthly basis.

(e) Delivery Docket

In addition to the information required by clause 1.7.3 of AS 1379 the following information shall also be recorded on the delivery docket:

- (i) the total water in the batch, including -
 - (1) the moisture content of both fine and coarse aggregates as specified in clause 610.13(d)
 - (2) batch water
 - (3) water added at the slump stand
 - (4) total amount of water permitted to be added on site
 - (5) water added on site before commencement of discharge, including water used to wash down the mixing blades of the mixer or agitator
- (ii) total specified mass of cementitious material
- (iii) slumps, including -
 - (1) nominated slump
 - (2) estimated slump
 - (3) measured slump
- (iv) any other additions to a batch
- (v) the unique identification number allocated to the concrete mix design in accordance with clause 610.07(b)(xiii).

Further to the above requirements, the following information shall be traceable to the concrete supplier's batching plant(s) for each batch (truck load) of concrete used in the works, and shall be made available for review upon request by the Superintendent Council.

- (vi) cementitious material brand and type, including -
 - (1) proportions of components (by mass)
 - (2) total actual mass of cementitious material
- (vii) chemical admixtures, including -
 - (1) types
 - (2) amounts.

(f) Period for Completion of Discharge

Concrete shall be placed and compacted within 60 minutes of the commencement of mixing. This time may be extended beyond the 60 minutes provided a hydration control admixture is added to the concrete mix to delay the hydration process and provided the concrete complies with the specified requirements. Where a hydration control admixture is added to the concrete mix to delay hydration the stated extended discharge time shall not be exceeded.

Concrete shall not be incorporated into the works if its consistency is outside the acceptable limits as specified in clause 610.16(c).

(g) Water Left in the Mixer or Agitator

Water left in the mixer or agitator from the previous load shall be discharged prior to reloading new concrete in accordance with the requirements of clause 4.1.3(c)(ii) 'water in mixing chamber' of AS 1379 and in order to ensure that the maximum W/C ratio is not exceeded in accordance with requirements of this section. For the purposes of verification of this requirement quality documentation shall be signed and dated by the batcher of the mixing plant.

(h) Addition of Water at the Slump Stand

Addition of water to the mixed batch of concrete at the slump stand shall be undertaken in a disciplined manner, such that slump stand water meters are initially zeroed and actual amounts of water added into the agitator drum are accurately recorded. Only hoses connected to a functioning and accurately calibrated slump stand water meter shall be used to add water to the freshly mixed concrete in the agitator drum. **Records of actual amounts of water added into the agitator drum at the slump stand shall be available for review by the Superintendent Council.**

(i) Calibration of weighing and metering equipment

All batch plant weighing and all water metering equipment shall be subject to regular maintenance and independently calibrated by an accredited organisation, as a minimum at three monthly intervals.

Chemical dispensers shall be calibrated as a minimum at three monthly intervals.

The accuracy of all weighing and metering equipment shall comply with the requirements of Section 3 of AS 1379.

610.14 STAND-BY MIXING PLANT

The Contractor shall arrange for alternative supplies of concrete from stand-by mixing plant(s) capable of being operated immediately in case of breakdown, together with adequate supplies of cementitious material, fine and coarse aggregates for an approved compatible mix(es).

Hand mixing will not be permitted.

610.15 TRACEABILITY OF CONCRETE

All concrete batches (truckloads) used in the works shall be traceable from the batch plant to its general location in the structure by a unique identification number.

610.16 CONCRETE CONTROL, SAMPLING AND TESTING

(a) General

All concrete shall be sampled and tested in accordance with AS 1012 unless otherwise specified in this section.

Each sample of concrete shall be tested for compressive strength, slump, air entrainment (when required), slump flow, T500 time and passing ability (when SCC is used), VPV value, drying shrinkage and soluble salts (at concrete mix design stage), as specified in this section.

(b) Frequency of Sampling and Testing

Whenever concrete is being cast in a structural member or a portion of it in one continuous casting operation, the minimum number of test samples shall be in accordance with Table 610.161.

A continuous casting operation is one in which the maximum time interval between the end of discharge of one truckload of concrete and the beginning of discharge of the next truckload does not exceed 45 minutes.

Whenever a group of structural members is being cast in separate operations, where the time interval between the end of discharge of one truckload of concrete and the beginning of discharge of the next truckload exceeds 45 minutes, the minimum number of test samples shall be one (1) per truckload of concrete

Samples shall be taken at the point of discharge prior to placement in a random and representative manner and at approximately equal portions of the volume of concrete cast in one continuous operation. Unless otherwise specified in this section or directed by the Superintendent Council, no sampling shall be undertaken from consecutive truckloads of concrete cast in one continuous operation.

Table 610.161

Volume Cast in One Continuous Operation (cubic metre)	Minimum Number of Samples
0 to 10	1
10 to 25	2
25 to 50	3
50 to 100	4

For each additional 50 m³ one additional sample shall be taken.

The Contractor shall develop and implement a site sampling and testing procedure in accordance with the minimum frequency requirements of this section for assurance of concrete quality, **and shall ensure that records are available for review by the Superintendent Council.**

(c) Consistency

The consistency of the concrete shall be determined by a slump test of a concrete sample in accordance with AS 1012.3.1.

The concrete represented by a sample shall be deemed to comply with the specified slump if the measured slump is within the limits stated in Table 610.162 for the corresponding specified slump.

Table 610.162

Specified slump, mm	Tolerance, mm
<60	±10
≥60 ≤80	±15
>80 ≤110	±20
>110 ≤150	±30
>150	±40

For concrete containing a superplasticiser, the consistency of all batches of concrete after the addition of the superplasticiser shall be determined by a slump test of a concrete sample. Testing of every batch of superplasticised concrete shall continue until five consecutive batches of concrete have achieved the specified requirements.

After satisfying this requirement, the Contractor may then make a submission to the Superintendent Council for agreement to reduce the frequency of slump testing of superplasticised concrete to be in accordance with Table 610.161, provided a high level of process control, including a high level of control of total water content in the mix in accordance with specified requirements, is supported with objective documented evidence.

If the Contractor has satisfied the above initial testing requirement and is slump testing superplasticised concrete at the frequency in Table 610.161 and any batch fails to achieve the specified standard, the Contractor shall test all subsequent batches of superplasticised concrete until three consecutive batches have achieved the specified standard, at which time the frequency of slump testing may again be reduced to the minimum frequency requirements of Table 610.161.

The consistency of SCC as represented by the three defining parameters of slump flow, T₅₀₀ time (measure of viscosity) and passing ability as stated in clause 610.13(b), shall be subject to the same frequency of testing requirements as for superplasticised concrete.

For the purpose of determining the actual slump of superplasticised concrete and the required testing parameters for SCC as stated in clause 610.13(b) and clause 610.16(n), the discharge of the first 0.2 m³ of concrete prior to taking the test sample shall not be required.

The concrete represented by the samples shall be deemed to comply with the nominated mix design slump if the measured slump is within the limits specified in Table 610.162.

If the measured slump is not within the limits specified in Table 610.162, one repeat test shall be made immediately from another portion of the same sample. If the value obtained from the repeat test falls within the limits given in Table 610.162, the concrete represented by the sample shall be deemed to comply with the appropriate nominated mix design slump, otherwise it shall be rejected.

The slump of the concrete shall be checked and recorded within 45 minutes of adding cement to the aggregate, or immediately prior to discharge when the actual haul time exceeds 45 minutes and/or when water is added to the mixed batch in accordance with clause 610.13(a).

Concrete used for the slump test and the required testing for SCC shall not be re-used to make concrete test cylinders.

Each batch (truckload) of concrete delivered to site shall be visually inspected to ensure consistency of concrete supply, and the estimated slump shall be recorded on the identification certificate for the batch. Both the visual inspection and slump estimate shall be carried out prior to the addition of any water which may be added on site and prior to any addition of a superplasticiser.

(d) Test Cylinders for Compressive Strength

Each sample of concrete for standard compression tests shall comprise a minimum number of:

- (i) 3 cylinders for reinforced and prestressed pre-tensioned concrete
- (ii) 3 or 5 cylinders for prestressed post-tensioned concrete when application of the post-tensioning force will be after or before 28 days respectively.

A minimum of 2 cylinders per sample shall be tested at 28 days.

For all concrete, a minimum of 1 cylinder per sample shall be tested at 7 days. This requirement shall not apply for pre-tensioned concrete.

For prestressed pre-tensioned concrete, a minimum of 1 cylinder per sample shall be tested prior to the application of the pre-tensioning force.

For prestressed post-tensioned concrete, a minimum of 2 cylinders per sample shall be tested prior to the application of the post-tensioning force.

(e) Curing of Test Cylinders

Test cylinders shall be cured in accordance with AS 1012. Cylinders shall be transported to the testing laboratory in moisture proof containers.

For steam or radiant heat cured members test cylinders shall be cured with the members or in the test cylinder heating box respectively for the duration of the curing cycle as specified in clause 610.23(g) and clause 610.23(h). Following the steam curing cycle curing of the cylinders shall continue in accordance with the requirements of AS 1012.

(f) Compression Testing Prior to Application of Prestress

For post-tensioned concrete members, the post-tensioning force shall only be applied when two cylinders per sample are tested and the average compressive strength of these cylinders is equal to or greater than the specified compressive strength as shown on the drawings, and the lower cylinder result is greater than 90% of the specified compressive strength.

For pre-tensioned concrete members(s) the pre-tensioning force shall only be applied when each cylinder per sample tested has achieved the specified compressive strength as shown on the drawings.

In the event that the above requirements are not satisfied, application of prestress shall be deferred until such time as the compressive strength of an additional cylinder per sample achieves the specified compressive strength for pre-tensioned concrete or the cylinders tested at 28 days satisfy the requirements of clause 610.16(g) for post-tensioned concrete.

(g) Testing and Acceptance of Concrete on the Basis of 28 Day Compressive Strength

(i) Test Cylinders

A minimum of two cylinders per sample shall be tested at 28 days after casting. The specification will be satisfied if the compressive strength of each sample, as determined from the average value of the test cylinders, is not less than the specified minimum 28 day compressive strength and provided that the compressive strength of any cylinder in each sample is not less than 90% of the specified minimum 28 day compressive strength.

Should the strength of any one sample representing the concrete fall short of the specified minimum 28 day compressive strength as shown in Table 610.051, the concrete represented by that sample may be rejected or the Contractor may elect to test concrete cores subject to approval by the Superintendent Council.

Non-destructive tests may be used to determine the in situ strength of suspect concrete subject to approval by the Superintendent Council.

(ii) Test Cores

Where required by the Superintendent Council, test cores shall be cut from the completed structural member, portion of member or group of members represented by the test cylinder sample(s). A minimum of three cores per sample shall be tested. All cores shall be clearly labelled to identify them with the structural member and location they represent.

The dimensions and testing of the concrete cores shall be in accordance with AS 1012.14.

The coring procedure shall comply with the requirements of clause 610.46.

Testing shall be undertaken in accordance with the requirements of clause 610.46 to ensure that the core locations are remote from existing steel reinforcement. Where cores are cut from concrete decks and slabs, core locations shall be remote from wheel paths. Cores containing steel reinforcement shall not be tested.

The coring procedure and core locations shall be submitted for approval by the Superintendent Council.

Cores shall not be cut from prestressed concrete after the prestressing force has been applied or transferred to the concrete, unless the proposed coring is certified by the proof engineer. The certification shall state that the proposed coring will not be detrimental to the prestressed concrete member.

The core holes shall be cleaned and repaired with a shrinkage compensating polymer modified cementitious repair material in accordance with the requirements of Section 689. The exposed surface of the repaired hole shall be similar in texture and colour to the surrounding concrete.

The specification will be satisfied if the compressive strength of each sample, as determined from the average value of the test cores, is not less than the specified minimum 28 day compressive strength and provided that the compressive strength of any core in each sample is not less than 90% of the specified minimum 28 day compressive strength.

Should the strength of any one sample representing the concrete fall short of the specified minimum 28 day compressive strength as shown in Table 610.051, the concrete represented by that sample may be rejected.

(h) Testing and Acceptance of Sprayed Concrete on the Basis of 28 Day VPV Value

A minimum of two cores per sample shall be cut from the sprayed concrete test panels and permanent sprayed concrete and tested at 28 days at the minimum specified sampling frequency. Each core shall be 75 mm diameter and a minimum of 150 mm long, cut transversely into two equal slices and tested for VPV at 28 days in accordance with test method AS 1012.21. The VPV value for each core shall be determined from the average value of the test slices. The specification will be satisfied if the VPV value for each sample, as determined from the average value of the test cores, is not larger than the specified maximum VPV values at 28 days as shown in Table 610.061.

(i) Testing and Acceptance of Concrete Mix Design on the Basis of 3, 7 and 28 Day Compressive Strengths

A minimum of two cylinders per sample per trial mix shall be tested. The specification will be satisfied if the compressive strength of each sample, as determined from the average value of the test cylinders, is not less than the specified minimum 3, 7 and 28 day compressive strengths and provided that the compressive strength of any cylinder in each sample is not less than 90% of the specified minimum 3, 7 and 28 day compressive strengths.

Should the strength of any one sample representing the concrete fall short of the specified minimum 3, 7 and 28 day compressive strengths as shown in Table 610.051, the Contractor shall take steps to modify the concrete mix design and re-test to ensure that the specified minimum compressive strengths have been achieved.

(j) Testing and Acceptance of Non-Conforming Concrete

In the event that any of the specified requirements of this section can not be clearly demonstrated to have been satisfied, the Contractor shall undertake appropriate measures to resolve the non-conformance(s) to the satisfaction of the ~~Superintendent~~ Council.

~~The Superintendent~~ Council may at his discretion require additional VPV testing and compressive strength testing to be undertaken from the remainder of the fresh concrete supply or the in situ hardened concrete or both, as described below.

(i) Fresh Concrete

In addition to the compressive strength requirements as specified in this section, additional samples of concrete as detailed in clause 610.16(b) and Table 610.161 of at least two cylinders shall be tested for VPV at 28 days, in accordance with test method AS 1012.21. The specification will be satisfied if the VPV value for each sample, as determined from the average value of the additional test cylinders, does not exceed the specified maximum 28 day VPV value in Table 610.061.

Should the VPV value of any one sample representing the concrete exceed the specified maximum 28 day VPV value as shown in Table 610.061, the Contractor shall modify the concrete mix design and undertake other measures as required at its own expense, to satisfy the specification requirements for subsequent concrete supply by further sampling and testing. The hardened concrete represented by the samples shall be subject to rejection, rectification by the Contractor, the requirements as described below, or as determined by the ~~Superintendent~~ Council.

(ii) Hardened Concrete

In addition to the requirements of clause 610.16(g)(ii) for compressive strength of test cores, a minimum of two cores per sample shall be cut from the relevant completed structural member, portion of member or group of members represented by a set of test cylinder sample(s) and tested at 28 days. Each core shall be 75 mm diameter x 150 mm long, cut transversely into two equal slices and tested for VPV at 28 days in accordance with test method AS 1012.21. The VPV value for each core shall be determined from the average value of the test slices.

For members where the thickness is less than 150 mm the core length shall be the full thickness of the member. The specification will be satisfied if the VPV value for each sample, as determined from the average value of the test cores, does not exceed the specified maximum VPV value at 28 days as shown in Table 610.061.

All cores shall be clearly labelled to identify them with the structural member and location they represent. Testing shall be undertaken to ensure that the core locations are remote from the existing steel reinforcement. Where cores are cut from concrete decks and slabs, core locations shall be remote from wheel paths. Cores containing steel reinforcement shall not be tested.

Core locations shall be submitted for approval by the ~~Superintendent~~ Council.

For coring from prestressed concrete the requirements of clause 610.16 shall be satisfied.

Where the VPV value of any one sample representing the concrete exceeds the specified maximum 28 day VPV value as shown in Table 610.061, the Contractor shall carry out rectification works. These works shall achieve the specified level of durability, otherwise the concrete represented by that sample may be rejected.

Non-destructive tests may be used to investigate non-conforming concrete of observed or suspect quality subject to approval by the Superintendent Council.

(k) Testing and Acceptance of Concrete on the Basis of 28 Day VPV Value

Notwithstanding the requirements of clause 610.16(j), where a concrete pour exceeds 50 m³ a sample consisting of at least two cylinders shall be sampled at the point of discharge and tested for VPV at 28 days, in accordance with test method AS 1012.21.

For concrete structures located in marine and other saline environments or which are subject to sulphate and chemical attack at least two cylinders per sample shall be tested for VPV at 28 days as detailed in clause 610.16(b) and Table 610.161.

Should the VPV value of any one sample representing the concrete exceed the specified maximum 28 day VPV value as shown in Table 610.061, the concrete represented by that sample and subsequent concrete supply shall be subject to the requirements of clause 610.16(j) for testing and acceptance of non-conforming concrete.

(l) Determination of early age compressive strength

Where early application of loading or early removal of formwork is proposed, or where concrete is to be placed over or adjacent to and connected with a previous section prior to achieving the minimum 7 day compressive strength, additional test cylinder(s) per sample shall be taken for the assessment of early age compressive strength.

The Contractor shall nominate the total number of cylinder(s) per sample in excess of the minimum number of cylinders specified in clause 610.16(d).

Further to the requirements of clause 610.16(e), when additional test cylinder(s) per sample above the specified minimum number are taken to vary a requirement of this specification, such as early application of loading or early removal of formwork, the test cylinder(s) shall be cured with the concrete member under conditions no more favourable than the most unfavourable conditions for the portion of the concrete which the test cylinders represent. Test cylinders shall not be moved or transported to the laboratory for testing prior to 18 hours from moulding in accordance with the requirements of clause 9.2.2 of AS 1012.8.1.

In addition to the early age compressive strength requirements of this sub-clause 610.16(l), the Contractor shall also comply with the curing requirements of clause 610.23 and the minimum curing period requirements as stated in Table 610.231.

(m) Maturity Testing and Temperature Matched Curing (TMC) for Estimating the In Situ Strength of Concrete

Further to the requirements of clause 610.16(d) and clause 610.16(e) various types of maturity testing and TMC may be used to determine the early age in situ strength development of concrete over a required time period for the purpose of facilitating early formwork removal, lifting precast units out of moulds or early application of loading, subject to the approval of the Superintendent Council.

Based on the specific application, a proposed maturity method or TMC of assessing early in situ strength shall be submitted for review by the Superintendent Council. Each proposal shall be supported with a documented detailed methodology and documented evidence of previous performance including accuracy in determining the in situ strength development of concrete.

The proposed method of maturity testing or TMC shall include:

- (i) the type of equipment to be used to monitor the in situ temperatures, or the control temperatures for TMC for the specific concrete mix and prevailing curing conditions:
 - (1) for maturity testing - to develop a maturity curve (correlation between compressive strength and maturity)
 - (2) for TMC – to monitor the heat development in the in situ concrete which heats the water in the TMC system and matches the temperature of the in situ concrete with the temperature of the cylinders in the TMC system to facilitate strength development
- (ii) method of recording the time/temperature relationship including the type of data loggers
- (iii) the period of monitoring
- (iv) the proposed number and location of temperature sensors to be used which shall include as a minimum the interior and near surface of the concrete member.

The maturity curve shall be updated as a minimum on a 3 monthly basis or earlier to allow for any changes in materials, in concrete mix proportioning, the performance of mixing equipment and construction conditions to ensure the ongoing validity of the maturity curve.

The maturity curve shall also be verified at the commencement of maturity testing and subsequently on a 3 monthly basis as follows:

- (i) compare the early age strengths of test cylinders sampled and tested in accordance with clause 610.16 during construction, with the maturity curve;
- (ii) monitor the maturity of an additional early age strength test cylinder per sample, sampled in accordance with clause 610.16, during construction and compare the strength with the maturity curve.

The Contractor shall maintain records of all maturity testing to demonstrate compliance with the specified requirements of this section. **The Contractor shall ensure that the records are available for review by the Superintendent Council.**

In addition to the maturity testing requirements of this sub-clause 610.16(m), the Contractor shall also comply with the curing requirements of clause 610.23 and the minimum curing period requirements as stated in Table 610.231.

(n) Sampling and Testing for Self Compacting Concrete (SCC)

Sampling and testing for SCC to demonstrate compliance with the requirements of Table 610.131 shall be in accordance with clause 610.16, except that the slump flow, T_{500} (measure of viscosity) and passing ability of SCC shall be sampled and tested at the same frequency as superplasticised concrete, as stated in clause 610.16(c).

When making test cylinders for SCC the test sample shall be placed into the cylinder moulds from a height not exceeding 100 mm from the top of the mould. The placing of the concrete into the moulds shall be done in one continuous motion. With the exception of light tapping of the sides of cylinder moulds with a plastic mallet, rodding or vibration shall not be applied to test cylinders made up of SCC.

610.17 TEMPERATURE, EVAPORATION LIMITS AND CONCRETING OPERATIONS

(a) General

All freshly finished concrete surfaces shall be protected where required from the sun, wind or rain, until curing is implemented.

Where extreme conditions of temperature, humidity, wind and/or rain are expected during and after placing the concrete, the Contractor shall implement special precautions to protect the concrete.

The temperature of concrete, measured immediately prior to placing, shall not be less than 10°C or greater than 32°C.

The Contractor shall minimise evaporative moisture losses from the freshly placed and unprotected concrete in accordance with the requirements of clauses 610.17(e) and 610.17(f).

The Contractor shall submit to the Superintendent Council for review, full details of the proposed hot or cold weather concreting procedure, not less than two weeks prior to placement of concrete. The Contractor shall not proceed with the placement of concrete until the hot or cold weather concreting procedure has been reviewed and approved by the Superintendent Council.

(b) Hot Weather Concreting

Concrete shall not be placed when the air temperature measured at the point of placement is above 35°C, unless special precautions as detailed in this clause are implemented to reduce the concrete temperature and facilitate hot weather concreting works.

Steel formwork, reinforcing steel and any other steel surfaces that will come in contact with the concrete shall be cooled by shading, by providing covers or wetting down with water before the concrete is placed, to prevent flash setting of the concrete.

Concrete temperature reducing precautions shall include the following measures to ensure compliance with the requirements of this section:

- (i) shading the aggregate stockpiles
- (ii) sprinkling aggregates with cold water ahead of time for evaporative cooling, provided the moisture content of aggregates complies with the requirements of clause 610.13(d) prior to batching of concrete
- (iii) using refrigerated water in the concrete mix
- (iv) injecting liquid nitrogen into the mixer
- (v) water mist spraying to cool the air provided that the water does not collect or pond on the exposed concrete surfaces.

For decks and slabs, the concrete surfaces shall be protected immediately after screeding and finishing operations are progressively completed in order to minimise evaporative moisture losses, until curing by one or a combination of the methods specified in clause 610.23 is implemented.

(c) Cold Weather Concreting

Concrete shall not be placed in the works when the air temperature measured at the point of placement is below 5°C, unless special precautions as detailed in this clause are implemented to facilitate cold weather concreting works.

Concrete which has been damaged by frost as a result of failing to maintain the temperature of the concrete surface above 5°C will be rejected.

Special precautions shall include the following measures to ensure compliance with the requirements of this section:

- (i) heating and blending mixing water to a maximum of 70°C and keeping concrete temperature to below 32°C
- (ii) heating the aggregates
- (iii) use winter grade admixtures
- (iv) use higher concrete grade
- (v) control sequence of batching ingredients when some are heated to avoid flush setting and balling within the agitator
- (vi) avoid delays in delivery to avoid heat loss during transit
- (vii) improve thermal effects by utilising insulating materials and thermal blankets as part of formwork and curing and maintain uniform temperature conditions within the curing chamber until required strengths are achieved.

(d) Wet Weather Concreting

Concrete shall not be placed during rain or when rain appears imminent.

The Contractor shall take measures to protect the freshly placed concrete from rain.

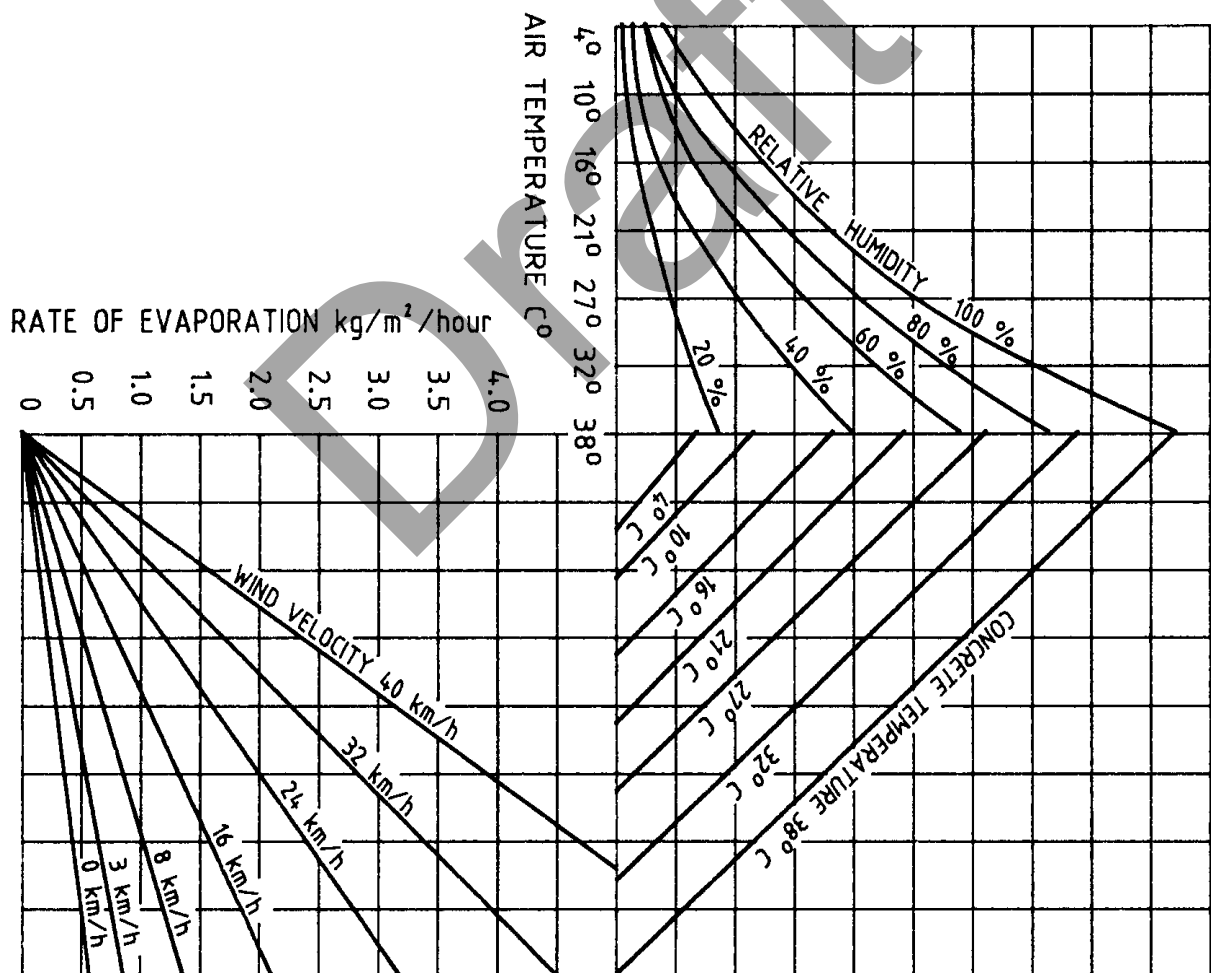
Any concrete which is exposed to rain or other precipitation within the period from placement to curing will be nonconforming.

(e) Evaporation Limits for Concreting Operations

The Contractor shall be responsible for measuring and recording the air temperature, relative humidity, concrete temperature and wind velocity (measured one metre above the as placed concrete) at the point of concrete placement from commencement of placing the concrete and continue until curing has commenced. This information shall be used in conjunction with Figure 610.171 to determine the rate of evaporation of water from the freshly placed and unprotected surface of the concrete. The rate of evaporation shall be monitored by the Contractor until such time as curing commences.

When the value of the rate of evaporation as determined from Figure 610.171 exceeds 0.50 kg/m² per hour the Contractor shall take precautions to minimise evaporative moisture losses such as the application of an aliphatic-alcohol based evaporative retarding compound or controlled fog spray.

Figure 610.171- Evaporation of Water from Freshly Placed Concrete



(f) Application of Evaporative Retarding Compound

The evaporative retarding compound, when required, is to be applied immediately after initial screeding. The remaining finishing operations can be carried out after application of the compound.

An evaporative retarding compound shall be used for concrete decks and slabs.

Application of the evaporative retarding compound shall be implemented in accordance with the manufacturer's instructions. It shall be applied in a uniform manner to produce a continuous film to protect freshly placed concrete and minimise the evaporative water loss during finishing operations.

The evaporative retarding compound shall contain a fugitive dye to ensure uniform application and enable clear differentiation between covered and non-covered areas.

Details of the proposed evaporative retarding compound and its application procedure including minimum application rates, shall be submitted to the Superintendent Council for review not less than four weeks prior to the commencement of concreting works.

610.18 PLACING AND COMPACTING CONCRETE

(a) Placing – General

The Contractor shall submit a detailed work method statement(s) (WMSs), inspection and test plan(s) (ITPs) and quality control checklist(s) for all concrete construction works which explicitly reference the acceptance criteria and all performance requirements of Sections 610, 611, 613 and 614, for review by the Superintendent Council not less than 4 weeks prior to the placement of concrete. Generic or incomplete WMSs and ITPs will not be accepted.

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Concrete shall not be placed until:

- (i) **the Contractor's has a quality system in place documenting WMS, ITPs and quality control checklist(s) have been reviewed by the Superintendent**
- (ii) **the evidence that the forms, reinforcement, any stressing materials and embedments conforming to the requirements of this specification and the drawings, has been reviewed by the Superintendent Council**
- (iii) **all foreign material has been completely removed from the forms**
- (iv) **the Contractor has implemented a documented process ~~submits documented evidence of~~ conducting tool box meetings of all concrete construction personnel on all aspects of the WMS, the ITPs, quality control checklist(s) and all specification requirements**
- (v) **the Contractor ~~submits~~ has implemented a site sampling and testing procedure in accordance with the minimum frequency of testing requirements of this section for assurance of concrete quality, and as stated in clause 610.16(b), clause 610.16(c) and clause 610.16(n), including superplasticised concrete and SCC.**

Concrete shall be transported, handled and placed so as to prevent segregation, loss or leakage of materials.

Concrete shall not be dropped freely from a height exceeding two metres. Where placing concrete would otherwise necessitate a drop exceeding two metres, suitable tremie pipes, chutes or other concreting devices shall be used to place the concrete to prevent segregation. Concrete shall not be moved horizontally by the use of vibrators.

Concrete shall be supplied at an adequate rate in a continuous operation to ensure that all the concrete in the forms can be kept plastic until placed in its final position and compacted, and all temporarily exposed surfaces covered by and knit in with fresh concrete so that no cold joints are formed. Equipment and personnel shall be adequate to maintain the rate of concrete placement adopted.

In continuous concrete pours the maximum time lag between truck loads on site shall not exceed 25 minutes.

No strain shall be placed on any projecting reinforcing steel or embedment for a period of at least 12 hours following completion of concreting.

For construction of deck slabs the fixed screed supports shall be placed parallel to the longitudinal centreline of the bridge.

Concrete above deck shall not be placed until the deck formwork or the falsework for the span has been released and/or any post-tensioning and grouting operations are completed.

Prior to placing concrete any absorbent surfaces including blinding concrete and construction joints shall be thoroughly moistened and excess free water shall be removed.

(b) Pumping of Concrete

Pumping of concrete may only be used when the concrete mix is designed for such placement method.

Prior to commencement of placing concrete, the initial discharge of concrete shall be pumped to waste until a consistent workable mix is discharged. Aluminium pipes shall not be used for the delivery of concrete.

Pumping equipment shall be positioned such that freshly placed concrete is not affected by vibration in accordance with the requirements of clause 610.38.

(c) Placing Concrete in Bored Piles, Under Water and in Dry Bores

The Contractor shall submit the procedure for placing concrete in bored piles, under water and in dry bores, for review by the Superintendent Council at least four weeks prior to concreting.

Concrete shall not be placed in bored piles, under water or in a dry bore until the proposed method of placement of concrete has been approved by the Superintendent Council. The minimum concrete grade for concrete placed in bored piles, under water or in dry bores shall be VR400/40, in accordance with the requirements of this section. The proposed mix shall be either a self compacting concrete (SCC) or a highly workable concrete as specified in clauses 610.13(b) and 610.13(c) respectively.

Highly workable concrete shall be compacted in accordance with the requirements of this section.

Placing of concrete in bored piles, underwater or in a dry bore shall be carried out in one continuous operation by tremie methods in accordance with Section 606. Concrete shall not be placed in water which has a temperature of less than 5°C.

Unsound or contaminated areas of exposed concrete shall be removed and the surface thoroughly prepared in accordance with clause 610.20 prior to subsequent placement of concrete.

Where cofferdams or cylinders have been sealed by underwater placement of concrete, dewatering shall not proceed until at least 48 hours after completion of concrete placement.

(d) Compaction, Screeding and Finishing of Concrete

(i) Compaction

Care shall be taken during compaction to fill every part of the forms or excavations, to force the concrete under and around the reinforcement and any other embedded fixtures without displacing them, to work coarse aggregate back from the face, and to remove air bubbles and voids.

Concrete shall be deposited in horizontal layers not more than 350 mm thick except in the manufacture of prestressed concrete members. For prestressed members the concrete shall be built up to the full depth of the section and the concrete face moved forward progressively. For prestressed concrete members over 600 mm deep this may occur in two or three passes.

During and immediately after placing, the concrete shall be effectively compacted by internal vibrators of adequate size, number and frequency and supplemented as required by external form vibrators. A minimum of two internal vibrators shall be provided at any time.

Vibration shall be applied to the full depth of each layer and extended into the top 100 mm of the underlying layer. Vibration shall continue at each point until air bubbles cease to emerge from the concrete, then withdrawn slowly to avoid leaving a defect. Concrete shall not be vibrated to the point where segregation of the ingredients occurs.

Internal vibrators shall be inserted vertically at successive locations at spacings not exceeding the manufacturer's stated zone of influence, and shall not be allowed to rest on the steel reinforcement, embedded fixtures or formwork.

Vibration shall not be applied either directly or through the reinforcement to any concrete which has taken its initial set

Concrete decks or slabs shall be compacted by internal vibrators and vibrating screeds such that uniform consolidation is achieved throughout the deck and slab area.

Where approved by the Superintendent Council proprietary power vibrating screeds of suitable widths may be used in narrow or constricted areas or where required by the deck and slab layout, with each new vibrating run overlapping the previous one by a minimum of 300 mm, such that uniform consolidation is achieved throughout the deck and slab area.

Where intense compaction is specified both external form vibrators and internal vibrators shall be used.

Where rigid formwork is specified on the drawings only steel forms shall be used.

Internal vibrators shall always be used when external form vibrators are used.

(ii) Screeding of Exposed Surfaces

Immediately after placing and compaction, exposed surfaces other than decks and slabs shall be screeded off to the specified levels and finished with a wooden float to an even uniform surface. Construction joints shall be left rough in accordance with clause 610.20.

During screeding surplus concrete shall be maintained ahead of the screed to ensure full and uniform compaction to exposed concrete surfaces.

Concrete deck and slab surfaces shall be screeded on a longitudinal direction using vibrating screeds on screeding guides. The screeding guides shall be accurately set and rigidly fixed in position. Guides shall be capable of sustaining construction loading without undue or permanent deflection.

The Contractor shall submit its proposed method of compaction adjacent to screed guides, and its proposed method and timing of repairs at screed guide supports for review by the Superintendent Council.

(iii) Finishing of Exposed Surfaces

Final finishing of exposed concrete surfaces shall be carried out after all bleed water has been removed and the concrete has become sufficiently hard to support the finishing operation. Driers (i.e. dry sand, cement or stone dust) shall not be used to absorb free water.

Finishing of concrete decks or slabs shall be effected with a power trowel fitted with rotating steel floats.

Any drying cracks which appear prior to initial set and before or during finishing operations shall be immediately closed as required with either a wooden or steel float.

Curing shall commence immediately following the progressive completion at any location of final finishing operations.

(iv) Protection of Self Compacting Concrete (SCC) from Vibration and Disturbance

Notwithstanding the requirements of this clause, SCC shall not be vibrated or be subjected to any physical disturbance after deposition. The Contractor shall undertake adequate precautions and manage the effects of external sources of vibration from nearby activities and construction equipment, in accordance with the requirements of clause 610.38, to ensure that the freshly placed SCC remains undisturbed and does not segregate.

610.19 CONCRETE CASTING SEQUENCE

The casting sequence shall be as shown on the drawings or as specified in this specification.

(a) Deck Casting Sequence

The deck casting sequence shall be as shown on the drawings or as specified in this specification. At least seven days shall elapse between the casting of adjacent sections. The maximum deck casting length shall be 25 metres.

(b) Box Girder or Voided Slab Casting Sequence

The Contractor shall submit details of the proposed casting sequence and falsework design, including the proof engineering certificate of compliance for review by the Superintendent Council. All falsework shall comply with the requirements of Section 613.

Casting sequence details shall include the length of segments, the order of casting and whether segments are to be cast monolithically or in stages. Box girders or voided slabs shall be cast in longitudinal segments with a maximum segment length of 25 metres. At least seven days shall elapse between the casting of adjacent segments.

Segments incorporating a transverse diaphragm shall be cast monolithically with the full cross section of the webs, floor and deck slab extending a distance of at least five metres from the face of the diaphragm.

Segments which do not incorporate transverse diaphragms shall be cast monolithically with the full cross section of webs, floor and deck slab, or alternatively may be cast in two stages with a construction joint provided between the webs and the deck slab. If the latter method is adopted, the deck slab shall be cast not later than 14 calendar days after the casting of the webs and floor slab.

610.20 CONSTRUCTION JOINTS AND BONDING OF NEW CONCRETE

The location and details of construction joints shall be as shown on the drawings.

Construction joints whose location and details are not as shown on the drawings shall be subject to approval by the Superintendent Council.

The placing of concrete shall proceed continuously from joint to joint.

Any point at which the placing of concrete has stopped and the concrete has taken its initial set shall be treated as a construction joint.

Construction joints shall be perpendicular to the principal lines of stress, and in general shall not be located in regions of maximum bending or maximum shear.

At the base of columns or walls construction joints shall be located at least 100 mm above the tops of the footings or pilecaps.

Where applicable, concrete in the existing structure shall be broken back as shown on the drawings. Any cracked or damaged concrete remaining after breaking back shall be removed and replaced with new concrete.

Before placing new concrete against concrete which has set, the forms shall be re-tightened.

Construction joints shall be prepared to produce a well-bonded interface between hardened concrete and freshly placed concrete.

Concrete against which new concrete is to be placed shall be roughened by removing all laitance and sufficient mortar to expose the coarse aggregate to a depth of 3 mm, with the coarse aggregate still firmly embedded in the concrete. The roughened surface shall be cleaned of foreign matter, laitance and loose or porous material. Any projecting steel reinforcement shall also be cleaned. The surface shall be thoroughly moistened with water and any excess surface water removed immediately prior to placing of concrete.

610.21 INSERTIONS AND GREASED JOINTS

Abutting surfaces of concrete shall be separated by grease or other surface coatings or insertions of bituminous impregnated felt or fibreboard as shown on the drawings, so as to prevent the surfaces from bonding or binding together.

Dowels shall be placed as shown on the drawings and prior to placing the surrounding concrete.

610.22 CONTROL OF EARLY AGE THERMAL CRACKING OF LARGE AND RESTRAINED MEMBERS

Measures shall be taken to control early age thermal cracking of concrete for large and restrained members including but not be limited to crossheads, diaphragms, columns, abutments, footings and pile caps where:

- (a) the least dimension of a member exceeds 500 mm; or
- (b) one or more faces of a concrete member is restrained by previously placed hardened concrete or by other external restraints.

Except where justified by analysis and testing, the temperature differential across the concrete member being constructed shall not exceed 20°C during the period of curing. The Contractor shall implement special precautions to reduce differential temperature build-up prior to the temperature differential between the concrete core and that of the exposed concrete surface exceeds 20°C. As a minimum the special precautions shall consist of 2 layers of 8 mm thick closed cell foam or inner double core aluminium foil based thermal blankets.

Thermocouples shall be placed at a range of positions within the large and restrained concrete member to determine the maximum temperature and differential temperature across the section of concrete. Thermocouples with an accuracy of $\pm 1^\circ\text{C}$ shall be cast into each large or constrained concrete member, located in the centre of the core and 25 mm below the exposed surface, and monitored at continuously regular intervals by data loggers until the temperature difference falls such that control measures are no longer required.

The temperature data acquired and proposed control measures to reduce differential temperature within the specified limits shall be submitted for review by the Superintendent Council.

Temperature differential monitoring shall be undertaken on at least one representative member from each type of large and restrained members, provided that any required control measures to reduce the differential temperature within the specified limits is adopted for the subsequent construction of members of the same type.

The maximum internal temperature of all concrete members following concrete placement shall not exceed 75°C.

610.23 CURING

- (a) General

Curing of concrete shall be carried out using one or a combination of the methods as specified in clauses 610.23(c), 610.23(d), 610.23(e), 610.23(f), 610.23(g) and 610.23(h).

The curing of exposed concrete surfaces shall commence immediately after finishing operations are progressively completed at any location and shall continue uninterrupted for not less than the periods specified in Table 610.231.

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The Contractor shall submit to the Superintendent Council for review, full details of the proposed methods of curing, as part of the concrete mix design submission, not less than four weeks prior to placement of concrete. The Contractor shall not proceed with the placement of concrete until the curing method(s) has been reviewed and approved by the Superintendent Council.

Details submitted shall include the following information for the proposed methods of curing:

- (i) Water Curing - materials, method and timing of curing
- (ii) Curing Compound - technical specification of the proposed curing compound including the timing, rate of application, procedure for the determination of the application rate and method of removal (where required)
- (iii) Polyethylene Sheet - material and method of application, sealing and control
- (iv) Maintaining Formwork in Place - timing, method of sealing the formwork and curing exposed surfaces
- (v) Steam or Radiant Heat Curing - full details of control methods and proposed curing cycle.

(b) Period of Curing

The period of curing shall be not less than the number of days given in Table 610.231.

The Contractor shall implement a quality procedure in accordance with the minimum requirements of Table 610.231 to ensure that for concrete decks and slabs, the periods of curing are extended by 2 days and when the average air temperature during the specified periods of curing falls below 10°C, the periods of curing are extended by 2 days. **The Contractor shall ensure that records of temperature monitoring during the curing period are available for review by the Superintendent Council.**

Table 610.231

Periods of Curing (excluding steam and radiant heat curing)				
Concrete Grade	Exposure Classification	Type of Cement	Periods of Curing (days)	
			Average Air Temperature During Curing	
			10°C to 17°C	Above 17°C
VR330/32	A, B1	GP	7	6
		GB	9	8
VR400/40	B2	GP	6	5
		GB	8	7
VR450/50 VR470/55	C1, C2	GP	5	5
		GB	7	7
For concrete decks and slabs, the periods of curing shall be extended by 2 days.				
Notes: 1. Type of cement: GP - General purpose portland cement GB - General purpose blended cement				
2. When the average air temperature during the specified periods of curing falls below 10°C, the periods of curing shall be extended by 2 days.				
3. Where a higher concrete grade is adopted than that shown for a particular exposure classification, the periods of curing for the higher concrete grade may be adopted.				

The curing periods for concrete grades higher than VR470/55 shall be the same as those for concrete grade VR470/55.

(c) Water Curing

All surfaces of the concrete shall be kept continually moist for the specified periods of curing by continuous spraying, ponding, wet hessian, felt matting or sand blankets and the concrete maintained at a temperature above 5°C. Wet curing materials used on vertical surfaces shall be securely wrapped during the whole curing period to ensure that all surfaces are evenly and effectively cured. The water used shall conform to the requirements of clause 610.09.

(d) Curing Compounds

(i) General

Curing compounds shall comply with the requirements of AS 3799. The concrete shall be maintained at a temperature above 5°C.

Prior to the use of curing compounds, full details of the proposed curing method shall be submitted to the Superintendent Council, including the time and rate of application, documented evidence of the effectiveness of the compound as a curing agent supported by test certificates endorsed in accordance with the AS ISO/IEC 17025 accreditation for the testing laboratory and method of removal where required. The test certificates of compliance shall relate only to the formulation on which the tests were made and shall be valid for not more than three years from the date of issue.

The test certificates shall present the results of uniformity testing of the curing compounds for both non-volatile content and density in accordance with AS 3799 clause 3.2, and for viscosity in accordance with AS 3799 clause 3.1.5.

(ii) Specific Requirements

Curing compounds shall not be used on concrete decks or slabs, unless an aliphatic-alcohol based evaporative retarding compound is also applied after initial screeding in accordance with clause 610.17(f).

PVA based curing compounds shall not be used.

The curing compounds shall be pigmented sufficiently to allow visual inspection to ensure full application on the surface. The pigment shall not be visible fourteen days after application. Curing compounds shall not have a deleterious effect on the concrete or stain the surface of the concrete.

The curing compound shall be applied by a pressurised sprayer to give a uniform cover. The sprayer shall incorporate a device for continuous agitation and mixing of the compound in its container during spraying.

The curing compound shall be applied using a fine spray at the rate stated on the certificate of compliance, or at a rate of 0.2 litres/m² per coat, whichever is the greater.

Two coats shall be applied at the full rate.

The time between the first and second coat shall be in accordance with the manufacturer's recommendation, or on the basis of a trial application.

Curing compounds shall not be applied to construction joints unless the joint is to be roughened or sandblasted at a later date.

Curing compounds shall not be applied to surfaces which are to be subsequently coated unless they are compatible with the coating, waterproofing or surfacing system or provision is made for removal of the compound from these surfaces prior to the application of the coating, waterproofing or surfacing system.

The curing membranes shall be maintained intact for not less than the specified period of curing. Any damage to the curing membranes during the period of curing shall be repaired immediately at the original rate of application.

(iii) Determination of Application Rate of Curing Compound

The application rate shall be checked by calculating the amount of curing compound falling on felt mats, each approximately 0.25 m² in area, placed on the concrete surface during the application of the curing compound.

The application rate shall be determined as follows:

- (1) pre-weighed absorbent felt mats placed at different places on the area to be sprayed
- (2) after the applicator has covered the area concerned, the felt mats are immediately folded with their wet sides together, placed in plastic bags to prevent evaporative losses and weighed
- (3) the application rate (r) shall be determined as follows:

$$r = m/A \times \rho$$

where r = application rate, (litres/m²)

A = area of felt mat, (m²)

ρ = density of curing compound (kg/litre), which may be available from the material manufacturer's data sheet or the test report

m = net mass (weight of felt mat with curing compound minus pre-weighed felt mat) (kg)

(e) Polyethylene Sheet

Polyethylene sheet shall be of sufficient strength to withstand wind and any imposed foot traffic or physical loading. Torn or punctured sheeting shall not be used. Laps shall be 300 mm minimum and edges and laps shall be sealed by tape or held down by boards or other means. All edges and laps shall be sealed against evaporative moisture losses for the duration of curing. Water shall be sprayed under the sheeting at the edges and at laps on the day after placing concrete and at regular intervals to maintain moist conditions.

Polyethylene sheet shall not be used on concrete decks or slabs unless used in conjunction with water curing.

(f) Curing by Maintaining Formwork in Place

Where formwork is left in place to satisfy the formwork removal times as specified in clause 610.25, or where formwork is left in place for the specified period of curing or part thereof, the exposed surfaces of the concrete shall be cured and the formwork shall be sealed against evaporative moisture losses for the duration of curing.

Where formwork is removed prior to the completion of the curing period, curing shall recommence within half an hour and continue until the total curing time is not less than the periods of curing specified in Table 610.231.

(g) Steam Curing

(i) General

Method of control and the proposed curing cycle to achieve the specified concrete compressive strength shall be submitted to the Superintendent Council. After the initial 'maturity' period, units shall be cured in an atmosphere saturated with water vapour at a pressure not exceeding atmospheric pressure.

The Contractor shall take measures to allow for the potential lower 28 day compressive strength obtained from test cylinders cured initially under in situ conditions, as compared to those cured in accordance with the requirements of AS 1012.

(ii) Steam Covers

To prevent drying out, steam covers shall be placed over the units immediately following the casting and screeding operations in such a manner as to ensure free circulation of the steam around the concrete mass.

(iii) Curing Cycle

After an initial 'maturity' of 40°C hours, but not less than two hours after batching the last batch of concrete for the units, steam shall be admitted to the steam covers at such a controlled rate that the maximum average temperature rise shall not exceed 24°C per hour. (Note: The initial 'maturity' period is calculated by dividing 40°C hours by the concrete temperature of the last batch of concrete placed in the unit. The concrete temperature is as measured on an indicating thermometer.) In addition, the temperature rise in any one fifteen minute period shall not exceed 6°C.

If the admission of steam to the steam covers is delayed by more than the initial specified 'maturity' of 40°C hours after the completion of placing of concrete, water curing, as specified in clause 610.23(c) shall be applied until steaming commences.

Steaming shall continue at a rate such that the temperature rise shall not exceed 24°C per hour, until a temperature under the steam covers of not greater than 70°C has been reached. The corresponding maximum temperature of the concrete shall not exceed 75°C.

After the elapse of sufficient time at the maximum temperature for the required concrete properties to have been reached, steam shall be completely shut down. Steam covers shall not be removed nor any part of the concrete units and test cylinders disturbed or operated upon in any way until the temperature under the steam covers has fallen to within 30°C of the ambient temperature. Also the rate of loss of temperature under the steam covers after shutting off steam shall not exceed 30°C per hour.

(iv) Temperature Controls

Temperature shall be recorded by means of recording thermometers supplied and installed by the Contractor. These thermometers shall be maintained in good condition and calibration. The temperature sensitive parts of the thermometers shall be so positioned under the steam covers as to cause the thermometers to record the minimum temperature under the covers. One recording thermometer shall be used for each unit or group of units in line up to a total length of 25 m. For greater lengths, additional recording thermometers shall be used and the distance between the temperature sensitive parts of the thermometers shall not exceed 25 m.

The recording thermometers shall be set in operation immediately upon completion of the casting and screeding, the temperature sensitive part of each thermometer being installed in position at the same time.

Charts shall not be removed from any recording thermometers, nor the recording thermometers disturbed or moved in any way until after the removal of the steam covers.

Charts from temperature recording thermometers shall be retained.

The following information shall be recorded on the chart:

- (1) date on which steaming commenced
- (2) unique identification and description of concrete unit
- (3) temperature correction, if any
- (4) time correction, if any
- (5) batching of concrete
- (6) temperature of concrete when placed
- (7) ambient temperature at time of removal of steam covers
- (8) name of Contractor or manufacturer.

(v) Steam Delivery

Under no circumstances shall steam jets be allowed to impinge upon any part of the concrete units or of a test specimen, or of their formwork or moulds. Neither shall any steam delivery pipe be attached directly to any formwork or moulds in such a manner as may cause localised overheating of the concrete.

Sufficient steam jets or steam entry points shall be provided to ensure that a substantially uniform temperature is maintained under the steam covers such that the difference in temperature between any two points adjacent to the concrete units is not more than 10°C.

(vi) Extent of Steam Curing

Unless otherwise specified, steam curing shall be continuously applied until at least the 7 day compressive strength for the specified concrete grade is obtained.

(vii) Partial Steam Curing

Where steam curing is used only to obtain sufficient compressive strength for removal of forms or for lifting, curing shall be continued by one or a combination of the methods specified in clauses 610.23(c), (d) and (e) for a minimum period of seven days from the time of finishing the concrete.

Where partial steam curing is employed as above, curing shall recommence within half an hour of the cessation of steam curing.

The minimum requirements of clause 610.23(g)(iii) shall be complied with.

(viii) Curing of Test Cylinders

Concrete compression test cylinders shall be placed near the concrete units, and shall be so positioned under the steam covers as to be midway between two adjacent points of steam entry, subject always to their being no closer to any points of steam entry than half the width of the concrete units. Test cylinders shall be positioned in a group at the lower face of the concrete unit and shall in no case be placed on top of the concrete unit or its formwork. Test cylinders shall remain in position under the steam covers until the steam curing cycle is complete. Test cylinders shall be suitably covered in such a way as to minimise moisture and temperature losses between the time of removal from the steam covers and the time of forwarding to an accredited laboratory for testing. Cylinders shall be transported in moisture proof containers.

(h) Radiant Heat Curing

(i) General

The application of heat shall be effected by the circulation of hot water which is fed through a series of conduits attached externally to the steel form. A heating box used for the curing of concrete test cylinders shall be connected to the hot water heating system.

(ii) Curing Cycle

The curing cycle of the radiant heat curing method shall be in accordance with clause 610.23(g)(iii) except that reference to steam curing shall be replaced by the application of hot water. The top surface of the finished concrete shall be kept moist throughout the curing cycle.

(iii) Temperature Controls

The water temperature shall be controlled by a thermostat and shall not exceed 70°C. The corresponding maximum temperature of the concrete shall not exceed 75°C. The temperature difference between ingoing and outgoing water shall be maintained at less than 10°C.

Temperature controls shall be in accordance with clause 610.23(g)(iv), except that reference to steam covers shall be replaced by curing covers. In addition to the specified requirements of clause 610.23(g)(iv), the Contractor shall also monitor the temperature of the test cylinder heating box by means of a recording thermometer. The difference in temperature between the test cylinder heating box and any point along the hot water heating system shall not exceed 10°C.

(iv) Curing Covers

To prevent drying out, curing covers shall be placed over the units after the top surface of the concrete has taken its initial set and the watering hose has been placed on the concrete.

(v) Extent of Radiant Heat Curing

Radiant heat curing shall be continuously applied until at least the 7 day compressive strength for the specified concrete grade is obtained.

(vi) Curing of Test Cylinders

Concrete test cylinders shall be placed in the heating box which is connected into the mould heating system as soon as the curing starts and shall remain in position until the curing cycle is complete. Test cylinders shall be suitably covered to minimise moisture and temperature losses between the time of removal from the heating box and the time of forwarding to an accredited laboratory for testing. Cylinders shall be transported in moisture proof containers.

(i) Delayed Ettringite Formation

To control the risk of delayed ettringite formation at later ages, the maximum concrete temperature during the curing period shall not exceed 75°C except where analysis has been performed that justifies a particular maximum temperature limit for concrete.

(j) Loading of concrete and vibration effects during the curing period

Concrete shall remain undisturbed and not be subjected to any loading or vibration effects for the minimum period of curing as stated in Table 610.231.

610.24 CRACKING OF CONCRETE

(a) General

The Contractor shall plan the various construction activities and control the supply and delivery of concrete, placing, compacting, finishing, curing and protection of freshly cast concrete such that cracking in concrete members is prevented.

(b) Maximum Acceptable Crack Widths

The concrete shall have no cracks at any stage after construction measured at the concrete surface of width greater than the relevant value given in Table 610.241 for the corresponding exposure classification. Where such cracks exist, they shall be identified as a non-conformance.

Notwithstanding the requirements of this clause the acceptable crack width at the concrete surface of pre-cast pre-stressed concrete members shall not exceed 0.1 mm.

Table 610.241

Exposure Classification	Maximum Acceptable Crack Widths (mm)
A	0.20
B1	0.20
B2	0.15
C, U	0.10

The Contractor shall undertake an assessment of the cracked concrete structure to evaluate the influence of cracks on the load bearing capacity, serviceability and durability.

The widths of cracks at the concrete surface may be measured using a plastic strip gauge with fixed width lines or a hand-held optical comparator fitted with a microscope and suitable measuring scale. Live/active cracks may be measured with the use of overlapping upper and lower plastic plates bonded across the crack or steel studs bonded across the crack and movement measured with a Demec gauge or similar device.

HP The assessment of the cracked concrete structure shall be undertaken by a technical specialist with a minimum of 5 years practical experience in the diagnostic assessment and investigation of concrete structures.

The assessment shall ensure that the cracking of concrete does not compromise the durability, strength, serviceability and appearance of the concrete structure.

The Contractor shall establish the cause(s) of the cracks, crack width, the moisture condition of the crack and whether a crack is active or inactive.

HP The Contractor shall submit a crack repair procedure for the ~~Superintendent~~ Council's review, prior to any repair works being undertaken.

The repair of concrete cracks shall be in accordance with Section 687.

(c) Repair of Inactive Cracks

Repair of inactive cracks shall be as follows:

- (i) Cracks up to 1 mm wide shall be repaired by pressure injection of low viscosity epoxy resin.
- (ii) Vertical cracks 1–2 mm wide shall be repaired by pressure injection of low viscosity epoxy resin. Horizontal cracks 1–2 mm wide shall be repaired either by pressure injection of epoxy resin or other repair methods which comply with the requirements of Section 687, provided a supporting assessment and evaluation by an appropriately experienced consultant has been submitted to the ~~Superintendent~~ Council for review.
- (iii) Cracks over 2 mm shall be repaired with filling materials and methods in accordance with the requirements of Section 687. Where the repair of such cracks is likely to result in the complete detachment of fractured pieces of concrete away from the main concrete member, such fractures shall be treated as patch repairs and repaired with polymer modified cementitious repair materials in accordance with the requirements of Section 689.
- (iv) Where cracks run through the entire cross section and are accessible from both sides of a concrete member the larger crack width measurement shall be the controlling width for the purposes of crack repair, thus requiring the full depth of the crack to be pressure injected with low viscosity epoxy resin and if necessary injected from both ends. Such concrete members shall include but not be limited to concrete decks slabs, all types of walls, slabs, columns, crossheads, diaphragms and abutments.

(d) Repair of Active Cracks

Live/active cracks shall be repaired using flexible filler materials and methods in accordance with the requirements of Section 687.

(e) Water Leakage through to Deck Slab Soffit

Following inspection, where crack repairs with pressure injected low viscosity epoxy resin fail to stop water leakage through the cross section to the concrete deck slab soffit, the whole of the top surface of the deck slab shall be waterproofed with the installation of a waterproofing membrane prior to the placement of asphalt in accordance with the requirements of Section 691.

610.25 REMOVAL OF FORMWORK

(a) General

Formwork shall be removed carefully and in such a manner as to avoid damage to the member or the concrete surfaces and maintain safety at all stages of removal.

(b) Formwork Removal Times

Formwork and formwork supports shall not be disturbed or adjusted during the concreting operation and shall remain in position and undisturbed until the minimum removal times given in Table 610.251 have elapsed, after completion of the placing of concrete.

(c) Vibration Effects Due to Construction Activities

Construction activities shall be planned and managed such that the formwork and concrete are not affected by vibration in accordance with the requirements of clause 610.38.

Table 610.251

Concrete Members	Minimum Period before Removal of Formwork and Formwork Supports
Soffits of beams, soffits of decks, soffits of slabs, soffits of cantilevers, soffits of diaphragms, soffits of pier and abutment crossheads and soffits of other structural members.	7 days or until such time as the concrete has reached the specified 7 day compressive strength, whichever is the greater.
(a) Vertical faces of members when height of each day's cast is: (i) Columns - greater than 7 metres (ii) Walls - greater than 4 metres (b) Load supporting sides of sloping walls of box girders.	5 days
(a) Vertical faces of members when height of each day's cast is: (i) Columns - 4 to 7 metres (ii) Walls - 2 to 4 metres (b) Vertical faces of beams and pier and abutment crossheads (c) Vertical faces of pad footings.	3 days
Vertical faces of members when height of each day's cast is: (i) Columns - less than 4 metres (ii) Walls - less than 2 metres	2 days
Sides of slabs and piles.	1 day
Where Type GB cement is used, the times for removal of formwork and formwork supports shall be increased by 1 day. This requirement shall not apply to vertical faces of beams and crossheads, columns and walls when the height of each day's cast is less than 4 metres or 2 metres respectively, or the sides of slabs and piles.	

Where the timing for the removal of formwork and formwork supports is based on compressive strength as given in Table 610.251, test cylinder(s) shall be prepared, cured and tested as specified in clause 610.16. In addition, the curing requirements of clause 610.23 shall apply to the newly exposed surfaces.

610.26 REINFORCEMENT BAR CHAIRS AND SPACERS

(a) Steel reinforcement supports

All steel reinforcement shall be securely held during placing and compacting of the concrete. Steel reinforcement supports shall comply with AS/NZS 2425. The supports shall be made of durable materials strong enough to withstand the imposed loads without movement of the steel reinforcement as specified in this section, shall be positively attached to the steel reinforcement, and of such size as to maintain the specified cover.

Concrete bar chairs and spacers shall be manufactured from machine mixed concrete and shall have a minimum 28 day concrete compressive strength of 60 MPa when tested in accordance with AS 1012.9. Notwithstanding the requirements of AS/NZS 2425, concrete bar chairs and spacers shall have a maximum VPV value at 28 days of 12% when tested in accordance with AS 1012.21. A sample consisting of two specimens shall be tested for each of compressive strength and VPV, in accordance with the sampling frequency as stated in clause 6.2 of AS/NZS 2425.

Each concrete bar chair and spacer mix design shall be tested for soluble salts (chloride ion and sulphate ion content) in accordance with AS 1012.20.1 on a 12 monthly basis or earlier if the mix design changes to demonstrate compliance with the requirements of clause 610.07(k) for soluble salts.

Reinforcement bar chairs and spacers for structures constructed in marine and other saline environments or subject to sulphate and chemical attack shall comply with the requirements of clause 610.29(f) in addition to the requirements of this clause.

Continuous bar chairs shall not be more than 350 mm in length and shall not be placed on a continuous straight line.

Bar chairs and spacers made of wood, metal, plastic coated metal and site made concrete shall not be used. Pieces of coarse aggregate or broken bricks or the like shall not be used to support steel reinforcement.

The Contractor shall submit for review by the Superintendent Council not less than 14 days prior to the proposed use of the steel reinforcement bar chairs and spacers, a signed statement including relevant test reports demonstrating compliance of the bar chairs and spacers with the specification.

Bar chairs and spacers which do not comply with the requirements of this section shall not be used in the Works.

(b) Placing

All steel reinforcement shall be securely held with the correct tie wire during placing and compacting of the concrete. The supports shall be positively attached to the steel reinforcement, and of such size as to maintain the specified cover. Bar chairs and spacers shall be placed sufficiently close together to ensure that the specified cover is maintained before and during concrete placement, compaction and finishing operations, and to prevent any potential deformation, displacement or crushing of the bar chairs and spacers such that deformation or displacement of the steel reinforcement is also prevented.

The specified minimum concrete cover shall be maintained at tie wire positions. Excess tie wire shall be cut off and the twisted ends of wire ties shall project away from the cover zone.

Placing bars on layers of fresh concrete as the work progresses and adjusting bars during the placing of concrete will not be permitted.

610.27 ERECTION OF BEAMS AND OTHER CONCRETE MEMBERS

Prestressed and reinforced concrete beams and other concrete members shall not be erected and landed until the specified 28 day concrete compressive strength for piers or pier and abutment crossheads has been achieved, and not before 14 days after casting. Beams shall not be placed until at least seven days after pedestals have been cast. Where fixed bearings are specified beams shall not be placed until at least four days after fixing the dowels. Beams shall be placed so that anchor dowels at fixed bearings are engaged in the holes provided in the sole plates of beams.

Beams shall be braced to prevent overturning at all stages of construction.

Should a Contractor desire to place slabs using construction equipment operating from a previously placed span of slabs, the written approval of the Superintendent Council shall be obtained.

610.28 CONSTRUCTION OF PEDESTALS

Pedestals with a depth of less than 200 mm shall be constructed using a proprietary single component, self consolidating, and dual compensating (plastic and hardened state) non-shrink cementitious grout or a single component low shrinkage mortar specifically formulated for the construction of pedestals, complying with the minimum compressive strength requirements as specified on the drawings and in this specification. Only whole bags of material shall be used. Test certificates, material data sheets and health and safety data sheets shall be available for all materials. Pedestals shall be cured in accordance with the requirements of clause 610.23.

Proprietary cementitious materials which are specifically formulated and marketed as lightweight concrete repair materials shall not be used for the construction of pedestals.

Three (3) 75 mm test cubes shall be taken from the first batch of material mixed, then three (3) 75 mm cubes for every 100 kg of material used thereafter to test for compressive strength. The cubes shall be cured for seven days under laboratory-controlled conditions. Two (2) cubes shall be tested at seven days and the third cube at 28 days to confirm compliance with the minimum compressive strength requirements as specified on the drawings and in this specification and the material manufacturer's technical data sheet. Test cubes shall be made in rigid steel moulds, cured and tested in accordance with AS 1478.2.

The contact face of the concrete shall be flat and have a surface roughness between an amplitude of 0.5 mm to 1.5 mm, with a surface presenting similar to Grade 40-grit sandpaper.

610.29 PROTECTIVE MEASURES FOR THE CONSTRUCTION OF STRUCTURES IN MARINE AND OTHER SALINE ENVIRONMENTS

Further to the requirements of clause 610.07(g) the following protective measures shall be implemented during the construction period to prevent the ingress of chlorides in the concrete in its early maturing and strength developing period.

(a) Protection Against Ingress of Chlorides

- (i) All reinforcement and embedded metallic fixtures shall be protected against chloride contamination.
- (ii) All reinforcement and construction joints shall be cleaned with water complying with the specification prior to casting the concrete to ensure that salt deposits are removed.

(b) Curing

Further to the requirements of clause 610.23, the period of continuous curing for all cast-in-place concrete shall be not less than 14 days.

Combinations of water adding techniques such as ponding or continuous sprinkling, or by continuous application of mist spray, retention of formwork in place and polyethylene plastic (in combination with wet hessian) shall be used to provide effective curing to the exposed surfaces of concrete of the various cast-in-place members.

Curing compounds shall not be used for the construction of structures in marine, brackish and other saline environments.

(c) Extended Protection of Concrete During the Curing Period

Formwork shall be kept in place for the minimum period in accordance with the requirements of clause 610.25 prior to removal. Immediately following the removal of formwork, and for the remainder of the curing period, polyethylene sheet in combination with wet hessian shall be used to protect the surfaces of concrete being cured against ingress of chlorides from salt water or sea spray.

(d) Electrical Continuity of the Steel Reinforcement

Steel reinforcement shall be made electrically continuous in all substructure concrete members, including piles, to allow for future application of a cathodic protection system if required.

(e) Application of Protective Coatings

The following protective coatings shall be applied in accordance with Section 686.

- (i) Concrete surfaces extending between 0.5 m below the low water level and 0.5 m above the high water level

An epoxy protective coating shall be applied to all exposed surfaces of concrete extending between 0.5 m below the low water level and 0.5 m above high water level. The epoxy protective coating shall be grey in colour and shall be a solvent free, high build epoxy system, providing good chemical, abrasion and corrosion resistance, for horizontal and vertical surfaces of concrete or steel. The epoxy coating shall be applied in a minimum of two coats to a dry film thickness of 300 microns.

The epoxy coating shall be a two pack, solvent free epoxy coating with a volume solids content of 100%, and shall exhibit the following chemical resistance characteristics to a range of aggressive chemicals including:

- (1) Sodium hydroxide, Sulphuric acid, Nitric acid and Hydrochloric acid @ 25%;
- (2) Tartaric acid and Acetic acid @ 15%;
- (3) Lactic acid @ 10%; and
- (4) Resistance to saturated salt, saturated citric acid, petrol and kerosene.

The appearance of the finished product has a high priority and the application of the coating system must ensure a uniformity of colour.

- (ii) Concrete surfaces 0.5 m above the high water level

A dual protective coating system consisting of a pore-lining penetrant (i.e. silane, solid silane or silane cream) and two coats of a film-forming decorative/anticarbonation top coat shall be applied to all exposed surfaces of concrete extending from 0.5 m above the high water level including columns, pier and abutment crossheads, all exposed beam surfaces, sides and exposed soffits of deck slabs, parapet units, end posts, fender walls, keeper walls and wingwalls in accordance with the requirements of Section 686.

In addition to the general requirements of clause 686.05(a) and clause 686.05(c)(i) the dual protective coating system shall satisfy the following requirements:

- (1) Silane pore-lining penetrants shall consist of at least 95% active ingredients and shall be applied in two applications and the application rate shall be a minimum 0.30 litres/m² per application. Solid silane or silane cream pore-lining penetrants shall consist of at least 80% active ingredients and shall be applied in one thick application and the application rate shall be a minimum 0.40 litres/m².
- (2) The film-forming topcoat shall satisfy the requirements of clause 686.05(b) for decorative / anti-carbonation coatings, except that its dry film thickness shall be at least 200 micron.

(f) Reinforcement Bar Chairs and Spacers for Structures Constructed in Marine and Other Saline Environments

Further to the requirements of clause 610.26 steel reinforcement for structures constructed in marine and other saline environments shall be supported by premium grade extruded fibre concrete bar chairs and spacers manufactured under factory controlled conditions, using non-metallic synthetic fibres.

The premium grade extruded fibre concrete bar chairs and spacers shall comply with the sampling and testing requirements of clause 610.26.

Supports and spacers made of plastic, wood, metal, plastic coated metal and site made concrete or factory produced non extruded fibre concrete shall not be used for structures constructed in marine and other saline environments. Bar chairs and spacers shall be placed sufficiently close together to ensure that the specified cover is maintained before and during concrete placement, compaction and finishing operations, and to prevent any potential deformation, displacement or crushing of the bar chairs and spacers such that deformation of the steel reinforcement is also prevented

(g) Construction Joints in Sea or Brackish Water

Further to the requirements of clause 610.20, unless shown otherwise on the drawings, construction joints in sea or brackish water shall not be located from 1.0 m below minimum low water to 1.5 m above maximum high water tide levels.

(h) Other Concrete Durability Enhancing Measures

Other concrete durability enhancing measures such as controlled permeability formwork (CPF), stainless steel reinforcement, and corrosion inhibiting admixtures, cathodic prevention and glass reinforced concrete permanent formwork shall be as specified in the drawings and specification.

610.30 PROTECTIVE MEASURES FOR CONCRETE STRUCTURES SUBJECT TO SULPHATE AND CHEMICAL ATTACK

Concrete structures subject to sulphate and chemical attack with a pH lower than 5.0, or where highly mobile ground water conditions exist or high exchangeable soil acid conditions prevail the environment shall be assessed as exposure classification U and be subject to special consideration. As a minimum when conditions as stated in this clause prevail, additional protective measures in addition to the requirements of clause 610.07(h) shall include the application of suitable protective coatings in accordance with Section 686 and/or other physical protection subject to approval by the Superintendent Council. Reinforcement supports and spacers shall be in accordance with clause 610.29(f).

610.31 SURFACE FINISH

(a) General

For any particular class of concrete surface finish, the method of construction and the materials used in the concrete and formwork shall remain consistent and shall be such as to comply with the requirements of this specification.

The Contractor shall undertake the works such that the standard of surface finish is not adversely affected by the quality of formwork, the formwork release oil used, the compaction of the concrete, and the manner in which the formwork is removed. The higher the standard of surface finish required the greater care shall be taken to satisfactorily address these factors.

Formwork release oils or lubricants used to prevent adhesion of the freshly placed concrete onto the formwork shall be of the non-staining type and shall not discolour the surface of the concrete. The release oil or lubricant shall be applied uniformly in a thin film and any surplus removed prior to the concrete placement.

The concrete shall be effectively placed and compacted in accordance with the requirements of clause 610.18 to avoid the entrapment of bubbles and formation of blowholes, surface imperfections and other defects in the surface of formed concrete. The surface finish of formed concrete shall be of a uniform colour and texture.

Formwork shall not be removed until the concrete has the required strength to resist any formwork suction forces in accordance with the requirements of clause 610.25.

The use of mortar topping will not be permitted.

(b) Types of Surface Finishes

The following surface finishes are specified:

- * Class 1
- * Class 2
- * Class 3
- * sandblast
- * rope
- * tooled and bush hammered
- * exposed aggregate
- * scabbled
- * broomed
- * off-form.

(c) Cast In Situ Concrete Surfaces

Except where other surface finishes are specified on the drawings, surface finishes Class 1, Class 2 and Class 3 shall be used as follows:

(i) Substructure

The back of abutments, culverts and wingwalls shall have a Class 1 surface finish. All exposed surfaces of abutments, wingwalls and piers from 300 mm below ground level shall have a Class 2 surface finish, except that in cellular structures the faces of wingwalls and ends of piers or walls only shall have a Class 2 surface finish.

Upper surfaces of concrete bearing pedestals shall have a Class 2 surface finish.

(ii) Superstructure

The underside of deck between beams shall have a Class 1 surface finish. The faces and undersides of the beams, the edges and the underside of the cantilevered deck slab shall have a Class 2 surface finish. The interior and exterior faces of kerbs and the upper surfaces of the kerbs shall have a Class 3 surface finish.

For box girder bridges, the inside surface of box girder webs, floor and deck shall have a Class 1 surface finish. All external surfaces of the box girder and voided slab shall have a Class 2 surface finish.

(iii) Above Deck Surface

All surfaces above the tops of kerbs shall have a Class 3 surface finish. End posts shall have a Class 3 surface finish. Precast parapet units and associated cast-in-place concrete shall have a Class 3 surface finish.

(d) Top Surface of Decks and Approach Slabs

All deck and approach slab surfaces shall have a broomed finish in accordance with clause 610.31(n).

(e) Precast Concrete

Except where other surface finishes are specified on the drawings, surface finishes for precast members shall be as follows:

(i) precast crown units shall have a Class 2 surface finish

(ii) precast parapet units shall have a Class 3 surface finish

(iii) precast piles shall have a Class 1 surface finish

(iv) precast members other than crown units and parapet units shall have a Class 2 surface finish.

(v) the top surface of precast beams shall be finished as for construction joints in accordance with clause 610.20.

(f) Rejection of Surfaces Finishes

Any concrete surface that does not comply with the requirements of this specification shall be subject to the following alternatives:

(i) rejection of the concrete, in which case the concrete shall be demolished and replaced

(ii) acceptance of the defective concrete surface will be withheld subject to remedial measures being carried out in accordance with clause 610.32.

(g) Class 1 Surface Finish

A Class 1 surface finish shall be of a uniform colour and texture and no defects which structurally affect the concrete or reduce the cover to the steel reinforcement will be permitted. All mortar fins shall be tooled away to expose a surface of dense sound concrete. Bolts, wires and other embedments shall be set back to the minimum clear cover specified and the ends filled with shrinkage compensating mortar. Concrete bar chairs and spacers shall comply with the requirements of clauses 610.26 and 610.29(f).

(h) Class 2 Surface Finish

A Class 2 surface finish shall achieve a concrete surface of uniform colour and texture and be free from any major surface defects. The design of the formwork shall be such as to give a deflection under the loads imposed on it of not more than 3 mm between studs or frame supports. The formwork shall be constructed so as to prevent water runoff carrying stains on to previously cast concrete surfaces. The finished concrete surface shall be protected from mortar slurry, physical damage, spillage and water borne staining. Steel shall be protected to prevent rust staining of the concrete surface. No defect which structurally affects the concrete or reduces the cover to the steel reinforcement or other embedded components will be permitted.

(i) Class 3 Surface Finish

A Class 3 surface finish shall achieve a concrete surface of uniform colour and texture and free from surface defects. The design of the formwork shall be such as to give a deflection under the loads imposed on it of not more than the following:

- (i) 1.5 mm between adjacent framing members
- (ii) 3 mm over the vertical face for the full depth of a panel, or height of a lift, whichever is the lesser
- (iii) 3 mm over a 3 m length horizontally.

(j) Sandblast Finish

The following grade of sandblasting shall be applied as shown on the drawings:

- (i) Brush Finish - sandblasting shall remove the surface laitance and expose only the cement matrix. There shall be no projection of the coarse aggregate from the concrete surface.
- (ii) Light Finish - sandblasting shall expose the fine aggregate with occasional exposure of coarse aggregate. Projection of the coarse aggregate shall not exceed 2 mm above the finished concrete surface.
- (iii) Medium Finish - sandblasting shall be such as to expose the coarse aggregate which shall project no more than 4 mm above the finished concrete surface.
- (iv) Heavy Finish - sandblasting shall expose the coarse aggregate so as to provide a rough and uneven finished surface. The maximum projection of the large aggregate shall be 6 mm above the finished concrete surface.

(k) Tooled and Bush Hammered Surface Finish

The types of tooled and/or bush hammered surface finishes are as follows:

- (i) Light Bush Hammering - sufficient only to break the concrete surface to remove surface mortar without fracturing the coarse aggregate. Usually achieved by the use of a combed head roller chisel, or disc bush hammer.
- (ii) Medium Bush Hammering - sufficient to expose the coarse aggregate pattern but without any pitting or spalling of concrete.
- (iii) Heavy Jack Picking - a coarse texture achieved through jack picking the concrete surface. Substantial lumps of concrete are spalled from the concrete surface.

The Contractor shall manufacture suitable test panels for each type of finish to be used prior to placing concrete.

(l) Exposed Aggregate Finish for Unformed Surfaces

The prepared surface shall have an exposed coarse aggregate finish free from loose aggregate and laitance.

(m) Scabbled Finish

Scabbling shall remove all laitance and loose or porous material without leaving excessive depressions. Exposed aggregate shall be firmly embedded in the concrete.

(n) Broomed Finish

The concrete surface shall be broomed in a direction at right angles to the bridge centre line with a stiff-bristled broom not less than 400 mm wide or using a suitable mechanical grooving device to produce a uniformly roughened surface texture with an average depth of not less than 0.9 mm. After texturing the concrete surface shall be cured in accordance with clause 610.23

610.32 REPAIRS TO FORMED SURFACES AND OTHER DEFECTS

The method of repair of minor surface imperfections including porous spots, shallow honeycombing, rough areas and blow holes not conforming to the class of surface finish as specified in clause 610.31, and the method of cementitious patch repair of other concrete defects shall be in accordance with Section 689.

Epoxy materials shall not be used for the patch repair of concrete.

The exposed surface of the repaired area shall have a texture and colour which is uniform with the colour and texture of the surrounding concrete.

610.33 MORTARS AND GROUTS FOR GENERAL APPLICATIONS

Where required for general applications other than those specified elsewhere in this specification, cementitious mortars and grouts shall be shrinkage compensating proprietary products with a consistency appropriate for the required use, and able to be placed and compacted to achieve full encapsulation. Cementitious mortars and grouts shall have a minimum 28 day compressive strength of not less than 40 MPa.

Cementitious grouts shall be as a minimum Type C Class dual shrinkage compensating.

Only whole bags of material shall be used. Test certificates, material data sheets and health and safety data sheets shall be available for all materials. The mortar and grout applications shall be cured in accordance with the requirements of clause 610.23.

Mortars and grouts shall be sampled and tested in accordance with the requirements of clause 610.28.

610.34 MEASUREMENT OF CONCRETE COVER TO REINFORCEMENT

A concrete cover measurement survey of reinforced and precast concrete members shall be undertaken after construction on a representative and randomly selected number of exterior surface areas using a commercially available concrete cover meter in at least one 3 m² test area for every 25 m² or part thereof. A minimum of 10 cover meter measurements shall be undertaken within the test area and the least distance from the reinforcement to the concrete surface recorded to the nearest millimetre.

The Contractor shall maintain records of all cover meter measurements to demonstrate that completed concrete members comply with the specified minimum concrete cover as shown on the drawings and the allowable dimensional tolerances as stated in clause 610.41. **The Contractor shall ensure that the records are available for review by the Superintendent Council.**

Any concrete members which exhibit cover less than the specified minimum shall be identified as a non-conformance and the affected locations marked and mapped.

The Contractor shall undertake an assessment of the low cover concrete to evaluate the influence of the low cover on the durability of the structure and submit a proposed corrective action to rectify the non-conformity for review by the Superintendent Council.

As a minimum, acceptable rectification shall include but not be limited to the application of approved protective treatment(s) in accordance with the requirements of Section 686.

The cover meter shall be supported with a current calibration certificate and shall be capable of detecting the presence of reinforcement and indicating the depth from the concrete surface to the nearest point on the surface of the reinforcement with an accuracy of ± 1 mm at a depth of 25 mm.

610.35 PLACEMENT OF FILL MATERIAL AGAINST CONCRETE

Fill material shall not be placed against concrete within 14 days of casting in accordance with the requirements of clause 204.11 of Section 204.

Proposed placement of fill material against concrete prior to 14 days from casting shall comply with the early application of loading requirements of clause 610.16(l) or maturity testing requirements of clause 610.16(m).

610.36 EARLY LOADING AND TRAFFICKING OF BRIDGE DECKS, DECK OVERLAYS AND APPROACH SLABS

Further to the requirements of clause 610.16 and clause 610.23, bridge decks, deck overlays and approach slabs shall not be loaded or opened to traffic until the concrete is at least 4 days (96 hours) old and not before a minimum compressive strength of 32 MPa after casting has been achieved.

Light plant and equipment operated in a strictly controlled manner may access the bridge deck, concrete deck overlay or approach slab, at least 3 1/2 days (84 hours) after casting, provided the minimum strength of 32 MPa has also been achieved.

Light plant and equipment shall be as follows:

- (a) equipment not exceeding 0.5 tonnes in weight
- (b) maximum axle loads: 5.0 tonnes single, 8.0 tonnes tandem, 9.0 tonnes triaxle
- (c) tracked vehicles: maximum 15 tonnes/m² pressure over the track area, providing the concrete is protected from surface damage.

The early age in situ compressive strength development of concrete shall be determined in accordance with the maturity testing requirements of clause 610.16(m).

The Contractor shall undertake temperature differential monitoring and maximum temperature measurements of concrete and control early age thermal cracking to demonstrate compliance with the requirements of clause 610.22.

Curing shall remain intact and completed in accordance with the requirements of clause 610.23 unless asphalt placement is completed immediately after the minimum 4 day period. Curing shall be supplemented with 2 layers of 8 mm thick closed cell foam or inner double core aluminium foil based thermal blankets.

Additional test cylinders shall be sampled and tested as required in order to demonstrate when the required strength has been achieved.

HP Early loading and trafficking of bridge decks, concrete deck overlays and approach slabs shall not proceed until:

- (i) **the Contractor's early loading and trafficking quality procedure and inspection and test plan(s) have been reviewed by the Superintendent Council**
- (ii) **the evidence that the minimum periods stated in this clause have been satisfied and maturity testing, temperature monitoring and compressive strength test results have been reviewed by the Superintendent Council.**

610.37 CONSTRUCTION OF DECK WIDENING, LONGITUDINAL STITCH POURS, IN-FILL STRIPS AND STAGED CONSTRUCTION OF DECK OVERLAYS UNDER LIVE TRAFFIC

Deck widening may necessitate the use of connecting longitudinal stitch pours or in-fill strips, between the main body of the new deck and the existing deck to provide a monolithic structural connection.

The Contractor shall implement quality procedures and undertake the works in a manner which minimises the effects of traffic induced vibrations, differential deflections and stresses on the new deck widening and in the vicinity of the stitch pour and staged deck overlay, including:

- (a) adverse effects on the bond between the steel reinforcement and the fresh concrete
- (b) development of any voids between the steel reinforcement and fresh concrete
- (c) adverse effects on the mechanical bond at the joint interface
- (d) adverse effects on bonded anchors if they are used in accordance with Section 680
- (e) cracking during the early hardening and strength developing period.

Construction of deck widening, longitudinal stitch pours and in-fill strips and staged construction of deck overlays under live traffic shall be subject to the following conditions:

- (i) Use a high early strength concrete of minimum 50 MPa (VR450/50) to facilitate early strength development.
- (ii) Close adjacent traffic lane to the deck widening, stitch pour or deck overlay and ensure a minimum clearance of 4.5 metres from the edge of the deck widening or stitch to the nearest wheel path. **For narrow roads the minimum clearance and overall configuration details including traffic detours if required shall be subject to approval by the Superintendent Council.**
- (iii) Limit traffic speed to 40 km/h until the concrete in the deck widening or stitch reaches 20 MPa.
- (iv) When 20 MPa is reached the speed limit can be increased to 60 km/hour until the concrete reaches a minimum strength of 32 MPa at which point the lane closure ends and the speed limit can increase to 80km/h.
- (v) Undertake peak particle velocity (PPV) measurements at edge of the deck widening or stitch. The average PPV shall be less than 5 mm/sec and the maximum instantaneous PPV of less than 55 mm/sec for the concrete for the deck widening and stitch pours. PPV measurements shall be made during the period between commencement of concrete placement and when the minimum compressive strength of 32 MPa has been achieved.
- (vi) The early age in situ compressive strength development of concrete shall be determined in accordance with the maturity testing requirements of clause 610.16(m).
- (vii) The Contractor shall undertake temperature differential monitoring and maximum temperature measurements of concrete and control early age thermal cracking to demonstrate compliance with the requirements of clause 610.22.
- (viii) Curing shall remain intact and completed in accordance with the requirements of clause 610.23 unless early trafficking is required in accordance with the requirements of clause 610.36. Curing shall be supplemented with 2 layers of 8 mm thick closed cell foam or inner double core aluminium foil based thermal blankets.
- (ix) Steel reinforcement from the existing deck to only extend into the in-fill strip for overlap with the new steel reinforcement
- (x) Steel reinforcement within the in-fill strip to be effectively tied such that rigid continuity is provided between old and new.
- (xi) If bonded anchors are used to comply with the requirements of Section 680.
- (xii) Sample and test additional test cylinders to demonstrate when the required strength has been achieved.

HP Construction of deck widening, longitudinal stitch pours and in-fill strips and staged construction of deck overlays under live traffic shall not proceed until the Contractor's quality procedure and inspection and test plan(s) have been reviewed by the Superintendent Council.

- HP Lane closures and speed restrictions shall not be removed until PPV measurements, maturity testing, temperature monitoring and compressive strength test results have been reviewed by the Superintendent Council.**

A 1 metre wide waterproofing membrane strip shall be installed over the construction joint formed at the interface with the new deck widening, longitudinal stitch pours and in-fill strips and staged construction of deck overlays in accordance with the requirements of Section 691, prior to the placement of asphalt.

610.38 EFFECTS DUE TO CONSTRUCTION ACTIVITIES AND GROUND VIBRATION ON FRESHLY PLACED CONCRETE

The Contractor shall implement adequate precautions and manage construction activities to prevent the disturbance of formwork or transmit vibrations through to recently cast concrete or projecting steel reinforcement. The Contractor's construction quality procedure and inspection and test plan(s) shall address as a minimum the distance from the source of vibration, the intensity and duration of vibration, and the nature of the medium or underlying soil type through which the vibration is travelling.

610.39 PLACING OUTSIDE DAYLIGHT HOURS

When concrete is placed and finished outside daylight hours or in any other conditions where natural light may be inadequate, the Contractor shall provide adequate lighting for the works including placement, compaction, finishing, curing, sampling and testing, monitoring and inspection.

610.40 SLIPFORMED CONCRETE BARRIERS

Construction of concrete barriers by slipforming shall be subject to approval by the Superintendent Council.

610.41 MINIMUM CONCRETE COVER TO REINFORCEMENT

The minimum concrete cover to steel reinforcement and other steel embedments shall be as shown on the drawings and in accordance with the requirements of clause 4.14.3 of AS 5100.5. The dimensional tolerance of concrete cover shall be 0 to +5 mm as stated in Table 610.471.

The curing of concrete shall be continuous and uninterrupted in accordance with clause 610.23 to ensure the effectiveness of the minimum concrete cover.

The minimum concrete cover for concrete members cast in standard formwork and compacted with standard compaction as defined in clause 610.03 shall be in accordance with the requirements of Table 4.14.3.2 of AS 5100.5.

Where lower minimum concrete cover is specified for concrete members cast in rigid steel formwork with intense compaction in accordance with Table 4.14.3.3 of AS 5100.5, the intense compaction shall consist of both external form vibrators and internal vibrators as defined in clause 610.03. A high level of supervision shall be employed to ensure that the required level of intense compaction is achieved and the rigidity of formwork is maintained during concrete placement.

Where curing compounds are used, the concrete cover shall be increased by 5 mm for classifications A and B1 and by 10 mm for other classifications in accordance with the requirements of Table 4.14.3.2 and Table 4.14.3.3 of AS 5100.5.

610.42 COVER AND SPACING REQUIRED FOR CONCRETE PLACEMENT

The minimum cover required for concrete placement and the minimum allowable steel reinforcement spacing within a concrete member shall not be less than 1.5 times the maximum size of aggregate in the concrete mix or the reinforcement bar diameter, whichever is the larger, unless greater concrete placement requirements apply as per AS 5100.5, to ensure that the concrete can be satisfactorily placed, flow and compacted around the steel reinforcement.

Continuous bar chairs shall provide a minimum gap between the formwork and the underside of the bar chair voids of 1.5 times the maximum nominal size aggregate in the concrete mix.

The maximum aggregate size shall ensure that effective consolidation and aggregate interlock is achieved within a dense concrete microstructure without voids and honeycombs which can adversely affect the durability and the in situ strength of concrete.

Steel reinforcement shall be placed such that adequate gaps exist for the insertion of poker vibrators and concrete can flow around the steel reinforcement. Congestion created by a large number of closely placed parallel bars with little or no separation shall not be allowed. Where bundled bars are used as part of design to overcome steel reinforcement congestion, they shall be limited to four in any one bundle with no more than two bars in one plane and shall be tied together in contact and be enclosed within stirrups or ties. Bundles of bars may consist in groups of two, three or four longitudinal bars to act as a unit.

610.43 PROVISIONS FOR STRAY CURRENT CORROSION

The effects of possible stray current corrosion shall be considered as required where bridges and concrete structures are adjacent to or carry electrified rail and tramways, especially where they are powered by direct current, concrete structures located in the vicinity of high voltage power lines and where impressed current cathodic protection is installed.

610.44 STEEL FIBRE REINFORCED CONCRETE

Where required steel fibre reinforced concrete shall be as specified in the drawings and specification and shall comply with the requirements of AS 5100.5.

Fibre reinforced sprayed concrete shall comply with the requirements of Section 684.

610.45 FIRE RESISTANCE OF CONCRETE

Where required fire resistance of concrete shall be as specified in the drawings and specification and shall comply with the requirements of AS 5100.5.

610.46 DRILLING OF HOLES IN CONCRETE MEMBERS

Holes shall not be drilled in concrete members unless approved by the Superintendent Council.

Drilling of holes in concrete members shall be located as shown on the drawings, as specified in this specification or as approved by the Superintendent Council. Holes may be drilled with carbide-tipped rotary hammer or diamond-tipped core drill.

Holes shall be drilled to the required length and diameter and be positioned to avoid damage to steel reinforcement and pre-stressing tendons or to services.

Prior to drilling of holes, reinforcing bars, pre-stressing tendons and cables and services that lie within the depth of the drill hole shall be accurately located by reference to as-constructed drawings.

The actual position of bars and tendons shall then be located by use of a recently calibrated concrete cover meter or ground penetrating radar (GPR), operated by a competent person. If reinforcement is encountered during drilling, drilling shall cease immediately and hole location shall be adjusted locally to avoid reinforcement.

Where drilling of holes is undertaken by coring the required depth shall be controlled by use of a positive stop device fitted to the coring machine or a depth measurement mark placed on the core barrel.

Drilling of holes into concrete members shall be undertaken under the direction of a qualified Contractor's representative and for the purposes of surveillance, the Contractor shall give the Superintendent Council a minimum of two (2) days written notice of its intention to drill holes into concrete members.

Drilling of holes shall not cause spalling, cracking, or other damage to the existing concrete, the steel reinforcement or other steel embedments. Any damage to the concrete member including the steel reinforcement shall be repaired to the satisfaction of ~~the Superintendent~~ Council.

Where existing steel reinforcement is encountered during the drilling operation, and holes have been relocated, the uncompleted holes shall be cleaned and repaired with a shrinkage compensating polymer modified cementitious repair material in accordance with the requirements of Section 689. The exposed surface of the repaired hole shall be similar in texture and colour to the surrounding concrete.

HP The drilling procedure and drill locations shall be submitted for approval by the Superintendent Council.

The Contractor shall maintain records of all hole drilling activities and immediately notify ~~the Superintendent~~ Council where the concrete member or steel reinforcement has been damaged. **Contractor shall ensure that all records are available for review by the Superintendent Council.**

610.47 DIMENSIONAL TOLERANCES

(a) General

The dimensional tolerances listed in Tables 610.471, 610.472, 610.473 and 610.474 are the allowable deviations of the completed concrete member from the dimensions shown on the drawings. These dimensional tolerances will be a basis for acceptance of the work.

The Contractor shall maintain records of dimensional measurements to demonstrate that all completed concrete members comply with the allowable dimensional tolerances as stated in this clause. **The Contractor shall ensure that the records are available for review by the Superintendent Council.**

Fitments and embedments shall be located with sufficient accuracy to prevent any misfit or misalignment between mating components.

(b) Soffits

The soffits of arches, box girders, beams and deck edges shall be continuous curves or straight lines as shown on the drawings, free from all visible irregularities.

(c) Slipformed Concrete Kerbs and Barriers

Cast in situ slipformed concrete kerbs and barriers and cast in situ off-structure concrete barriers shall comply with the tolerance requirements for precast concrete units as stated in Table 610.474. In addition, the vertical and horizontal alignment between adjacent segments shall not exceed 5 mm.

Table 610.471 General Tolerances

Item	Tolerance (mm)
Placing of reinforcement	5
Placing of post-tensioning sheathing	5
Concrete cover	0 to +5

Table 610.472 Cast In Situ Concrete

Item	Tolerance (mm unless shown otherwise)
(i) Footings * Plan dimensions - Formed footings and pile caps - Unformed footings (when approved by the Superintendent Council) * Thickness - < 300 mm - > 300 mm * Top of footing or pile cap reduced level * Departure from the plan position in any direction	-15 to +50 0 to +150 -5 to +25 -10 to +50 -25 to +25 50
(ii) Cylinders * Variation from the vertical * Departure from the plan position in any direction	25 mm in 3 m 75
(iii) Variation in Cross Section of Columns, Piers, Pier and Abutment Crossheads, Slabs, Walls, Beams and Similar Parts (excluding deck slabs and end posts) * < 3 m * > 3 m	-5 to +15 -10 to +25
(iv) Variation of Cross Section of End Posts	-5 to +5
(v) Deck Thickness of Deck Slabs (excluding allowance for correction of camber or hog) Deck surface reduced level	0 to +10 -10 to +10
(vi) Deck Joints * Width of slot	-3 to +3
(vii) Variation from Vertical or Specified Batter of Columns, Piers, Walls, Handrail Posts and Arises * Unexposed concrete * Exposed concrete	10 mm in 2.5 m (1/250) 5 mm in 2.5 m (1/500)
(viii) Variation from Grades Indicated on Drawings for Railings, Kerbs and Arises	2.5 mm in 2.5 m (1/1000)
(ix) Reduced Level of Tops of Pier and Abutment Crossheads and Piers * With pedestals * Without pedestals * Difference in Level across width of crosshead	-10 to +10 -5 to +5 5
(x) Bearing Pedestals * Reduced level * Variation from grade across the width of individual pedestals shall not exceed * Deviation from flat surface	-2.5 to +2.5 1 in 200 +1.0 to -1.0
(xi) Departure from Plan Position at any level * Columns, Piers, Walls, Pier and Abutment Crossheads, Beams, Slabs, Kerbs, Railing and other similar parts * Relative displacement of adjoining members shall not exceed	25 10
(xii) Departure from Alignment * Rows of columns, faces of piers or walls * Handrails, Faces of hand rail posts, Kerbs	10 5
(xiii) Maximum Allowance for Irregularities in Exposed Concrete Surfaces * Sections less than 1 m in dimension when measured with a straightedge across the dimension of the section * Sections greater than 1 m in dimension when measured with a straightedge across the dimension of the section, except that when sections are greater than 2.5 m in dimension, a 2.5 m straightedge shall be used	2.5 5
(xiv) Irregularities in Railings	2.5 mm in 2.5 m
(xv) Slab Surface Finish	5 mm in 2.5 m

Table 610.473 Pre-tensioned Concrete

Item	Tolerance (mm unless shown otherwise)
(i) Cross Section * Dimension - < 2 m - > 2 m * Out of square - > 2 m	-3 to +3 -6 to +6 0.5 in 250, or Desirable 3, Maximum 5
(ii) Strand and Reinforcement * Placing of reinforcement * Placing of prestressing strand * Concrete cover	5 3 0 to +5
(iii) Squareness of Ends * Dimension - < 500 mm * - > 500 mm	Deviation from a plane perpendicular to the longitudinal axis of a member, or from the specified end plane: 3 mm 6 mm per metre (10 mm maximum)
(iv) Length * Diagonal length for precast unit * Overall length or length centre to centre of bearings (for beams and slabs) * Centre to centre spacing of holes for transverse rods or both	5 0.06% x specified length (max 20) 5
(v) Profile in a Vertical Plane (Hog)	The deviation in hog of any unit from the mean hog of all units shall not vary by more than 0.07% of the length of the units. The absolute value for hog for any unit shall not be less than zero. Hog measurements shall be made at transfer of prestress.
(vi) Profile in a Horizontal Plane (Bow)	The deviation of a unit from the required profile shall not exceed 0.06% of the length of the unit or a maximum of 15 mm.
(vii) Twist	The angular rotation of any cross section relative to an end cross section shall not exceed 1 in 200.
(viii) Sole Plates	The plane of the sole plate or bearing surface shall not vary from that shown on the drawings by more than 1 in 200 in any direction.
(ix) Deviation * The distance of any point from a flat plane held against that surface.	3 mm in 2 m

Table 610.474 Precast Concrete Units

Item	Tolerance (mm)
(i) General * Placing of reinforcement * Placing of sheathings for post-tensioned segmental members * Concrete cover	5 5 0 to +5
(ii) Cross Section * Dimension - < 2 m - > 2 m * Out of square	0 to +3 0 to +6 Maximum 5
(iii) Squareness of Ends * Dimension - < 500 mm * - > 500 mm	Deviation from a plane perpendicular to the longitudinal axis of a member, or from the specified end plane: 3 mm 6 mm per metre (10 mm maximum) For parapet units and new jersey barriers, the deviation from a plane perpendicular to the longitudinal axis shall not exceed 3 mm.
(iv) Length * Diagonal length for precast unit * Overall length or length centre to centre of bearings (for beams and slabs) * Centre to centre spacing of holes for transverse rods or bolts * Overall length for parapets and new jersey barriers	5 0.06% x specified length (max 20) 5 3
(v) Profile in a Vertical Plane (Camber)	The deviation of a unit from the design camber, after allowance has been made for the deflection due to the mass of the member, shall not exceed 0.10% of the length of the unit with a maximum of 6 mm. Measurement of camber shall be made at the mid-point of the member which shall be supported at the bearing positions.
(vi) Profile in a Horizontal Plane (Bow)	The deviation of a unit from the required profile shall not exceed 6 mm or 0.10% of the length of the unit, whichever is the greater. Bow in precast parapet and new jersey barriers shall not exceed 3 mm.

SECTION 611 - STEEL REINFORCEMENT

~~##This section cross references Section 175. Section 175 must be included in the specification.:~~

611.01 GENERAL

This section covers the supply, handling and placing of steel reinforcing materials for concrete. Two types of reinforcing material are covered:

- (a) carbon steel reinforcement, as described in AS/NZS 4671
- (b) stainless steel reinforcement, as described in BS 6744.

611.02 STANDARDS

Australian Standards and other documents are referenced as stated in this clause.

Section 175 details the relevant references to these documents.

Reference	Title
(a) Australian Standards	
AS 1391	Metallic materials - Tensile testing at ambient temperature
AS 2062	Non-destructive testing - Penetrant testing of products and components
AS 2205.5.1	Methods for destructive testing of welds in metal - Macro metallographic test for cross-section examination
AS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS 5100	Bridge Design Set
AS 5100.5	Bridge Design – Part 5 - Concrete
AS/NZS 1554.1	Structural steel welding – Part 1 - Welding of steel structures
AS/NZS 1554.3	Structural steel welding – Part 3 - Welding of reinforcing steel
AS/NZS 1554.6	Structural steel welding – Part 6 - Welding stainless steels for structural purposes
AS/NZS 4671	Steel reinforcing materials
(b) Other Documents	
BS 6744	Stainless steel bars - Reinforcement of concrete - Requirements and test methods (2016)
EN 10088.1	Stainless Steels – List of Stainless Steels
VicRoads Bridge Technical Note – BTN 025	AS 5100 Part 5
VicRoads Technical Bulletin TB46	Guide to Surveillance of Structural Steelwork

611.03 GRADES OF STEEL REINFORCEMENT

Grades of steel reinforcement used shall comply with the following requirements.

- (a) Carbon Steel Reinforcing Material

Unless otherwise shown on the drawings, steel for reinforcing bars shall be Grade 500N, complying with the requirements of AS/NZS 4671. Steel for welded steel reinforcing mesh shall be Grade 500L, complying with the requirements of AS/NZS 4671.

(b) Stainless Steel Reinforcement

Where the use of stainless steel reinforcement is indicated on the drawings, stainless steel reinforcement shall consist of ribbed (deformed) bars or coil, deformed wire or welded mesh complying with the requirements of BS 6744 Grade 500. The chemical composition of stainless steel reinforcement shall conform to one of designations 1.4301, 1.4162, 1.4429, 1.4436 or 1.4462 to BS EN 10088.1 (as identified by BS 6744). Wire used to tie stainless steel shall conform to one of the designations 1.4301, 1.4162, 1.4429, 1.4436 or 1.4462 to BS EN 10088.1 (as identified by BS 6744).

611.04 STEEL REINFORCEMENT SUPPLY

The Contractor shall be responsible for the preparation of the steel reinforcement schedule for all steel reinforcement required for the Contract Works.

The Contractor shall make appropriate allowances when preparing the steel reinforcement schedule to achieve the specified tolerances on member dimensions, concrete cover and location of steel reinforcement and any post-tensioning sheathing or other fitments, taking into account the practical variations in the tolerances noted and other margins normally applied by steel reinforcement suppliers.

Steel reinforcement shall be supplied cut to length and bent to shape, as detailed on the drawings.

The surface condition of reinforcement shall be such as to not impair its bond to the concrete or its performance in the member.

Steel reinforcement shall not be coated unless specified, in which case the nature and type of the coating to be used and the conditions of application shall be separately specified. When carbon steel reinforcement is specified on the drawings to be hot-dip galvanised, the hot-dip galvanising shall be in accordance with AS 4680. Use of epoxy coated steel reinforcement shall not be permitted.

Stainless steel reinforcement shall be supplied, handled and stored separately from other steels. Tools used for cutting, bending and transport of stainless steel reinforcement shall not have been used for other materials.

611.05 CERTIFICATION AND TESTING

(a) Third Party Certification

Manufacturers and suppliers of steel reinforcement materials must be in possession of a current certificate of approval, issued by the Australian Certification Authority for Reinforcing Steel (ACRS), (<http://www.acrs.net.au/> or <http://steelcertification.com/>). Evidence of compliance with this clause shall be submitted to the Superintendent Council within 14 days prior to the commencement of Works. ~~of award of the Contract.~~

(b) No Third Party Certification

HP

Approval shall be obtained in writing from the Superintendent Council for the use of steel reinforcing materials that are not covered by the long-term quality level of AS/NZS 4671 at least 14 days prior to the intended first date of use of such steel. Steel reinforcing materials that are not covered by the long-term quality level of AS/NZS 4671 shall not be ordered or placed in the works without approval. The Contractor shall nominate the members in which the reinforcing steel is to be used and the country and mill of origin and the specification to which the steel is produced, and clearly demonstrate how it is equivalent to that specified by AS/NZS 4671.

Where use of steel reinforcement is not covered by the long-term quality level of AS/NZS 4671, testing shall be carried out in accordance with Clause B7 of AS/NZS 4671, including the frequency of sampling and testing, and to the appropriate Australian Standard, as listed in AS/NZS 4671.

Where the certification of the steel is incomplete, the Contractor shall arrange for testing to be carried out, as required in Clause 611.05(c), to demonstrate compliance of the material, at the rate of one test per 1000 lineal metres of material.

(c) Test Certificates and Laboratory Accreditation

Laboratories that perform tests required by this section shall meet the requirements of AS ISO/IEC 17025. All test reports shall be endorsed in accordance with the AS ISO/IEC 17025 accreditation for that laboratory. Testing laboratories shall comply with the resource requirements for competent testing personnel and appropriate supervision as required by AS ISO/IEC 17025. (Test reports may be called test certificates.)

NOTE: Accreditation bodies which are signatories to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) for testing laboratories can offer accreditation against the requirements of AS ISO/IEC 17025. A listing of ILAC signatories is available from the ILAC website (www.ilac.org). In Australia, the National Association of Testing Authorities (NATA, <https://www.nata.com.au>) is a signatory to the ILAC MRA.

The appropriate logo or further details of the ILAC (MRA) signatory shall be noted on the test document, and all reporting requirements of the test method and material standard shall be included. All test reports shall be in English alphanumeric characters.

611.06 BENDING

Bending or re-bending of steel reinforcement shall be done in accordance with the requirements of AS 5100.5, CI 17.4.3, and be read in conjunction with VicRoads Bridge Technical Note BTN 025 AS 5100 Part 5, CI 2.2.

Steel reinforcement shall not be bent or straightened in a manner that will cause damage to the steel. Steel with kinks or bends not shown on the drawings or in the steel reinforcement schedule shall not be used.

Heating of Grade 500N steel reinforcement to a maximum of 450°C is permitted under controlled workshop conditions, subject to methods in accordance with the manufacturer's recommendations, provided:

- (a) the steel is heated uniformly through and beyond the portion to be bent
- (b) the temperature of the steel does not exceed 450°C
- (c) the bar is not cooled by quenching.

Hot bending of stainless steel reinforcement shall not be permitted.

Tools used for bending stainless steel reinforcement shall not have been used for fabricating other materials. Pins used in the bending of stainless steel shall be made from stainless steel.

611.07 RE-BENDING ON SITE

On-site heating of steel reinforcement will not be permitted.

Re-bending of steel reinforcement shall be by an approved means. Steel reinforcement that has been bent and subsequently straightened shall not be bent again within 20 bar diameters of the previous bend. Minimum internal diameter of re-bend bars shall be in accordance with AS 5100.5, CI 17.4.3.

HP—Re-bending of steel reinforcement shall not commence until the procedure has been reviewed and approved by the Superintendent Council, and shall be witnessed by the Superintendent Council's representative.

611.08 IDENTIFICATION

Steel reinforcement and welded steel reinforcing mesh shall be bundled and tagged with a label identifying the bar reference number.

611.09 HANDLING, STORAGE AND SURFACE CONDITION

Steel reinforcement that has been damaged in any way shall not be incorporated into or used in the works.

Steel reinforcement shall be stored in conditions that minimise or prevent the formation of surface rust.

Steel reinforcement shall be kept free from rust, oil, grease, tar, paint, mud or any other deleterious substance which may reduce bond between the steel reinforcement and concrete.

The presence of mill scale or surface rust shall not be cause for rejection of reinforcement.

Steel reinforcement that has the surface pitted by corrosion, where the loss of cross-section is greater than the tolerance on mass per metre of bar (4.5%), shall not be used in the works.

Stainless steel reinforcement shall be supplied, handled and stored separately from other steels. Stainless steel reinforcement shall be stored so that it is not contaminated by debris from processing operations, grease, oil, iron or other steels.

611.10 PLACING

All steel reinforcement shall be securely held during placing and compacting of the concrete. Steel reinforcement supports shall be made of durable materials strong enough to withstand the imposed loads without movement of the steel reinforcement, shall be positively attached to the steel reinforcement, and of such size as to maintain the specified cover.

Wooden supports, metal supports and plastic-coated metal supports which extend to the surface of the concrete shall not be used. Placing bars on layers of fresh concrete as the work progresses and adjusting bars during the placing of concrete will not be permitted.

The specified minimum concrete cover shall be maintained at tie-wire positions.

The Contractor shall ensure that the method of placement of stainless steel reinforcement does not allow it to become contaminated by contact with other steel. In particular, welding or cutting of black steel reinforcement or any other structural steel shall not occur after any stainless steel has been placed.

Stainless steel embedment items shall be fixed in place by tying with stainless steel wire of the same grade, or by anchoring to the forms using stainless steel fixings of the same grade.

611.11 SPLICING

Steel reinforcement shall be supplied in the full lengths shown on the drawings. Alternatively, and where directed by the Superintendent Council, the Contractor shall splice the bars by lapping. In lapped splices, the reinforcements shall be placed in contact and the specified cover shall be maintained. The lap shall be long enough to develop the full strength of the reinforcement and unless shown on the drawings shall be not less than the tensile or compressive development length determined in accordance with AS 5100.5, CI 13.1.

Splicing of steel reinforcement shall be in accordance with AS 5100.5, CI 13.1.

611.12 PROJECTING STEEL REINFORCEMENT

Where shown on the drawings, projecting steel reinforcement shall be provided for the purpose of splicing to the adjacent sections of reinforced concrete. Care shall be taken to avoid damage to the projecting steel reinforcements after they have been set and any damage to the bars or their setting shall be repaired by the Contractor. Projecting steel reinforcement in newly poured concrete shall remain undisturbed for a minimum period of 24 hours following the completion of placing concrete in order to avoid damage to the concrete surrounding the reinforcements.

611.13 TACK WELDING

(a) Carbon Steel Reinforcement

Tack welding of steel reinforcement will be permitted for Grade 250N and Grade 500N carbon steel reinforcement bars provided welding is not within 50 mm of the tangent point of a bend in the steel.

All tack welding shall comply with the requirements of AS/NZS 1554.3. In cases where the application of AS/NZS 1554.3 indicates that welding procedure testing is required for tack welding, the tack welding procedure shall be qualified in accordance with Appendix C of AS/NZS 1554.3.

(b) Stainless Steel Reinforcement

Tack welding of stainless steel reinforcement is not recommended.

611.14 WELDED SPLICES IN CARBON STEEL REINFORCEMENT**(a) General**

Welding of carbon steel reinforcement shall be in accordance with AS/NZS 1554.3.

Steel reinforcement shall be spliced by welding only at the locations shown on the drawings.

The steel reinforcement projecting from the ends of beams shall be spliced as shown on the drawings.

Pairs of bars with misalignments less than 8 mm may be realigned prior to welding. Splices for pairs of bars with misalignments greater than 8 mm shall be packed prior to welding.

Care shall be taken during welding to avoid excessive heating of the reinforcing bar.

The earth lead shall be attached to the steelwork being welded at all times to prevent leakage of currents.

(b) Welding Procedure Qualification**HP**

Welding of splices in steel reinforcement, including to other steelwork and to continuity bar reinforcement, shall not commence until the welding procedure has been qualified and reviewed by the Superintendent Council.

The qualification process shall be in accordance with AS/NZS 1554.3 and with the following additional requirements:

- (i) production of a weld test plate, witnessed by either a Structural Steelwork Surveillance Officer, accredited to VicRoads Technical Bulletin TB46, or the Contractor's Welding Supervisor
- (ii) submission to the Superintendent Council of test certificates demonstrating compliance of the procedure with AS/NZS 1554.3 including a photograph of the weld section, prepared and etched to AS 2205.5.1, at a magnification of x1 or greater.

The welding procedure shall provide a weld with the specified throat thickness, free from inclusions and imperfections, and with satisfactory fusion and surface appearance.

(c) Inspection and Quality of Welds**(i) Direct Butt Splices**

The Contractor shall carry out non-destructive inspection processes at a frequency sufficient to ensure that welding of direct butt weld splices complies with the specified requirements but shall not be less than that shown in Table 611.141.

Table 611.141 Inspection and Quality of Direct Butt Splice Welds

Inspection process	Minimum extent of inspection (% of welds, as no.)	Detail of inspection of direct butt splice welds	Quality requirements
Visual inspection	100	Each full weld circumference	AS/NZS 1554.3, Table 6.2
Non-destructive internal inspection by Radiography	First two inspection lots		
	20	with a minimum of 12 bars inspected per lot, and at least 6 of these 12 bars to be examined at two directions, at least 60 degrees apart	AS/NZS 1554.1, Table 6.2.1
	Subsequent inspection lots after first two		
	10	If more than one weld in an inspection lot does not comply with the quality requirements, revert to extent of inspection as for the first two inspection lots	AS/NZS 1554.1, Table 6.2.1
Non-destructive surface inspection by Magnetic particle, or Liquid penetrant	5	Each full weld circumference	AS/NZS 1554.3, Table 6.2

(ii) All other welds

Inspection of the welding of steel reinforcement shall be in accordance with AS/NZS 1554.3.

The quality of welds shall conform to AS/NZS 1554.3, and any imperfections shall be assessed in accordance with AS/NZS 1554.3, Table 6.2.

611.15 WELDING STAINLESS STEEL REINFORCEMENT

(a) General

Welding of stainless steel reinforcement shall be in accordance with AS/NZS 1554.3 and AS/NZS 1554.6.

Stainless steel reinforcement shall be welded only in a welding workshop specifically set up for the purpose. Such facility shall maintain conditions preventing any contamination of the stainless steel and consumables used in the proper performance of the welding for the full duration of the Contract Works. All consumables shall be stored, conditioned and handled in accordance with the manufacturer's recommendations.

HP Prior to the commencement of works, the Contractor shall submit to the Superintendent Council the results of an independent assessment that the purpose-specific welding shop has been established.

Reports of re-assessment shall be submitted to the Superintendent Council at 3 month intervals until welding and fabrication works are completed.

Welding procedures and consumables shall comply with the bar manufacturer's recommendations. Weld preparations shall be clean and free of any contamination prior to welding.

(b) Welding Procedure Qualification

HP Welding of splices in stainless steel reinforcement, including to other steelwork and to continuity bar reinforcement, shall not commence until the welding procedure has been qualified and reviewed by the Superintendent Council.

The qualification process shall be in accordance with AS/NZS 1554.3 and AS/NZS 1554.6 and with the following additional requirements:

- (i) production of a weld test plate, witnessed either a Structural Steelwork Surveillance Officer, accredited to VicRoads Technical Bulletin TB46, or the Contractor's Welding Supervisor; and
- (ii) submission to the Superintendent Council of –
 - test certificates demonstrating compliance of the procedure with AS/NZS 1554.3 and AS/NZS 1554.6, including a photograph of the weld section, prepared and etched to AS 2205.5.1, at a magnification of x1 or greater, and
 - test certificates demonstrating that the weld procedure does not result in the loss of ductility and corrosion resistance as specified in sub-paragraph (e) below.

(c) Inspection and Quality of Welds

Welds shall be examined by liquid penetrant methods, to AS 2062, at a frequency of 5% of the welds manufactured.

Inspection of the welding of stainless steel reinforcement shall be in accordance with AS/NZS 1554.6. The quality of welds shall conform to Category 1B to AS/NZS 1554.6, Table 6.1, and any imperfections shall be assessed in accordance with AS 1554.6, Table 6.3.2.

All arc strikes shall be treated as welds, and inspected 100% by liquid penetrant methods, to AS 2062, and shall be assessed in accordance with AS 1554.6, Table 6.3.2.

(d) Cleaning of Welds

Unless otherwise specified, any welds in stainless steel reinforcement covered by concrete shall be acceptable as surface condition III, after removal of slag or wire brushing to AS/NZS 1554.6, Table 6.2.1. Any pickling compounds used shall be chloride free.

(e) Corrosion Resistance of Welds

When specified, welds on stainless steel reinforcement shall be tested for corrosion resistance against pitting and inter-granular corrosion in accordance with AS/NZS 1554.6, Appendix E. Corrosion resistance testing shall be carried out on test specimens sampled from the weld procedure qualification tests and on three product samples, each prepared and tested at equally spaced quantity intervals during the works.

611.16 MECHANICAL SPLICES

If mechanical splices are proposed or required in the drawings, the Contractor shall submit full details of tests that demonstrate compliance of the proposed mechanical splice with the requirements of VicRoads Bridge Technical Note BTN 025 AS 5100 Part 5 to the Superintendent Council. The tests shall be conducted in accordance with the appropriate Australian Standard, for example AS 1391, in a laboratory accredited as required by CI 611.05(c).

Details of the type and location of mechanical splices together with the supporting test data shall be submitted to the Superintendent Council not less than 14 days before their proposed use in the works. Mechanical splices shall not be incorporated in the works until the Superintendent Council has accepted their proposed use.

Mechanical splices for stainless steel reinforcement shall be manufactured from stainless steel that conforms to one of the designations 1.4301, 1.4162, 1.4429, 1.4436 or 1.4462 to BS EN 10088 (as identified by BS 6744).

611.17 CONTACT BETWEEN DISSIMILAR METALS EMBEDDED IN CONCRETE

Contact between carbon steel and galvanised steel reinforcement or carbon steel and stainless steel reinforcement or other similar metal embedments shall not be allowed.

Where contact between such dissimilar metals embedded in concrete is unavoidable, the two different metals shall be electrically isolated to prevent galvanic or bimetallic corrosion.

Electrical isolation may be effected by using PVC conduit sleeves, suitable soft plastic wrapping or tapes or by other approved means.

Steel reinforcement and other metal embedment items shall only be fixed in place with tie wire made of the same metal and same grade.

SECTION 614 - FORMWORK

~~##This section cross references Sections 175, 610 and 689.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

614.01 GENERAL

This section specifies the requirements for the design and construction of formwork required to produce the finished concrete to the shape, lines and dimensions shown on the drawings, and in accordance with the finishes and tolerances specified in Section 610.

614.02 STANDARDS

(a) Australian Standards

Australian Standards are referenced in an abbreviated form (e.g. AS 3610).

AS 1366	Rigid cellular plastics sheets for thermal insulation - Rigid cellular polystyrene – Moulded (RC/PS - M)
AS/NZS 1594	Hot-rolled steel flat products
AS 2271	Plywood and Blockboard for Exterior Use
AS 3610	Formwork for Concrete
AS 5100	Bridge Design Set

(b) Additional Documents

Occupational Health and Safety Act 2004

Occupational Health and Safety Regulations 2017

Section 175 details the relevant references to these documents.

614.03 DEFINITIONS

Formwork: A temporary structural system comprising the form that contacts the concrete, and includes the supporting members, bracing and other fixtures used to give the required shape, lines and dimensions and to support the freshly placed concrete while it is setting and gaining sufficient strength to be self supporting.

Void Former: Prefabricated or solid light weight material, including associated anchorages and fixtures for the purpose of forming circular or irregular shaped voids in concrete components.

614.04 FORMWORK DESIGN

Formwork shall conform to the requirements of AS 3610 and the additional requirements of this section.

Formwork shall be rigid, watertight, braced and tied together to confine freshly placed concrete and maintain position and shape during construction, and shall be constructed in such a way that it can be removed without damage to the concrete. Where formwork is to be re-used, the formwork design shall allow for the deterioration of materials through use and handling.

The submission of formwork documentation and certification for the various concrete members shall be in accordance with the requirements of Table 614.041, and Attachments A, B and C to this section.

Table 614.041

Concrete members	Formwork documentation	Certification of formwork design	Proof Engineering of formwork design	Certification of erected formwork
(a) Abutments, pilecaps, footings, solid piers, pier columns and walls, with heights less than or equal to 2.0 metres	N/A	N/A	N/A	Contractor's Engineer (Attachment C, as per Clause 614.08)
(b) Abutments, pilecaps, footings, solid piers, pier columns and walls, with heights greater than 2.0 metres	Design drawings and specifications	Design Engineer	Proof Engineer (Attachment A, as per this clause)	Contractor's Engineer and Design Engineer (Attachment B, as per Clause 614.08)
(c) All other concrete members				
(d) Any member for which self-compacting concrete is proposed				

Where formwork requires design and the production of design drawings and specifications as stated in Table 614.041, the Contractor shall submit to the Superintendent Council for review its detailed drawings and specifications of the proposed formwork not less than two weeks prior to the commencement of formwork construction.

The formwork design shall be certified as stated in Table 614.041 by a Design Engineer who is a member of Engineers Australia and with a minimum of 5 years experience in the design and construction of formwork of similar complexity. The formwork design shall be verified in accordance with the Contract to confirm that design satisfies the performance requirements of the formwork.

The formwork design shall also be proof engineered as stated in Table 614.041 by a Proof Engineer, who is independent of the design consultant's firm and is prequalified at Level PE under the VicRoads' prequalification scheme.

HP The Proof Engineering Certificate of Compliance shall be forwarded to the Superintendent Council at least two days prior to the construction of any formwork. The Proof Engineering Certificate of Compliance shall be in accordance with the form included as Attachment A to this section.

Any amendment to the design after the issue of the Proof Engineering Certificate of Compliance shall be referred to the Proof Engineer for review and written confirmation that the Certificate of Compliance remains valid.

The formwork drawings shall include all details of formwork, formwork joints, sealing procedures, ties, size and spacing of framing and details of any proprietary fittings or systems proposed to be used. Where vibration is to be applied externally, the design of formwork shall include details of external vibrators to ensure efficient compaction and to avoid surface blemishes. The requirements of the Occupational Health and Safety Regulations 2017 shall be satisfied with respect to all formwork.

614.05 FORMWORK MATERIALS

The formwork surface material for exposed concrete surfaces shall be steel plate conforming to AS/NZS 1594 or plywood conforming to AS/NZS 2271, unless otherwise shown on the drawings.

The type and condition of formwork sheeting and lining, and the ability of the formwork and its supports to withstand distortion caused by the placement, lateral pressure and compaction of the fresh concrete, and the standard of workmanship used in the formwork construction shall be such that a uniform concrete surface texture is produced, and the finished surfaces of the concrete will conform to the requirements of the specifications and drawings.

All formwork panels shall be placed in a neat, symmetrical pattern such that the exposed panel joints do not detract from the geometry or from the final appearance of the structure. The proposed soffit and side formwork panel arrangements shall be detailed on the formwork drawings.

Formwork panels shall be supplied in the maximum practicable width and length to minimise the number of joints. Plywood panels shall be placed with the grain of the outer plies in the direction of the span.

614.06 FORMWORK CONSTRUCTION

Formwork shall be constructed and shall be of sufficient stiffness to tolerate the rate of concrete placement and high frequency vibration, and shall be of uniform stiffness to avoid causing varying vibration amplitudes over the formwork surfaces during compaction of the concrete. The constructed formwork shall be solidly braced and tight and maintain correct position and shape and achieve the specified dimensions, levels, cover to steel reinforcement and geometry of the finished structural component in accordance with the tolerance requirements of Section 610.

The use of wires or bolts extended to the surface of the concrete will not be permitted. Any embedded ties shall remain embedded and shall terminate not less than the minimum clear cover specified on the drawings. All recesses shall be filled with a shrinkage compensating cementitious mortar in accordance with Section 689.

Errors in line or level of the formwork, or positioning and/or quantity of steel reinforcement shall be corrected prior to placing concrete. The Contractor will be responsible for any defects to the formwork, reinforcement, embedded components, or the formed concrete surface, which may become apparent during or after casting the concrete.

Formwork shall not be placed in locations where steel reinforcement and other fixtures cannot be inspected, until evidence that the reinforcement and other fixtures conform to the requirements of the specifications and the drawings has been obtained and recorded by the Contractor.

All corners of cast-in-place or precast concrete shall have 20 mm x 20 mm chamfers or fillets. Chamfers and fillets shall be formed and cast integrally with the concrete member. Cutting or grinding of chamfers shall not be allowed.

The interior surface of formwork shall be thoroughly cleaned out and treated with form oil or lubricant to prevent adhesion of the exposed concrete surface, in accordance with the manufacturer's instructions. The form oil or lubricant shall be of the non-staining type and shall not discolour the surface of the concrete. The oil or lubricant shall be applied uniformly in a thin film and any surplus removed prior the concrete placement. Reinforcement and other embedments shall not be soiled by the form oil or lubricant.

Prior to commencement of the concreting operations all tie wire ends, wood chips and other debris shall be removed from the forms.

Formwork shall be sufficiently tight at joints to prevent loss of slurry or mortar while the concrete is in its freshly placed state, consistent with the method of placement and compaction. Formwork shall also be mortar tight where holes are needed to facilitate projecting reinforcement or fixing devices.

All relevant requirements of the Occupational Health and Safety Act 2004 and Occupational Health and Safety Regulations 2017 shall be satisfied with respect to all formwork.

614.07 VOID FORMERS

(a) General

Formers used for the purpose of forming voids in concrete components shall be as follows:

- (i) prefabricated formers, including associated end caps and anchorages, for circular voids;
- (ii) solid formers made of lightweight material, including associated anchorages, for voids with irregular shapes.

(b) Void Former Details

The Contractor shall submit the void former details for review by the Superintendent Council not less than 4 weeks prior to the placement of concrete. Concrete shall not be placed until the void former details have been reviewed by the Superintendent Council.

The void former details shall include the following:

- (i) a full technical description of the proposed void former, including documented evidence of previous use and performance;
- (ii) the material type;
- (iii) the method of construction and installation;
- (iv) the type and spacing of anchors and supports to hold down the void former;
- (v) the maximum pressure head and maximum height differential between the two sides of the void former which shall be consistent with the most adverse conditions that may exist during the concreting operations.

(c) Certificates of Compliance of Materials and Components

The Contractor shall submit for review by the Superintendent Council not less than 4 weeks prior to the proposed use of materials and components, a signed statement including relevant test reports demonstrating the compliance of the materials and components with the requirements of Clause 614.07(d).

The Contractor shall also submit for review by the Superintendent Council not less than 4 weeks prior to the proposed use of materials and components, computations carried out and certified by a design engineer confirming the ability of anchors and supports to securely restrain the void former in position during and after the concreting operations and confirm compliance with this section. The design engineer shall be experienced and qualified in structural design, with a minimum of five years experience in the design and construction of formwork and shall be verified in accordance with the requirements of Section 160.

(d) Materials

The void formers shall be made watertight to prevent ingress of concrete slurry and sufficiently strong and tough to withstand handling, transport, storage and installation and the placing and compaction of the concrete without suffering damage or deformation. Void formers and associated fixtures shall remain dimensionally stable and retain their physical properties under normal conditions of use, shall be resistant to fire, shall not cause staining or discolouration and shall not alter physically or chemically by contact with concrete slurry or moisture.

As a minimum solid formers shall be rigid cellular expanded polystyrene complying with Class S as stated in AS 1366.3.

(e) Fabrication

Void formers shall be fabricated such that after the concreting operations they maintain correct position and shape and achieve the specified dimensions, levels and geometry of the finished structural component in accordance with the specified tolerance requirements.

Any stiffening ribs of prefabricated void formers shall project inwards to ensure a smooth outer surface profile and seams shall be watertight, recessed to present a smooth outer surface and mechanically overlapped when fabricated from spirally-wound strip material. Joints to any fixtures shall be sealed and watertight.

Void formers and associated fixtures shall not be dented, cracked, spalled or porous, exhibiting signs of corrosion or are otherwise damaged in any way prior to installation, to prevent local instability of the void former under pressure from the wet concrete.

Void formers shall be fabricated to the following tolerances:

- (i) outside dimension/diameter to within ± 3 mm (for cylindrical formers diameters measured at right angles);
- (ii) overall length, with required fixtures in place to within + 0 to – 20 mm;
- (iii) diagonal dimensions for solid void formers to within ± 3 mm;
- (iv) for horizontal bow the deviation of the void former from the required profile shall not exceed 0.06% of the length of the void former or a maximum of 8 mm.

(f) Installation

The void former shall be securely restrained in position during and after the concreting operations. Large uplift forces acting as a result of the buoyancy effect and any lateral pressure due to concrete placement shall be resisted by external means and not by securing the void former to the steel reinforcement.

Joints between void former segments shall be watertight.

The tolerance on final position of the void former at any location shall be within ± 7 mm.

614.08 CERTIFICATION OF FORMWORK

Further to the requirements of Clause 614.04 and parts (b), (c) and (d) of Table 614.041, the Contractor shall arrange for the design engineer who certified the formwork drawings to carry out an on site inspection and any other activities necessary to certify that the erection of the formwork has been completed in accordance with the certified design drawings.

The Contractor shall submit to ~~the Superintendent~~ Council a Certificate of Compliance – Formwork Inspection for the constructed formwork signed by the Contractor and the Design Engineer responsible for the certification of the formwork drawings, and shall be in the form shown in Attachment B to this section.

Further to the requirements of Clause 614.04 and part (a) of Table 614.041, the Contractor's Engineer responsible for designing, supervising and certifying the erection of the formwork shall be a member of Engineers Australia who is experienced in the design and construction of formwork of similar complexity. As part of the certification, the Contractor's Engineer shall carry out an onsite inspection and any other activities necessary, to certify in accordance with the form included as Attachment C to this section, that the erection of the formwork has been completed in accordance with the specified requirements.

The relevant Certificate of Compliance – Formwork Inspection for the constructed formwork shall be submitted to ~~the Superintendent~~ Council not less than two days prior to the application of any load.

HP The application of any load shall not proceed until the signed Certificate of Compliance - Formwork Inspection of the constructed formwork has been reviewed and accepted by the Superintendent Council.

614.09 REMOVAL OF FORMWORK

The period of time before formwork and formwork supports can be removed shall be in accordance with the minimum formwork removal times and requirements as specified in Section 610.

Formwork shall be so constructed as to allow for its undisturbed dismantling and removal from the cast concrete without shock or damage. Shock or damage to the cast concrete shall also be prevented when removing formwork in the vicinity of projecting reinforcement or fixing devices.

All formwork shall be removed on completion.

All relevant requirements of the Occupational Health and Safety Act 2004 and Occupational Health and Safety Regulations 2017 shall be satisfied with respect to removal of all formwork.

ATTACHMENT A TO SECTION 614

PROOF ENGINEERING CERTIFICATE OF COMPLIANCE

(Form to be used by the Proof Engineer at intermediate stages and final completion of design and construction)

For concrete members as stated in parts (b), (c) and (d) of Table 614.041

I **certify that I have:**

- (1) undertaken an independent engineering review in relation to the design represented by the drawings and specifications provided by the Contractor as listed in the attached schedule;
- (2) carried out a detailed check of individual structural elements and the structure as a whole including the specified material properties;
~~##(3), (4) and/or (5) below if these aspects are not included in the specified scope of proof engineering):~~
 ##:(3) reviewed the Site Conditions Information Report in accordance with AS5100 – Bridge Design, the appropriate foundation investigation, the recommended design values, material properties and possible failure mechanisms;
- ##:(4) reviewed the hydrologic and hydraulic design parameters including design flood discharges and levels, stream velocities and afflux as well as evaluation of potential for and protection against scour and bank erosion;
- ##:(5) reviewed the proposed construction procedure and the aspects of temporary works critical for structural integrity and safety.

In performing the function of Proof Engineer I have used due skill, care and diligence and from my review and in my opinion as a professional engineer I consider that:

- A. all relevant design actions and design criteria are covered by the design and that these actions and criteria and overall concept meet the requirements of the Principal's Project Requirements;
- B. the strength, stability and serviceability and other Limit State requirements as defined in the Principal's Project Requirements are met; and
- C. the construction drawings and specifications accurately describe the following matters critical to the structural integrity –
~~##(3), (4) and/or (5) below if these aspects are not included in the specified scope of proof engineering)~~
 : (a) the detailing and dimensions,
 (b) the required material properties, and
 (c) the construction procedure and temporary works.

Signed

Name (please print)

On behalf of **(Company)**

Date

ATTACHMENT B TO SECTION 614

CERTIFICATE OF COMPLIANCE – FORMWORK INSPECTION

For concrete members as stated in parts (b), (c) and (d) of Table 614.041

CONTRACTOR’S ENGINEER

I....., the undersigned
(Please print person’s name)

am responsible for supervising the construction of formwork detailed on the following listed final drawings and specifications certified by the Proof Engineer. Using due skill, care and diligence, I have reviewed the relevant geometric surveys and test reports and made inspections during the construction of the formwork and certify that the completed formwork complies with the certified drawings and specifications.

Signed

On behalf of (Company)

Date

DESIGN ENGINEER

I....., the undersigned
(Please print person’s name)

am responsible for the design of formwork detailed on the following listed drawings and specifications certified by the Proof Engineer. Using due skill, care and diligence, I have made an inspection of the completed formwork and certify that it complies with the certified drawings and specifications.

Signed


On behalf of (Company)

Date

Contractor to Schedule all Drawings and Specifications of formwork certified by the Proof Engineer, applicable to this joint Certificate of Compliance.

.....
.....
.....
.....
.....

For concrete members as stated in part (a) of Table 614.041



SECTION 619 - MANUFACTURE, TESTING AND DELIVERY OF PRECAST REINFORCED CONCRETE BOX CULVERTS

~~##This section cross-references Sections 610, 611 and 801.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

619.01 GENERAL

The supply of materials, manufacture, testing, handling and delivery of precast reinforced concrete box culverts up to 1200 mm in width shall be in accordance with the requirements of AS 1597.1 and this section.

619.02 STANDARDS

Australian Standards are referenced in an abbreviated form (e.g. AS 1379).

AS 1012	Methods of testing concrete
AS 1379	Specification and supply of concrete
AS 1478	Chemical admixtures for concrete, mortar and grout
AS 1597.1	Precast reinforced concrete box culverts - Small culverts
AS 2193	Calibration and classification of force-measuring systems
AS 2758.1	Aggregates and rock for engineering purposes - Concrete aggregates
AS 3582	Supplementary cementitious materials for use with portland and blended cement concrete
AS 3582.1	Part 1 : Fly ash
AS 3582.2	Part 2 : Slag - Ground granulated iron blast furnace
AS 3582.3	Part 3 : Amorphous silica
AS 3610	Formwork for concrete
AS 3799	Liquid membrane-forming curing compounds for concrete
AS 3972	General purpose and blended cements
AS 5100	Bridge Design

619.03 DEFINITIONS

Definitions of concrete related terms shall be as described in Section 610.

619.04 TYPES OF BOX CULVERTS

The types of culvert covered by this specification are as designated in AS 1597.1, Clause 1.5:

- (a) 'U' shape consisting of invert and lid.
- (b) Inverted 'U' shape consisting of crown and base.

Note: Where the word unit appears in this specification, it is deemed to mean a complete box culvert as described above.

619.05 STANDARD DIMENSIONS AND LENGTHS

Unless otherwise specified or shown on the drawings box culvert dimensions shall comply with the requirements of Table 2.5 of AS 1597.1 and the standard nominal length of box culverts shall be as follows:

- (a) where imperial moulds remain in use, 1.22 m and 2.44 m;
- (b) where metric moulds are in use, 1.20 m and 2.4 m.

All references to 1.22 m and 2.44 m units shall equally apply to 1.2 m and 2.4 m units and vice versa.

619.06 DIMENSIONAL TOLERANCES**(a) Internal and External Dimensions**

The actual internal dimensions of a unit shall not differ from the manufacturer's designated dimensions by more than ± 5 mm.

(b) Thickness

The actual thickness of a unit shall not differ from the specified thickness by more than - 3 to + 5 mm.

(c) Length

The actual length of a unit shall not differ from the manufacturer's designated length by more than ± 10 mm.

(d) Straightness

When the inner surface of a unit is tested by means of a 1 m long straight edge, the deviation from straightness at any point shall not exceed 5 mm.

(e) Ends**(i) Squareness**

The end faces shall not depart from planes at right angles to the sides and base by more than 5 mm or 1/200 of the height or width, whichever is the greater.

(ii) Straightness

The end faces shall not depart at any point from a straight edge held against them by more than 5 mm.

(f) Section**(i) Squareness**

The external cross-section anywhere in the length of the unit shall at no point depart from a true rectangle by more than 5 mm or 1/200 of the height or width, whichever is the greater.

(ii) Straightness

When the surfaces of a unit are tested by means of a straight edge, the deviation from straightness at any point shall not exceed 5 mm for a 1.22 m unit or 5 mm for a 2.44 m unit.

The Contractor shall undertake a check for compliance with dimensional tolerances as stated in this clause at the frequency of one unit for every ten units manufactured of each size class of box culvert units.

619.07 DURABILITY REQUIREMENTS

Box culverts shall be designed for a minimum exposure classification of B1 in accordance with AS 5100.5 and AS 1597.1. Box culverts used in saltwater applications shall be designed for exposure classification C1 or C2 as specified in accordance with AS 5100.5 and AS 1597.1. The minimum concrete strength grade and concrete cover to the steel reinforcement shall be as shown in Table 619.071.

Table 619.071

Exposure Classification	Minimum Cover to Steel Reinforcement (mm), for Characteristic Strength (f'c) at 28 days		
	40 MPa	50 MPa	≥55 MPa
B1	35	30	30
B2	50	40	40
C1	Not Applicable	65	65
C2	Not Applicable	Not Applicable	75

619.08 MATERIALS**(a) Concrete General**

Concrete used for the manufacture of precast reinforced concrete box culverts shall comply with the requirements of AS 1379. The concrete shall consist of a mixture of cementitious material, fine aggregate, coarse aggregate and water. **The concrete may also contain chemical admixtures, details of which shall be submitted for review by the Superintendent Council.** In its finished state concrete shall be sound and dense and durable and free from honeycombing and shall have the strength and other properties specified.

(b) Cementitious Material**(i) Cement**

Cement shall comply with the requirements of AS 3972. Cement per batch of concrete shall be from one manufacturer and of one brand, type and grind. Cement more than three months old shall not be used in the Works unless it is re-tested to demonstrate compliance with the requirements of AS 3972.

(ii) Fly Ash, GGBF Slag and Amorphous Silica

Fly Ash, GGBF Slag and Amorphous Silica shall comply with the requirements of AS 3582.1, AS 3582.2 and AS 3582.3 respectively and shall be from one manufacturer and of one brand, type and fineness.

(iii) Minimum Portland Cement Content

The minimum mass of portland cement in concrete mixes containing GGBF Slag, Fly Ash or Amorphous Silica shall be 60%, 75% or 90% respectively, of the total mass of cementitious material in the concrete mix. The inclusion of GGBF Slag, Fly Ash or Amorphous Silica in concrete mixes shall only be in single or double combination with portland cement. In a triple blend concrete mix, the portland cement content shall be a minimum of 60% and the individual contribution of GGBF Slag, Fly Ash or Amorphous Silica shall be a maximum of 40%, 25% or 10% respectively, of the total mass of the cementitious material in the concrete mix.

(iv) Cementitious Type and Content for Saltwater Applications and Exposure Classification C1 and C2

Box culverts used in saltwater applications or exposure classification C1 and C2 shall be manufactured with concrete containing at least 20% fly ash and 7% to 10% silica fume as a replacement of portland cement, or at least 30% fly ash as a replacement of portland cement.

(c) Chemical Admixtures

Chemical admixtures when used shall comply with the requirements of AS 1478. They shall be used in accordance with the requirements of Clause 2.5 of AS 1379 and the manufacturer's recommended method of use and shall not reduce the strength of concrete below that specified. Chemical admixtures shall be accurately measured by means of dispensers which are subject to regular maintenance and are calibrated as a minimum at three monthly intervals. Chemical admixtures shall not contain calcium chloride, calcium formate, chlorine, sulphur, sulphides or sulphites.

(d) Aggregates

Source rock shall comply with the requirements of Section 801 - Source Rock for the Production of Crushed Rock and Aggregates. Fine and coarse aggregate for concrete shall comply with the requirements of AS 2758.1 unless otherwise specified in Table 619.081.

Table 619.081

Property	Relevant Standard and Clauses	Test Limits for Product Acceptance
General Requirements		
1. Particle density	AS 2758 1-7.1	Greater than 2100 kg/m ³
2. Bulk density	AS 2758 1-7.2	Greater than 1200 kg/m ³
3. Water absorption	AS 2758 1-7.3	Less than 2.5% for Coarse Less than 1.5% for Fine
Dimensions		
1. Grading	AS 2758 1-8.1 Table 1,2,3	Single-sized aggregate Coarse and fine
2. Material finer than 75 microns	AS 2758 1-8.2	Coarse 2% max., Fine 5% max.
3. Particle shape	AS 2758 1-8.3	10% max. at 3:1 ratio for misshapen, flat and elongated
Durability		
1. Los Angeles Value	AS 1141.23	35% maximum
2. Unsound Stone Content	AS 1141.30	Unsound stone content: 5% max. Total of unsound stone and marginal stone: 10% max.
Impurities		
1. Organic impurities	AS 2758 1-14.1	Not darker than the Standard Reference Colour No. 3
2. Sugar	AS 2758 1-14.2	Less than 1 part in 10,000
3. Alkali-Aggregate Reactivity	610.11(c)	Limits as per 610.11(c)
4. Soluble salts (% to cementitious material mass)	610.07(k)	5.0% max. Sulphate salts (concrete cured at ambient temperature) 4.0% max. Sulphate salts (steam-cured concrete) 0.15% max. Chloride salts

(e) Water

The quality of mixing water to be used in the concrete mix shall comply with the requirements of Clause 610.09.

(f) Steel Reinforcement

Steel reinforcement used in the manufacture of precast reinforced concrete box culverts shall comply with Section 611.

619.09 PLACING AND COMPACTING CONCRETE

Concrete shall be deposited in horizontal layers in a manner to avoid segregation and displacement of the steel reinforcement or other embedded items or formwork.

The compaction of concrete shall be carried out by using external vibrators to achieve the desired level of compaction.

Immersion vibrators of adequate size, number and frequency shall only be used as back-up when external vibrators fail. Care shall be taken to ensure that no steel reinforcement or embedded items are displaced by vibration.

619.10 CURING, STRIPPING AND REMOVAL FROM FORMWORK

Concrete shall be cured using one or a combination of methods described in this clause.

The concrete shall be protected from moisture loss until commencement of curing, which shall continue until the concrete reaches the age or the maturity, whichever is the lesser, and the compressive strength is as shown in Table 619.101. The concrete compressive strength for checking the adequacy of curing shall be determined by test cylinders cured with and in the same manner as the concrete unit.

The unit shall not be completely stripped from all forms or handled off the base forms until the compressive strength reaches 15 MPa. Curing shall be carried out to meet the requirements of Table 619.101 and where curing is interrupted by more than 30 minutes the unit shall be protected from moisture loss.

Table 619.101

Exposure Classification	Minimum Characteristic concrete compressive strength (f'c) at 28 Days (MPa)	Required concrete compressive strength at completion of accelerated curing MPa	Required minimum concrete age (days) and minimum maturity (°C hrs) at completion of curing					
			Moist		Membrane		Accelerated	
			Age Days	Maturity °C hrs	Age Days	Maturity °C hrs	Age Days	Maturity °C hrs
B1	40	25	7	3864	7	3864	0.25	420
	50	32						
B2	40	25	7	3864	7	3864	0.25	420
	50	32						
C1	50	32	7	3864	Not permitted		0.25	550
C2	≥55	35	7	3864	Not permitted		0.25	550

Notes:

- For concrete exposure classification U, curing shall be as specified on the drawings and in this specification.
- The required concrete compressive strengths at completion of curing are based on Table 4.4.1(A) of AS 5100.5, i.e. compressive strength at completion of curing = 0.625 f'c.
- Maturity (°C hrs) for moist and membrane curing is calculated by adopting the minimum days x 24 x 23°C. Minimum days are based on Table 4.4 of AS 3600.
- Maturity (°C hrs) for accelerated curing is calculated by adopting the minimum days x 24 x 70°C.

Where moist curing is used concrete shall be kept continuously moist and the concrete maintained at a temperature above 5°C and all surfaces of the culvert must remain fully saturated.

Membrane curing in the form of curing compounds may be used in accordance with Table 619.101 for exposure classifications B1 and B2 in lieu of moist curing. Curing compounds shall be applied to all exposed concrete surfaces to manufacturer's specifications. The concrete shall be maintained at a temperature above 5°C. Curing compounds shall comply with the requirements of AS 3799.

Accelerated curing shall be carried out by low pressure steam curing in accordance with Appendix C of AS 1597.1.

619.11 SAMPLING AND TESTING FOR COMPRESSIVE STRENGTH

A sample consisting of a minimum of four concrete compression cylinders shall be taken at not greater than ten hours of continuous manufacture of culvert units and tested for strength. The concrete compression cylinders shall be made in accordance with AS 1012.1 and AS 1012.8 and subsequently tested in accordance with AS 1012.9. The minimum compressive strength requirements for each strength grade shall be in accordance with Clause 619.10 and as shown in Table 619.101.

Curing of concrete compression cylinders shall be carried out in accordance with AS 1012.8. Concrete compression cylinders shall be cured initially with the product. As soon as practicable after a period of 18 hours from moulding, the test cylinders shall be placed under standard moist curing conditions. The time between moulding and entry into standard moist curing conditions shall not exceed 36 hours.

619.12 CONCRETE COVER TO STEEL REINFORCEMENT

The tolerance on concrete cover shall be 0 to +5 mm.

For normal service conditions spacers or bar chairs used to maintain cover to the steel reinforcement shall be made of plastic or steel, provided the box culvert is manufactured using rigid formwork and intense vibration.

Where box culverts are to be placed in saltwater applications, stainless steel spacers or plastic bar chairs shall be used.

The concrete cover to the steel reinforcement shall be measured with a calibrated cover meter to ensure compliance with the requirements of Clause 619.07. The Contractor shall select one unit for concrete cover measurements from each 100 units of a batch or a maximum period of 3 months production. The cover meter device shall be capable of detecting the presence of reinforcement and indicating the depth from the concrete surface to the nearest point on the surface of the reinforcement with an accuracy of ± 1 mm at a depth of 25 mm.

619.13 PROVISION FOR LIFTING AND HANDLING OF UNITS

Units shall be handled in a manner which will avoid damage to them and shall be lifted using the lifting points provided.

Where units are lifted in the legs-up position, a lifting beam shall be used in order to avoid inducing excessive bending moments.

Precast units shall not be handled before the concrete has reached compressive strength of 15 MPa and stored in a manner such that their:

- (a) serviceability is not impaired;
- (b) shape is not distorted to affect installation alignment; and
- (c) surface and edge finishes are not unduly damaged.

Provision shall be made for lifting and handling the precast units. Where lifting inserts are provided, they shall be installed in accordance with the lifting inserts supplier's recommendations. All provisions for lifting shall comply with the requirements of the appropriate regulatory authority.

619.14 WORKMANSHIP AND FINISH

All units shall be free from fractures, cracks and from any other defects.

(a) Surface Condition

The interior and exterior surfaces of the units shall be smooth and dense and free from voids, chipped edges, fins, protrusions, surface roughness and other defects.

Blowhole defects 6 mm diameter and 3 mm deep will be accepted provided that there are no more than 5 defects in an area 300 mm square, or an equivalent area of larger or smaller diameter holes providing they are not more than 3 mm deep.

Units with defects greater than this allowance shall be rejected.

Units shall not be coated with cement wash or any other preparation.

(b) Dents, Bulges and Defects

Dents not exceeding 3 mm deep, and bulges not exceeding 3 mm high, shall be accepted provided they do not extend over the surface for a distance greater than twice the wall thickness of the unit, and provided that the minimum cover is maintained.

Dents shall be repaired by the Contractor if necessary to maintain the minimum cover.

Units shall be free from fractures and cracks wider than 0.15 mm and residual test cracks wider than 0.08 mm in accordance with the requirements of Clause 619.17 and Appendix E of AS 1597.1.

619.15 IDENTIFICATION OF UNITS

All units shall be clearly stencilled by the Contractor with indelible ink on the interior surface of each unit prior to inspection. Lids shall be stencilled on the underside and base slabs on the top side.

Information required on each unit shall be as follows:

- (a) nominal dimensions
- (b) date of manufacture and identification number
- (c) name of the manufacturer and/or its registered trade mark
- (d) locality of the supplying factory
- (e) maximum mass of the unit
- (f) number of the relevant Australian Standard, i.e. AS 1597.1.

619.16 TESTING AT THE MANUFACTURERS WORKS

A batch is defined as a maximum of 50 number units of the same size and manufactured and cured at the same works within two calendar months.

Units supplied from more than one source, or manufactured outside of a two month period, then those units shall be deemed to be more than one batch and the requirements of the specification shall apply to each separate batch.

619.17 PROOF LOAD TEST

From each 25 units of a batch, the Contractor shall select one unit as defined in Clause 619.04 for proof-load testing in accordance with AS 1597.1. The two test units shall represent the first sample for the batch.

For batches of less than 25 units, a sample of one unit shall be selected by the Contractor for proof-load testing.

Every selected unit not more than 1.22 metres long shall sustain a vertical force of 112 kN without developing a test crack as defined in Note 1, and on removal of the load, no crack caused by the load shall be greater than that defined in Note 2 below as a residual test crack.

For batches greater than 25 units, if:

- (a) in the first sample two non-conforming units are found, then reject the batch; or
- (b) one unit in the first sample is non-conforming, select a second random sample of two units, one unit from each 25 units of the same batch, and subject them to the same crack load test in accordance with AS 1597.1. If any unit in the second sample fails, then reject the batch. If no units in the second sample fail, accept the batch.

For batches of less than 25 units, should the sample test unit fail to comply then select a random second sample of one additional unit from the same batch and subject it to the same crack load test in accordance with AS 1597.1. If the unit in the second sample fails, reject the batch. If no non-conforming unit is found in the second sample, accept the batch.

Note 1: A test crack is defined as one into which the point of a test crack measuring gauge conforming to the details given in Figure E1 of AS 1597.1 may be inserted to a depth of 2 mm over a length of at least 300 mm at intervals not exceeding 50 mm.

Note 2: A residual test crack is defined as one into which the point of a residual test crack measuring gauge conforming to the details given in Figure E1 of AS 1597.1 may be inserted to a depth of 2 mm over a length of at least 300 mm at intervals not exceeding 50 mm.

619.18 ULTIMATE LOAD TEST

From each 25 units of a batch, the Contractor shall select one unit as defined in Clause 619.04 for ultimate-load testing in accordance with AS 1597.1. The two test units shall represent the first sample for the batch.

For batches of less than 25 units, a sample of one unit shall be selected by the Contractor for ultimate-load testing.

Every selected unit not more than 1.22 metres long shall sustain a vertical force of 202 kN.

For batches greater than 25 units, if:

- (a) in the first sample two non-conforming units are found then reject the batch; or
- (b) one unit in the first sample fails to comply, select a second random sample of two units, one unit from each 25 units of the same batch, and subject them to the same ultimate load test in accordance with AS 1597.1. If any unit in the second sample fails, then reject the batch. If no units in the second sample fail, accept the batch.

For batches of less than 25 units, should the sample test unit fail to comply with the requirements of this clause then select a random second sample of one additional unit from the same batch and subject it to the same ultimate load test in accordance with AS 1597.1. If the unit in the second sample fails, reject the batch. If no non-conforming unit is found in the second sample, accept the batch.

619.19 LOAD TESTING OF 2.44 METRE UNITS

For unit sections of 2.44 m, the loads specified for proof and ultimate test shall be applied over each 1.22 m end of the culvert either separately or at both ends simultaneously.

When the unit is loaded at both ends simultaneously, the specified load for proof and ultimate shall be doubled.

619.20 CALIBRATION OF TESTING MACHINE

The testing machine used for load testing shall meet the requirements of AS 2193 Class B and shall be calibrated in accordance with the terms of laboratory accreditation for the specific testing machine type. A jack and pressure gauge system may be used provided that calibration is carried out at not more than six monthly intervals.

619.21 TRANSPORT AND STORAGE**(a) Transporting**

Units shall not be transported from the precast yard within seven days after casting and the curing has been completed in accordance with Clause 619.10.

Units shall be supported on timber bearers which are fitted with rubber strips on top. Rubber strips shall also be placed between units, both laterally and longitudinally. All tie down straps and chains shall have rubber protection strips over box culvert edges. The legs of all box culverts shall be adequately braced to prevent whipping and bending. The precast invert base slabs and lids to be transported shall be loaded in the laid position.

(b) Stacking

- (i) Inverts or crowns shall be stored in separate stacks of identical units up to a maximum height of 2 metres or two units high separated by timber packers.
- (ii) Lids or base slabs shall be stored in separate stacks of identical units up to a maximum height of six units separated by timber packers.

(c) Final Visual Inspection of Units upon Delivery to Site

The Contractor shall undertake a final visual inspection of units upon transport and delivery to site and the findings of such inspection shall form part of the acceptance requirements of Clause 619.22.

619.22 ACCEPTANCE

Box culverts shall be accepted on the basis of full compliance with the requirements of this section and AS 1597.1.

Documentation supporting the following quality requirements shall be submitted for review by the Superintendent Council upon transport and delivery of units to site:

- (a) visual inspection
- (b) dimensional measurements
- (c) measurements of clear cover to steel reinforcement
- (d) concrete compressive strength test results
- (e) proof load test results
- (f) ultimate load test results.

SECTION 620 - PRECAST CONCRETE UNITS

~~##This section cross references Sections 610, 611 and 614.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

620.01 GENERAL

This section covers the manufacture, storage, handling and delivery of precast concrete units.

Concrete for these units shall be in accordance with Section 610 'Structural Concrete' and reinforcement shall be in accordance with Section 611 'Steel Reinforcement'.

620.02 FORMS

Forms shall be manufactured from steel, except where otherwise approved by the Superintendent Council.

The formwork shall be constructed so as to produce the finished concrete to the shape, lines and dimensions shown on the drawings, and in accordance with the surface finish and tolerances specified in Section 610 'Structural Concrete'.

Void formers shall be securely restrained in position vertically against the action of placing concrete and subsequent flotation under vibration. The void former shall likewise be laterally restrained against forces arising from differential pressures during placing of concrete. Void formers shall comply with the requirements of Section 614.

The use of wires or bolts extended to the surface of the concrete will not be permitted except where shown on the drawings. Any embedded ties shall remain embedded and shall terminate not less than the specified concrete cover. All recesses shall be filled in accordance with the surface finish provisions of Section 610.

620.03 REMOVAL OF UNITS FROM FORMS

Individual precast units with mass of five tonnes or less shall have a minimum concrete compressive strength of 10 MPa for removal of units from forms. For individual precast units of mass greater than five tonnes, the minimum concrete compressive strength shall be 20 MPa for removal of units from forms.

Lifting of precast units at a minimum concrete compressive strength other than that specified in this clause shall be supported with structural calculations and maturity testing for estimating the in situ strength of concrete in accordance with the requirements of Clause 610.16(l). The structural calculations shall be certified by an Engineer who has qualifications admitting to Corporate Membership of the Institution of Engineers, Australia, with a minimum of five years experience in structural design.

620.04 PROJECTING REINFORCEMENT

Where shown on the drawings, steel reinforcement shall be left projecting for the purpose of bonding on subsequent work. Care shall be taken to avoid disturbing the bars during the specified period for curing of the concrete. Projecting reinforcement which has been damaged or dislodged or which is loose in the concrete will be cause for rejecting of the units.

Continuity bars shall be positioned within 3 mm of the positions shown on the drawings. The relative deviation of any two bars cross sections, taken at right angles to the longitudinal centreline of the unit over the projecting length of bar, shall be within 3 mm.

620.05 SOLE PLATES AND BEARING RETAINERS

Material for sole plates and bearing retainers shall be of structural grade steel complying with the requirements of AS 3678. All surfaces and edges of sole plates shall be finished smooth and bearing surfaces shall have a maximum out of flatness of 0.4 mm unless otherwise specified on the drawings. Prior to galvanizing, the surface finish on edges shall be equivalent to a Class 1 flame cut surface as specified by the Australian Welding Research Association. Welding shall comply with the requirements of AS/NZS 1554, Part 1.

Unless otherwise specified, steel sole plates shall be galvanized in accordance with the requirements of AS/NZS 4680. The minimum mass of zinc coating shall be 0.6 kg/m² of surface.

Sole plates shall be set to the required grades shown on the drawings, or as specified by the Superintendent Council. They shall be arranged so that the bearing surfaces are at right angles to the vertical axis of the unit.

620.06 MARKING

The identification number, date of casting, the manufacturer's name or registered mark and the maximum mass shall be marked on every precast unit.

Temporary identification shall be made on the top surface of the unit near an end, except for parapet units. Final marking shall be made by indelible marking material, using letters approximately 40 mm high.

For parapet units, temporary identification shall be made on the broomed surface of the parapet as shown on the drawings. Final markings shall be made on one end of each unit.

Piles shall be marked and numbered at 500 mm increments starting from the toe with an indelible marking material.

620.07 HANDLING AND STORAGE

Units shall not be stored in areas subject to flooding.

Units shall not be stored within 10 m of existing or proposed overhead power or telephone lines, or over service conduits, drainage pipes or uncompacted fill.

The units shall be supported on bearers clear of the ground. Bearers shall support the units over their full width and be placed perpendicular to the longitudinal axis of the unit. Unless specified otherwise, bearers shall be placed beneath the specified or approved lifting points clear of any sole plates. The ground or space between the bearers supporting the units shall be carefully cleared and levelled so as to prevent the unit from being supported other than on the bearers. The bearers shall rest on a firm foundation, and adequate precautions shall be taken to prevent subsidence from occurring and to prevent the units bearing other than at the specified support positions.

Any units damaged or distorted in excess of the specified tolerances prior or during installation shall be replaced at the Contractor's expense.

Where the method of handling and supporting is not specified, the Contractor shall submit, for review by the Superintendent Council, details of his proposals 14 days prior to lifting and supporting the units.

Unless otherwise specified, precast units shall be lifted using the lifting points provided and supported with the top surface uppermost at all times. The angle subtended by the slings and the longitudinal axis of the unit shall be not less than 60°.

Beams shall be stored and handled with webs vertical at all times.

All beams shall be laterally supported. The lateral bracing shall be designed for 10% of the dead load of the beam at the mid height of the beam.

Beams and parapet units shall not be stored in stacks.

Slabs, planks and piles may be stored in separate stacks of identical units up to a maximum height of 2 m, or two units high, whichever is greater. Crown units may be stored in separate stacks of identical units up to a maximum height of 3 m. The upper layers shall be separated from the lower layers by suitable timber bearers in line vertically at the specified supporting points. Timber supports for upper layers shall be placed directly above the supports of the layer below.

620.08 TRANSPORTING

Units shall not be transported from the precast yard until specified 28 day concrete compressive strength has been achieved, and not before 7 days after casting.

Units shall be securely fixed to the transporter and provision shall be made to protect the units from damage caused by lashings.

During transport of beam units the Contractor shall provide end bracing and, if necessary, top flange bracing. Bearings and supports shall allow for longitudinal rotation of the unit in transport and have adequate width and bearing capacity.

No beam shall be transported and erected if it has a bow in excess of 1 in 400 of the length or 75 mm whichever is the lesser. Should the bow at any time exceed the maximum allowable limit steps shall be taken to ensure the safety of the unit throughout the journey.

620.09 TRACEABILITY OF PRECAST CONCRETE UNITS

All manufactured precast concrete units shall be traced from the completion of manufacture to their final location by a unique identification number.

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SECTION 626 - INSTALLATION OF PRECAST CONCRETE CROWN UNIT CULVERTS

~~##This section cross references Sections 173, 204, 602, 610, 611, 613, 614, 687, 689 and 812.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent:~~

626.01 GENERAL

This section specifies requirements for the installation of reinforced precast concrete crown unit culverts and the associated cast-in-place concrete, including excavation, bedding preparation, placing of units, backfilling and compaction.

626.02 CONSTRUCTION PROCEDURE

HP Culvert construction shall not commence until the Contractor's construction quality procedure and inspection and test plan(s) addressing all requirements of this section are in place ~~have been reviewed by the Superintendent.~~

626.03 TOLERANCES FOR PLACEMENT OF UNITS

The culvert shall be constructed in the location, to the alignment, cross sectional shape, dimensions and levels shown on the drawings with the following tolerances:

Grade	5 mm in 5 m (1 in 1000)
Overall plan position	50 mm
Gap between adjacent units	12 mm maximum
Step at joint between adjacent units	12 mm maximum horizontal or vertical.

626.04 DIVERSION AND DISPOSAL OF WATER

Before obstructing or diverting any waterway, stream or channel for construction purposes, the Contractor shall obtain and provide to the Superintendent Council the written approval of the relevant authority to construct the obstruction or diversion. The Contractor shall observe all requirements imposed by the relevant authority and included in the written approval.

The Contractor shall:

- (a) Divert or dispose of water where necessary to enable construction of the culvert. The diversion shall be in the form of temporary channels or temporary pipes. **Pumping options shall not be used.**

Culvert construction shall not commence until water flow has been diverted to the satisfaction of the Superintendent Council.

- (b) Devise and install measures to prevent the escape of sediment and/or construction materials into the watercourse in accordance with the approved Site Environmental Management Plan (SEMP).
- (c) Implement appropriate measures to prevent damage to other parts of the works or surrounding properties that might result from the temporary modification of flows. The Contractor shall rectify any damage that may occur to the works or to adjacent properties to the satisfaction of ~~the Superintendent Council.~~

The Contractor shall produce a written declaration from the relevant ~~authority~~ authorities that the waterway has been left in a satisfactory condition prior to Practical Completion/Statement of Compliance.

Where a cofferdam is constructed to facilitate construction of the culvert, the cofferdam shall be extended below the foundation to prevent loosening of the foundation materials by water rising through the bottom of the excavation and it shall be watertight to prevent seepage of water from the sides and damage to the concrete.

Cofferdams shall be adequately braced and the cofferdam details including supporting calculations shall be proof engineered in accordance with Section 613 and Section 614.

Removal of the cofferdam shall be such that the in situ structure is not damaged or weakened.

626.05 EXCAVATION

Excavation shall be as shown on the drawings and shall comply with Section 204.

The required ground bearing pressure shall be as stated on the drawings.

Excavation for the culvert shall include all excavation necessary to provide the specified depth of bedding to place the units and associated walls, working space and space required for filling, including the removal and replacement of unsuitable material below the level of the underside of the bedding.

The foundation material at the level of the underside of the bedding shall be test rolled in accordance with Section 173. Foundation material that is soft, excessively wet, unstable, does not comply with the requirements for test rolling, or does not achieve the required ground bearing pressure stated on the drawings, shall be treated as unsuitable material. Such unsuitable material shall be excavated and replaced with 40 mm Class 3 crushed rock, spread in layers not exceeding 150 mm compacted thickness and compacted to achieve the required ground bearing pressure stated on the drawings.

When the foundation is in rock, all loose rock and pockets of unsound material, mud or water, shall be removed to expose the sound rock and the surface shall be brought to level as necessary with blinding concrete.

The excavation shall be supported in accordance with Section 602.

626.06 BEDDING

Bedding material shall comply with Section 812.

Bedding for the cast-in-place concrete base slab shall consist of a compacted layer of 20 mm Class 3 crushed rock, of not less than 150 mm compacted thickness or as shown on drawings. ~~Where shown on the drawings, this material shall be placed on 40 mm Class 3 crushed rock spread in layers not exceeding 150 mm compacted thickness and compacted to achieve the required bearing pressure specified on the drawings.~~

HP No bedding material shall be placed until the foundation or foundation materials have been inspected and approved by the Superintendent Council.

626.07 CAST-IN-PLACE CONCRETE

All cast-in-place concrete for culvert construction shall comply with the drawings and Section 610.

Steel reinforcement shall comply with the drawings and Section 611.

HP Construction of the concrete base slab shall not commence until the bedding has been approved by the Superintendent Council.

626.08 PLACING CROWN UNITS

The cast-in-place concrete base slab shall be cured in accordance with Section 610. Precast concrete units shall not be placed on the concrete base slab prior to 7 days after casting and shall also ensure that the minimum curing periods of Clause 610.23, Table 610.231 are satisfied. Placement of precast concrete units earlier than 7 days shall comply with Clause 610.16(l) or Clause 610.16(m) for early application of loading.

Crown units shall not be moved sideways along the ground during handling or installation. Crown units shall be lifted clear off the ground when moved, to prevent inducement of any lateral stresses in the legs.

Immediately prior to placing crown units, including link slab units, the surfaces of the bearing areas which support the crown units or link slab units shall be cleaned, wetted and then covered with a sufficiently stiff cementitious mortar to give a continuous finished thickness not less than 5 mm and not more than 10 mm after the crown units or link slab units have been placed.

The cementitious mortar shall comply with Clause 610.32 and shall be mixed with only sufficient water to a moist dry-pack consistency that can be displaced to provide an even bearing.

The crown units or link slab units shall be placed in position before the mortar has stiffened to ensure that a uniform bearing is achieved.

All surplus mortar shall be removed from the installation before the mortar hardens.

After placing the crown units, any gap between the inside bottom of the crown unit leg and the side of the base recess or upstand shall be filled with cementitious mortar.

All mortar joints shall be protected and cured in accordance with Section 610.

Cast-in lift anchors shall be cut off flush with the concrete substrate, and recesses filled to the surface with shrinkage compensating proprietary polymer modified cementitious mortar in accordance with Section 689.

626.09 COVERING OF EXTERNAL SURFACES OF JOINTS BETWEEN ADJACENT UNITS WITH FABRIC COVER

External surfaces of joints (top and sides) between adjacent units shall be covered full length with one layer strips of 150 mm wide synthetic nonwoven fabric, factory impregnated with a rubberised bitumen or a neutral petrolatum based compound, to seal the joints and prevent loss of fines.

The nonwoven fabric shall have the following properties:

- (a) breaking tensile strength not less than 200 N (50 mm wide strip)
- (b) thickness not less than 1.25 mm, and
- (c) mass not less than 1.4 kg/m².

The fabric covers shall not be wrinkled and shall be applied on surfaces free of foreign matter in accordance with the manufacturer's recommendations to ensure effective adhesion onto the outer surfaces of the adjacent units.

In the case of multi-cell culverts, fabric covers are not required where the gap between adjacent cells is filled with cementitious mortar or grout which complies with Clause 610.32.

HP The Contractor shall submit to the Superintendent Council for review all test certificates related to the supply of fabric cover material at least 14 days prior to commencement of installation.

626.10 STRUCTURAL FILLING

Structural filling shall comply with the drawings and Section 204.

626.11 CONSTRUCTION LOADING ON CULVERTS

If construction vehicles or plant are required to cross the culvert at any time before completion of the road construction, the Contractor shall construct a temporary riding surface over the culvert.

Construction vehicles or plant with axle load-effects (including the load due to the actual depth of construction or temporary riding surface) that exceed the design load-effect shall not be permitted to pass over the culvert at any time without the approval of the Superintendent Council. The Contractor shall submit its proposals (including supporting calculations) to move such vehicles to the Superintendent Council for review not later than two weeks prior. Supporting calculations shall be proof engineered in accordance with Section 613.

The temporary riding surface shall have a smooth profile to produce a surface free from ruts and bumps. The depth of the temporary riding surface shall be determined by the Contractor but shall be not less than 600 mm.

Construction vehicles or plant shall not pass over the culvert or base slab until at least 7 days has elapsed following casting of the base slab, and provided that the cylinder compressive strength of the base slab concrete has achieved 32 MPa. The minimum curing periods of Clause 610.23, Table 610.231 shall also be satisfied.

If vibrating rollers are required to work on or move over the temporary riding surface, the axle load for determining the required depth of cover shall be the combined static and dynamic load.

The Contractor shall maintain the temporary riding surface for the period during which construction traffic is required to pass over the culvert and shall remove it prior to construction of the final embankment and pavement. The temporary materials may be left in place at the discretion of the Superintendent Council subject to the suitability of the material, its density and condition.

626.12 REPAIR OF CONCRETE

Repair of damaged or defective cast in situ or precast concrete shall be undertaken in accordance with Section 610, Section 687 and Section 689.

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SECTION 701 - UNDERGROUND STORMWATER DRAINS

~~##This section cross references Sections 173, 175, 610, 619, 632, 687, 689, 703 and 709.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

701.01 GENERAL

This section covers the requirements for the supply, delivery, transport, and installation of underground stormwater drains, including pipes and culverts, together with the construction of inlet and outlet structures (endwalls, catchpits, basins, etc.), erection of marker posts, and the removal and/or relaying of existing culverts, as shown on the drawings or as specified.

701.02 STANDARDS

Materials, design and construction of underground stormwater drains shall comply with the requirements of relevant Standards including:

(a) Australian Standards

AS 1254	Unplasticized PVC (UPVC) pipes and fittings for storm water and surface water applications
AS 1646	Elastomeric seals for waterworks purposes
AS 1683	Methods of testing for elastomers
AS/NZS 2041	Buried corrugated metal structures
AS/NZS 2566	Buried Flexible Pipelines
AS 3571	Plastics piping systems
AS 3572	Plastics — Glass filament reinforced plastic (GRP) — Methods of test
AS 3582.1	Supplementary cementitious materials for use with portland and blended cement – Part 1: Fly ash
AS 3582.2	Supplementary cementitious materials for use with portland and blended cement – Part 2: Slag - Ground granulated iron blast furnace
AS 3582.3	Supplementary cementitious materials for use with portland and blended cement – Part 3: Amorphous silica
AS 3972	General purpose and blended cements
AS/NZS 4058	Precast concrete pipes (pressure and non pressure)
AS 4139	Fibre reinforced concrete pipes and fittings
AS/NZS 4441	Oriented PVC (PVC-O) pipes for pressure applications
AS/NZS 5065	Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
AS 5100	Bridge Design

(b) Additional referenced specifications

ATIC-SPEC SP43 – Cementitious Materials for Concrete published by ATIC (Australian Technical Infrastructure Committee)

Section 175 details the relevant references to these documents.

701.03 DEFINITIONS

Cement: Material complying with the requirements of AS 3972 and as specified in this section.

Cementitious Material: Portland cement or a mixture of portland cement with one or more of Fly Ash, Ground Granulated Blast Furnace Slag (GGBF Slag), or Amorphous Silica complying with the requirements of AS 3582.1, AS 3582.2 and AS 3582.3 respectively and as specified in this section.

Culvert: An underground stormwater drain consisting of pipes, arch or box sections.

Flexible Pipes: Buried flexible pipes which rely primarily upon side support to resist vertical loads without excessive deformation. It applies specifically to plain or structured wall plastic pipes and fittings manufactured from the following materials:

- (a) unplasticized polyvinyl chloride (UPVC)
- ~~(b) oriented polyvinyl chloride (OPVC)~~
- ~~(c) acrylonitrile butadiene styrene (ABS)~~
- ~~(d) glass filament reinforced plastics (GRP)~~
- ~~(e) polyethylene (PE)~~
- ~~(f) high-density polyethylene (HDPE)~~
- ~~(g) polypropylene (PP)~~

Precast reinforced concrete pipes: Pipes manufactured from Portland cement-based concrete or geopolymer binder-based concrete as specified in Section 703. In the context of the manufacture of reinforced concrete pipes, portland cement concrete and geopolymer binder concrete are equivalent products.

701.04 PRECAST REINFORCED CONCRETE BOX CULVERTS

Precast reinforced concrete box culverts shall comply with the requirements of Section 619.

701.05 PRECAST REINFORCED CONCRETE PIPES

- (a) General

Pipes up to and including 750 mm diameter shall have rubber ring joints complying with the requirements of AS 1646.

Pipes greater than 750 mm diameter shall have rubber rings complying with the requirements of AS 1646 or interlocking joints with a 200 mm wide rubber ring external band complying with the requirements of Section 701.13 Jointing.

Portland cement-based conventional precast reinforced concrete pipes shall comply with the requirements of AS/NZS 4058 and as specified in this section.

Geopolymer binder-based precast reinforced concrete pipes shall comply with the requirements of AS/NZS 4058 and this section, except that the concrete used shall comply with the requirements of Section 703 for geopolymer concrete with compressive strengths appropriate to the nominated load class performance requirements.

Precast reinforced concrete pipes covered by this section shall be used for drainage not subject to internal pressure and the required sizes and load classes shall be as specified on the drawings and specification.

Rubber ring joints shall comply with the requirements of AS 1646.

The clear cover to steel reinforcement shall be in accordance with the requirements of Table 3.1 of AS/NZS 4058 for normal and marine environments.

For precast reinforced concrete pipes subject to an aggressive environment (i.e. other environment as defined in Clause 1.3 of AS/NZS 4058), additional clear cover, use of coatings, other protective treatments or a combination of these shall be as specified on the drawings and specification.

Aggregates for precast reinforced concrete pipes shall comply with the requirements of Section 610.

Pressure pipes shall be as specified on the drawings and specification.

(b) Concrete mix design

Concrete mix designs used for the manufacture of precast reinforced concrete pipes shall not be more than 12 months old and shall be available for review by the Superintendent Council.

(c) Cementitious material blends

Cementitious materials shall comply with the requirements of Clause 701.09. Cementitious material blends used for the manufacture of precast reinforced concrete pipes for normal, marine and aggressive environments shall be as stated in this clause.

(i) Normal environment

The minimum mass of Type General Purpose (GP) cement in concrete mixes containing Slag, Fly Ash or Amorphous Silica shall be 60%, 75% or 90% respectively, of the total mass of cementitious material in the concrete mix. The inclusion of Slag, Fly Ash or Amorphous Silica in concrete mixes shall only be in single or double combination with Type GP cement.

In a triple blend concrete mix, the Type GP cement content shall be a minimum of 60% and the individual contribution of Slag, Fly Ash or Amorphous Silica shall be a maximum of 40%, 25% or 10% respectively, of the total mass of the cementitious material in the concrete mix.

(ii) Marine and aggressive environments

Cementitious material shall be a blend of Type General Purpose (GP) cement compliant with any of the following criteria with the combined total adding to 100%.

- 65% to 80% GP cement, 20% to 35% 3fly ash
- 50% to 55% GP cement, 20% to 25% ground granulated blast furnace slag, and 25% to 30% fly ash
- 60% to 70% GP cement, 5% to 10% amorphous silica, and 25% to 30% fly ash.

Type High Early (HE) cement which also satisfies the requirements of Type General Purpose (GP) cement may be substituted for Type GP Cement in any of the blends.

(d) Additional requirements

Additional routine sampling and testing of precast reinforced concrete pipes shall include ultimate load, water absorption, cover to steel reinforcement, dimensional accuracy and joint assembly in accordance with the requirements of AS/NZS 4058.

The design diameter as defined in AS/NZS 4058 shall not be less than:

- (i) 95% of the nominal size shown on the drawings for all classes of pipes up to and including Class 6.
- (ii) 90% of the nominal internal diameter for -
 - Class 8 and 10 pipes with 10 mm of cover
 - Pipes with 20 mm or more of cover.

(e) Acceptance of precast reinforced concrete pipes

Precast reinforced concrete pipes shall be accepted on the basis of full compliance with the requirements of this section and AS/NZS 4058.

Documentation supporting the following quality requirements shall be submitted for review by the Superintendent Council upon transport and delivery of pipes to site:

- (i) visual inspection
- (ii) proof load test results
- (iii) ultimate load test results
- (iv) dimensional measurements
- (v) measurements of clear cover to steel reinforcement
- (vi) joint assembly.

(f) Identification of units

All units shall be clearly stencilled by the Contractor with indelible ink on the exterior surface of each unit prior to inspection.

Information required on each unit shall be as follows:

- (i) name of the manufacturer and/or its registered trade mark
- (ii) date of manufacture
- (iii) nominal diameter and load class
- (iv) maximum mass of the unit
- (v) number of the relevant Australian Standard, i.e. AS/NZS 4058.

701.06 FIBRE-REINFORCED CONCRETE (FRC) RIGID PIPES

(a) General

- ~~FRC rigid pipes shall comply with the requirements of AS 4139 and shall have a design life of 100 years.~~
- ~~FRC rigid pipes shall comply with the rigid pipe strength requirements of Clause 11.1(a) of AS 4139, with the load regression factor (R) determined in a manner consistent with the design life of 100 years.~~
- ~~FRC rigid pipes may be supplied in diameter sizes up to and including 750 mm.~~
- ~~FRC rigid pipes shall be used for drainage and the required sizes, load classes and installation conditions shall be as shown on the drawings.~~
- ~~The FRC rigid pipe jointing shall consist of flexible elastomeric, double V-ring joints in accordance with AS 1646 and an external collar in accordance with AS 4139 Appendix M figure M1 (b)(i). Flush or butt joints shall only be used for the first pipe when extending existing pipes.~~

(b) Additional requirements

- ~~Further to the requirements of AS 4139 the following tests shall be undertaken:~~
 - ~~(i) one pipe per 100 pipes or part thereof of each size and class shall be load tested in accordance with clause 10.1 of AS 4139~~
 - ~~(ii) one pipe per 50 pipes or part thereof of each size and class shall be tested for internal diameter, wall thickness, pipe length, squareness of ends, and straightness in accordance with the dimension and tolerance requirements of clause 9 of AS 4139~~
 - ~~(iii) testing for restrictions on chemical content (acid soluble chloride and sulphate ions) as described in Section 6.1.7 of AS 4139 shall be at 6 monthly intervals.~~
- ~~The design diameter as defined in AS 4139 shall not be less than 95% of the nominal size shown on the drawings for all classes of pipes.~~
- ~~FRC rigid pipes shall be accepted on the basis of full compliance with the requirements of this section and AS 4139. Documentation supporting these quality requirements shall be submitted for review by the Superintendent upon transport and delivery of pipes to site.~~

701.07 — BURIED CORRUGATED METAL CULVERTS

~~Buried corrugated metal culverts shall be designed and constructed in accordance with the requirements of Section 632 and AS/NZS 2041.~~

701.08 — BURIED FLEXIBLE PIPES

~~Buried flexible pipes shall be designed and constructed in accordance with relevant Australian Standards listed in Section 701.02.~~

~~Buried flexible pipes shall not be used directly under the road pavement area.~~

701.09 ADDITIONAL MATERIAL REQUIREMENTS**(a) Cement**

Cement used in the manufacture of pipes shall comply with the requirements of AS 3972 and ATIC-SPEC SP43. Cement per batch of concrete shall be from one manufacturer and of one brand, type and grind.

Cement shall be pre-registered under the Cementitious Material Registration Scheme (CMRS) in accordance with ATIC-SPEC SP43.

Cement more than 3 months old shall not be used in the manufacture of pipes unless it is re-tested to demonstrate compliance with the requirements of AS 3972 and ATIC-SPEC SP43.

(b) Fly Ash, Slag and Amorphous Silica

Fly Ash, Slag and Amorphous Silica used in the manufacture of pipes shall comply with the requirements of AS 3582.1, AS 3582.2 and AS 3582.3 respectively and ATIC-SPEC SP43 and shall be from one manufacturer and of one brand, type and fineness.

Fly Ash, Slag and Amorphous Silica shall be pre-registered under the cementitious Material Registration Scheme (CMRS) in accordance with ATIC-SPEC SP43.

(c) Reinforcement

Further to the requirements of AS/NZS 4058 steel reinforcement used in the manufacture of precast reinforced concrete pipes shall carry third party certification by the Australian Certification Authority for Reinforcing Steel (ACRS) or equivalent. Steel reinforcement used with no third-party certification shall be subject to approval by the Superintendent Council.

Nibs and spacers used to maintain cover to reinforcement during manufacture of precast reinforced concrete pipes shall be one of the following:

- (i) Normal and Marine Environments – Steel Nibs or Stainless Steel Nibs
- (ii) Aggressive Environments – Stainless Steel Nibs.

Steel nibs shall be manufactured from material compliant with AS/NZS 4671. Stainless steel nibs shall be manufactured from a grade of stainless steel in accordance with Section 3.2 of AS 5100.5.

Plastic nibs or spacers shall not be used.

(d) Bedding and backfill materials

~~Materials used for bedding and selected backfill shall be free from perishable matter and lumps and shall conform with the requirements of Table 701.091 and Table 701.092 below.~~

~~Ordinary backfill shall be free from perishable matter and shall conform with the requirements of Table 701.091.~~

Table 701.091

Material	Sieve Size – AS (mm)				
	75.0	37.5	19.0	2.36	0.075
	Percentage Passing (by mass)				
Bedding	-	-	100	-	5-40
Selected Backfill	-	100	-	-	5-40
Ordinary backfill	100	-	-	40-100	-

Table 701.092

Test	Test Value
Plasticity Index (Max.)	20

Unless shown otherwise shown on the drawings, the material used for bedding, select backfill and ordinary backfill shall conform with the requirements of Table 701.041.

Table 701.041

Material	Requirements
Bedding	20 mm nom size Class 3 crushed rock as specified in Section 812 Or 20 mm nominal size Class 3 crushed concrete as specified in Section 820
Select Backfill	20 mm nom size Class 3 crushed rock as specified in Section 812 Or 20 mm nominal size Class 3 crushed concrete as specified in Section 820
Ordinary Backfill	Clay or fill from site free of vegetation and other deleterious matter. It shall not contain more than 20% rock. The rock shall not be larger than 75mm.

(e) General concrete paving

Cast-in-place concrete edgings, paths and other surfacings shall comply with the requirements of Section 703.

(f) Mortar

Mortar used in the laying of box culvert sections or as jointing for pipes shall comply with the requirements of clause 610.332.

(g) Marker posts

Marker posts shall comply with the requirements of Section 709.

701.10 CONFORMITY WITH DRAWINGS

The Contractor shall set out the drainage work in accordance with the drawings.

HP Prior to commencement of backfilling excavation for the culverts the Contractor shall confirm the levels, alignment, jointing and haunching position of all culverts with the Superintendent Council.

The culverts constructed shall be constructed true to line and level.

~~Where it is necessary to modify the line or levels of drainage lines shown on the drawings the Superintendent shall be notified of the proposed design change prior to excavation for the drainage lines. The design change notice shall include certification by the designer that the change complies with the design requirements.~~

Unless specified otherwise the tolerance on location of pipes compared to the design or a change to the design notified in accordance with this clause shall be:

- (a) offset of entry pits required to match lines of kerbs or barriers ± 20 mm
- (b) plan location of pits other than offsets to kerb lines or barriers ± 100 mm
- (c) invert level of pipes at pits ± 50 mm
- (d) departure from design grade of pipe runs ± 10 mm in 10 m provided minimum grade is not less than 1:250

The location of each run of underground drainage shall be verified by a survey certificate prior to backfilling the culverts and shall be recorded progressively on the Contractor's as-constructed drawings.

701.11 STOCKPILING OF MATERIALS

Materials shall not be stockpiled or stored on any carriageway or footpath without the consent of ~~the Superintendent Council~~.

Proprietary products (e.g. flexible pipes) shall be transported and stockpiled in accordance with the manufacturer's requirements. Where necessary, shield pipes and fittings from sunlight to avoid UV damage and heat distortion.

701.12 PROVISION FOR DRAINAGE DURING CONSTRUCTION

The Contractor shall provide for the safe discharge of seepage, and stormwater at all times during the construction of any culvert, and for the effective de-watering of excavations. Before obstructing any waterway, channel, culvert, or pipe, the Contractor shall make provision for temporary diversion of flow, and obtain prior written approval from the relevant waterway authority.

701.13 INSTALLATION OF CULVERTS IN FILLS UNDER CONSTRUCTION

Before laying any single row or multiple row culvert in fill, the fill shall first be constructed and compacted to subgrade level or to a level 0.3 m above the top of the proposed culvert, whichever is the lower, for a distance of not less than 6 m clear on either side of the proposed trench. The trench shall then be excavated through this fill as provided in clause 701.15 and the culvert installed.

701.14 CONSTRUCTION LOADING ON CULVERTS

Until the minimum compacted thickness of cover specified in Table 701.141 below for a particular range of axle or track loading has been provided over any culvert, construction traffic shall not be permitted to cross that culvert. A temporary embankment extending not less than 15 m on both sides of the culvert may be used to provide the necessary cover.

Table 701.141

Range of Axle or Track Loading (tonne)	Required Cover Thickness (Metre) (Min.)							
	Type, Size, and Class of Culvert							
	Pipe						Corrugated Metal	Box Culvert 90 kN Proof Load
	Pipe Class						D 1200-3600 mm	
	2		3		4			
	D<1.2m	D>1.2m	D<1.2m	D>1.2m	D<1.2m	D>1.2m		
0 – 9	0.4	0.4	0.4	0.4	0.4	0.4	-	0.1
9 – 20	0.4	0.4	0.4	0.4	0.4	0.4	1.2	0.6
20 – 35	0.7	0.4	0.4	0.4	0.4	0.4	1.5	0.9
35 – 50	0.9	0.7	0.6	0.5	0.5	0.4	1.8	1.2
50 – 60	#	#	0.8	0.8	0.7	0.7	2.1	1.5

This range of loading not permissible.

D Nominal Pipe diameter

D less than 1200 mm not permitted, D more than 3600 mm as directed by the Superintendent Council.

701.15 EXCAVATION

Excavation for installation of culverts shall include all excavation necessary to prepare the culvert foundation and provide the full specified depth of culvert bedding. Where necessary the foundation shall allow for pipes with protruding sockets. Where practical, trench walls shall be vertical, with temporary protection as required.

For box culverts, the width of the trench shall be such that the clearance from the outside of the culvert to the wall of the trench is in the range 0.5 to 1.0 times the overall height of the culvert.

For pipe culverts, the width of trench at and below the level of the top of the pipe shall be such that the horizontal clearance from the outside of the pipe to the wall of the trench is within the limits shown in Table 701.151.

Table 701.151

Pipe Type	Nominal Pipe Diameter or Width (mm)	Horizontal Clearance to Wall of Trench	
		Min. (mm)	Max. (mm)
Corrugated Metal Culvert	All	300	1,000
Other	All	300	600

The base of the trench shall be compacted to refusal using mechanical plant.

The Contractor shall treat or replace all soft, wet or unstable material below the level required to provide the minimum specified thickness of culvert bedding, as specified in clause 701.16. Replacement material if used, shall be compacted in accordance with clause 701.20.

For flexible pipes, the width of trench excavations shall be as shown on the Drawings, or where no dimension is shown, in accordance with minimum dimensions specified in AS/NZS 2566.1.

701.16 CULVERT BEDDING

Bedding material shall be provided and placed for the full width of the trench or, where the culvert is to be placed without trenching, to a width 0.8 m greater than the overall width of the culvert. The compacted thickness of bedding material following any shaping necessary shall be not less than:

- 100 mm where $D < 1500$ mm
- 200 mm where $D \geq 1500$ mm

where D is the nominal pipe diameter or culvert width.

When the sections are in position, an additional layer of bedding material shall be placed to a height equal to 30% of the nominal pipe diameter or culvert height. This material shall be placed between the pipe and the outer limits of the lower layers of bedding, and shall be compacted as specified in clause 701.20.

701.17 LAYING

(a) General

Laying of pipes or box culverts shall not commence until the Contractor has verified that culvert bedding complies with the specified lines and levels and compaction requirements, and that box culverts and pipes are not damaged and comply with the requirements of clause 701.04 and Clause 701.05 respectively. Laying of pipes or box culverts shall commence from the downstream end.

(b) Pipe culverts

Rebate and socket ends of pipe sections shall be placed facing upstream and be fully entered. The lower portion of the pipe shall be in contact with the bedding for the full length of each section. The compacted bedding shall be shaped to accommodate the joint collar and ensure that the pipe is supported along its full length.

Where applicable, the top of the pipe as marked shall be within five degrees of the vertical axis of the culvert.

~~Corrugated metal culverts shall be assembled and laid as specified in clause 701.21.~~

The spacing for multiple row culverts shall be as shown in Table 701.171.

Table 701.171

Pipe Type	Corrugated Metal		Corrugated Metal Pipe Arch		Other		
	Less than 2,400	Over 2,400	Less than 3,600	Over 3,600	Less than 600	600 to 1,800	Over 1,800
Nominal Diameter (D) or Width (mm)							
Clear space between rows	D/2	1.2 m	D/3	1.2 m	0.3 m	D/2	0.9 m

(c) Box culverts

Consecutive sections of box culverts shall be firmly butted together. The top sections shall be matched to the bottom sections and shall not be lapped over adjoining bottom sections.

~~The All~~ contact areas between ~~the top and bottom~~ sections shall be mortared as per the manufacturer's requirements.

Multi-row box culverts shall be laid with the sections in each row in contact with the sections in the adjacent rows.

(d) Cutting of culverts

Where it is necessary to cut any culvert section to length or to create a penetration, cutting shall be done by machine to achieve a clean vertical face and any exposed reinforcement shall be coated with an approved epoxy treatment to prevent corrosion.

(e) ~~Flexible pipes~~

~~Install to the dimensions shown on the Drawings, or where no dimension is shown, in accordance with the embedment geometry specified in AS/NZS 2566.1~~

~~Where Embankment Installation condition is specified, prior to commencing placing bedding and laying pipes, place and compact embankment fill to the height of the top of the side support zone above the foundation and for a minimum lateral distance from the centreline of the pipe of 2.5 times the largest external diameter of the pipe. Provide an alternate waterway area unless otherwise approved by the Superintendent.~~

~~Where Trench Installation condition is specified for pipes in an embankment, complete the embankment to the top of the Embedment Zone prior to the commencement of excavation.~~

701.18 JOINTS AND LIFTING HOLES

All interlocking (flush) joint reinforced concrete pipes shall be ~~mortar jointed~~, or wrapped with a 200 mm wide external joint rubber band. External rubber bands shall be manufactured from natural rubber and have a minimum tensile strength of 18 MPa and a minimum elongation of 400% at break as determined in accordance with AS 1683, Method 11. Rubber band thickness shall not be less than 2 mm. In the case of internally jointed pipes 600 mm diameter and larger, the mortar shall be struck off flush with the bore of the pipe.

Rubber ring joint pipes shall be jointed with rubber rings.

Rubber rings shall be kept undisturbed, clean, and free from dirt and other foreign materials and shall be stored undercover if pipes are not to be installed immediately. Rubber ring joints shall be assembled and prepared in accordance with the manufacturer's recommendations, shall be free of kinks and twists and shall be uniformly tensioned. Where rubber rings are disturbed they shall be cleaned and re-assembled prior to refitting.

Following the installation of each length of pipe and before proceeding to install the next length of pipe, the conformity of the assembled joint shall be verified by checking that the position of the rubber ring on the spigot, and the clearance and overlap between the spigot and socket, are within the values specified by the manufacturer.

Where lifting holes are provided, the pipes shall be laid with the hole uppermost. Lifting holes shall be plugged or otherwise closed off in accordance with the manufacturer's instructions after the pipe is installed. Plugs shall not impair the pipe durability or serviceability.

701.19 PLACEMENT OF FILLING

- (a) Unless the culvert is installed through an existing paved area, selected and ordinary backfill shall be placed as follows under, around, and above the culvert after the sections are bedded and compacted as specified in clause 701.20.

Where drainage culverts and/or drainage trenches expose backfilling of utility services and/or utility service trenches, the backfill requirements of the drainage trench is to match either the requirements of the relevant service authority or the requirements of select backfill shown in Table 701.041 (whichever is the higher specification).

- (i) Culverts under area to be paved (including concrete surfaces)

~~Where the trench has been excavated from design subgrade level or above, the~~ The trench shall be backfilled to design subgrade level with selected backfill material, and above that level with appropriate pavement material. Select backfill to be placed to the underside of all concrete surfaces.

Where the trench is excavated from below design subgrade level the trench shall be filled with selected backfill material.

(ii) Culverts within One Metre of the Road Pavement Boxing

The trench shall be backfilled with select backfill material to design subgrade level or 0.3 m above the top of the culvert whichever is the greater and with Ordinary backfill above that level.

(iii) Culverts under area not to be paved (including easements)

The trench shall be backfilled with selected backfill material to a level 0.3 m above the top of the culvert and with ordinary backfill material above that level.

(b) Where non-trench conditions are permitted the following shall apply.

Selected backfill material shall be placed for the full width of the previously placed bedding material to a height of 0.3 m above the top of the culvert, or to subgrade level, whichever is the lower. To provide support for the selected backfill material, ordinary backfill material shall be placed simultaneously with the selected backfill material to a distance two culvert diameters clear of the culvert.

During filling, the maximum difference between filling placed on opposite sides of the culvert shall not exceed the lesser of one-quarter the height of the culvert or 0.5 m.

Filling shall not be placed within 2 m of an exposed culvert end where a further section is to be placed.

(c) Backfilling with cement stabilised sand

Where approved by the Superintendent Council, culverts in trenches may be backfilled to 0.3 m above culvert to half the pipe diameter or box culvert height with 3% cement stabilised sand with a water content sufficient to ensure penetration beneath the pipe or box culvert invert without leaving free surface water.

701.20 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF COMPACTION AND MOISTURE CONTENT

Bedding and backfill materials shall be placed and compacted in layers not exceeding 150 mm loose thickness unless otherwise approved by Council.

~~Bedding and backfill shall be assessed for compaction and or moisture in lots. The number of tests per lot shall be three. A lot shall consist of one layer of bedding or backfill for a culvert length between adjacent pits or endwalls. Notwithstanding the provisions of Section 173, a minimum of 20% of all lots for each culvert shall be tested. The calculation of density and moisture ratios shall be based on standard compactive effort.~~

Bedding, Select Backfill and Ordinary Backfill shall be assessed for compaction and / or moisture content.

The number of tests shall be one test between pits and a minimum of one test per 80 metres length of trench backfill, or part thereof, for culverts under paved and non paved areas (including easements).

(i) Under paved areas testing shall be undertaken at subgrade level.

(ii) In non-paved areas testing shall be undertaken at a depth equal to one third the cover to the culvert.

Where the nominal size of bedding or backfill material after compaction is greater than 40 mm, the moisture ratio shall be determined on material that passes the 19.0 mm sieve.

(a) Bedding

Bedding shall be compacted to refusal using hand held mechanical equipment. Bedding material which has a swell equal to or greater than 2.5% shall be maintained at a mean moisture ratio of 92% between the completion of rolling and the placement of the overlying layer.

(b) Select Backfill

Select backfill shall be compacted to a mean density ratio of not less than 97% Modified Compaction.

(b) Ordinary Backfill**(i) Material of nominal size 40 mm or less after compaction**

Backfill material which will have a nominal size after compaction of 40 mm or less shall be compacted to a mean value of density ratio of not less than 95%. Backfill material which has a swell equal to or greater than 2.5% shall be maintained at a mean moisture ratio of 92% between the completion of rolling compaction and the placement of the overlying layer.

(ii) Material of nominal size greater than 40 mm after compaction

Backfill material which will have a nominal size after compaction greater than 40 mm shall be compacted using a grading, mixing, watering and rolling procedure.

Backfill material which has a swell equal to or greater than 2.5% shall be maintained at a mean moisture ratio of 92% between the completion of rolling compaction and the placement of the overlying layer.

701.21 ASSEMBLY OF CORRUGATED METAL CULVERTS

All corrugated metal culvert sections supplied by the Contractor shall be assembled in accordance with the manufacturer's assembly instructions.

Where culvert sections are supplied free to the Contractor, the following will be provided:

- Manufacturer's Assembly Drawings
- Schedule of Parts Supplied
- General Assembly Instructions

701.22 ASSEMBLY OF BURIED FLEXIBLE PIPELINES

All buried flexible pipe sections supplied by the Contractor shall be assembled in accordance with the manufacturer's assembly instructions.

Where sections are supplied free to the Contractor, the following will be provided:

- Manufacturer's Assembly Drawings
- Schedule of Parts Supplied
- General Assembly Instructions.

701.23 INSTALLATION OF CULVERTS THROUGH EXISTING PAVED AREAS

The trench of culverts through existing paved areas shall be backfilled to the existing subgrade level with selected backfill material and the pavement restored using materials as shown ~~below: on the drawings, or if not shown on the drawings, the same, or better, material comprising the existing pavement in layers no greater than 150 mm thickness. Consent for works within the road reserve is required from the coordinating road authority. Conditions of the consent will override the requirements of this specification.~~***

Pavement Layer	Material Type	Thickness (mm)
1. ##:	##:	##:
2.		
3.		
4.		
5.		

701.24 REMOVAL OF EXISTING CULVERTS**(a) General**

Where specified the Contractor shall remove culverts from existing paved areas.

Except where the pavement under which the culvert passes is to be abandoned, the trench shall be kept to the minimum width to allow removal of the culvert or laying a replacement.

(b) Treatment of residual excavation

Where a culvert has been removed and the excavation is not to be backfilled, the excavation shall be neatly trimmed to slopes not steeper than 1 in 1.5 and the ends of the trench shaped to facilitate the smooth flow of water.

Where the trench is to be backfilled, this shall be done in accordance with the provisions of clause 701.20 and the final surface shall be shaped to conform with the adjoining profile.

(c) Pavement restoration

Pavement restoration shall be carried out using materials as shown ~~below: on the drawings, or if not shown on the drawings, the same, or better, material comprising the existing pavement in layers no greater than 150 mm thickness.~~

Pavement Layer	Material Type	Thickness (mm)
1. ##:-	##:-	##:-
2.		
3.		
4.		
5.		

701.25 INLET AND OUTLET STRUCTURES

Inlet and outlet structures shall be constructed in accordance with the drawings and specification. Concrete used for the construction of inlet and outlet structures shall comply with the requirements of Section 610.

Footings shall extend to the depths shown on the drawings or as necessary to achieve a satisfactory foundation. If backfilling to the specified level is required, selected backfill material shall be used.

~~When the proposed foundation is unsatisfactory due to neglect or the use of inappropriate methods, no payment will be made for the work and materials necessary to provide a satisfactory foundation at the specified level.~~

701.26 MARKER POSTS ~~##(striethrough if not required):~~

At all locations specified the Contractor shall supply and erect guide posts at the edges of the formations on the side of the culvert nearer approaching traffic.

701.27 EXIT AND ENTRY CHANNELS

Channels shall be excavated to facilitate the flow of water. They shall be of regular shape and sufficient area to take the flow of water without any low spots that might retain water. Any low areas shall be filled with suitable excavated material and firmly compacted.

701.28 FLUSHING OF CULVERTS

All culverts shall be flushed clean from end to end on completion and maintained in proper working order.

701.29 MINIMUM TESTING REQUIREMENTS

The Contractor shall test the bedding and backfill material at a frequency as shown in Table 701.291 to ensure that all materials comply with the specified requirements.

Table 701.291

Test	Minimum Frequency of Testing
Grading	One per 1000 tonnes or part thereof
Plasticity Index	One per 1000 tonnes or part thereof

Table 701.291

Material	Test and Minimum Frequency of testing
<u>Bedding and Select backfill</u>	<u>20 mm Class 3 Crushed Rock as per Section 812</u>
	<u>20 mm Class 3 Crushed Concrete as per Section 820</u>

701.30 INSPECTION OF DRAINAGE LINES

HP **Unless approved otherwise by Council All all drainage lines constructed shall be inspected:**

(i) Under pavements

After the completion of the upper subbase and prior to the placement of the prime or asphalt layer.

(ii) Non paved areas

Prior to the issue of Statement of Compliance.

~~after completion of earthworks to subgrade level and prior to construction of pavement layers, by an independent testing organisation using closed circuit television (CCTV) to verify that the flow of water is not obstructed by waste construction material left inside and to check for visible signs of defects.~~

Reporting of the CCTV inspections shall be in accordance with WSA 05-2020 43 – Conduit Inspection Reporting Code of Australia, published by Water Services Association of Australia.

The report shall be provided to the Superintendent Council, with a copy of the CCTV record including any video recordings and a summary of the location of any defects detected by the survey.

Any sections of damaged pipe or box culvert which do not comply with the requirements of Clause 701.31 shall be removed and replaced.

Where approved by the Superintendent Council defects shall be repaired in accordance with the requirements of Clause 701.31 and a further CCTV survey shall be undertaken to verify correction of the defects.

Inspection of existing drainage lines shall be as specified in the drawings and specification.

701.31 REPAIRS TO DAMAGED PIPES AND BOX CULVERTS**(a) Steel reinforced concrete pipes**

Any steel reinforced concrete pipes that have cracks wider than 0.2 mm or are damaged prior to laying and backfilling shall be rejected.

Where inspections after backfilling identify any of the following defects they shall be notified as a non-conformance:

- cracks wider than 0.5 mm
- spalling of concrete
- exposed reinforcement
- joints that are not fully engaged.

Any pipes with defects greater than the following limits shall be removed and replaced:

- longitudinal cracks greater than 2 mm
- circumferential cracks around the full circumference with width greater than 3 mm or with lateral displacement of the cracked sections exceeding 3 mm
- circumferential cracks around part of the circumference with width greater than 4 mm
- penetrations with area greater than 400 mm²
- pipe joints that are separated.

The Superintendent Council may agree to accept pipes with defects as noted above subject to demonstration that repairs will ensure that pipes will operate effectively for their design life. Consideration will only be given to products and procedures with proven performance and to the following types of treatments:

- hot sprayed epoxy coatings for cracks not wider than 4 mm with no lateral displacement
- fibre glass reinforced epoxy sleeving for cracks not wider than 4 mm with lateral displacements up to 3 mm
- spalled concrete, exposed steel reinforcement and penetrations shall be treated as patch repairs and repaired with polymer modified cementitious repair materials in accordance with the requirements of Section 689.

The Contractor shall submit details of proposed rectification treatments including manufacturer's product specifications and warranties, the area and thickness of repair treatment, detailed repair procedures, and inspection and test plans.

HP No repairs shall be undertaken without the Superintendent Council's approval of the repair materials and procedures.

All repairs shall be inspected using CCTV to verify compliance with the repair specifications.

~~(b) Fibre reinforced concrete (FRC) rigid pipes~~

~~Any FRC rigid pipes that have cracks wider than 0.1 mm or are damaged prior to laying and backfilling shall be rejected.~~

~~Where inspections after backfilling identify any of the following defects they shall be notified as a non-conformance:~~

- ~~• cracks wider than 0.1 mm~~
- ~~• any other type of defect~~
- ~~• joints that are not fully engaged.~~

~~FRC rigid pipes subject to such non-conformance shall be removed and replaced, unless the Superintendent approves repairs to be undertaken in accordance with the FRC pipes manufacturer's repair procedures and materials.~~

~~(c) Other types of pipes~~

~~Other types of pipes which exhibit defects or are otherwise damaged prior to laying and backfilling shall be rejected.~~

~~Where inspections after backfilling identify any defects, such pipes shall be removed and replaced, unless the Superintendent approves repairs to be undertaken in accordance with the manufacturer's repair procedures and materials.~~

(d) Box culverts

Box culverts which do not comply with the requirements of clause 619.14 prior to laying and backfilling shall be rejected and removed from the site.

Where inspections after backfilling identify defects which do not comply with the requirements of clause 619.14, such culverts shall be removed and replaced, unless the Superintendent Council approves repairs to be undertaken in accordance with the requirements of Section 610, and Section 687 for crack repairs and Section 689 for conventional patch repairs.

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SECTION 702 - SUBSURFACE DRAINAGE

~~##This section cross-references Sections 175, 210, 701, 703 and 801.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

702.01 DESCRIPTION

This section covers the requirements for the supply and installation of subsurface drainage pipes, geocomposite drains and filter materials as shown on the drawings.

Section 175 details the relevant references to Australian Standards (AS), Test Methods and Codes of Practice referenced in this section.

702.02 DEFINITIONS

Pervious Pipe System

A pervious pipe system comprises drainage pipes which permit the entry of water from surrounding material and convey it to a discharge point. Such pipes may be perforated, slotted or porous pipes or impervious pipes laid with open joints.

Subsurface Drain

A subsurface drain is a pervious pipe system laid in a trench and surrounded by granular filter material or sleeved with a geotextile.

Geocomposite Drain

A geocomposite drain comprises a highly permeable core material wrapped in a geotextile. The core shall be non-crushable and flexible, and shall completely support the geotextile fabric. The geotextile shall have the filtration and separation properties to perform the functions of a single or second stage filter.

Single Stage Filter

Single stage filter is granular filter material placed in contact with the trench sides and surrounding the pervious pipe system.

First Stage Filter

First stage filter is granular filter material or geotextile placed in contact with the trench sides and surrounding a second stage filter.

Second Stage Filter

Second stage filter is granular filter material or geotextile placed in contact with the pervious pipe system and surrounded by a first stage filter.

Registered Mix

A registered mix is a crushed or screened product which has been placed on the VicRoads Crushed Rock Mix Register; as described in VicRoads Code of Practice 500.02.

Glass Fines

Glass fines are recycled glass cullet crushed to a cubic shape and passing the 4.75 mm AS sieve.

EAF Slag Aggregate

EAF slag aggregate is the processed slag by-product from the production of steel using an electric arc furnace (EAF). Once cooled, the slag by-product is crushed, graded and suitably conditioned (by weathering to reduce free lime content) to produce a non expansive aggregate.

No Fines Concrete

No fines concrete is a material containing graded coarse aggregate, generally of a single AS sieve size, bonded together by a paste of cement and water sufficient to provide adequate strength while producing an open-textured cellular concrete with a high volume of voids and high permeability.

702.03 CONFORMITY WITH DRAWINGS

Subsurface drains, whether pipe or geocomposite systems, shall be constructed true to line, level and depth, as shown on the drawings.

The invert of the subsurface drainage pipe or the geocomposite drain shall be not more than 25 mm from the specified level and not more than 50 mm from the specified line. Changes of grade shall not be abrupt, or occur at a rate exceeding 10 mm in any 3 m length, or lead to ponding of water within the drainage pipe. Hence, there are only tolerances on line and level.

702.04 DRAINAGE PIPES AND GEOCOMPOSITE DRAINS

Subsurface drainage pipes and geocomposite drains shall be supplied by the Contractor.

Subsurface drainage pipes and geocomposite drains are grouped into three categories as follows:

- Category 1: Perforated plastics Class 1000
Precast concrete Class "2"
- Category 2: Perforated plastics Class 400
- Category 3: Geocomposite drains

Pipes supplied shall be of the category and diameter shown on the drawings or specified in clause 702.12 and shall comply with the requirements of the appropriate Australian Standard in accordance with Section 175 or as follows:

- Perforated plastics - AS 2439 (except for perforation dimensions)
- Precast concrete - Section 701

Category 1 pipes may be substituted for Category 2.

Geotextiles used for the outer covering of the geocomposite drain shall comply with the requirements of clause 702.06 and Section 210.

Perforated plastic pipes and geocomposite drains supplied in coils shall be free from any permanent curved set when uncoiled.

Plastic pipes and geocomposite drains shall be stored away from sunlight and shall not be exposed unnecessarily to sunlight during delivery, storage and placement.

702.05 GRANULAR FILTER MATERIALS**(a) Material Source**

Granular filter material shall only be produced from a VicRoads accredited source, which has undergone assessment in accordance with VicRoads Code of Practice 500.00.

Coarse and fine aggregate components of granular filter material shall comply with the relevant requirements of Section 801 Material Sources for the Production of Crushed Rock and Aggregates, unless otherwise approved by VicRoads.

Synthetic or blended aggregates from different sources shall only be used with the approval of the Superintendent Council.

(b) Granular Filter Material

Granular filter material shall consist of hard, durable and clean sand, gravel or crushed rock, EAF slag aggregate or recycled glass fines which is free from clay balls and organic matter.

Materials used shall have a pH value greater than 6.0 and less than 10.0.

The portion of a granular filter material passing a 4.75 mm AS sieve shall have a Sand Equivalent value not less than 80 when tested in accordance with AS 1289.3.7.1.

EAF Slag and glass fines can be used a granular filter material provided the produced aggregates comply with the relevant additional requirements listed below.

Any synthetic, recycled or blended aggregate proposed to be used as a granular filter material must be accredited and registered in accordance with VicRoads Code of Practices 500.00 and 500.02.

EAF Slag aggregate shall be conditioned (weathered) for a minimum of three months prior to use to ensure volumetric expansion and % free lime are at acceptable levels for use in road construction.

Glass fines shall:

- (i) be cubical in shape, not sharp edged or elongated
- (ii) be generally free of contaminants such as paper, corks, metals, and other harmful materials (maximum limit of 2% by mass)
- (iii) be primarily container glass and shall not include glass from ceramics, cathode ray tubes, fluorescent light fittings and laboratory glassware
- (iv) be thoroughly washed and retested prior to use, where the measured Total Dissolved Solids (TDS) of the granular filter material exceeds 1500 mg/L.

(c) Grading Requirements for Granular Filter Material

The grading of granular filter material shall comply with the requirements of Table 702.051 relevant to the granular filter type specified in clause 702.12.

Table 702.051 Grading Requirements for Granular Filter Material

Sieve Size AS (mm)	Limits of Grading (% passing by mass)								
	Single and First Stage Filters					Second Stage Filters			
	A2	A3	A4	A5	A6	B1	B2	B3	B4
37.5	-	-	-	-	100	-	-	-	-
26.5	-	-	-	-	-	-	-	-	100
19.0	-	-	-	100	85-100	-	100	100	70-100
13.2	-	-	-	90-100	-	-	90-100	90-100	0-70
9.50	100	100	100	70-100	65-100	100	70-100	40-70	0-25
4.75	90-100	90-100	70-100	28-100	48-82	70-100	28-100	0-15	-
2.36	75-100	70-100	0-50	0-28	30-60	0-50	0-28	0-5	0-5
1.18	50-98	40-65	0-10	0-8	15-40	0-10	0-8	-	-
0.600	30-80	12-40	-	-	5-25	-	-	-	-
0.300	10-40	0-16	0-5	0-5	0-10	0-5	0-5	-	-
0.150	0-7	0-4	-	-	0-5	-	-	-	-
0.075	0-3	0-3	0-3	0-3	0-3	0-3	0-3	0-3	0-3

(d) Crushed Rock Components

The percentage by mass of unsound and marginal rock in that fraction of an aggregate retained on a 4.75 mm AS sieve shall not exceed the values specified in Table 702.052.

Table 702.052 Marginal and Unsound Rock

Total of Marginal and Unsound Rock % (by mass) (max)	Unsound Rock % (by mass) (max)
10	5

(e) No Fines Concrete

No fines concrete shall consist of Type GP cement, water and coarse aggregate. The quantity of cement used shall be 4.0% by volume. Grading limits shall be as specified in Table 702.051 for B4 granular filter material.

Type GP Cement, water and coarse aggregate shall comply with the requirements of Section 703.

The water/cement (W/C) ratio shall be in the range of 0.35 to 0.5.

The W/C ratio shall provide for complete cementitious paste coverage of the aggregate. The water and paste content shall be such that it does not cause the paste to flow during mixing, handling or placing.

702.06 GEOTEXTILE FILTERS

A geotextile filter shall consist of a fabric manufactured from synthetic fibres of a long-chain polymer such as polypropylene, polyethylene, polyester or similar material and shall be stabilised against deterioration due to ultraviolet light. After forming, the geotextile shall be processed so that the fibres retain their relative positions with respect to each other. The geotextile shall be free from defects or flaws which significantly affect its physical and/or filtering properties.

A geotextile filter may be non-woven or knitted fabric and shall comply with the requirements of Table 702.061 relevant to the geotextile filter type specified in clause 702.12.

Continuous knit seamless sleeve geotextile filter may be used as a second stage filter.

Table 702.061 Requirements for Geotextile Filter

Geotextile Filter Type	Minimum Robustness G⁽¹⁾	EOS⁽²⁾ (microns)	Minimum⁽³⁾ Elongation (%)
1. First Stage Filter	900 (moderately robust)	85 - 230	45
2. Second Stage Filter (non-woven)	600 - 900	125 - 350	20
3. Second Stage Filter (knitted seamless sleeve)	N/A	125 - 350	50

(1) G = Geotextile strength rating

(2) EOS = Equivalent Opening Size using AS 3706.7
Determination of Pore Size Distribution - Dry Sieving Method.

(3) Elongation at break as determined by AS 3706.2
Determination of Tensile Properties - Wide Strip Method.

Geotextiles shall be stored away from sunlight and shall not be exposed unnecessarily to sunlight during delivery and placement. Geotextiles shall be handled with care and suitable equipment to avoid damage.

Storage areas shall be secure to protect geotextiles from potential construction vehicle damage, and shall be relatively flat, well drained and free of sharp rocks and other objects which may cause puncture to the geotextiles.

Geotextiles shall be supported off the ground and the integrity of the protective plastic wrapping maintained, such that the geotextile is well covered and protected from UV radiation, sunlight and weather and other aggressive agents. Any damage to the protective plastic wrapping shall be repaired immediately.

If geotextiles are to be stored on site with their protective plastic wrapping for longer than 4 weeks they shall be further protected by additional cover such as the application of a UV-resistant and waterproofed tarpaulin.

Site handling and storage practices shall ensure that exposure to conditions which may reduce or alter the geotextile properties and overall effectiveness are avoided.

702.07 DRAINAGE SYSTEM AT STRUCTURES

Where a geotextile drainage system is used at structures the system shall consist of geocomposite drains placed vertically over the full height of the backfilling at the intervals as shown on the drawings.

Where a geocomposite drainage material is made up of a permeable drainage layer with one or both faces bonded to a geotextile filter fabric, such a system shall be placed over the full height of fill which is in contact with the structure.

The geotextile filter used in such drains shall be a non-woven product conforming to the requirements of clause 702.06.

The geocomposite drainage layer shall have the following minimum hydraulic properties under unit hydraulic gradient:

- (a) permeability perpendicular to the geocomposite under 0.2 kPa normal pressure - 0.005 m/sec
- (b) transmissivity in the plane of the geocomposite –

Normal Pressure	Transmissivity
10 kPa	350 x 10 ⁻⁶ m ² /sec
100 kPa	250 x 10 ⁻⁶ m ² /sec
200 kPa	150 x 10 ⁻⁶ m ² /sec
300 kPa	100 x 10 ⁻⁶ m ² /sec

Geocomposite drains shall be connected to a collector pipe with an outlet to a fitting immediately adjacent to the structure or as shown on the drawings. The collector pipe shall be fitted with a flush-out riser connected to an inspection opening in the verge adjacent to the structure or as shown on the drawings.

Preformed PVC fittings shall be used for all connections between the geocomposite drains and the collector pipe and all connections shall be sealed and protected to prevent displacement during backfilling.

702.08 EXCAVATION

Where a geotextile is to be used as a first stage filter in contact with a trench wall, the trench wall shall be excavated to allow the geotextile to be in close contact with the wall when the granular filter material is placed against the geotextile.

The bottom of the trench shall be compacted and shall be not more than 50 mm below the specified level of the invert of the pipe. There shall be no departures from the grade of the base of the trench that would allow ponding of water. Excess trench excavation shall be made good by filling back to grade with compacted material of permeability similar to that of the surrounding material and any loose material shall be removed.

HP The base of the trench shall be inspected to verify compliance with the requirements in this clause prior to placing bedding in completed excavations. ~~The Superintendent shall be notified at least 24 hours prior to the inspection.~~

702.09 INSTALLATION

(a) Depth

Subsurface drainage pipes or geocomposite drains shall be laid to the depths or levels shown on the drawings. ~~The top of any subsurface drainage pipe shall be at least 200 mm below subgrade.~~

(b) Grade

The grade of pipes or geocomposite drains shall be not flatter than 1 in 250.

(c) Bedding for Drainage Pipe System

A bedding of granular filter material of thickness between 25 mm and 50 mm shall be placed across the bottom of the trench. The bedding shall be tamped and screeded or graded to level. Bedding is not required for geocomposite drains.

(d) Placing of Pipes

Pipes shall be placed centrally in the trench on the prepared bedding and held firmly in place.

Slotted pipes shall be laid with the openings in the lower half of the pipe.

(e) Placing of Geocomposite Drains

Geocomposite drains shall be placed such that the drain stands vertical, held firmly in place and is centrally located within the trench.

(f) Jointing

Preformed pipe joints and fittings may be used.

Splice joints in geocomposite drains and pipes shall be made either with preformed geocomposite drain joints or fittings, or by butting together the sections of drain to be joined and wrapping the joint area with geotextile. Joints made by butting and wrapping with geotextile shall be secured to prevent separation during installation. The minimum width of geotextile used for wrapping shall be 450 mm.

Lap joints in geotextile used as first stage filters shall consist of an overlap of not less than 900 mm longitudinally and 150 mm transversely.

Lap joints in geotextile used as second stage filters shall consist of an overlap of not less than 300 mm.

(g) Placing Granular Filter Material

Filter material shall be placed moist and compacted with minimal disturbance to pipes or geocomposite drains, geotextiles and trench walls. The loose thickness of layers shall not exceed 300 mm.

No-fines concrete shall be placed and compacted within 1 hour of mixing.

HP The method of compaction shall be in accordance with the Contractor's quality procedures. and shall be submitted for review by the Superintendent.

HP Where no fines concrete is used as filter material ~~the Contractor~~ the method shall be in accordance with the Contractor's submit quality procedures, ~~for review by the Superintendent~~ which detail detailing the method of placing the no-fines concrete to prevent segregation and the formation of a slurry layer at the surface of the concrete which may prevent the passage of water into the filter material.

(h) Flushing

A flushing test shall be carried out on each subsurface drainage line after completion of subsurface drains, flushers and outlets, and after completion of all adjacent kerb and channel, barriers and road furniture.

The test shall be witnessed by a representative nominated by ~~the Superintendent~~ Council. Each drain shall be flushed with sufficient water to remove material that has entered the pipes during construction and to ensure that the drainage line is free from obstruction.

The Contractor shall maintain a record of flushing tests for every sub-surface drainage line including the date and time of notification to ~~the Superintendent~~ Council, the date and time of flushing, and witnesses to the flushing.

(i) Inspection of Subsurface Drainage Lines

HP All subsurface drainage lines constructed shall be inspected, after completion of the flushing test as stated in clause 702.09(h) and prior to placement of asphalt, by an independent testing organisation using closed circuit television (CCTV) to verify that the flow of water is not obstructed by waste construction material left inside and to check for visible signs of defects.

Reporting of the CCTV inspections shall be in accordance with WSA 05-2020 43 – Conduit Inspection Reporting Code of Australia, published by Water Services Association of Australia.

The report shall be provided to ~~the Superintendent~~ Council, with a copy of the CCTV record including any video recordings and a summary of the location of any waste construction materials, obstructions and defects detected by the survey.

Any sections of damaged or deformed subsurface drainage pipe shall be removed and replaced. A further CCTV survey shall be undertaken to verify that the damaged or deformed subsurface drainage pipes have been replaced and are defects free.

Any sections of subsurface drainage pipe which still exhibit waste construction material or obstructions after the flushing test, shall be flushed again and a further CCTV survey shall be undertaken to verify that subsurface drainage pipes are fully cleaned.

Subsurface drainage pipe which cannot be fully unblocked following the flushing test shall be removed and replaced. A further CCTV survey shall be undertaken to verify that the replacement subsurface drainage pipes are waste free.

HP Placement of asphalt shall not proceed until the CCTV inspection and flushing test have been completed, damaged or deformed subsurface drainage pipe has been removed and replaced and the waste and defects free condition of subsurface drainage lines has been verified by the Superintendent Council.

Inspection of existing subsurface drainage lines shall be as specified in the drawings and specification.

702.10 ACCESS POINTS AND INSPECTION OPENINGS

Subsurface drainage pipes and/or geocomposite drains shall have access points at the beginning and end of the drainage run and shall have inspection openings at intervals of between 100 and 150 metres along the drainage run.

Where stormwater drainage pits are used as access points, the invert at the beginning of each drainage run shall be located above the top of the pit outlet and the invert at the end of each drainage run, when not shown on the drawings, shall be located not less than 100 mm above the invert of the pit outlet.

702.13 MINIMUM TESTING REQUIREMENTS

The Contractor shall test the granular filter material at a frequency which is sufficient to ensure that all materials supplied under the contract complies with the specified requirements but which is not less than that shown in Table 702.131.

Table 702.131 Minimum Frequency of Testing

Test	Minimum Frequency of Testing
Grading	On each production day – one per 500 tonnes
Unsound Rock Content	On each production day – one per 500 tonnes
Sand Equivalent	One per 5000 tonnes of product
pH	One per 5000 tonnes of product
Total Dissolved Solids (glass fines only)	One per 5000 tonnes of product

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SECTION 703 - GENERAL CONCRETE PAVING

~~##This section cross-references Sections 175, 304, 610, 687, 714, 812 and 820.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

703.01 GENERAL

This section specifies the requirements for the supply of materials and construction of portland cement-based and geopolymer binder-based concrete paving for edgings, footpaths, other surfacing, and shared use paths, together with the necessary excavation and backfilling. This section also specifies the requirements for concrete which contains fine glass aggregate.

In the context of general concrete paving, portland cement concrete and geopolymer binder concrete are equivalent products.

Concrete for edgings, footpaths, and other surfacings shall be normal class to AS 1379 as specified or equivalent geopolymer concrete as defined in this section.

Concrete for shared use paths shall be concrete grade VR330/32 in accordance with Section 610 or equivalent geopolymer concrete.

Requirements for structural concrete for bridgeworks and other major concrete components and structures are specified in Section 610.

703.02 STANDARDS

Australian Standards are referenced in an abbreviated form (e.g. AS 1379).

(a) Australian Standards

AS 1012.3.1	Methods of testing concrete, Method 3.1: Determination of properties related to the consistency of concrete—Slump test
AS 1379	Specification and supply of concrete
AS 1478.1	Chemical admixtures for concrete, mortar and grout – Part 1: Admixtures for concrete
AS 2876	Concrete kerbs and channels (gutters) - Manually or machine placed
AS 3582.1	Supplementary cementitious materials for use with portland and blended cement – Part 1: Fly ash
AS 3582.2	Supplementary cementitious materials for use with portland and blended cement – Part 2: Slag - Ground granulated iron blast furnace
AS 3582.3	Supplementary cementitious materials for use with portland and blended cement – Part 3: Amorphous silica
AS 3610	Formwork for concrete
AS 3799	Liquid membrane-forming curing compounds for concrete
AS 3972	General purpose and blended cements
AS/NZS 4671	Steel reinforcing materials
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

(b) Other Standards and Referenced Specifications

ISO 3310	Test sieves – Technical requirements and testing
ASTM C1116	Standard Specification for Fiber Fibre-Reinforced Concrete
ASTM C1609	Standard Test Method for Flexural Performance of Fiber Fibre-Reinforced Concrete (Using Beam With Third-Point Loading)
ASTM C1399	Standard Test Method for Obtaining Average Residual-Strength of Fiber Fibre-Reinforced Concrete
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D3822	Standard Test Method for Tensile Properties of Single Textile Fibers-Fibre's
ASTM A820	Standard Specification for Steel Fibres for Fibre-Reinforced Concrete

(c) VicRoads Test Methods

ISO 3310 RC 377.01 Determination of the Fibre Content of Fresh Concrete (Wash-out Method)

Section 175 details the relevant references to these documents.

703.03 DEFINITIONS

For the purpose of this section, the following definitions apply:

Alkaline Component: Combinations of alkali and alkali earth containing salts, minerals and glasses.

Cement: Material complying with the requirements of AS 3972.

Cementitious Material: Portland cement or a mixture of portland cement with one or more of Fly Ash, Ground Granulated Blast Furnace Slag (GGBF Slag), or Amorphous Silica complying with the requirements of AS 3582.1, AS 3582.2 and AS 3582.3 respectively.

Edgings: Kerbs, channels, mowing and other edge strips including those behind kerbs and channels.

Fine Glass Aggregate: Recycled glass cullet crushed to a cubic shape and passing the 4.75 mm aperture sieve, as designated in the ISO 3310 series.

Geopolymer Binder: Binder containing greater than 80% Fly Ash, Ground Granulated Blast Furnace Slag (GGBF Slag) or Amorphous Silica complying with the requirements of AS 3582.1, AS 3582.2 and AS 3582.3 respectively, metakaolin and up to 20% alkaline components.

Geopolymer Concrete: Concrete which comprises geopolymer binder, aggregates, water and admixtures.

Glass Aggregate Concrete: Concrete which contains fine glass aggregate as a proportion of the total fine aggregate content.

Glass Cullet: Glass which has been recovered, sorted and crushed from postconsumer waste, which shall be primarily container glass and which shall not include glass from ceramics, cathode ray tubes, fluorescent light fittings and laboratory glassware.

Local Streets: Collector roads and all other local roads and streets.

Macro Synthetic Fibres: Fibres used to provide the concrete with significant post-cracking capacity and which, subject to satisfactory test results, provide the same performance as steel reinforcement in ground supported concrete paving and shared use paths.

Micro Synthetic Fibres: Fibres that create a support network within the concrete which increases its tensile strain capacity for control of plastic shrinkage cracking, but do not offer concrete post-cracking bearing capacity.

Portland Cement: General purpose portland cement Type GP complying with the requirements of AS 3972.

Shared Use Path: Path which is designated for shared use by pedestrians, cyclists and maintenance vehicles.

Steel Fibres: Straight or deformed pieces of cold-drawn steel wire, straight or deformed cut sheet fibres, melt extracted fibres, shaved cold drawn wire fibres and fibres milled from steel blocks, which are suitable for homogeneous mixing into concrete or mortar to improve prescribed properties.

Surfacings: Traffic islands, median slabs, grass mowing strips, bicycle paths, footpaths, vehicle and pram crossings and other similar slabs or pathways on prepared bedding.

Traffic Routes: Highways, freeways and arterial roads (M, A, B, C roads).

703.04 KERB AND CHANNEL AND OTHER EDGINGS

Kerb and channel and other edgings shall comply with the requirements of AS 2876.

703.05 SUPPLY OF PREMIXED CONCRETE**(a) Portland Cement-based Concrete**

Portland cement-based concrete shall be either N20, N25 or N32 standard strength grade, as specified for concrete paving complying with the requirements of AS 1379; or concrete grade VR330/32 for shared use paths.

(b) Kerb and Channel

Concrete used in kerb extrusion machines will not be subject to compressive strength requirements but shall have a minimum cementitious material content in the finished concrete as follows:

- Traffic Routes – a minimum of, or equivalent to, 320 kg of cementitious material or geopolymer binder per cubic metre of concrete
- Local Streets – a minimum of, or equivalent to, 280 kg of cementitious material or geopolymer binder per cubic metre of concrete.

Where kerb and channel is placed and compacted with internal vibration between previously placed formwork, concrete shall be:

- Traffic Routes – N32 portland cement-based concrete or 32 MPa geopolymer concrete standard strength grade; and
- Local Streets – N25 portland cement-based concrete or 25 MPa geopolymer concrete standard strength grade as specified.

(c) Geopolymer Concrete**(i) General**

Geopolymer concrete for concrete paving shall be manufactured to comply with the minimum 28 day compressive strength requirements for each strength grade ranging from 20 MPa to 32 MPa; or for shared use paths, geopolymer concrete equivalent to concrete grade VR330/32.

The mix design for each geopolymer concrete strength grade shall have a unique identification number.

Geopolymer concrete shall not be mixed when the air temperature is lower than 5°C or greater than 35°C.

Water may be added to the freshly mixed geopolymer concrete prior to commencement of discharge subject to the manufacturer's approval and provided a means of accurately measuring the volume of water is available.

No water shall be added after commencement of discharge of geopolymer concrete unless expressly approved by the manufacturer.

Geopolymer concrete which has begun to stiffen shall not be used in the works.

Prior to the discharge of geopolymer concrete at the site, the mixer or agitator shall be operated at mixing speed for not less than three minutes, until the geopolymer concrete achieves the required uniformity.

(ii) Water

The quality of water used in the manufacture of geopolymer concrete shall comply with the requirements of Clause 610.09, except that no recycled water shall be allowed.

(iii) Moisture Content of Aggregates

The determination of moisture content of the fine and coarse aggregates shall comply with the requirements of Clause 610.13(d).

(iv) Addition of Water at the Slump Stand

Addition of water to the mixed batch of concrete at the slump stand shall comply with the requirements of Clause 610.13(h).

(v) Delivery Docket

All information recorded on the delivery docket shall comply with the requirements of Clause 610.13(e).

(vi) Period for Completion of Discharge

The period for completion of discharge shall comply with the requirements of Clause 610.13(f) except that this time may be extended beyond 60 minutes provided the geopolymer concrete complies with the specified requirements.

(vii) Water Left in the Mixer or Agitator

Water left in the mixer or agitator from the previous load shall comply with the requirements of Clause 610.13(g).

(viii) Calibration of Weighing and Metering Equipment

All batch plant weighing and water metering equipment shall comply with the requirements of Clause 610.13(i).

(ix) Manufacturer Competency

Manufacturers and/or licensed technology providers utilised in the supply of geopolymer concrete shall have a minimum of three years continuous experience in commercial supply and a demonstrated competency in the technology of the geopolymer concrete to be applied.

Documented evidence shall be available to demonstrate supply experience and competency of manufacturers in the geopolymer concrete technology.

(d) Glass Aggregate Concrete

Concrete specified in this section, including concrete grade VR330/32 specified for use in shared use paths in accordance with Section 610, may contain up to 30% of fine glass aggregate as a replacement of the total mass of fine aggregate in the concrete mix.

Fine glass aggregate shall comply with the requirements of Clause 610.11(e) for alkali aggregate reactivity (AAR).

Where concrete specified in this section contains fine glass aggregate, blended cement consisting of a minimum amount of deemed to comply supplementary cementitious material shall be used in the concrete in accordance with the minimum proportions as shown in Table 610.112 to mitigate AAR.

Any proposed blended cement deviations from the minimum blended cement requirements of Table 610.112 shall demonstrate compliance with both the maximum mortar bar and concrete prism expansion limits stated in Clause 610.11, and as determined by both the VicRoads accelerated mortar bar test method RC 376.03 and the VicRoads concrete prism test method RC 376.04.

The Contractor shall submit the glass aggregate concrete mix design details for review by the Superintendent Council not less than 4 weeks prior to the placement of concrete, which shall also include verification of the addition of the minimum amount of supplementary cementitious materials to mitigate AAR in accordance with Table 610.112. Concrete shall not be placed until the glass aggregate concrete mix design has been reviewed by the Superintendent Council,

703.06 AGGREGATES

(a) General

Concrete aggregates shall comply with the requirements as set out in Section 610.

(b) Fine glass aggregate

In addition to the requirements of Clause 703.06(a) fine glass aggregate shall:

- (i) consist of a uniformly graded product manufactured by crushing of recycled glass cullet
- (ii) be cubical in shape, and not sharp edged or elongated
- (iii) be generally free of contaminants such as paper, corks, metals, glues and other harmful materials (maximum limit of 2% by mass)

- (iv) be thoroughly washed and be free from sugar, clay balls and organic matter
- (v) comply with the grading limits specified in Table 610.111 when tested with standard sieves.
When combined in the required proportions the resulting fine aggregate mix shall also comply with the grading requirements of Table 610.111
- (vi) comply with the minimum frequency of testing requirements of Table 610.121.

703.07 CHEMICAL ADMIXTURES

Chemical admixtures shall comply with the requirements of AS 1478.1. They shall be used in accordance with the requirements of Clause 2.5 of AS 1379 and the manufacturer's recommended method of use.

Air entraining admixtures shall not be used unless approved by the ~~Superintendent~~ Council.

Chemical admixtures containing calcium chloride, calcium formate or triethanolamine shall not be used.

Chemical admixture dispensers shall be subject to regular maintenance and calibrated in accordance with the requirements of AS 1379, except that in the case of geopolymer concrete production, they shall be calibrated as specified in Section 610.

703.08 PLACING, COMPACTING AND FINISHING CONCRETE

Concrete shall be transported, handled and placed to prevent segregation, loss or leakage of materials. Fresh concrete shall not be placed against concrete which has taken its initial set, except at properly formed construction joints. Concrete shall be thoroughly compacted by means of continuous tamping and internal vibration and shall be worked around any embedments and into corners of formwork or excavations to produce a dense concrete free from voids, honeycombing, segregation or surface defects.

Unformed surfaces shall be hand tamped to ensure a smooth surface with a uniform colour and appearance, and screeded to achieve the specified level, dimensions, falls and tolerances.

Geopolymer concrete shall be placed and finished in accordance with this clause and the geopolymer manufacturer's placement guidelines.

Any concrete repairs shall be carried out using a method and materials accepted by the ~~Superintendent~~ Council.

703.09 AMBIENT WEATHER FOR CONCRETING OPERATIONS

Concreting operations shall comply with the requirements of Clauses 610.17(a), 610.17(b), 610.17(c) and 610.17(d) for limits, restrictions and treatments to be applied for concreting in hot, cold and wet weather, except that curing shall be in accordance with Clause 703.10.

703.10 CURING OF CONCRETE

(a) General

The curing of exposed concrete surfaces shall commence immediately after finishing operations are progressively completed and shall continue uninterrupted for a period of not less than 7 days after placing the concrete, with the exception of concrete edgings which shall be cured for a period of not less than three days after placing the concrete.

Concrete shall be cured either by water curing, wet hessian, polyethylene sheeting which is adequately sealed, curing compound or a combination of these. Freshly finished exposed concrete surfaces shall be effectively protected from rain or damage from other sources, until hard set has occurred.

Curing compounds shall comply with AS 3799. The curing compound shall be applied in two coats using a fine spray at the rate stated on the certificate of compliance. The curing membrane shall be maintained intact for not less than the specified period of curing. Any damage to the curing membrane during the period of curing shall be repaired immediately at the original rate of application.

At the end of the curing period, concrete paving and shared use paths shall provide a dense, hard wearing surface.

(b) Curing of Geopolymer Concrete

Geopolymer concrete shall be cured in accordance with the requirements of Clause 703.10(a), including the specified minimum curing periods, and as follows:

- (i) The curing methods acceptable for curing of geopolymer concrete are:
 - (1) covering with polyethylene sheet
 - (2) maintaining the formwork in place in accordance with the requirements of Clauses 610.23(e) and Clause 610.23(f) respectively
 - (3) covering with wet hessian blankets. Hessian or burlap mats shall consist of at least two layers of hessian having a combined weight of at least 0.5 kg/m² dry and shall have a width after shrinkage of at least 300 mm greater than necessary to cover the entire width and vertical faces of concrete paving and shared use paths. The hessian blankets or mats shall be new or have only been used for curing concrete, shall be free from tears and shall be soaked in water for at least one hour prior to concrete placement proceeding.
- (ii) Further to the requirements of this clause curing of geopolymer concrete shall also be carried out in conjunction with the procedures as stated in the manufacturer's placement guidelines.

703.11 CONFORMANCE TESTING FOR CONCRETE STRENGTH AND CONSISTENCY

The minimum compressive strength requirements for each strength grade shall be as shown in Table 703.111.

Table 703.111

Portland Cement Concrete Strength Grade	Geopolymer Binder Concrete Strength Grade	Minimum Compressive Strength at 28 days (MPa)
N20	20	20
N25	25	25
N32	32	32
VR330/32	32	32

Sampling and testing of the strength of concrete shall be carried out in accordance with Clause 6.2 of AS 1379. The frequency of sampling and testing shall provide at least one sample at the point of discharge to be tested of each 50 m³ or part thereof of each strength grade placed on any one day. Where less than 50 m³ is provided for any one day then one sample shall be tested of each strength grade.

The consistency of the concrete shall be determined by a slump test of each concrete strength sample in accordance with AS 1012.3 and Clause 5.2 of AS 1379. The concrete represented by the samples shall be deemed to comply with the nominated concrete slump if the measured slump is within the limits given in Table 5.1 of Clause 5.2 of AS 1379.

Sampling and testing for concrete used in shared use paths shall be in accordance with Section 610.

Compressive strength testing and slump testing shall not be required for concrete used in extruded kerbs and channels and other edgings.

703.12 FORMWORK

The materials, design, construction and stripping of formwork shall comply with the relevant requirements of AS 3610. Joints in formwork shall be constructed such that loss of mortar is prevented.

Prior to placing concrete in an earth excavation, formwork shall be erected so that fresh concrete is not placed directly against the sides of the excavation.

Formwork shall not be stripped until the minimum times specified in AS 3610 Table 5.4.1 have elapsed from the time of completion of the placing of concrete. The minimum time shall also not be less than:

- (a) 2 days for vertical formwork on external surfaces; and
- (b) 1 day for vertical forms on permanently hidden surfaces.

703.13 STEEL REINFORCEMENT

Steel reinforcement shall comply with the relevant requirements of AS/NZS 4671.

Galvanising where specified shall be in accordance with the requirements of AS/NZS 4680.

The minimum cover of any steel reinforcement to the nearest concrete surface shall be 50 mm unless shown on the drawings.

Reinforcement shall be supported using either concrete or plastic chairs. Wire chairs with or without plastic tips, bricks or pieces of timber or coarse aggregate shall not be used to support steel reinforcement.

703.14 FIBRE REINFORCED CONCRETE**(a) General**

~~Concrete paving and shared use paths may be constructed with fibre reinforced concrete in lieu of steel reinforcement, provided the fibre reinforced concrete provides equivalent performance to steel reinforced concrete in accordance with this section.~~

(b) Macro Synthetic Fibres

~~Where it is proposed to replace up to SL82 steel mesh with synthetic fibres, such fibres shall be in the form of fine macro synthetic high performance fibres produced from virgin polypropylene or copolymer. Macro synthetic fibres shall be collated or supplied in water soluble pucks and supplied in fully biodegradable bags to ensure that fibres are uniformly distributed.~~

~~Micro synthetic fibres shall not be used alone to replace steel reinforcement or to achieve long term crack control. Where required micro synthetic fibres shall only be used for control of plastic shrinkage cracking, impact and abrasion resistance and explosive spalling resistance of concrete. Where specifically designed into concrete paving and shared use paths, micro synthetic fibres shall only be used in conjunction with macro synthetic fibres or steel fibres or with steel reinforcement.~~

(c) Steel Fibres

~~Where specified the type and quantity of steel fibres used shall as a minimum provide equivalent performance to concrete paving and shared use paths constructed with steel reinforcement.~~

~~The use of steel fibres in concrete paving and shared use paths shall be such that the steel fibres are not exposed at the surface to eliminate any potential injury to users.~~

(d) Performance Requirements

~~Fibres shall comply with the requirements of ASTM C1116 and shall be supported with documentary evidence confirming their long term resistance to deterioration when in contact with the moisture and alkalis present in cementitious paste or the substances present in chemical admixtures and shall have nil absorption. A current certificate of compliance shall be provided to the Superintendent.~~

Fibres shall be tested to the requirements of ASTM C1609 (flexural toughness) and ASTM C1399 (average residual strength of fibre reinforced concrete).

Fibres shall be added to the concrete in such a manner to ensure that they are uniformly distributed, balling does not occur, and the concrete mix remains workable and cohesive without any segregation.

—(i) Macro synthetic fibres

The macro synthetic fibre shall be capable of absorbing maximum energy without breakage and shall be designed to retain its cross sectional shape and avoid brittle failure.

(1) Properties of macro synthetic fibre

The macro synthetic fibres shall possess the following properties:

- Tensile strength (ASTM D3822) ————— > 400 MPa
- Modulus of elasticity (ASTM D3822) ————— > 5.0 GPa
- Specific gravity (fibre density) (ASTM D792) ————— > 0.91 g/cm³
- Fibres shall be at least 45 mm or at least twice the length of the aggregate that will be used in the concrete mix (i.e. 20 mm aggregate requires minimum 40 mm fibre).
- Where specifically designed and tested, macro synthetic and micro synthetic fibres may be used in combination to address both early age and long term crack control provided the minimum performance requirements of this clause are satisfied.

(2) Properties of macro synthetic fibre reinforced concrete

Macro synthetic fibre reinforced concrete shall possess the following properties:

- Average residual strength (ASTM C1399) ————— > 0.56 MPa
- Flexural toughness (ASTM C1609) ————— > 1.5 MPa
- Re3 (Flexural toughness factor) (ASTM C1609) ————— > 30%

Note: Re3 = % of flexural strength at 3 mm deflection of standard beam test.

Macro synthetic fibres shall have supporting evidence in the form of satisfactory test results by an accredited and independent testing facility stating that the fibres, at the dosage rate specified by the manufacturer, provide the same performance as the steel reinforcement being replaced.

Where macro synthetic fibres are proposed to replace SL82 steel mesh, they shall be added into the concrete mix at the minimum dosage rate of 5.6 kg per cubic metre in fully degradable and disintegrating bags. Where macro synthetic fibres are proposed to replace up to SL72 steel mesh, they shall be added into the concrete mix at the minimum dosage rate of 4.6 kg per cubic metre.

—(ii) Steel fibres

Steel fibre reinforcement shall comply with the requirements of ASTM A820 for Type I, cold drawn wire, or Type II, cut sheet.

All fibres shall be deformed and have a minimum tensile strength of 800 MPa and an aspect ratio between 40 and 70.

(e) Fibre Content

The fibre content of fresh concrete shall be determined in accordance with the VicRoads fibre wash-out test method RC 377.01 as described in the VicRoads Code of Practice RC 500.16.

The worksheet and/or report for determination of fibre content shall be submitted for review by the Superintendent.

(f) Sampling and Testing for Fibre Content

The fibre content of fresh concrete shall be determined by sampling at the minimum sampling and testing frequency as stated in Clause 703.11.

The concrete represented by the sample shall be deemed to comply if the fibre content as determined is within 1% of the fibre content in the approved mix design.

703.15 TOLERANCES ON LINE, LEVEL AND SHAPE

All surfaces shall be finished in conformity with the lines, grades, thicknesses and cross sections shown on the drawings or as specified, within the following limits:

- (a) Concrete paving including footpaths, edgings, other surfacings and shared use paths shall be shaped to match existing fixtures, e.g. pit covers, edgings and vehicle crossings, within 5 mm.
- (b) The departure of the finished work from line or level shall not exceed 10 mm at any point, and the rate of change of deviation from line or level shall not exceed 10 mm in 10 m. Except on curves or in shaped areas, the deviation of the finished work from a 3 m straightedge shall not exceed 5 mm at any point.
- (c) Section dimensions shall not differ from those shown on the drawings by more than 5 mm except that overall width shall not exceed the specified width by more than 15 mm; and on dimensions less than 25 mm the tolerance shall be ± 3 mm.
- (d) Where median surfacings are to be constructed between edge sections of the same level, paving shall be crowned to produce a crossfall between 1% and 3% towards the edges.
- (e) Kerb and channel shall be constructed to the level of the adjoining pavement with a tolerance of -0 to +10 mm. Except on curves or in shaped areas, the deviation of the finished work from a 3 m straightedge shall not exceed 5 mm at any point.

703.16 THICKNESS AND STEEL MESH REQUIREMENTS

Unless shown on the drawings, refer to the Standard Drawings for the thickness of concrete paving and steel mesh reinforcement.

The following thickness and steel mesh requirements shall apply:

- (a) Concrete paving including footpaths, edgings and other surfacings shall be 125 mm thick, and when steel reinforcement is specified, they shall be reinforced with SL72 steel mesh.
- (b) Shared use paths shall be 150 mm thick, and when steel reinforcement is specified, they shall be reinforced with SL82 steel mesh.
- (c) Median surfacings within 2 m of the edges of medians and bays of footpath adjacent to intersecting kerb and channel shall be 150 mm thick and reinforced with SL72 steel mesh.
- (d) Private entrance vehicle crossings shall be 150 mm thick and when steel reinforcement is specified, they shall be reinforced with SL72 steel mesh.
- (e) Commercial vehicle crossings shall be 170 mm thick, and when steel reinforcement is specified, they shall be reinforced with SL82 steel mesh.

703.17 SETTING OUT

The Contractor shall set out the work in accordance with the drawings and as specified.

HP ~~The Superintendent~~ Council will review and confirm the set out. The work shall be constructed in accordance with the confirmed set out to the line and level and cross-sectional profiles as shown on the drawings.

703.18 PROVISION FOR DRAINAGE DURING CONSTRUCTION

Before obstructing any waterway, channel or culvert, the Contractor shall make appropriate provision for its temporary diversion, and obtain prior written approval from the relevant waterway authority. The Contractor shall make provision for the safe discharge of drainage and stormwater at all times during construction.

703.19 HOUSEHOLD DRAINAGE CONNECTIONS

Existing household drains which are not connected to underground stormwater drains shall be altered as necessary and connected through the kerbing to drain into the channel.

Provision shall be made for connection of future household drains as specified or shown on the drawings.

703.20 EXCAVATION

The Contractor shall carry out any necessary excavations and disposal of excavated material.

The Contractor shall box out to a sufficient depth to allow for the required compacted thickness of bedding material under the full width of concrete paving.

Where it is necessary to excavate existing pavement, the excavation shall not extend more than 150 mm from the edge of the adjacent face. Existing asphalt or bituminous surfacing shall be saw cut for a sufficient depth to produce a neat vertical face.

703.21 BEDDING PREPARATION

All bedding material used for cast in place concrete paving works shall be compacted size 20 mm Class 3 or Class 4 crushed rock or Class 3 or Class 4 crushed concrete, manufactured and supplied in accordance with Sections 812 or 820 respectively.

Bedding material for shared use paths shall be compacted size 20 mm Class 3 crushed rock or Class 3 crushed concrete in accordance with Section 812 or 820 respectively, and Section 304.

(a) Edgings

Where edgings are constructed over pavement layers, bedding shall be provided between the pavement layer and the underside of the edging, or the edging thickened to match the pavement layer.

Where edgings are not constructed over pavement layers, bedding shall be as shown on the drawings or if not shown not less than 100 mm compacted thickness.

(b) Shared Use Paths

Bedding shall be as shown on the drawings, ~~not less than 150 mm thick compacted in accordance with Section 304.~~

(c) Footpaths, Crossovers and other Surfacing

Bedding shall be as shown on the drawings, ~~not less than 100 mm compacted thickness.~~

Bedding shall be trimmed to the appropriate levels, moistened as necessary, and firmly compacted.

For footpaths, crossovers, other surfacings and shared use paths the foundation shall be true to grade and cross section as shown on the drawings by filling and excavating as necessary. All soft wet or unstable material shall be removed to a depth of not less than 100 mm below the design level of the underside of bedding and filled with bedding material moistened and compacted to form a stable foundation. Any service trenches under paved areas shall be backfilled in accordance with Section 733.06 (c).

Immediately before concrete is placed, the bedding shall be moist but shall have no free water on the surface.

703.22 PROVISION FOR PERMANENT SIGNS

Sign post sockets shall be supplied and placed by the Contractor to provide for erection of permanent signs in the areas to be paved.

Sockets shall be placed at the locations shown on the drawings.

Socket depths, dimensions and installation requirements shall be in accordance with Section 714.06(d). Any concrete which falls into the sleeve shall be removed.

703.23 MACHINE EXTRUSION

Where an extrusion or slip-form machine is used, the datum for grade and alignment of the section to be extruded shall be established by the Contractor.

Concrete shall be fed to the machine at a uniform rate. The machine shall be operated to produce a satisfactorily compacted, dense mass of concrete free of any faulty or honeycombed patches. Surfaces shall be substantially free from surface pitting larger than 5 mm diameter.

Where work using fixed forms is combined with extruded work and similar concrete mixes are used for both, the concrete in the fixed form sections shall be compacted with internal vibration to produce a satisfactory compacted mass of concrete.

703.24 PROFILE TRANSITIONS AND MATCHING EXISTING SECTIONS

Where it is necessary to join to an existing section of profile different from that being constructed, the change of profile shall be made at a constant rate between 10 and 20 mm per metre. Transitions between different profiles shall be made in accordance with the drawings.

Matching of new to existing concrete paving shall be such that it appears identical to the existing section. When replacing damaged sections of concrete paving or shared use paths, the damaged section shall be removed completely to the nearest construction joint and replaced with identical material to the existing.

703.25 SURFACE FINISH

Exposed surfaces shall be treated as follows:

(a) Edgings

All edgings shall be rendered and have a steel trowel finish.

Rendering shall be applied within 30 minutes of placing or extruding concrete. The mortar used shall consist of two parts of fine aggregate, one part of cement, and sufficient water to produce a mix of suitable consistency. The thickness of rendering shall not exceed 3 mm. Exposed surfaces shall be given a steel trowel finish.

(b) Footpaths, other Surfacing and Shared Use Paths

Fresh concrete shall be compacted with internal vibration and worked until all the coarse aggregate is below the surface and the mortar comes to the top. It shall then be struck off and finished to grade and cross section with a wooden float to produce a lightly textured non skid surface. All outside edges of slabs and all joints shall be finished with a suitable edging tool.

After finishing, all work shall present a consistently neat appearance of uniform colour. All edges shall be sharp and clean and bullnoses shall be regular and of uniform radius. All discoloured concrete shall be cleaned or replaced by the Contractor.

Permanently hidden concrete surfaces of concrete paving including footpaths, edgings, other concrete surfacing, and shared use paths shall have a Class 4 surface finish in accordance with AS 3610.

All other concrete elements constructed with reference to Section 703 shall have a Class 3 surface finish for external surfaces and a Class 4 surface finish for permanently hidden surfaces in accordance with AS 3610.

703.26 JOINTS

Unless shown on the drawings, refer to the Standard Drawings for the joint detailing.

~~Transverse~~ Weakened plain joints shall be constructed at right angles to the back of edgings and the edge of footpaths and shared use paths. Joints in footpaths and shared use paths shall be opposite to joints in adjacent edgings.

(a) Edgings**(i) ~~Transverse~~ Weakened Plain Joints**

Weakened Plain Joints ~~Transverse joints~~ shall be constructed at regular intervals not exceeding ~~2.5 m~~ the width of path. For extruded edgings this shall be done by a method which does not damage or distort the adjacent surfaces. For edging constructed using fixed forms, templates shall be removed as soon as practicable after finishing the work. The guillotine (for extruded work) or template (for fixed work) shall cut between 40% and 70% of the area of the section. In both cases the resultant slot in the edging shall be tooled to a depth of 20 mm to produce a neat groove not less than 5 mm wide on the exposed surfaces, following which a vertical cut shall be made through the base of the groove to a depth not less than 50 mm from the surface.

(ii) Expansion Joints

Expansion joints shall be placed at junctions with bridges, and shall be 15 mm wide and filled with cork or bituminous impregnated particle board strip extending for the full width and full depth of the edging. The filler shall be placed in position before concrete is placed, and shall be held firmly in position during the placing of the concrete.

(b) Footpaths, other Surfacing and Shared Use Paths**(i) Expansion Joints**

Expansion joints shall be placed at intervals as shown on the drawings ~~not exceeding 10 m~~, on either side of vehicle crossings, at junctions with existing footpaths and shared use paths, at junctions with bridges and around all abutting structures such as pits, utility services, power poles, kerbs and other such features. The expansion joint shall be 15 mm wide and filled with cork or bituminous impregnated particle board strip extending for the full width and full depth of the paving. The filler shall be placed in position before concrete is placed, and shall be held firmly in position during the placing of the concrete.

Where required dowelled expansion joints shall be installed in accordance with the details and locations as shown on the drawings.

(ii) ~~Control Joints~~ Weakened Plain Joints

Weakened Plain Joints ~~Control joints~~ at least 25% of the paving thickness deep and 5 mm wide shall be formed with a cutting tool at intervals not exceeding the width of path along the full width of footpaths, other surfacings and shared use paths, within four hours of placing the concrete where the air temperature measured at the time of placement is between 20°C and 35°C and within 24 hours of placing the concrete where the air temperature measured at the time of placement is less than 20°C.

~~(c) Between Concrete Paving and Shared Use Path~~

~~Except on narrow medians (less than 2.0 m wide) surfaced full width, bonding between the concrete paving or shared use path and the edging shall be prevented by painting the back of the edging with bitumen, or by using a strip of bituminous felt material between the edging and the concrete paving or shared use path.~~

703.27 PROTECTION OF CONCRETE

All concrete shall be protected from damage from early loading by pedestrians, animals, vehicles and from rain or any other cause.

The Contractor shall ensure that no vehicles are permitted to cross over private entrance or commercial vehicle crossings a minimum of four days after completion of casting of the concrete. Vehicles equal to or less than 1.5 tonnes in weight may be permitted to cross after 4 days, vehicles greater than 1.5 tonnes may be permitted to cross after 7 days.

703.28 MARKING OF CONDUIT POSITIONS

The positions of any existing conduits passing under edgings shall be marked by a chase in the edging immediately above the conduit together with a suitable identification mark.

703.29 BACKFILLING AND PAVEMENT RESTORATION

As soon as the concrete has cured sufficiently and not earlier than 3 days after placing, topsoil material, free from perishable matter and lumps, shall be placed and firmly compacted in layers not exceeding 150 mm in thickness and to a width not less than 300 mm behind the edging to the top of the edging.

Where edging has been constructed alongside an existing pavement, part of which has been excavated to permit the construction of the edging, the excavated space shall be backfilled to the surface level of the existing pavement. Size 7 or Size 10 asphalt shall be used for this work and firmly compacted in layers not exceeding 100 mm in thickness.

703.30 CRACKING OF CONCRETE

The concrete shall have no surface cracks at any stage after construction of width greater than 0.2 mm. Where such cracks exist, they shall be identified as a non-conformance.

Cracked sections of concrete shall be either removed and replaced, or repaired in accordance with ~~Section 687~~, as directed by the Superintendent Council.

For damaged kerb and channel and edgings, a length of at least 1 m shall be removed and the replacement section shall be:

- (a) constructed on compacted bedding;
- (b) dowelled into the adjoining sections with 12 mm diameter hot dip galvanised dowels embedded at least 100 mm each side of the joint; and
- (c) shaped and finished with curved trowels to match the profile and surface finish of adjoining sections.

SECTION 704 - PRECAST CONCRETE KERB

~~##This section cross references Section 701.~~

~~If Section 701 is relevant, it should be included in the specification.~~

~~If Section 701 is not included in the specification, all references to it should be struck out, ensuring that the remaining text is still coherent:~~

704.01 DESCRIPTION

This section covers the requirements for the supply and placing of precast concrete kerb as shown on the drawings or at locations as specified.

704.02 ~~SUPPLY OF KERBS~~ ~~##[strikethrough (a) or (b) below]:~~

~~*** (a) All kerbs required under this Contract will be supplied free of cost to the Contractor on site or at another agreed location in lengths of 1.2 m.~~

~~— All sections shall be carefully inspected at the time of delivery by the Contractor's representative, and any damaged sections clearly marked in the presence of the Superintendent.~~

~~— The Contractor shall notify the Superintendent at least two weeks in advance of the date on which kerb sections are required.~~

~~*** (b) All kerbs required under this Contract shall be supplied by the Contractor and shall conform with the profiles shown on the drawings.~~

Unless otherwise specified or shown on the drawings, concrete shall be N20 standard strength grade complying with the requirements of AS 1379 - Specification and supply of concrete. Aggregates for the concrete mix shall comply with the requirements as set out in Table 701.021 of Section 701. The construction of the items covered by this section shall comply with the relevant requirements of AS 3600 - Concrete Structures and as specified herein.

Kerbs shall be cast in lengths of 1.2 m, and in order to ensure that all sections butt together neatly, holes for placing dowels or interlocking joints shall be provided in each section.

Any section damaged during handling, storing and transporting shall not be used.

The surface of all sections shall be consistently smooth and of uniform colour.

704.03 PLACING OF PRECAST KERBS

(a) Preparation of Base

The foundation shall be excavated or filled to levels 75 mm below the levels fixed for the base of the kerb. All soft, wet or unstable material shall be removed to a further depth of 75 mm and the resulting space filled with earth, sand or gravel of a quality that when moistened and compacted will form a stable foundation. Bedding material consisting of sand, gravel or crushed rock shall then be placed and fully compacted to the specified level.

(b) Placing

The kerb shall be set so that the top conforms with the line and grade specified within a tolerance of ± 15 mm. All sections shall be firmly butted together.

704.04 PLACING OF PRECAST SPIKED KERBS

Where precast kerbs are to be pinned to existing pavements, they shall be placed true to line with adjoining sections firmly butted together. Where necessary, the sections shall be bedded on 6 to 1 cement mortar in order to maintain an even grade along the top of the kerb.

The kerb sections shall be held in position by 12 mm diameter steel spikes 300 mm long driven into the pavement so that the tops are at least 10 mm below the tops of the kerbs. The holes in the tops of the kerbs shall then be filled level with the top with 3 to 1 cement mortar.

704.05 BACKFILLING

Where specified filling shall be placed and thoroughly compacted behind and up to the level of the top of the kerb.

SECTION 705 - DRAINAGE PITS AND COVERS

~~##This section cross references Sections 175, 610, 611, 689, 701 and 703.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

705.01 GENERAL

This section specifies the requirements for the supply of materials and construction of drainage pits including the associated excavation, backfilling, culvert connections and supply and fitting of covers and associated components.

The supply of concrete and construction of items covered by this section shall comply with the requirements of Section 610.

705.02 STANDARDS

Standards are referenced in an abbreviated form (e.g. AS/NZS 4680).

(a) Australian Standards

AS 1170	Structural design actions
AS 2439	Perforated plastics drainage and effluent pipe and fittings
AS 3571	Plastics piping systems
AS/NZS 3679.1	Structural steel – Hot rolled bars and sections
AS 3600	Concrete structures
AS 3735	Concrete structures retaining liquids
AS 3996	Access covers and grates
AS/NZS 4058	Precast concrete pipes (pressure and non-pressure)
AS/NZS 4671	Steel reinforcing materials
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 5065	Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications
AS 5100	Bridge Design Set

(b) Other Standards and Referenced Specifications

ASTM C1116	Standard Specification for Fiber-Reinforced Concrete
ASTM C1609	Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading)
ASTM C1399	Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D3822	Standard Test Method for Tensile Properties of Single Textile Fibers
ASTM A820	Standard Specification for Steel Fibres for Fibre-Reinforced Concrete

(c) VicRoads Test Methods

RC 377.01	Determination of the Fibre Content of Fresh Concrete (Wash-out Method)
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Section 175 details the relevant references to these documents.

705.03 DEFINITIONS

Drainage pit: A reinforced concrete chamber constructed or installed below ground, which is designed to receive water from the surface and from connected upstream underground stormwater drain(s) and facilitate its discharge into a connected downstream stormwater drain.

Fibre reinforced concrete (FRC): A concrete mixture containing uniformly dispersed and randomly oriented fibres.

Prototype testing: Load testing of the first type of unit(s) from a specific design and production.

705.04 MATERIALS

(a) Concrete

(i) Conventional Portland Cement-based Concrete

All concrete shall be manufactured to the concrete mix design registered by VicRoads and comply with the requirements of Section 610. Concrete grades shall comply with Table 705.041

Table 705.041

Minimum Concrete Grade	Used for:
VR330/32	Drainage pits reinforced with steel reinforcement
VR450/50	Precast drainage pits using fibre reinforcement

(ii) Geopolymer Concrete

Geopolymer binder-based concrete as defined in Section 703 may be used for the construction of drainage pits provided the supply of geopolymer concrete and construction comply with the requirements of Section 610 and satisfy the concrete grade requirements of Table 705.041.

If precast units are proposed for use to construct drainage pits, the base units (or any other riser units to which incoming drainage pipes will be joined) must be manufactured specifically to suit the design configuration of the particular pit with pre-formed knockouts only in the walls that require them. Standard precast pit base units with thinned wall sections on all four sides are not acceptable

(b) Registration of Concrete Mix Designs

Concrete mix designs shall be registered in accordance with the requirements of Section 610, and re-registered on an annual basis, unless mix components change prior to the expiry of registration.

(c) Covers, Grates, Lids and Lintels

Covers, grates, lids and lintels shall be as shown on the drawings.

Metal access covers, grates and frames must comply with AS 3996. Covers and grates must not dislodge or rock in their frame when subjected to traffic loading. Covers and grates must be of the liftout type, unless otherwise specified or shown on the Drawings.

(d) Step Irons

Step irons shall be manufactured from steel to AS/NZS 3679.1 Grade 250, or AS/NZS 4671 Grade N500 and after fabrication shall be prepared, pre-treated and hot dip galvanized in accordance with the requirements of AS/NZS 4680 with a minimum average coating thickness equivalent to 600 g/m², **or manufactured from 13 mm steel bar covered with polypropylene plastic to a design and sample approved by the Superintendent Council.**

(e) Reinforcement

All steel reinforcement shall comply with the requirements of Section 611.

(f) Fibres

When relevant to the registered concrete mix, fibres shall comply with the requirements of ASTM C1116 and shall be supported with documentary evidence confirming their long term resistance to deterioration when in contact with the moisture and alkalis present in cementitious paste or the substances present in chemical admixtures.

Fibres shall be tested to the requirements of ASTM C1609 (flexural toughness) and ASTM C1399 (average residual strength of fibre reinforced concrete) to ensure compliance of the fibre reinforced concrete with the requirements of AS 5100.

(i) Synthetic Fibres

Synthetic fibres shall be in the form of fine micro and macro virgin copolymer or polypropylene, consisting of twisted bundle non-fibrillated monofilament and fibrillated network fibre.

The synthetic fibre shall be capable of absorbing maximum energy without breakage and shall be designed to retain its cross sectional shape and avoid brittle failure.

(1) Properties of synthetic fibre

The synthetic fibres shall possess the following properties:

- Tensile strength (ASTM D3822) > 550 MPa
- Modulus of elasticity (ASTM D3822) > 5.0 GPa
- Specific gravity (fibre density) (ASTM D792) > 0.91 g/cm³
- Aspect ratio (length divided by the equivalent diameter of the fibre) between 70 and 170

(2) Properties of synthetic fibre reinforced concrete

Synthetic fibre reinforced concrete shall possess the following properties:

- Average residual strength (ASTM C1399) > 1.0 MPa
 - Flexural toughness (ASTM C1609) > 4.5 MPa
 - Re3(Flexural toughness factor) (ASTM C1609) > 40%
- Note: Re3 - % of flexural strength at 3 mm deflection of standard beam test.

(ii) Steel Fibres

Steel fibres shall comply with the requirements of ASTM A820 for Type I, cold drawn wire, or Type II, cut sheet.

All fibres shall be deformed and have a minimum tensile strength of 800 MPa and an aspect ratio between 40 and 70.

705.05 EXCAVATION

(a) General

Excavation shall be to the depth indicated on the drawings or as necessary to secure a satisfactory foundation. Backfill material conforming to the requirements of Section 701 shall be supplied, placed and compacted in accordance with clause 705.17.

(b) Precast Pits

For precast pits the excavation shall provide a clearance from all external faces of the pit to each face of the excavation of not less than 400 mm. Bedding conforming to the requirements of Section 701 shall be supplied, placed and compacted to a thickness not less than 80 mm on a clay foundation or 150 mm on a rock foundation.

705.06 CAST IN PLACE DRAINAGE PITS

Cast in place drainage pits shall be constructed at the locations and to the dimensions shown on the drawings.

Cast in place drainage pits shall be constructed in accordance with the requirements of Section 610 and Section 611.

Cast in place drainage pits shall not be constructed with fibre reinforced concrete (FRC).

705.07 PRECAST STEEL REINFORCED CONCRETE DRAINAGE PITS

Precast steel reinforced concrete drainage pits shall be manufactured, supplied and installed in accordance with the requirements of Section 610 and Section 611.

~~Where precast steel reinforced concrete drainage pits do not conform to the drawings, the~~ The Contractor shall submit to the Superintendent Council detailed drawings and design computations carried out by a prequalified consultant and proof engineered by a Proof Engineer who is prequalified in accordance with the VicRoads scheme for prequalification, to demonstrate that the design meets the requirements of AS 5100.

705.08 PRECAST FIBRE REINFORCED CONCRETE DRAINAGE PITS**(a) General**

Precast fibre reinforced concrete (FRC) drainage pits shall be manufactured, supplied and installed in accordance with the requirements of Section 610 and relevant Australian Standards listed in clause 705.02.

Precast FRC drainage pits shall be subject to the following conditions:

- (i) The design of FRC drainage pits shall comply with the requirements of AS 5100 and the following additional loading requirements:
 - (1) the combined factored lateral pressure from axle loadings at any point at the ultimate limit state shall be not less than 25 kPa
 - (2) adequate drainage to be provided to drainage pit walls to avoid hydrostatic pressure
 - (3) vertical load 210 kN applied anywhere on the drainage pit
 - (4) equivalent minimum reinforcement area to be 150 mm²/m.

The design shall as a minimum provide equivalent performance to drainage pits constructed with steel reinforcement.
- (ii) The design of the FRC drainage pits shall be supported by detailed drawings and design computations carried out by a prequalified consultant and proof engineered by a Proof Engineer who is prequalified in accordance with the VicRoads scheme for prequalification.
- (iii) FRC drainage pits shall not be located under roads.
- (iv) Concrete used for the construction of FRC drainage pits shall comply with the requirements of clause 705.04 and Section 610.

(b) Prototype Testing

A sample of two prototype FRC drainage pits shall be load tested in accordance with the requirements of AS 5100 to demonstrate that FRC drainage pits manufactured under the same conditions, and to the same design, satisfy the requirements of this section.

The Contractor shall submit to the Council a detailed report prepared by a VicRoads pre-qualified consultant and proof engineered by a Proof Engineer who is prequalified in accordance with the VicRoads scheme for prequalification, to demonstrate that the design meets the requirements of AS 5100.

Where a new design or a significant departure from a proven design is proposed, prototype testing, appropriate to the design or design change, shall be carried out in accordance with the requirements of this section.

A significant change to an existing design shall be a change in the concrete mix design, decrease in the quantity of reinforcing fibre, change in the agreed brand, type and source of reinforcing fibre or decrease in the design wall thickness.

(c) Fibres

Fibres used in the manufacture of precast FRC drainage pits shall comply with the requirements of clause 705.04(f).

Fibres shall be added to the concrete in such a manner to ensure that they are uniformly distributed, balling does not occur, and the concrete mix remains workable and cohesive without any segregation.

(d) Fibre Content

The fibre content of fresh concrete shall be determined in accordance with the VicRoads fibre wash-out test method RC 377.01 as described in the VicRoads Code of Practice RC 500.16.

The worksheet and/or report for determination of fibre content shall be submitted for review by the Superintendent Council.

(e) Sampling and Testing for Fibre Content

Further to the requirements of clause 610.16(a) for sampling and testing of concrete, the fibre content shall be determined by sampling at a frequency of one test per five batch loads of concrete.

The concrete represented by the sample shall be deemed to comply if the fibre content as determined is within 1% of the fibre content in the approved mix design.

705.09 ADDITIONAL REQUIREMENTS FOR PRECAST CONCRETE DRAINAGE PITS

(a) General

Precast drainage pits shall be installed at the locations and to the dimensions shown on the drawings.

Precast concrete Circular Punch Out drainage pits shall comply with the requirements of AS/NZS 4058.

(b) Provision for Stormwater Drainage Connections

Provision shall be made for the connection of all stormwater drainage, culverts and subsurface drains as shown on the drawings.

Holes for subsurface drains shall be 150 mm diameter.

~~Weepholes of 50 mm diameter shall be provided in all precast pits and shall be placed between the midpoint and top of the stormwater drain in those walls which have openings for drains.~~

(c) Segments

If a precast drainage pit is cast in segments, each section of the drainage pit shall be rebated to ensure correct alignment and to prevent horizontal movement. A minimum rebate of 15 mm shall be used.

(d) Completion on Site

Where precast drainage pits are to be completed on site, the provision of cut outs and protruding reinforcement shall be as specified or in accordance with the drawings.

705.10 TRENCH DRAINS

Trench drains shall withstand the load classes as defined by AS 3996:2019. The materials used specifically in the manufacture and supply of covers and grates for trench drains shall comply with the requirements of AS 3996:2019.

705.11 STORMWATER DRAINAGE CONNECTIONS

All stormwater drainage connections to drainage pits shall be neatly made, and where necessary the ends of all drains shall be trimmed off and finished with cementitious mortar as stated in clause 705.15.

Openings into drainage pit walls to facilitate stormwater drainage connections shall be neatly saw cut to the required size.

~~Weepholes or holes~~ Holes installed on site shall be cut. Breaking out of holes is not permitted. Drainage pits shall be replaced if circumferential or longitudinal cracking occurs as a result of installing holes or if the hole exceeds the pipe diameter by more than 50 mm.

Reinforcement exposed by the cutting of holes shall be coated with an approved epoxy treatment to prevent corrosion prior to rendering around the pipes.

705.12 STEP IRONS

Drainage pits greater than 1.0 m deep shall be fitted with step irons as shown on the drawings. Steps shall be located so that they do not obstruct openings and that water does not discharge onto them. Steps shall be set into a wall which has no openings, or beside an opening, or across a corner of the pit.

Step irons shall be installed horizontal, vertically in line and shall project uniformly from drainage pit walls.

Where drainage pits are extended in height from the lowest pit, step irons shall be located such that an equidistant spacing between step irons is still maintained.

Step irons of an approved proprietary type shall be installed in accordance with the manufacturer's instructions.

Where step irons are cast in place, they shall be epoxy mortared into drilled holes using an epoxy material and method approved by the Superintendent Council. The joints between the step irons and the shafts shall be completely filled and neatly pointed so that the step irons are held rigid and the joints are watertight.

705.13 SHAPING OF FLOOR

Drainage pit floors shall be smoothly shaped from the inlets to the outlet for a height of one-third of the diameter of the outlet pipe with cementitious mortar, to provide a profile that will ensure smooth flow conditions between inlet and outlet pipes and prevent any snagging of debris. The cementitious mortar shall comply with the requirements of clause 610.33.

705.14 SURFACE FINISH

The method of construction and the materials used in the concrete and formwork shall remain consistent and shall comply with the requirements of this specification for surface finish.

Surfaces shall be finished uniform in appearance with a Class 2 surface finish in accordance with the requirements of Section 610.

705.15 JOINTING

The ends of components shall be free of any foreign matter at the time of jointing and shall be arranged to give best fit.

The joints between various components such as drainage pits, access chambers and pipes shall be made watertight using a cementitious mortar in accordance with the requirements of clause 610.33. The joint areas shall be thoroughly cleaned and wetted just prior to filling. The cementitious mortar shall be used within its allowable application time and shall not be retempered.

The joints shall be finished to provide smooth surfaces, uniform with the inner surfaces of drainage pits and access chambers.

Mortared joints and recesses shall be cured for a period of not less than 48 hours. Backfilling operations against end structures shall not be carried out during the curing period.

705.16 CONCRETE REPAIRS

The method of repair of minor surface imperfections including porous spots, shallow honeycombing, rough areas and blow holes not conforming to the class of surface finish as specified in clause 705.14, and the method of cementitious patch repair of other concrete defects shall be as agreed or accepted by Council in accordance with Section 689.

Epoxy materials shall not be used for the patch repair of concrete.

The exposed surface of the repaired area shall be similar in texture and colour to the surrounding concrete.

705.17 FITTING OF COVERS

Frames for drainage pit covers shall be cast into the top of the drainage pit or bedded on fresh mortar, 5 mm thick, consisting of two parts of sand, one part of cement and sufficient water to produce a mix of suitable consistency or fixed as per the suppliers specification.

The level at every point of the perimeter shall be within 10 mm of the design level for that point, and the line of the cover shall be within 10 mm of the design kerb line.

705.18 BACKFILLING AROUND DRAINAGE PITS

Backfilling around drainage pits shall be placed in layers not exceeding 300 mm loose thickness and compacted to refusal using hand held mechanical equipment.

705.19 TOLERANCES

The tolerances listed in clause 610.46 are the allowable deviations of the finished product from the dimensions shown on the drawings. These tolerances will be a basis for acceptance of the work.

SECTION 706 - INSTALLATION OR REPLACEMENT OF UTILITY INFRASTRUCTURE WITHIN ROAD RESERVES

~~##This section cross-references Section 173.~~

~~If Section 173 is relevant, it should be included in the specification.~~

~~If Section 173 is not included in the specification, all references to it should be struck out, ensuring that the remaining text is still coherent.~~

706.01 DESCRIPTION

This section covers requirements for the installation or replacement of utility infrastructure (e.g. conduits, pipes, service pits, poles, aerial services/cables) within the existing and future road reserve ~~of an arterial road or freeway~~, as shown on the drawings, or as specified.

706.02 LEGISLATIVE FRAMEWORK

The management principles and practices applying to utilities and road authorities for the installation, maintenance, replacement and operation of utility infrastructure within road reserves are set out in the Road Management Act 2004, Road Management (Works and Infrastructure) Regulations 2005 and the Code of Practice for Management of Infrastructure in Road Reserves (Victoria Government Gazette No. S 269 Monday 6 October 2008).

All planning, design and installation or replacement of utility infrastructure, as shown on the drawings, or as specified, shall be carried out in accordance with the requirements set out in the above legislative framework and the additional requirements specified in this section.

Any consultation required with, and authorisation required from, other authorities under relevant utility regulations and codes shall be the responsibility of the Contractor.

706.03 POSITIONING, DEPTH AND HEIGHT CLEARANCE

All utility infrastructure within road reserves shall be clear of road carriageways and parallel or at right angles to the centreline of road carriageways unless otherwise agreed with ~~the Superintendent~~ Council.

Aerial services shall have a minimum height clearance of 5.5 m above the finished road surface level or the natural surface. Poles for aerial services shall have a minimum lateral clearance of 3 m from the edge of carriageway in urban areas and 9 m in rural areas, except where frangible poles are used.

Unless otherwise shown on the drawings or specified, utility infrastructure and associated conduits installed under road carriageways ~~for freeways and arterial roads~~ shall be at depths to provide a minimum of 450mm or to the service authority requirements, whichever is the greater ~~the following~~ cover over the top of the infrastructure to subgrade level (including conduit):

- ~~(a) 1200 mm minimum cover to the finished road surface level; and~~
- ~~(b) 750 mm minimum cover to the invert level of road carriageway open drains.~~

706.04 BORING UNDER CARRIAGEWAYS

Unless otherwise specified or approved by ~~the Superintendent~~ Council, all utility infrastructure (including conduits) under road carriageways shall be installed by boring.

Detailed proposals for boring under carriageways or alternative underground methods proposed by the Contractor shall be submitted to ~~the Superintendent~~ Council for review two weeks prior to the programmed commencement of work.

Unless otherwise specified, boring by water jetting will not be permitted.

Unless otherwise specified, the annulus between the bore and the pipe or carrier-conduit shall be filled by pressure grouting.

706.05 EXCAVATION

Where the open trench method of crossing under a carriageway pavement is accepted, the line of the trench shall be straight, at right angles to the carriageway, and form the shortest link between terminals wherever practical. The width of trench shall be not greater than that necessary to carry out the work as approved by Council.

The edges of all trenches located within a road pavement shall be sawcut.

Any infrastructure located within the road reserve that is disturbed as a result of the work shall be reported immediately to the ~~Superintendent~~ Council and shall be reinstated promptly in consultation with the relevant infrastructure manager.

706.06 MATERIALS

Unless otherwise specified, materials used for bedding and backfilling shall be uniform in composition and free from perishable matter and shall comply with the requirements specified in Table 706.061.

Table 706.061 Material Properties

Material	Sieve Size - AS (mm)					Plasticity Index	
	Percentage Passing (by mass)						
	75.0	37.5	19.0	2.36	0.075	min	max
Bedding	-	-	100	-	10-40	2	10
Selected backfill	-	100	-	-	10-40	5	20
Common backfill	100	-	-	40-100	-	-	-

Pavement material shall be as specified in Clause 706.12 and shall comply with the requirements of the specified sections as applicable.

Table 706.061 Material Properties

<u>Material</u>	<u>Requirements</u>
<u>Bedding</u>	<u>20 mm nom size Class 3 crushed rock as specified in Section 812</u> <u>Or</u> <u>20 mm nominal size Class 3 crushed concrete as specified in Section 820</u>
<u>Selected Backfill</u>	<u>20 mm nom size Class 3 crushed rock as specified in Section 812</u> <u>Or</u> <u>20 mm nominal size Class 3 crushed concrete as specified in Section 820</u>
<u>Ordinary Backfill</u>	<u>Clay or fill from site free of vegetation and other deleterious matter. It shall not contain more than 20% rock. The rock shall not be larger than 75mm.</u>

706.07 BEDDING

Where specified in Clause 706.12 that bedding is required, bedding shall be placed below, around and above the pipe or carrier conduit for the full width of the trench. Not less than 25 mm compacted depth of bedding shall be placed below, and not less than 150 mm compacted depth of bedding shall be placed above, the pipe or carrier conduit. Bedding shall be placed in layers not exceeding 150 mm loose thickness and shall be compacted as specified.

Bedding shall be no less than 50mm compacted depth consisting of a minimum 20mm nominal size Class 3 crushed rock or as required by the relevant service authority.

706.08 BACKFILLING

Unless otherwise specified or shown on the drawings, selected and common backfill shall be placed and compacted as follows under, around, and above the conduit after the sections are bedded:

(a) Conduits under Area to be Paved, including Shoulders and Verges

The trench shall be backfilled to design subgrade level with selected backfill material as per Table 706.061 and above that level with the design and / or existing pavement material, in layers not exceeding 150mm loose thickness. Where the trench has been excavated from the nominated or designed subgrade level or above, the trench shall be backfilled up to the nominated or designed subgrade level with selected backfill material placed and compacted in layers not exceeding 150 mm loose thickness, and above that level with common backfill material.

~~Where the trench is excavated from below the nominated or design subgrade level, the trench shall be filled with selected backfill material placed and compacted in layers not exceeding 150 mm loose thickness.~~

(b) Conduits within one metre of areas to be paved

The trench shall be backfilled with select backfill material to design subgrade level or 150mm above the top of the culvert whichever is the greater and with ordinary backfill above that level, in layers not exceeding 150mm loose thickness.

(b) Conduits under Area not to be Paved

~~The opening shall be backfilled with common backfill placed and compacted as specified in layers not exceeding 200 mm loose thickness.~~

(c) Conduits under Area not to be Paved

The trench shall be backfilled with selected backfill material to a level 150mm above the top of the culvert and with ordinary backfill material above that level, in layers not exceeding 200mm loose thickness.

~~The opening shall be backfilled with common backfill placed and compacted as specified in layers not exceeding 200 mm loose thickness.~~

(d) Conduits through Existing Paved Areas including Shoulders and Verges

Unless otherwise specified or shown on the drawings, the opening shall be backfilled to the existing subgrade level with selected backfill material as per Table 706.061 placed and compacted in layers not exceeding 150 mm loose thickness and the pavement material placed and compacted in layers not exceeding 400 150 mm loose thickness ~~using materials in accordance with Clause 706.12 (b).~~

706.09 COMPACTION STANDARDS**(a) Bedding and Backfill (except pavement)**

Unless otherwise specified, bedding and backfill shall have during compaction a uniform moisture content within the range 85% to 115% of the optimum moisture content as determined in the Standard compactive effort. For backfill of nominal size greater than 40 mm the fraction of material passing the 37.5 mm sieve shall have during compaction a uniform moisture content within the range 85% to 115% of the optimum moisture content as determined for that fraction in the Standard compactive effort.

Bedding and backfill shall be compacted to refusal using hand held mechanical equipment.

Backfilling beneath or within one metre of areas to be paved shall be assessed for compaction in lots as defined in Section 173. The number of tests per lot shall be three. ~~Backfill, the whole of which passes the 37.5 mm AS sieve, shall be compacted to a mean value of density ratio of not less than 987%. The calculation of density ratio shall be based on Standard modified compactive effort. A lot shall consist of a single layer of work. A minimum of 20% of all lots constructed shall be tested.~~

~~Detailed proposals for the compaction of backfill materials of nominal size greater than 40 mm shall be submitted to the Superintendent for review before commencing work.~~

(b) Pavement

Unless otherwise specified, pavement material shall have during compaction a uniform moisture content within the range 85% to 115% of the optimum moisture content as determined in the Modified compactive effort.

Pavement material shall be assessed for compaction in lots as defined in Section 173. The number of tests per lot shall be three. All pavement layers shall be compacted to a mean value of density ratio not less than 98% the percentage specified in Clause 706.12(b). The calculation of density ratio shall be based on Modified compactive effort. All pavement layers shall be tested.

706.10 CLEANING OF SITE

Surplus excavated material shall be removed from the road reserve. Areas affected by the work shall be restored to a condition similar to that which existed prior to the commencement of the work.

706.11 MAINTENANCE OF PAVEMENT

The reinstated surface shall be maintained in a trafficable condition after the completion of backfilling. Additional pavement material shall be placed in the trench and compacted as specified where in paved areas settlement or loss of material from the surface exceeds 20 mm measured from a straight edge laid across the top of the trench.

706.12 SCHEDULE OF DETAILS

*** (a) Bedding (Clause 706.07) - ~~###(strikethrough 'Required' or 'Not Required')~~:Required / Not required

*** (b) Pavement Material (Clause 706.06)

Pavement Layer	Material Type	Thickness (mm)	Density Ratio (Modified)
1. ###:			
2.			
3.			
4.			
5.			

SECTION 707 - FENCING

~~##This section cross references Section 703.~~

~~If Section 703 is relevant, it should be included in the specification.~~

~~If Section 703 is not included in the specification, all references to it should be struck out, ensuring that the remaining text is still coherent.~~

707.01 GENERAL

This section covers the requirements for the supply and quality of materials, preparation of the site, removal of existing fencing, supply and installation of all fencing materials, including gates and connections to existing fencing at the locations shown on the drawings or described in this specification.

The Contractor shall conduct its operations in such a manner as to prevent the escape or improper movement of livestock.

Existing fencing shall not be removed until the new fencing has been erected and is stock-proof.

Existing fencing which has been damaged by the Contractor and which is required to remain in place shall be repaired or replaced to the satisfaction of the ~~Superintendent~~ Council at the Contractor's expense.

707.02 AUSTRALIAN STANDARDS

AS 1074	Steel tubes and tubulars for ordinary service
AS/NZS 1111	ISO Metric hexagon commercial bolts and screws
AS/NZS 1112	ISO Metric hexagon nuts, including thin nuts, slotted nuts and castle nuts
AS/NZS 1163	Cold-formed structural steel hollow sections
AS 1214	Hot-dip galvanized coatings on threaded fasteners
AS 1237	Flat metal washers for general engineering purposes (metric series)
AS/NZS 1390	Cup head bolts with ISO metric coarse pitch threads
AS 1397	Continuous hot-dip metallic coated steel sheet and strip - Coatings of zinc and zinc alloyed with aluminium and magnesium
AS 1450	Steel tubes for mechanical purposes
AS 1604	Timber, preservative treated, sawn and round
AS 1725.1	Chain link fabric fencing - Security fences and gates - General requirements
AS 2082	Timber – hardwood – visually graded for structural purposes
AS 2334	Steel nails – metric series
AS 2423	Coated steel wire fencing products for terrestrial, aquatic and general use
AS 2858	Timber – softwood – visually graded for structural purposes
AS 3600	Concrete Structures
AS 3750.9	Paints for steel structures – Organic zinc-rich primer
AS 4534	Zinc and zinc/aluminium-alloy coatings on steel wire
AS 4680	Hot dipped galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4792	Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process

707.03 MATERIALS

Unless specified otherwise, all fencing materials and products shall be supplied by the Contractor and shall be of the dimensions, manufacture, quality and structural grade in accordance with the requirements of this specification and drawings.

(a) Untreated Timber Posts and Stays

Untreated timber posts and stays shall be hardwood timber in accordance with AS 2082 and shall be cut from sound timber, stripped of all bark and backed off with ends sawn square and dried to equilibrium moisture content. Posts and stays shall be straight and of dimensions not less than shown on the detailed drawings.

(b) Treated Timber Posts and Stays

Treated timber posts and stays shall be hardwood timber in accordance with AS 2082 or pine in accordance with AS 2858 and be of sound timber treated to comply with the requirements of AS 1604 for Hazard Level 4 protection. Treated timber posts and stays shall be of round or sawn rectangular shape and be free of any defect making them unsuitable for the purpose intended.

Round posts and stays shall be peeled to remove all bark, except that strips of inner bark may remain if not over 15 mm wide or over 75 mm long. All knots shall be trimmed flush with the sides, spurs and splinters removed and ends cut square.

The slope of grain in sawn rectangular posts, for the full length, shall not exceed 1 in 10; and knots shall be sound, tight, well spaced, and shall not exceed 40 mm in size in any face.

Treated timber posts and stays shall be straight and of dimensions not less than shown on the detailed drawings. Posts to be driven shall be square ended, or shall be blunt pointed prior to treatment to a bevel angle not exceeding 30 degrees.

(c) Tubular Steel Posts, Rails and Stays

Steel posts shall be manufactured from steel complying with one of AS 1074, AS/NZS 1163, AS 1397 or AS 1450, and having a minimum yield strength of 195 MPa. The dimensions of tubular steel shall be in accordance with the requirements for medium tubes to AS 1074.

Steel posts shall be either:

- hot dipped galvanised in accordance with AS/NZS 4680; or
- pre-galvanised prior to forming in accordance with Z275 coating class to AS 1397 (total minimum coating mass on both surfaces of 275 g/m²). The finished tube must be equivalent to AS/NZS 4792 ZB135/135. The weld seam made during forming of pre-galvanised steel post sections shall be repaired in accordance with AS/NZS 4792, Section 3, by applying a coating using a metal spraying system employing a suitable zinc or zinc-alloy wire/powder.

All steel shall be free from distortion, with the galvanizing intact, and protected from damage at pipe connections.

Posts shall be either adapted before galvanizing, or modified and protected after galvanizing, to provide means for attaching the fencing to the posts in a manner that will not damage the posts or fencing material, and shall be fitted with watertight galvanized steel tops.

Any damage to the galvanized coating of tubular steel posts, rails and stays and other galvanized products specified in this section shall be repaired using an organic zinc-rich primer complying with AS 3750.9.

(d) Steel Posts other than Tubular Steel Posts

Non-tubular steel posts shall be of 'Star' or other specified cross section and shall be black varnished or hot-dip galvanized in accordance with AS/NZS 4680 and drilled to suit the spacings of the wires and the lengths shown on the drawings.

(e) Reinforced Precast Concrete Posts

Precast concrete posts shall be steel reinforced and designed in accordance with AS 3600. Unless otherwise specified or shown on the drawings, concrete shall be N32 standard strength grade, placed, compacted and cured in accordance with the requirements of Section 703. Steel reinforcement shall comply with the requirements of AS 3600.

(f) Droppers

Timber droppers shall be sawn hardwood timber in accordance with AS 2082 or pine in accordance with AS 2858 and free from cross grain and large knots and of the length shown on the drawings.

Bored hardwood droppers shall be of 50 mm x 38 mm nominal size timber. Treated hardwood droppers to AS 1604 attached without boring shall be not less than 35 mm x 19 mm section.

Pine droppers shall be 42 mm x 35 mm minimum size timber and be pressure treated with preservative to AS 1604.

Metal droppers shall be hot dipped galvanized in accordance with AS/NZS 4680 and to the lengths shown on the drawings.

(g) Wire

All wire products including tie wire shall comply with the requirements of AS 2423, galvanized in accordance with AS 4534 and be of the gauge and type specified on the drawings.

Fabricated wire fencing shall be standard proprietary manufactured item. The width, mesh and gauge shall be as specified or as shown on the drawings.

(h) Gates

Gates shall be standard proprietary manufactured items with galvanized tubular steel frame in accordance with AS 4680 of the type and dimensions specified or shown on the drawings.

Hinges, catches and other fittings for gates shall be standard proprietary manufactured items fabricated from grade 250/300 structural steel and hot-dipped galvanized in accordance with the requirements of AS 4680.

(i) Miscellaneous Materials

All ferrous bolts, nuts and washers, shall be standard proprietary manufactured items complying with the requirements of AS/NZS 1111, AS/NZS 1390, AS/NZS 1112 and AS 1237. Bolts, nuts and washers shall be hot-dipped galvanized in accordance with the requirements of AS 1214. Ties, staples and other minor fittings for fences shall be galvanized standard proprietary manufactured items.

All brackets for steel posts and treated timber posts shall be standard proprietary manufactured items fabricated from grade 250/300 structural steel and hot-dipped galvanized in accordance with the requirements of AS 4680.

All concrete specified or shown on the drawings shall be strength grade N20 complying with the requirements of Section 703.

Steel nails shall be manufactured in accordance with AS 2334 and shall be hot-dipped galvanized to 300 g/m² coating mass in accordance with AS 4680.

(j) Electrical Insulation Materials

All fittings shall be standard proprietary manufactured items of the type and dimensions specified or shown on the drawings.

(k) Certificate of Compliance

The Contractor shall submit for review by the Superintendent Council not less than 14 days prior to the proposed use of fencing materials, gates and connections to existing fencing, a signed Certificate including relevant test reports demonstrating the compliance of the materials and components required for the construction of each type of fencing, gates and connections to existing fencing, comply with the requirements of this specification.

The Certificate of Compliance shall identify the item and record the product certification, inspection or test records that verify conformance. All certification, inspection and test records shall be available for review upon request by the Superintendent Council.

707.04 CONSTRUCTION

Fences shall be constructed true to the lines pegged on the ground. All logs, stumps, saplings and undergrowth within 1 m of the fence line, and all trees which will interfere with the proper construction of the fence shall be removed and disposed of by the Contractor. Any high points which interfere with the placing of wire or wire netting shall be cut down to provide the clearance shown on the detailed drawings, and any low spots shall be filled with surplus earth from holes and trimmings.

Fences shall be constructed in accordance with the drawings. All posts shall be set in line so that the tops line up uniformly without sudden dips or irregularities.

Unless otherwise specified, surplus earth from holes and trimming shall be spread within the road reserve and the area shall be left clean and tidy on completion of the work.

Straining of wires shall be done using an approved friction type wire strainer which incorporates a non-scarring wire grip and a tensioning gauge with calibrating springs for measurement of the tension as shown on the drawings or to the manufacturer's recommended maximum tensions. The Contractor shall take all precautions necessary to avoid kinking and overstraining of the wire during handling and installation.

(a) Post and Wire Fences

Timber and concrete posts shall be set in dug or drilled holes, except that posts of treated round timber may be driven provided the method of driving does not damage the post. Posts shall be set solidly and any space left around the posts shall be backfilled and the backfilling compacted. Posts to be driven shall be driven small end down. Other posts shall be placed butt end down.

Steel posts shall be set by driving using a method that does not damage the posts or their galvanizing.

At all grade changes where posts are liable to be lifted by strained wires, posts shall be at least 2.1 m long, set at least 900 mm into the ground and tied down. Tie down posts comprising 600 mm galvanized star steel posts shall be driven into the ground at an angle of 45 degrees, and the bottom four wires preferably adjacent to a post or dropper shall be tied to it by galvanized tie wire at least 2 mm diameter.

Unless otherwise shown on the drawings all other posts shall be set at least 600 mm into the ground.

Strainer assemblies shall be provided at all ends, angles, abrupt changes of grade, and intersections of cross fences as shown on the drawings. Intermediate strainer assemblies shall be provided on straights at intervals not exceeding 200 m, and spaced to the best advantage in the circumstances.

Strainer assemblies at ends and gates shall be single strainer except where provision of double strainer assemblies is specified. Intermediate strainer assemblies shall be single strainer assemblies with both diagonals braced. Corner posts shall be braced in two directions and gate posts shall be braced in one direction.

Plain wires shall be reeved through holes drilled in the posts except that where treated round posts are used wires may be attached with staples after straining. The length of staples shall be 50 mm for pine posts and 40 mm for hardwood posts. Barbed wire shall be secured with galvanized tie wire of not less than 2.5 mm diameter passed through holes bored in the posts, and twisted to the barbed wire on each side of the post, or shall be stapled to treated posts with staples. Top and bottom wires shall be firmly attached to droppers by preformed ties or twisted galvanized tie wire of not less than 2.5 mm diameter. Intermediate wires shall be similarly attached or shall be threaded through holes bored in the droppers.

(b) Wire Netting Fences

Posts and wire shall be erected as for post and wire fences. The netting shall be tightened between posts, and shall be fastened to timber posts and droppers with 25 mm staples at 150 mm intervals and to steel posts and droppers with proprietary galvanized clips or 2.5 mm galvanized tie wire, at 150 mm intervals. The netting shall also be fastened to each wire with 2.5 mm diameter galvanized tie wire or proprietary galvanized clips at intervals not exceeding 1 m.

(c) Wire Mesh Fences

Posts and wire shall be erected as for post and wire fences.

Wire mesh shall be attached to posts and droppers by stapling or tying the top and bottom line wires and at least every alternate intermediate wire to each post after straining.

(d) Chain Wire Fences

Posts shall be set in concrete footings of the dimensions shown on the drawings, with the top of the concrete crowned to shed water. End, corner and gate posts shall be braced as shown on the drawings. Line posts shall be braced as shown on the drawings at not more than 120 m intervals. Chain wire shall comply with the requirements of AS 1725.

Chain wire shall be tightened and securely fastened to posts and line wires on the side as shown on the drawings. Fastening to end, corner and gate posts shall be by lacing through each outer mesh with 2.5 mm diameter galvanized tie wire. Chain wire shall be fastened to line posts and line wires with 2.5 mm diameter galvanized tie wire or clips. The fastenings shall be spaced at not more than 400 mm intervals on line posts and at not more than 500 mm intervals on line wires.

(e) Steel Post and Welded Mesh Fences

Posts shall be set in concrete footings of the dimensions shown in the drawings, with the top of the concrete crowned to shed water.

Welded mesh panels shall be attached to posts with standard proprietary manufactured galvanized fittings.

(f) Paling and Timber Post Sound Attenuation Fences

Posts shall be set in concrete and the fence shall be constructed to the dimensions and locations as shown on the drawings.

Palings shall be straight and clean, and free from splits and major defects. Palings shall be fixed to each rail as shown on the drawings.

(g) Electrical Insulation of Fences

Where specified, insulation panels and fittings shall be incorporated in fences in close proximity to overhead power transmission lines, in accordance with the drawings.

707.05 GATES

The Contractor shall install gates of the type, size and location as specified, or shown on the drawings. Gate posts shall be of the dimensions shown on the drawings and be firmly set into the ground to the depth specified or as shown on the drawings. Each post shall be fitted with a strut as shown on the drawings. Tubular metal posts shall be set in concrete as detailed. At gateways in wire netting fences, a timber sill shall be set tightly between the posts and flush with the ground.

All gates shall be hung with galvanized hinges securely attached to the gate posts and be able to swing freely. Each gate shall be fitted with a galvanized catch for holding them securely closed, of a type to suit the gate and adjoining fence. For wire netting fences, gates shall be finished so as to be rabbit-proof when closed.

707.06 JUNCTIONS WITH EXISTING FENCES

New fences shall be connected to existing cross fences and existing fences which continue the line of the new fences. Posts with braces for every direction of strain shall be placed at the junction with existing fences. The wire in existing fences shall be strained and securely fastened to the junction posts.

707.07 REMOVAL OF EXISTING FENCES

Where specified or shown on the drawings, existing fences, including all wires, mesh, posts, rails, strainers, netting and concrete footings shall be removed and re-erected to the pattern existing prior to removal.

Fences no longer required shall be removed. All materials comprising the removed fences shall become the property of the Contractor and shall be removed from the site. All footing, post and strainer holes shall be backfilled and compacted in layers of a maximum depth of 150 mm with surplus earth or topsoil to the relative compaction of the surrounding ground material.

707.08 CONSTRUCTION TOLERANCES

Unless stated otherwise, tolerances for the construction of fencing shall be as follows:

- (a) the vertical tolerance on the height of fencing shall be ± 20 mm from the design line;
- (b) the longitudinal line tolerance for fencing shall be ± 20 mm in plan view; and
- (c) the tolerance on the verticality of fencing shall be 1 in 50.

SECTION 708 - STEEL BEAM GUARD FENCE

~~##This section cross references Sections 175, 703, 711, 812 and 820.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

708.01 GENERAL

This section covers the requirements for the supply and/or installation of steel beam guard fence including proprietary guard fence systems and guard fence terminals.

708.02 STANDARDS

(a) Australian Standards

Australian Standards are referenced in an abbreviated form (e.g. AS 1012).

AS 1012	Methods of testing concrete
AS 1111.1	ISO Metric hexagon bolts and screws
AS 1112.1	ISO Metric hexagon nuts
AS 1214	Hot dip galvanized coatings on threaded fasteners
AS/NZS 1365	Tolerances for flat-rolled steel products
AS 1379	Specification and supply of concrete
AS 1391	Metallic materials - Tensile testing at ambient temperature
AS/NZS 1554.1	Welding of steel structures
AS/NZS 1594	Hot rolled steel flat products
AS 1627	Metal finishing
AS 1720.2	Timber structures – Timber properties
AS 1742	Manual of Uniform Traffic Control Devices
AS/NZS 1906.2	Retroreflective materials and devices for road traffic control purposes - Retroreflective devices (non-pavement application)
AS 3569	Steel wire ropes – Product specification
AS/NZS 3750	Paints for steel structures
AS/NZS 3845	Road safety barrier systems
AS 4100	Steel Structures
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated ferrous articles

(b) Other Documents

VicRoads	Traffic Engineering Manual
VicRoads	Supplement to AGRD Part 6, Section V6.7.12 Provision of Concrete Paving Adjacent to Traffic Barriers
VicRoads	Safe System Design Notes
VicRoads	Road Design Notes
VicRoads	RDN 06-04 - Accepted safety barrier products
VicRoads	RDN 06-08 - The use of Guard Fence
VicRoads	Standard Drawings for Roadworks
Proprietary	Manufacturer's specification and drawings for proprietary guard fence systems and associated national or international standards

Section 175 details the references to these documents.

Other Documents

Manufacturer's recommendations and any applicable VicRoads requirements for each proprietary end treatment.

708.03 DEFINITIONS

The following definitions below will apply to this section.

Manufacturer's recommendations: The specification, installation manual and drawings for a specific proprietary safety barrier device, prepared by or for the manufacturer, detailing the components, the device, and the methods and/or procedures for installation.

Nested w-beams: Two or more steel w-beams erected together (one inside the other) to increase stiffness. Nested w-beams share bolts.

Definition of terms: The meaning of terms and definitions in this section shall be as defined in AS/NZS 3845.

Snug-tight: Is the tightness attained by at least two impacts of an impact wrench or by the full effort of a person using a standard podger spanner in accordance with AS 4100.

708.04 ACCEPTED PRODUCTS

Only safety barrier products listed in VicRoads Road Design Note 06-04 shall be used.

Unless specifically noted within the relevant sub clause, the requirements of this specification apply to public domain and proprietary guard fence systems equally.

Products which are discontinued and in this case including legacy products, or the manufacturer has identified as to be discontinued shall not be used.

New guard fence installations shall not be connected to any products which have been discontinued or identified for discontinuance unless approved by the Superintendent Council.

708.05 GUARD FENCE COMPONENTS

(a) Identification

Mark on any steel w-beams, posts at both ends and all plastic components of proprietary end treatments unobtrusively and permanently in text not more than 20 mm high, the following information:

- (i) name of the manufacturer
- (ii) batch number, or date of manufacture
- (iii) strength grade and base metal thickness of the steel w-beams.

(b) Material test certificates

The properties of all steel for the Works shall be evidenced by test certificates.

HP **Where requested the Contractor shall submit to the Superintendent Council all test certificates related to the supply of steel for the Works at least 14 days prior to commencement of installation.**

Laboratories that perform tests required by this Section shall meet the requirements of AS ISO/IEC 17025. All test reports shall be endorsed in accordance with the AS ISO/IEC 17025 accreditation for that laboratory. Testing laboratories shall comply with the resource requirements for competent testing personnel and appropriate supervision as required by AS ISO/IEC 17025. (Test reports may be called test certificates.)

NOTE: Accreditation bodies which are signatories to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) for testing laboratories can offer accreditation against the requirements of AS ISO/IEC 17025. A listing of ILAC signatories is available from the ILAC website (www.ilac.org). In Australia, the National Association of Testing Authorities (NATA, <https://www.nata.com.au>) is a signatory to the ILAC MRA.

The appropriate logo or further details of the ILAC (MRA) signatory shall be noted on the test document, and all reporting requirements of the test method and material standard shall be included. All test reports shall be in English alphanumeric characters.

Where the certification of the steel is incomplete, the Contractor shall arrange for testing to be carried out to demonstrate compliance of the material, at the rate of one test per 1000 lineal metres of material. All test certificates shall be endorsed in accordance with the AS ISO/IEC 17025 accreditation for the testing laboratory

(c) Metal components

Metal components supplied by the Contractor shall be new and conform to the dimensions shown on the drawings.

(i) W-beams

The w-beams shall be manufactured from steel which meets the requirements of AS/NZS 1594 Grade HA350.

The mechanical properties of the base metal shall conform to the following requirements when tested in accordance with AS 1391:

Minimum yield strength 350 MPa

Minimum tensile strength 430 MPa

Minimum elongation in 80 mm 16%

The base metal shall comply with the following tolerances when measured in accordance with the methods of AS/NZS 1365:

Base metal thickness 2.7 mm -0.10 mm, +0.21 mm

Mill tolerance on strip width +2.5 mm, -0.0 mm

Mill camber tolerance on 2500 mm length 10.0 mm maximum

(ii) Steel Posts and Blocks

Steel posts and blocks shall be manufactured from steel which meets the requirements of AS/NZS 1594 Grade HA250.

The base material thickness shall be 6.0 mm \pm 0.27 mm.

(iii) Terminal sections

Terminal sections and stiffener plates shall be manufactured from steel which meets the requirements of AS/NZS 1594 Grade HA350.

(d) Protective treatment

Unless stated otherwise in the manufacturer's recommendations, the surfaces of all ferrous metal components including posts, blocks, beam elements, anchor plates, connectors and end treatment pieces must, after fabrication, be treated in accordance with the requirements of AS 1627 - Parts 1 and 4, and finished by hot-dipped galvanising in accordance with AS/NZS 4680.

All galvanised coatings shall be smooth, adherent and free from stains, gross surface imperfections, markings, brand names and/or inclusions. Appearance is of prime importance and colour shall be uniform.

Hot-dipped galvanised coating on bolts, nuts and washers shall comply with AS 1214.

Where the galvanising on guard rail or associated fittings has been damaged, the coating shall be repaired by regalvanising or by painting with a minimum of two coats of a zinc-rich inorganic paint in accordance with AS/NZS 3750.9 and one coat of aluminium paint.

Where curved w-beam of less than 45 m curve radius is specified, the curving operation shall be carried out off site in a manner that will not result in damage to the galvanising.

(e) Timber

Timber posts and blocks shall be supplied to the dimensions shown on the drawings. The treatments shown in SD 4091 and SD 4092 are the only ones where timber posts are used

Timber posts and blocks shall be seasoned timber dried to equilibrium moisture content and sawn from species complying with Class 1 or 2 durability and stress grading as specified.

All timber shall be straight and sound, and free from shakes, pipes, cores, flaws and other imperfections. The timber shall be sawn parallel to the grain, and exposed knots shall be sound, tight, well spaced and shall not exceed 25 mm in size on any face.

(f) Wire rope

Wire rope in anchor assemblies for post and w-beam end treatments shall comply with the requirements of AS 3569 and the details shown on the Drawings.

Wire rope used in proprietary devices must comply with the manufacturer's recommendations.

(g) Concrete

Concrete for guard fence maintenance strips shall comply with the requirements of AS 1379, and as specified in VicRoads Section 703, for either:

- (i) Portland cement-based concrete, N20 strength grade, or
- (ii) Geopolymer binder-based concrete, 20 MPa strength grade.

The use of chemical admixtures shall comply with the requirements of Section 703.

708.06 MATERIAL HANDLING AND STORAGE

The Contractor shall ensure that loading, transport, unloading, stacking and handling operations before and after fabrication, are carried out in such a way that items are protected from distortion and that galvanised surfaces are protected from damage.

All materials and components shall be stored in such a manner that damage and corrosion are prevented. Generally, storage at least 200 mm above the ground on platforms, slabs, or other supports under cover will be satisfactory. Rusted or bent or damaged steel shall be rejected.

The Contractor shall store components in such a manner that the freshly galvanised surfaces are protected from the attack of 'white rust', which can occur on freshly galvanised articles that are transported or stored under damp or badly ventilated conditions (including contact stacking).

If stacks are located behind a serviceable road safety barrier system, the clear space between the road safety barrier system and the stack must allow for the dynamic deflection of the system and be at sufficient distance from the ends of the system to allow the proper functioning of the end treatments.

708.07 CONSTRUCTION

(a) General

Construction of guard fence includes supply, delivery, handling and assembly of component and devices, setting out, and supply and installation of delineation.

The Contractor shall plan and execute the work in a manner that prevents damage to underground and above ground facilities such as utilities, services, structures, pavements, vegetation, etc.

The Contractor shall construct the guard fence to form a smooth line vertically and horizontally, when viewed along the line of the installation, free of humps, sags, or other irregularities, within tolerances.

Any component of a guard fence must not be welded or flame cut in the field under any circumstances. Welding and flame cutting in a workshop may be undertaken only where shown on the Drawings or in accordance with the manufacturer's recommendations.

(b) Damage

Where the galvanising on guard fence components or associated fittings has been damaged, the coating shall be repaired by regalvanising or by painting with a minimum of two coats of a zinc-rich inorganic paint in accordance with AS/NZS 3750.9 and one coat of aluminium paint.

(c) Sequence of work

Where the guard fence is being constructed on a road open to traffic, the Contractor shall carry out the work so end treatments and transitions can be commissioned at the earliest practicable time, desirably on the day of installation. Where this cannot be achieved on the day, temporary end treatments to the satisfaction of the Superintendent Council shall be provided until the permanent treatment is complete.

(d) Removal of redundant safety barrier systems

Removal of an existing installed safety barrier system includes:

- (i) dismantling or demolition of safety barriers, transitions and end treatments;
- (ii) extracting all posts, anchors and other in-ground components and materials;
- (iii) removing all components and waste materials from the site;
- (iv) cleaning, backfilling and mechanically compacting all excavations and holes formed by the extraction of posts, anchors and other in-ground components and materials; and
- (v) stacking or disposing of components and waste materials.

Following the removal of all redundant posts, anchors and other in-ground components by extraction or excavation, the holes shall be cleaned and backfilled. Backfilling and compaction of holes shall proceed in 150 mm layers using similar materials to existing surrounding layers. The backfill shall be compacted to not less than the density of the surrounding layers.

708.08 INSTALLATION

HP Prior to installation the Contractor shall confirm with the Superintendent Council the required location and length of all guard fence.

The guard fence shall be installed at the positions so confirmed and shall be constructed true to line and level.

(a) Posts

Posts shall be installed to the depth, line and spacing shown on the drawings, and to the tolerances in Clause 708.07(d).

Posts shall be orientated to the direction of traffic as shown on the drawings.

Posts shall be installed by driving, provided there is no distortion or damage which may reduce their effectiveness. The installation must not cause any damage to the pavement beyond 100 mm from any part of any post, including any soil plate attached to the post.

If site conditions dictate that the posts cannot be driven, then the posts shall be installed in holes. The bottom of the holes shall be adequately compacted to achieve the same density as the surrounding soil. The posts shall be supported to true line and level while the holes are backfilled with clean, well-graded, non-cementitious subbase or base course granular material and compacted to achieve the same density as the surrounding soil.

All post holes in rock shall have a 75 mm minimum clearance from the back of the post to the face of the hole.

Except for anchorage posts, post holes in rock shall be backfilled with granular material. Other post holes shall be backfilled with selected earth, free of rock. The backfilling shall be firmly compacted in layers not exceeding 100 mm compacted thickness. Where posts are located in areas to be paved with concrete or premixed bituminous material, the backfilling of the post holes shall be finished 50 mm below the underside of such paving and the remaining depth of the holes shall be filled and compacted with material similar to the surrounding material.

The foundation of any post shall be deemed complying when the displacement at ground level does not exceed 3 mm when a 1 kN force is applied 200 mm below the top of the post in any direction. For any posts failing the test, the Contractor shall take remedial measures and retest the rectified post plus one other similar post within 5 m.

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Prior to the installation of any w-beam barrier system where non standard post lengths are required or other special measures (e.g. shallow concrete foundations) are proposed to be used, the Contractor shall provide details of the measures proposed and evidence that the effectiveness of the barrier system will be maintained, for consideration by the Superintendent Council. Where shallow foundations that require a concrete ground beam are proposed to be constructed, the design shall be proof engineered by a VicRoads pre-qualified consultant.

Alternative methods of support are not permitted for end treatments unless otherwise accepted in RDN 06-04. For proprietary systems requiring alternative arrangement, the Contractor shall consult with and implement the requirements of the licensed product supplier. The Contractor may submit proposals for extending the guard fence to a location where installation of the end treatment is feasible, or proposals for a different end treatment.

Surplus excavated material remaining after the guard fence has been constructed shall be disposed of off site by the Contractor.

(b) W-beams

The w-beam sections shall be lapped so that the exposed ends face away from near-side approaching traffic. The edges of the w-beam section or backing plate adjacent to posts shall be fixed in contact with the post or post blocks and all bolts shall be fully tightened.

End treatments of the types specified shall be constructed in accordance with the details shown on the drawings.

Posts attached to bridges and culverts shall be bolted to supporting members and/or set on mortar pads as shown on the drawings.

All bolts used in guard fence construction, other than nuts on wire rope assemblies, shall be tightened to a snug-tight condition.

All bolts on the traffic side of w-beam installations shall be flush with the w-beam.

(c) End treatments

During installation of wire ropes in the end treatments of w-beam, the Contractor shall ensure that no twisting of the rope occurs. When rope assemblies are used, the nuts at each end of the rope shall be tightened to a minimum torque of 50 Nm on the assemblies or as per the manufacturer's requirements.

The Contractor shall maintain tension in the wire ropes in end treatments until the Date of Completion, by keeping the nuts at both ends tightened to 50 Nm or to manufacturer's requirements.

(d) Tolerances

W-beam guard fence shall be erected to the following tolerances:

- (i) Variation from true plan position of posts±20 mm
- (ii) Variation of line of w-beams from specified vertical profile±10 mm
- (iii) Variation of w-beams from specified horizontal alignment±20 mm
- (iv) Variation of posts from vertical (measured at top of the post)±15 mm
- (v) Orientation of block and/or post to w-beam+0 mm, -15 mm
(measured at the point of greatest offset between
the block or post to the w-beam)
- (vi) Dimension of holes-0 mm, +50 mm
- (vii) Top of bolt head relative to w-beam-0 mm, +5 mm

After installation the top of the rail shall be within 25 mm of the specified level and 50 mm of the specified line. Variations from specified line and level shall not occur at a rate exceeding 15 mm in any 5 m length.

Notwithstanding these requirements the line and level of the guard fence shall be adjusted where necessary to provide a smooth and even vertical and horizontal alignment.

For proprietary systems refer to manufacturer requirements.

(e) Barrier offsets to kerb and channel, traffic lanes and batters

Guard fence shall be installed at the offsets shown on Standard Drawing SD 3502. The desirable level shall be adopted unless otherwise approved by the Superintendent Council.

Where practicable, w-beam guard fence should not be installed behind kerb and channel.

Posts shall be installed such that the back of post is not less than 500 mm from hinge point. This also applies where a manufacturer's proprietary system allows for installation at less than 500 mm from the hinge point.

(f) Height of guard fence

Where the face of the guard fence is erected within 0 to 1 m behind the back of kerb, the mounting height (vertical dimension from ground surface to centre of w-beam) shall be measured from the lip of kerb. Where the face of the guard fence is erected within 1.5 m from edge of carriageway without kerb, the mounting height shall also be measured from that edge of carriageway (typically the edge line). For distances beyond 1.5 m, the mounting height shall be measured from the nominal ground surface at the guard fence location.

708.09 PROTECTION OF GUARD FENCE POSTS FOR MOTORCYCLIST SAFETY

Where specified, steel rub rail or other proprietary under-run systems, as listed in RDN 06-04, shall be attached below the w-beam in accordance with the manufacturer's recommendations and the following:

- installation shall only be on nominated sections of barrier as shown on the drawings
- rails are to be placed in line with the face of w-beam
- rails shall be placed in accordance with the requirements for steel guard fence
- a 50 mm gap shall be provided between the rub rail and the ground to allow for passage of water, litter and leaves.

708.10 CERTIFICATE OF COMPLIANCE

HP Further to Clause 708.07 Installation, and prior to the issue of **Statement of Compliance** the ~~Certificate of Practical Completion~~, the Contractor shall arrange for a safety barrier compliance audit on all proprietary guard fence end treatments constructed under the Contract. The audit shall be undertaken and a report prepared by the Australian Licensed Supplier of the safety barrier system. A Certificate of Compliance (CoC), signed by the Contractor's Representative and the Licensed Supplier, shall be provided certifying that the products have been installed in accordance with the manufacturer's Installation Manual and this specification. A CoC shall be provided for each end treatment installed.

In addition, the Contractor shall complete and submit to the Superintendent Council a signed copy of the Checklist / Inspection and Test Plan as per the manufacturer's Product and Installation Manual.

708.11 DELINEATORS

The Contractor shall supply and fasten delineators to the top of the w-beam, comprising flexible plastic mounting brackets fitted with 100 cm² of Class 1A retro-reflective material, as defined in AS/NZS 1906.2. Delineators shall be installed in accordance with VicRoads Supplement to AS 1742.2 Clause 4.2.5.4(b).

The Contractor shall arrange delineators so that vehicles approaching from either direction at night will only see:

- red delineators on the left side of one-way and two-way roadways;
- white delineators on the right side of two-way roadways; and
- yellow delineators on the right side of one-way roadways.

Delineators shall not be installed on guard fence when the barrier offset is greater than 4 m from the traffic lane. White guide posts with delineators shall be installed in accordance with VicRoads Supplement to AS 1742.2 Clause 4.2.4 – Guide Posts.

Where guard fence delineators are required to be installed as part of the Works, they shall be installed in accordance with the requirements of VicRoads Supplement to AS 1742.2.

708.12 MAINTENANCE STRIPS FOR GUARD FENCE

The Contractor shall provide maintenance strips beneath the guard fence and terminals as indicated on the drawings and/or as nominated in Table 708.121.

Table 708.121 Maintenance Strip Locations

Location	Start CH	Finish CH	Direction	Strip Type
## The following item is an example only - change text to suit your specification. DELETE THIS ROW BEFORE PRINTING:				
Road Name	00	125	North Bound	Concrete

(a) Concrete maintenance strips

The concrete maintenance strip shall be placed parallel to the barrier, such that it extends a minimum of 300 mm clear of the rear of the post and 300 mm clear from the face of w-beam. It shall be constructed with minimum 2% crossfall away from the road and shall be flush with the adjacent ground level so the finished level does not impede road runoff.

The concrete maintenance strip shall be placed between and around the posts to not affect the performance of the guard fence.

All bedding material used for cast in place concrete construction works shall be in accordance with Section 812 for Class 3 Crushed Rock or Section 820 for Class 3 Crushed Concrete.

The concrete maintenance strip shall consist of 75 mm depth of N20 strength grade portland cement-based concrete or 20 MPa geopolymer binder-based concrete conforming to the requirements of Clause 708.05(g), on 75 mm of compacted Class 3 crushed rock.

The edges of the infill area shall be boarded up prior to placing concrete to ensure smooth edges are produced. Alternatively, the expansion joints may be sawcut to 75% of the concrete depth. The infill area may utilise low strength concrete (< 0.85 MPa).

The edge board shall be placed parallel with the steel beam guard fence. The surface of the maintenance strip shall be finished with a wooden float to produce a lightly textured surface.

Where the concrete maintenance strip is adjacent to kerb or pavement, separation from the kerb or pavement by the use of a cork expansion joint (or approved alternative) shall be produced. Full depth expansion joints shall be provided perpendicular to the line of the steel beam guard fence 200 mm each side of every post.

The Contractor shall topsoil and grass all disturbed areas as necessary to ensure that the concrete maintenance strip is flush with the adjacent ground surface level.

708.13 INTERACTION OF GUARD FENCE WITH EXISTING ASSETS

The Contractor shall install the guard fence to provide for its dynamic deflection that does not interfere with any existing roadside furniture.

The Contractor shall remove any existing guard fence located between existing assets, such as gantry legs, variable speed signs and bridge piers. The Contractor shall allow for the interaction between all roadside furniture, including slip base light poles, and the guard fence by providing for the dynamic deflection zone or providing reduced post spacing as per the Drawings.

The Contractor shall integrate the guard fence with any existing lengths of safety barriers protecting ends of bridge parapets as shown on the drawings and in accordance with Clause 708.13.

The Contractor shall remove and dispose of existing guide posts that conflict with a new guard fence, including any in front of a new guard fence located within a 4 m offset from the traffic lane and any behind a new guard fence greater than 4 m offset from the traffic lane, as well as bollards or other roadside furniture affected by the Works or where shown on the drawings or instructed by the Superintendent Council.

708.14 MODIFICATION TO THE GUARD FENCE AT THE INTERFACE WITH WRSB

The Contractor shall be responsible for any alteration and/or relocation of any existing WRSB, including the removal and disposal of existing redundant WRSB, dismantling and reinstating existing WRSB (including terminals) and extension of existing WRSB (including the provision of a concrete maintenance strip where specified) where required and as shown on the drawings.

The Contractor shall terminate the guard fence at the interface with the WRSB ensuring sufficient overlapping of systems as detailed on the drawings.

Any variations to the interface of the guard fence with the WRSB shall be reviewed for acceptance by the Superintendent Council prior to installation of the guard fence.

Any modifications to the WRSB shall be in accordance with Section 711 and the relevant VicRoads Standard Drawings.

The Contractor shall be responsible for the supply of all materials and labour necessary to undertake the modification works as specified above and as shown on the drawings.

708.15 ASSOCIATED PAVEMENT (SHOULDER) WIDENING

Where specified, the Contractor shall widen the existing shoulder on the median or outer verge applications adjacent to locations where guard fence is to be installed, as per VicRoads Supplement to AGRD Part 6, Section V6.7.12, or as shown on the typical cross section, drawings or specification.

The Contractor shall provide additional pavement between the edge of existing pavement and the guard fence. The Contractor shall adopt the nominated pavement design. Where a nominated pavement design has not been specified the Contractor shall construct the widening with a pavement that matches the existing.

The edge of shoulder shall be saw-cut to provide a neat straight edge against which the additional pavement can be placed.

Pavement layers shall be stepped a minimum 150 mm horizontally to enable new widening to be keyed into the existing pavement.

708.16 CONCRETE

Unless otherwise specified, and any applicable requirements for proprietary barrier systems, the placement of concrete shall comply with the requirements of Section 703.

708.17 EXISTING SIGNS AND MARKINGS

All existing signs that are temporarily removed or relocated during the execution of the works shall be reinstated to their original location as soon as practicable to ensure that adequate information is provided to road users. In all cases the Contractor shall provide continuity of regulatory and warning signs.

The Contractor shall reinstate all signs to a standard not less than the pre-existing condition and to the satisfaction of ~~the Superintendent~~ Council.

The Contractor shall reinstate any existing painted edge lines, including audible edge lines and reinstate or replace any missing Raised Reflective Pavement Markers (RRPMs) along the length of the Works, including RRPMs damaged by the installation process for the guard fence.

708.18 MEDIAN CROSSINGS

Where a median crossing is removed, the Contractor shall reinstate the median with a treatment consistent with the surrounding area. Any redundant median crossing signs within the Limit of the Works shall be removed and delivered to a storage area nominated by ~~the Superintendent~~ Council.

Median crossings within the Limit of the Works shall be retained by the Contractor.

Where detailed on the drawings, new median crossing points shall be constructed in accordance with the pavement details specified, to provide for adequate access for emergency vehicles and shall be integrated with the guard fence installation.

708.19 EXISTING VEGETATION

The Contractor shall ensure that the existing vegetation within the Limit of Works is not affected by the Works. Areas where no works are required shall not be disturbed. Any damage to existing vegetation shall be rectified immediately to the satisfaction of ~~the Superintendent~~ Council.

708.20 GRASSING OF DISTURBED AREAS**(a) General**

All disturbed areas shall be topsoiled and grassed in accordance with the requirements of Section 740.
~~All areas are to be cultivated to a minimum 50 mm depth, and moistened prior to the application of grass seed and fertiliser.~~

~~Grass seed shall be applied at a rate of not less than 200 kg/Ha. Fertilizer shall be applied in accordance with the manufacturer's recommendations.~~

HP ~~A joint inspection of all grassed areas shall be carried out between the Contractor and Superintendent three months after sowing has taken place.~~

~~Areas with less than 90% cover shall be re-sown by the Contractor.~~

~~Any remedial works required are to be performed within two weeks of the date of inspection.~~

(b) Maintenance of grassed areas

~~The Contractor shall be responsible for the maintenance of grassed areas, including mowing, for the duration of the Defects Liability Period for the Whole of the Works.~~

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SECTION 709 - GUIDE POSTS

709.01 GENERAL

This specification sets out the requirements for the supply and installation of guide posts. Refer to VicRoads Road Design Note RDN 06-10 for a list of VicRoads accepted guide posts.

709.02 DEFINITIONS

Delineator

Small retro reflective panel or sheeting attached to guide posts to provide a consistent pattern of delineation of the edges of road carriageways to aid road users during night time driving.

Guide Post

Posts used to mark the edge of the road carriageway and give road users an indication of the approaching alignment and geometry of the road.

Rigid Guide Post

A guide post which fractures or remains intact and horizontal when impacted.

Semi-Flexible Guide Post

A guide post which fails by bending when impacted and can be reinstated to vertical position with maintenance intervention.

Flexible Guide Post

A guide post which deflects when impacted and then returns to a vertical position, without maintenance intervention.

709.03 PRODUCT REQUIREMENTS

All guide posts including delineators installed in a section of road shall be uniform material and design.

(a) General Requirements

Guide posts shall be between 90 mm and 100 mm across the face visible by traffic. The tops of guideposts shall be flat, the bottom ends made to suit the method of installation as recommended by the manufacturer.

Guide posts shall be straight, smooth, structurally sound and of a shape that allows delineators to be permanently and securely attached. The above ground section of each guide post shall be free of sharp edges and burrs and discoloration or other defects that may affect its appearance and/or serviceability.

The supplier shall state the type of material used in manufacture of the guide posts as well as recommended methods of installation, anchoring depth, cleaning, removal, and disposal. Test certification shall be submitted to the Superintendent Council, addressing post strength, flexibility, impact performance, durability, heat resistance, fire retardant ability, corrosion resistance and cold resistance. The supplier shall provide a performance guarantee statement clearly indicating the nature of the guarantee and the service life expectancy. Where a product is a VicRoads approved guide post product the above shall not be required.

All types of guideposts shall respond in a safe manner when struck, and not present a further danger in their damaged condition.

(b) Delineators

The Contractor shall fix retro reflective type delineators to guide posts on both sides of the carriageway to expose to approaching traffic a red delineator on the left and a white delineator on the right.

Delineators shall be either:

- (i) circular 80 mm diameter Type A corner cube retro reflectors conforming with Type 'A' delineator in AS 1906.2; or
- (ii) Class 1A retro reflective sheeting having a total minimum reflective output equivalent to 100 cm², as defined in AS/NZS 1906.1. The nominal dimension of retro reflective material shall be 50 mm x 200 mm. Delineators made from retro reflective sheeting shall be installed such that the sheeting manufacturer's preferred orientation for optimum performance is followed.

Delineators shall be placed centrally between the edges of posts, with the top of the delineator 50 mm below the top edge. Delineators shall be attached to posts following completion of final protective coatings by a vandal-proof and weatherproof means so they can be replaced if necessary without damaging the post.

(c) Markings

To enable traceability of the manufacturer, each post shall be legibly and indelibly marked with the manufacturer's name, date of manufacture and warranty period with lettering no greater than 10 mm high. The markings shall be placed at the bottom of the guide post just above recommended ground level installation depth. Guide posts shall be clearly marked to show the recommended ground level installation depth. Markings shall be installed on one side of the guide post only, and remain visible for the full life expectancy of the guide post.

709.04 PERFORMANCE REQUIREMENTS

The finished surface of guide posts shall be uniform and free from discontinuities, areas of discoloration, blisters, runs and other surface defects which affect appearance and serviceability. Guide post surfaces shall be durable gloss or semi-gloss opaque white capable of being repeatedly cleaned. All materials used shall retain 85% of the original colour, appearance and physical properties and be resistant to ultraviolet radiation for at least ten (10) years when exposed to all weather conditions experienced in Victoria.

Guide posts shall be designed to resist bending, twisting and displacement due to wind. They must be effective in resistance to vertical displacement of ± 5 mm for the life of the guidepost, with the exception of any displacement associated with impact or physical force. Flexible guide posts shall return to within ± 5 mm of the original vertical position following impact or physical force application for the life of the guide post.

709.05 INSTALLATION

Installation of guide posts includes setting out, excavation, supply, placement, backfilling, erection, driving, removal and disposal of guide posts.

Guide posts shall be installed in accordance with the requirements of Traffic Engineering Manual Volume 2, as shown on the drawings, or as specified by the Superintendent Council. Guide posts shall be placed at a uniform distance from the road pavement edge with the widest face presenting to oncoming traffic. Posts shall be set into the ground so that the posts are vertical and the tops present a uniform profile.

Guide posts shall be installed such that the exposed length above ground is nominally 1000 mm and minimum anchoring depths recommended by the manufacturer to achieve the specified performance requirements under service conditions. Allowance shall be made in the height of guide posts above the ground for the effects of superelevation and other road geometry in order to keep guide posts within the range of the beam of vehicle headlights.

Guideposts shall be installed as per the manufacturer's recommendation.

Where guide posts are to be set in the ground they shall be erected in excavated holes which are subsequently backfilled and compacted to a density that is not less than that of the adjacent undisturbed ground.

Guide posts shall be installed such that they effectively resist removal by persons other than personnel using recommended removal tools.

Where guide posts are to be installed directly onto concrete, asphalt or any other hard wearing surface, the Contractor shall submit to ~~the Superintendent~~ Council the details of the proposed installation method.

(a) Wire Rope Safety Barrier Installations

Where new installations of Wire Rope Safety Barrier (WRSB) are proposed on the edge of shoulder, and will conflict with guide post installation locations, WRSB posts shall be converted into guide posts in accordance with the above product requirements. Posts shall be spaced in accordance with the Drawings or the requirements of Traffic Engineering Manual Volume 2. The Contractor shall submit to ~~the Superintendent~~ Council the details of the proposed installation.

(b) Underground Services

Underground service locations shall be determined prior to installation of posts.

(c) Tolerances

Maximum installation tolerances are as follows:

- (i) within 3 degrees of true vertical position
- (ii) within ± 5 mm across the face visible by traffic
- (iii) within +50 mm of the uniform profile height (nominally 1000 mm)
- (iv) within 200 mm longitudinally of the design spacing requirement and 100 mm transversely of the plan position with reference to the design line for the road, or as per the requirements of Traffic Engineering Manual Volume 2.

(d) Removal and Disposal of Existing Guideposts

Existing guide posts where required, are to be removed as directed by ~~the Superintendent~~ Council.

All holes left after removal shall be backfilled and compacted to a density that is not less than that of the adjacent undisturbed ground, or the same characteristics of the shoulder material from where they were removed. All existing guide posts removed by the Contractor shall be disposed of offsite. Existing guideposts manufactured from recyclable materials shall be recycled.

SECTION 710 - FIXING RAISED PAVEMENT MARKERS

710.01 DESCRIPTION

This section covers the fixing of both reflective and non-reflective raised pavement markers to asphalt, concrete or sealed pavements using epoxy adhesive or hot melt bitumen adhesive.

710.02 TOLERANCES ON POSITION

Markers shall be affixed to the pavement at the positions shown on the drawings, or specified or directed by the Superintendent Council within the following limits, unless otherwise specified.

(a) Markers in Line with Broken Line Segments

Transverse position within 25 mm of the centreline of the segments.

Longitudinal position within 0.5 m of the specified position.

(b) Markers in a Longitudinal Group

Transverse position of the centre of each marker within 25 mm of the specified position and within 10 mm of a line joining the centres of the end markers of the group.

Longitudinal position of the end markers of the group within 0.5 m of the specified position.

Spacing of markers within the group within 50 mm of the specified spacing.

(c) Markers Adjacent to Unbroken Line

Clearance to edge of line within 5 mm of that specified.

Longitudinal mismatch between markers in transverse pairs at barrier line not more than 25 mm.

Longitudinal position of markers within 0.5 m or 10% of the specified spacing, whichever is the less.

(d) Orientation of Reflective Markers

Lower edge of the reflective face at 85° to 95° to the centreline of the roadway or any adjacent line.

710.03 MATERIALS

The Contractor shall supply all materials required to complete the work covered by this section, unless otherwise specified.

(a) Markers

Markers shall comply with the relevant requirements of AS 1906, Part 3.

Only markers approved for use by VicRoads shall be used and all raised non-reflective pavement markers shall be of the ultra hard plastic type unless otherwise directed. Glass faced raised reflective pavement markers shall be used on all National Roads and State Freeways unless specified otherwise.

(b) Adhesive

Epoxy adhesive shall be Standard Set or Rapid Set adhesive complying with the relevant requirements of AS 3554.

Only adhesives approved for use by VicRoads shall be used.

710.04 MIXING EPOXY ADHESIVE

Adhesive components shall be batched so that the mixed adhesive contains not less than 45% nor more than 55% by volume of either component. Before starting work each day, or when changing to a different batch of adhesive, a hand-mixed colour standard shall be prepared for reference during the day.

When machine mixing is used the mixing equipment shall use positive displacement pumps which proportion the two components in the specified range. At the beginning of each day and at any other time ordered by the Superintendent Council, the Contractor shall check the proportions in the presence of the Superintendent Council. Adhesive which has remained in the mixing head for longer than 90 seconds for rapid set adhesive or 180 seconds for standard set adhesive shall be discharged to waste.

When hand-mixing is used not more than 500 g of each component shall be mixed at any time. The components shall be mixed on a flat surface and the mixed adhesive shall be used within 10 minutes of the time the two components are brought together.

Only standard set adhesive shall be mixed by hand, unless the Superintendent Council consents otherwise.

710.05 PREPARING HOT MELT ADHESIVE

Hot melt bitumen adhesive shall not be used on days of total fire ban without the written approval of the Country Fire Authority. Two 9 kilogram Dry Powder extinguishers and one knapsack sprayer shall be carried at all times.

The hot melt bitumen adhesive shall be heated in accordance with the manufacturer's specification in a heater designed specifically for the purpose. It shall be regularly stirred in the heater during the laying operation to maintain uniformity of the component proportions.

710.06 PAVEMENT PREPARATION

The Contractor shall sweep or air blast each marker site as necessary to remove loose material before placing markers. Markers shall only be placed at locations where the pavement is free from dirt, oil, grease, paint, or any other material which would adversely affect the bond of the adhesive to the pavement, unless otherwise specified.

Unless specified otherwise, the Contractor shall clean the pavement to remove oil or grease at every marker site by sand blasting, chipping or burning of bitumen as appropriate to ensure that the surface is clean and sound.

710.07 PLACING MARKERS

Markers shall not be placed in any of the following circumstances:

- when the pavement is wet;
- when the relative humidity is greater than 80%;
- when the ambient temperature or the temperature of the road surface is less than 15°C for standard set adhesive or 0°C for rapid set or hot melt adhesive.

Epoxy adhesive shall be placed on the base of the marker in such quantity and manner as to completely cover the base of the marker and extrude slightly all round when the marker is placed on the road. The marker shall be then positioned correctly on the pavement and pressure shall be applied until the adhesive is uniformly extruded from each edge of the base of the marker indicating that the full base area is supported by adhesive. The thickness of adhesive remaining under the marker shall be approximately 1 mm. The orientation and position of the marker should then be visually checked and if necessary immediately corrected.

Hot melt bitumen adhesive shall be placed on the road in the correct position and the marker quickly placed, correctly orientated and pressed into the adhesive.

Adhesive of either type on the exposed surfaces of the marker shall be removed using soft rags moistened with kerosene, petrol, or mineral turpentine. Any adhesive on the pavement which might obscure the reflective faces or aspect of the marker shall be removed using a square-ended spatula or similar.

Where a marker is not positioned correctly within 10 seconds for hot melt bitumen adhesive, 2 minutes for rapid set machine mix adhesive, 4 minutes for standard set machine mix, or 10 minutes for standard set hand mix from the time mixing commences, it shall be discarded and a new marker placed.

Similarly, any marker dislodged by traffic after these times up to the end of the Defect Liability Period ~~maintenance period~~ shall be removed and replaced with a new marker.

On concrete and asphalt pavements, wherever possible markers shall be placed clear of longitudinal or transverse joints and on all pavements markers shall be placed clear of any surface cracks or positions from which markers have been removed and the surface is damaged.

710.08 PROTECTION FROM TRAFFIC

Markers shall be protected from traffic after placing for periods not less than those shown in Table 710.081 below, unless the ~~Superintendent~~ Council directs or consents otherwise.

Table 710.081

Ambient Temperature (°C)	Standard Set Adhesive (hours) (min)	Rapid Set Adhesive (minutes) (min)	Hot Melt Adhesive (minutes) (min)
35	1¼	25	4
30	2	30	4
25	3½	35	3
15	6	40	3
10	-	45	2
5	-	60	2
0	-	85	2

SECTION 711 - WIRE ROPE SAFETY BARRIER (WRSB)

~~##This section cross-references Sections 703, 708 and 812.~~

~~Section 703 should be included in the specification when this section is used.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

711.01 GENERAL

This section covers the requirements for the supply and/or installation of wire rope safety barrier (WRSB) systems and associated works.

711.02 STANDARDS

(a) Australian Standards

Australian Standards are referenced in an abbreviated form (e.g. AS 1012).

AS 1012	Methods of testing concrete
AS 1214	Hot dip galvanized coatings on threaded fasteners
AS 1379	Specification and supply of concrete
AS 1397	Continuous hot-dip metallic coated steel sheet and strip-coatings of zinc and zinc alloyed with aluminium and magnesium
AS/NZS 1163	Cold formed structural steel hollow sections
AS/NZS 3000	Wiring rules
AS/NZS 3750	Paints for steel structures
AS/NZS 3845	Road safety barrier systems
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4792	Hot dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process

(b) Other Documents

Proprietary	Manufacturer's specification and drawings for the proprietary WRSB system and associated national or international standards.
NCHRP 350	National Cooperative Highway Research Program Report 350
AASHTO	Manual for Assessing Safety Hardware (MASH-1) 2009
Austrroads	Guide to Traffic Management
VicRoads	Safe System Design Notes
VicRoads	Traffic Engineering Manual
VicRoads	Road Design Notes
VicRoads	Road Design Note RDN 06-02 - The use of wire rope safety barriers (WRSB)
VicRoads	Road Design Note RDN 06-04 - Accepted safety barrier products
VicRoads	Standard Drawings

Section 175 details the reference to these documents.

711.03 WRSB SYSTEM

The WRSB shall be a four wire rope proprietary system, which satisfies the requirements of the current version of VicRoads Road Design Note RDN 06–02, including:

- (a) Conformance with the Recommended Procedures for the Safety Performance Evaluation of Highway Features, National Cooperative Highway Research Program (NCHRP) Report 350 -with the matrix of test conditions, as follows:
 - (i) minimum Test Level 4 for the length of need and transition as shown in Table 3.1; and
 - (ii) minimum Test Level 3 for all terminals as shown in Table 3.2.
- (b) Conformance with the requirements of AS/NZS 3845.
- (c) Details of the particular WRSB systems (longitudinal barrier and terminals) have been submitted to VicRoads and accepted for use in accordance with the current version of VicRoads Road Design Note 06-04.

711.04 MATERIALS

- (a) WRSB Materials

Materials for the WRSB shall be manufactured in accordance with the specification for the proprietary WRSB system and satisfy the requirements of the system for a minimum design life of 20 years. The proprietary WRSB systems shall have the same composition, mechanical properties and geometry as those used in the verification and acceptance tests in its country of origin. Posts may also be manufactured from steel complying with AS/NZS 1163 or AS 1397.

Steel posts shall be either:

- Hot dipped galvanised in accordance with AS/NZS 4680; or
- Pre-galvanised in accordance with Z600 coating type to AS 1397 (total minimum coating mass on both surfaces of 600 g/m²); or
- Pre-galvanised in accordance with ZM275 coating type to AS 1397 (total minimum coating mass on both surfaces of 275 g/m²)

The weld seam made during forming of pre-galvanised steel post sections shall be repaired in accordance with AS/NZS 4792, Section 3 by applying a coating using a metal spraying system employing a suitable zinc or zinc-alloy wire/powder.

- (b) Protective Treatment

Hot dipped galvanised posts or pre-galvanised posts shall be powder coated with a thermosetting polyester powder coating (Dulux Anotec Heritage Green or approved equivalent), while specified posts shall be white. The powder coating shall provide a grainy, low gloss appearance. Table 711.041 provides details of the location of different post types.

Table 711.041

Colour	Location
Galvanized	##:
Green (low gloss)	##:
White (low gloss)	##:

- (i) **Green Posts** shall be powder coated with a thermosetting polyester powder coating (Dulux Anotec Heritage Green or approved equivalent)
- (ii) **White Posts** shall be white and the powder coating shall provide a grainy, low gloss appearance.

All galvanised coatings shall be smooth, adherent and free from stains, gross surface imperfections, markings, brand names and/or inclusions.

Hot-dipped galvanised coating on bolts, nuts and washers shall comply with AS 1214.

Where the galvanising has been damaged, the coating shall be repaired by re-galvanising or by painting with a minimum of two coats of a zinc-rich inorganic paint in accordance with AS/NZS 3750.9 and one coat of aluminium paint.

(c) Concrete

(i) Portland Cement-based Concrete

Portland cement-based concrete shall be N20, N25 or N32 standard strength grade, as specified for the application and complying with the requirements of AS 1379 and as stated in Table 711.042.

(ii) Geopolymer Binder-based Concrete

Geopolymer binder-based concrete shall comply with the requirements of Section 703 and manufactured to comply with the minimum 28 day compressive strength requirements for each strength grade ranging from 20 MPa to 32 MPa as stated in Table 711.042.

The use of chemical admixtures shall comply with the requirements of Section 703.

Table 711.042

Portland Cement Concrete Strength Grade	Geopolymer Binder Concrete Strength Grade	Minimum Compressive Strength at 28 days (MPa)
N20	20	20
N25	25	25
N32	32	32

711.05 CERTIFICATES OF COMPLIANCE OF MATERIALS, COMPONENTS AND PROCESSES

The Contractor shall submit for review by the Superintendent Council not less than 14 days prior to the proposed use of materials and components, a signed statement including relevant test reports demonstrating the compliance of the materials and components with the specification for the proprietary WRSB system and this specification.

HP The installation of the WRSB shall not proceed until the signed statement and certificates of compliance have been accepted by the Superintendent Council.

The Contractor's statement shall also be supported with certificates of compliance certifying that the zinc coating mass of galvanised steel components, the powder coating and welding procedures for relevant components of the proprietary WRSB systems are in accordance with the manufacturer's specification and the associated national or international standards and the specification.

The Contractor's statement and supporting documentation shall identify all relevant national or international standards with which the various materials, components or fabrication and welding processes must comply.

711.06 MATERIAL HANDLING AND STORAGE

All materials and components shall be handled and stored such that damage that may affect performance is avoided, particularly to threaded components. Care shall be taken to avoid damage to galvanised and powder coating systems. Any damage that occurs shall be made good in accordance with the national or international standard with which the various materials or components must comply, the specification, and to the satisfaction of the Superintendent Council. Wire ropes shall be supplied on reels and shall not be twisted or kinked.

The Contractor shall provide, for each of the materials and components, a copy of the manufacturer's information as specified below:

- (a) Manufacturer's name
- (b) Product reference
- (c) Certificate of date of manufacture.

All posts shall be permanently and clearly marked with the manufacturer's identification mark, which shall be clearly visible at the completion of the installation.

711.07 INSTALLATION OF WRSB

(a) General

The Contractor shall install the WRSB in accordance with the drawings and the manufacturer's requirements.

(b) Post Foundations and Anchor Blocks

- (i) Where no geotechnical investigation is undertaken the proprietary WRSB supplier's nominated default anchor and post footing shall be used in accordance with the manufacturer's product manual and VicRoads Road Design Note RDN 06-04.
- (ii) A geotechnical investigation shall be undertaken to determine the soil properties and to ensure the accuracy of the installation and performance of the barrier where:
 - (1) The Contractor proposes to use an approved alternative anchor or post foundation as identified within the manufacturer's product manual and VicRoads Road Design Note RDN 06-04.
 - (2) Where site constraints restrict the use of the default or an approved alternative anchor or post foundation. In which case the Contractor shall provide the geotechnical information to the proprietary WRSB supplier and obtain a written statement from the supplier that the anchor block size and post foundation size are appropriate for the existing natural or constructed ground conditions and the installation meets the operational requirements.

The geotechnical investigation shall ensure that the completed in situ concrete post foundation system meets the requirements of the proprietary WRSB system and will not crack, lift or displace during impact by a vehicle equivalent to the design vehicle during the design life of the barrier.

The Contractor shall confirm with the supplier the geotechnical information required, but shall include as a minimum:

- soil bearing pressure
- soil type
- average allowable soil stress.

The Contractor shall include sufficient time for the geotechnical investigation in its program.

HP Anchor blocks and post foundations shall not be constructed until the design and manufacturer's acceptance has been reviewed by the Superintendent Council.

(iii) General Construction and Concrete Requirements

HP Anchor blocks and post foundation shall not be cast until inspected by the Superintendent Council.

Anchor block foundation and post foundation holes shall be free of loose material, debris and water prior to the placement of concrete.

Further to any installation guidelines for construction of anchor blocks for a proprietary WRSB system, the Contractor shall form anchor block holes by excavating the hole to the correct dimension, shape, level and alignment specified by the proprietary system.

Over-excavation of the anchor block excavation shall not be reformed with form work or soil, but shall be cleaned out and filled with concrete forming the concrete anchor block.

In situ concrete post foundations shall be constructed using N25 strength grade concrete or 20 MPa geopolymer binder-based concrete conforming to the requirements of Clause 711.04(c).

Notwithstanding the specific proprietary WRSB system requirements, the anchor blocks shall be constructed using N32 strength grade concrete or 32 MPa geopolymer binder-based concrete conforming to the requirements of Clause 711.04(c).

All anchor frames, posts, sockets and reinforcing rings shall be positioned to the line and levels as specified in the drawings and shall be secured against displacement during placing of the concrete.

No construction joints shall be provided within the anchor block.

The finished surface of all anchor blocks and footings shall be shaped such that water cannot pool on the surface.

(c) Wire Rope and Posts

The Contractor shall install the wire rope and posts to the line, level and height as shown on the drawings, the specification, manufacturer's specification and to the tolerances specified in Clause 711.08.

Posts shall be spaced in accordance with the manufacturer's specification unless otherwise required by the design requirements of VicRoads Road Design Note RDN 06-02. Posts shall be installed with their correct profile in the direction of travel.

Intermediate anchors shall be spaced in accordance with the lesser of the manufacturer's specification or Section 4.3.7 of VicRoads Road Design Note RDN 06-02, and installed as per the manufacturer's specification and drawings.

The vertical alignment of the wire ropes shall be smooth and uniform, without sudden changes in gradient and generally consistent with the vertical alignment of the edge of the traffic lanes. The length of the post socket or overall length of the post may be adjusted in accordance with the tolerances specified by the manufacturer to achieve the specified vertical alignment. **Any such adjustment shall be as per the manufacturer's specification and obtained written statement of advice, which shall be submitted by the Contractor to for review by the Superintendent Council.**

HP

The WRSB shall not be installed until the set out alignment of the posts has been reviewed and accepted by the Superintendent Council.

The Contractor shall allow the Superintendent Council a minimum of one working day to inspect the pegged alignment and a further minimum period of five working days to provide its acceptance including details of any required changes in alignment, length or number of installations or terminals.

In the event that the horizontal and/or vertical geometry of the alignment do not satisfy the manufacturer's requirements or the specification, the Contractor shall immediately notify the Superintendent Council advising details of the deficient areas along with the proposed dispositions. Any adjustments accepted by the Superintendent Council shall then be made to the alignment or the level of the median or outer verge to ensure that the installation complies with the requirements of the proprietary WRSB system and the specification.

(d) Location of Posts Adjacent to Batter Hinge Points

WRSB posts constructed with the manufacturer's default post footing design shall be located at the greater of a minimum 1 m offset from the batter hinge point and the manufacturer's specification, subject to dynamic deflection requirements being met. The batter hinge point is defined as per VicRoads Standard Drawing SD 4551.

Where the minimum offset to the batter hinge point is to be reduced, the depth of footing is to be adjusted as per the manufacturer's specification and the Contractor shall obtain a written statement of advice from the manufacturer based on geotechnical testing. This shall be submitted by the Contractor ~~to for review by the Superintendent Council~~. Side Load Testing as per Clause 711.07(f) shall also be undertaken at 45 degrees to the WRSB in ALL directions at locations nominated by ~~the Superintendent Council~~.

(e) Tensioning of the Wire Rope

Each wire rope shall be tensioned in accordance with the relationship between rope tension and ambient temperature, applicable to the proprietary WRSB system as per the manufacturer's specification. The tension shall be measured using a tension meter supported with a current calibration certificate. Prior to commissioning the WRSB system, the tension in each wire rope shall be checked, and re-tensioned if required, to ensure compliance with the ambient temperature/rope tension relationship.

The Contractor shall prepare and submit a tensioning report ~~to for review by the Superintendent Council~~ within seven days of the tensioning works being carried out.

(f) Loading Test of Post Foundations

Side load testing of posts shall be undertaken at locations nominated by the Superintendent Council prior to the installation of the wire rope to provide evidence that the foundations satisfy the specification requirements and will not crack, lift or displace during impact by a vehicle equivalent to the design vehicle during the design life of the barrier.

~~The Superintendent Council may request side load testing be undertaken at the discretion of the Superintendent Council:~~

- where non-standard post foundations are to be used, i.e. not the manufacturer's nominated default foundation
- in the event that the soil type cannot be verified
- ground conditions are such that the required depth of footing cannot be installed
- in certain geological conditions, i.e. a rock cut section where the post foundation may be reduced in length, or where soft clay or medium to loose sand profiles have been identified and the standard foundation dimensions may be insufficient
- where posts are required to be located at the minimum offset to batter hinge points [refer Clause 711.07(d)].

Side load testing of posts shall be carried out by applying a force of 10 kN (approximately 1 tonne) to the post 600 mm above ground level at an angle of 45 degrees to the WRSB. The top of the footing shall not move more than 3 mm. If the footing withstands the force with a movement of less than 3 mm at ground level then the footing shall be considered acceptable.

The test shall be carried out by placing a post into the completed concrete footing and using a lever hoist or equivalent and calibrated load cell anchored to a truck.

At the completion of the load testing, the Contractor shall remove the test posts and rectify any disturbed or damaged post foundations.

The result of all tests shall be recorded digitally (photograph) and logged against location. For any footings failing the test the Contractor shall seek advice from ~~the Superintendent Council~~ based on relevant advice from the manufacturer, take remedial measures and re-test the rectified post plus one other similar post at no cost to Council ~~the Principal~~.

(g) WRSB over Box Culverts and Concrete Pipes

Where WRSB has been designed to straddle a box culvert or a concrete pipe crossing, as shown on the drawings or as stated in this specification, the post spacing shall be located centrally about the box culvert or concrete pipe. Adjacent post spacing at box culverts or concrete pipe crossings may be locally reduced to meet this requirement.

711.08 CONSTRUCTION TOLERANCES

Tolerances for construction of the WRSB system shall be in accordance with the lesser of the manufacturer's specification or as follows:

- (a) vertical tolerance on the height of the WRSB shall be ± 20 mm from the design line
- (b) longitudinal line tolerance for the WRSB system shall be ± 20 mm in plan view
- (c) tolerance on post spacing shall be ± 25 mm.

WRSB height shall be measured from the road pavement when it is located within 1.5 m of the edge of pavement. For distances beyond 1.5 m, the WRSB height shall be measured from the ground surface at its location.

711.09 COMPLIANCE AUDITING OF BARRIER SYSTEM INSTALLATION

HP Further to Clause 711.07 Installation of WRSB, and prior to the issue of the Statement of Compliance Certificate of Practical Completion, the Contractor shall arrange for a safety barrier compliance audit on all WRSB installations constructed under the Contract. The audit shall be undertaken and a report prepared by the Australian Licensed Supplier of the safety barrier system. A Certificate of Compliance (CoC) signed by the Contractor's Representative and the Licensed Supplier shall be provided certifying that the product systems (including terminals) have been installed in accordance with the manufacturer's Installation Manual and this specification. A CoC shall be provided for each length of WRSB installed including terminals.

In addition the Contractor shall complete and submit to the Superintendent Council a signed copy of the manufacturer's Installation Checklist/Inspection and Test Plan as per the manufacturer's Product and Installation Manual.

711.10 DELINEATORS

The Contractor shall supply and fasten delineators to the WRSB system, comprising post caps fitted with 50 x 100 mm Class 1A retro-reflective material, as defined in AS/NZS 1906.2, or placed on the front top of the post above the wire ropes. Delineators shall be installed at approximately 12.5 to 15 m spacing. Delineators shall not be placed on flared sections.

The Contractor shall arrange delineators so that vehicles approaching from either direction at night will only see:

- red delineators on the left side of one-way and two-way roadways
- white delineators on the right side of two-way roadways
- yellow delineators on the right side of one-way roadways.

Delineators shall not be installed on WRSB posts when the WRSB offset is greater than 4 m from the traffic lane. White guide posts with delineators shall be installed in accordance with the VicRoads Traffic Engineering Manual Volume 2.

Where guard fence delineators are required to be installed as part of the Works, they shall be installed in accordance with the VicRoads Traffic Engineering Manual Volume 2.

711.11 STRAY CURRENT EFFECTS ON WRSB

All wires within a WRSB system shall be tested for induced currents and voltages relative to all other adjacent wires and the ground using calibrated equipment in accordance with AS/NZS 3000 Wiring Rules by a qualified electrical contractor. Tests shall be undertaken at each location where two sections of WRSB overlap at anchorage points. Where an induced current or voltage is recorded, or high voltage powerlines are within 50 m of the barrier, the WRSB system shall be earthed to remove current or voltage running through the wires.

All wires in the WRSB and overlapping sections of WRSB shall be connected to earth using a flexible system, detailed in a submission for acceptance by ~~the Superintendent~~ Council. The earthing shall occur at the location of overlapping WRSB and at a maximum of 500 m intervals along the length of each affected section of WRSB.

Prior to putting the WRSB system into service the earthing shall be checked to ensure that any further stray current effects have been eliminated.

711.12 INTERACTION OF WRSB WITH EXISTING ASSETS

The Contractor shall install the WRSB to provide for its dynamic deflection that does not interfere with any existing roadside furniture.

The Contractor shall remove any guard fence located between existing assets, such as gantry legs, variable speed signs and bridge piers, and the WRSB as shown on the drawings. The Contractor shall allow for the interaction between the WRSB and all roadside furniture, including slip base light poles, by providing for the maximum barrier deflection as per VicRoads Road Design Note RDN 06-02, or providing reduced post spacing therefore reducing the WRSB dynamic deflection as per VicRoads Road Design Note RDN 06-04 and the manufacturer's specification.

The Contractor shall integrate the WRSB with any existing lengths of safety barriers protecting ends of bridge parapets as shown on the drawings and in accordance with Clause 711.13.

The Contractor shall not connect new WRSB to existing WRSB unless it is the same system comprising the same components.

The Contractor shall remove and dispose of existing guide posts that conflict with a new WRSB, including any in front of a new WRSB located within a 4 m offset from the traffic lane and any behind a new WRSB greater than 4 m offset from the traffic lane, as well as bollards or other roadside furniture affected by the Works or where shown on the drawings or instructed by ~~the Superintendent~~ Council.

711.13 MODIFICATION TO THE WRSB AT THE INTERFACE WITH GUARD FENCE

The Contractor shall be responsible for any alteration and/or relocation of any existing guard fence, including the removal and disposal of existing redundant guard fence, dismantling and reinstating existing guard fence (including terminals) and extension of existing guard fence (including the provision of a concrete maintenance strip) where required and as shown on the drawings.

The Contractor shall terminate the WRSB at the interface with the guard fence ensuring sufficient overlapping of systems as detailed on the drawings.

Any variations to the interface of the WRSB with the guard fence shall be reviewed for acceptance by ~~the Superintendent~~ Council prior to installation of the WRSB.

Any modifications to the guard fence shall be in accordance with Section 708 and the relevant VicRoads Standard Drawings.

The Contractor shall be responsible for the supply of all materials and labour necessary to undertake the modification works as specified above and as shown on the drawings.

711.14 ASSOCIATED PAVEMENT (SHOULDER) WIDENING

The Contractor shall widen the existing shoulder on the median or outer verge applications adjacent to locations where WRSB is to be installed, in accordance with VicRoads Supplement to AGRD Part 6 Section V6.7.12, or as shown on the typical cross section, drawings or specification.

The Contractor shall provide additional pavement between the edge of existing pavement and the WRSB. The Contractor shall adopt the nominated pavement design. Where a nominated pavement design has not been specified the Contractor shall construct the widening with a pavement that matches the existing.

The edge of shoulder shall be saw-cut to provide a neat straight edge against which the additional pavement can be placed.

711.15 MAINTENANCE STRIP FOR WRSB

The Contractor shall provide maintenance strips beneath the WRSB and terminals as indicated on the drawings and/or as nominated in Table 711.151.

Table 711.151 Maintenance Strip Locations

Location	Start CH	Finish CH	Direction	Strip Type
## The following item is an example only - change text to suit your specification. DELETE THIS ROW BEFORE PRINTING:				
Road Name	00	125	North Bound	Concrete

The Contractor shall provide a concrete maintenance strip beneath the WRSB and terminals in unpaved areas of median or outer verge applications as shown on the drawings or as specified. Where ~~concrete~~ paving adjoins the sealed carriageway, the paving shall match the level of the adjacent shoulder.

(a) Concrete Maintenance Strips

The concrete maintenance strip shall be placed parallel to the barrier, such that it extends a minimum of 300 mm clear of both sides of the WRSB post or as otherwise specified. It shall be constructed with minimum 2% crossfall or with the same slope as abutting pavement and shall be constructed flush with the adjacent ground level so the finished level does not impede road runoff.

The concrete maintenance strip shall be placed between and around the post foundations to not affect the performance of the WRSB.

The concrete maintenance strip shall consist of minimum 75 mm depth of N20 strength grade concrete or 20 MPa geopolymer binder-based concrete conforming to the requirements of Clause 711.04(b), on minimum 75 mm of compacted Class 3 crushed rock. Where the soil is solid well compacted in situ material as agreed by the Superintendent Council, the crushed rock can be omitted and a minimum 100 mm depth of N20 strength grade concrete placed for the maintenance strip.

Where the maintenance strip is adjacent to kerb or pavement, separation from the kerb or pavement by the use of a cork expansion joint (or approved alternative) shall be used.

~~Where the maintenance strip is concrete, weakened plane joints~~ ~~Dummy joints~~ at least 20 mm deep and 5 mm wide shall be formed at 2 m intervals across the full width of the concrete maintenance strip. Expansion joints shall be placed at intervals not exceeding 12 m.

The Contractor shall topsoil and grass all disturbed areas as necessary to ensure that the concrete maintenance strip is flush with the adjacent ground surface level.

All bedding material used for cast in place concrete construction works shall be Class 3 Crushed Rock in accordance with Section 812.

711.16 CONCRETE

Unless otherwise specified, and any applicable requirements for proprietary barrier systems, the supply and placement of concrete shall comply with the requirements of Section 703

711.17 EXISTING SIGNS AND MARKINGS

All existing signs that are temporarily removed or relocated during the execution of the works shall be reinstated to their original location as soon as practical to ensure that adequate information is provided to road users. In all cases the Contractor shall provide continuity of regulatory and warning signs.

The Contractor shall reinstate all signs to a standard not less than the pre-existing condition and to the satisfaction of ~~the Superintendent~~ Council.

The Contractor shall reinstate any existing painted edge lines and reinstate or replace any missing Raised Reflective Pavement Markers (RRPMs) along the length of the Works, including RRPMs damaged by the installation process for the WRSB.

711.18 ~~SUPPLY OF ADDITIONAL MATERIALS~~

~~The Contractor shall supply additional posts and associated fittings as specified. These posts and fittings shall be delivered to a storage area nominated by the Superintendent and shall include all appropriate components as required by the proprietary WRSB system to repair damage which occurs beyond the expiration of the Defects Liability Period.~~

~~The Contractor shall provide details of the posts and associated fittings as required by the proprietary WRSB system. The Contractor shall make due allowance for the supply and delivery of all required components to be paid under the relevant Provisional Quantity items.~~

711.19 ACCIDENT DAMAGE TO WRSB

In the event of any damage to the WRSB caused by errant vehicles prior to the Date of Statement of Compliance ~~Practical Completion and during the Defects Liability Period~~, the Contractor shall make the area immediately safe for traffic and shall be responsible for repairs, including all associated traffic management measures. Repairs shall be undertaken within five working days of an impact or of a request by ~~the Superintendent~~ Council.

The Contractor shall be responsible for the supply of all WRSB materials including any concrete necessary to undertake the repair works. ~~to be paid under the relevant Provisional Quantity items.~~

During the ~~construction~~ Contract period, the Contractor shall record the number of vehicle impacts where damage has occurred to the WRSB so that ~~VicRoads~~ Council can maintain a maintenance history of the WRSB installations.

711.20 MEDIAN CROSSINGS

Where a median crossing is removed, the Contractor shall reinstate the median with a treatment consistent with the surrounding area. Any redundant median crossing signs within the Limit of the Works shall be removed and delivered to a storage area nominated by ~~the Superintendent~~ Council.

Median crossings within the Limit of the Works shall be retained by the Contractor.

Where detailed on the drawings, new median crossing points shall be constructed in accordance with the pavement details specified, to provide for adequate access for emergency vehicles and shall be integrated with the WRSB installation.

711.21 EXISTING VEGETATION

The Contractor shall ensure that the existing vegetation within the Limit of Works is not affected by the Works. Areas where no works are required shall not be disturbed. Any damage to existing vegetation shall be rectified immediately to the satisfaction of ~~the Superintendent~~ Council.

711.22 GRASSING OF DISTURBED AREAS**(a) General**

All disturbed areas shall be topsoiled and grassed in accordance with Section 740.

All areas are to be cultivated to a minimum 50 mm depth, and moistened prior to the application of grass seed and fertiliser.

~~Grass seed shall be applied at a rate of not less than 200 kg/Ha. Fertilizer shall be applied in accordance with the manufacturer's recommendations.~~

~~HP A joint inspection of all grassed areas shall be carried out between the Contractor and Superintendent three months after sowing has taken place.~~

~~Areas with less than 90% cover shall be re-sown by the Contractor.~~

~~Any remedial works required are to be performed within two weeks of the date of inspection.~~

(b) Maintenance of Grassed Areas

~~The Contractor shall be responsible for the maintenance of grassed areas, including mowing, for the duration of the Defects Liability Period for the Whole of the Works.~~

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SECTION 713 - BEACHING

~~##This section cross references Sections 175, 210, 703 and 801.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

713.01 DESCRIPTION

This section covers the requirements for the supply and placement of rock, stone or manufactured block beaching for the protection of batter slopes, drainage channels and culvert endwalls as shown on the drawings. Six types of beaching are covered by this section:

- Type 1: Un-grouted rock beaching
- Type 2: Grouted rock beaching
- Type 3: Grouted flat stone beaching
- Type 4: Butted paving block beaching
- Type 5: Melbourne Water waterway beaching
- Type 6: Armour Stone

713.02 CONFORMITY WITH DRAWINGS

The finished surface of the beaching shall conform to the levels, lines and grades as shown on the drawings or as specified.

713.03 MATERIALS

The Contractor shall supply all materials necessary, including rock or paving blocks, bedding, filter materials, geotextile, concrete, mortar, reinforcement and drainage pipes.

Prior to the commencement of work, the Contractor shall nominate the source of the proposed materials, supply specified test results and provide a representative sample to for approval by the Superintendent Council.

Materials used for rock beaching shall be resistant to weathering action of air, wind and water and shall be free from staining, laminations, cracks and other structural defects which may reduce its mechanical strength.

All rock materials used for beaching shall comply with the material requirements for 'sound' rock as specified in Section 801 and the Los Angeles Value (LAV) requirements of Table 801.033. The rock shall have a minimum apparent particle density of 2.5 t/m³ when tested in accordance with the requirements of the current Australian Standard - *Method for sampling and testing of aggregates-Particle density and water absorption of coarse aggregate-Weighing-in-water method* as listed in Section 175. In addition, the rock beaching shall have a minimum wet strength of 100 kN and a wet/dry strength variation not exceeding 45% when tested in accordance with the requirements of the current Australian Standard – *Methods for Sampling and Testing Aggregates-Wet/Dry Strength Variation* as listed in Section 175.

(a) Beaching Material

(i) Type 1 - Un-grouted rock beaching

Rock for Type 1 beaching shall consist of field or quarry rock.

All rocks shall have a mass of between 20 and 70 kg and at least 60% by number shall be over 40 kg. Rocks shall be of such size that the layer of beaching is not less than 225 mm thick.

(ii) Type 2 – Grouted rock beaching

Rock for Type 2 beaching shall consist of field or quarry rock. The rocks shall be uniform in colour.

All rocks shall have a mass of between 10 kg and 40 kg and at least 60% by number shall be over 25 kg. Rocks shall be of such size that the layer of beaching is not less than 150 mm thick.

(iii) Type 3 – Grouted flat stone beaching

Type 3 beaching shall consist of dense, flat stone.

Beaching stone shall be uniform in size, shape and colour. Each piece shall be not less than 65 mm thick and have a face area not less than 0.1 m². At least 50% of the pieces by number shall have an area of more than 0.2 m².

(iv) Type 4 – Butted paving block beaching

Paving blocks shall be of the type, face size, thickness and colour specified.

All masonry units used for Type 4 beaching shall be solid units and shall comply with the requirements for masonry units in AS/NZS 4455.1. Masonry units shall be sampled to AS/NZS 4456.1 and tested in accordance with AS/NZS 4456.4, and shall have a minimum unconfined compressive strength for masonry units in AS/NZS 4455.1.

(v) Type 5 – Melbourne Water waterway beaching

Rock for Type 5 beaching shall consist of field or quarry rock, preferably of a type/colour that is indicative of the local area.

Primarily the material will be angular in shape, and of even grading (including 5% by weight of rock fines), that creates an interlocked effect when constructed.

The nominal rock size/thickness, D50, is to be specified by the designer and signed off by Melbourne Water. Unless otherwise specified, the minimum D50 shall be a 300 mm rock sizing, with a depth of 2 x D50 (600 mm).

All beaching on Melbourne Water assets shall be structurally stable and scour proof, and as per Melbourne Water requirements. Final Melbourne Water rock beaching is to support agreed revegetation.

Prior to the commencement of work, the Contractor shall provide a record of Melbourne Water design acceptance to the Superintendent Council for approval.

(vi) Type 6 – Armour stone

Armour stone shall comply with the requirements of Type 1 beaching, unless specified, and all armour stone shall have a mass of between ##: and ##: kg and at least 60% by number shall be over ##: kg. Rocks shall be of such size that the layer of beaching is not less than ##: mm thick.

Armour stone used on Melbourne Water assets shall include rock fines to create an interlocked effect when constructed.

Prior to the commencement of work on a Melbourne Water waterway, the Contractor shall provide a record of Melbourne Water design acceptance to the Superintendent Council for approval.

(b) Bedding

Type 1 beaching shall not routinely require a granular bedding, however a very robust needle-punched non-woven geotextile (mass >250 g/m²) shall be laid over the trimmed surface where rock beaching is to be placed. Geotextiles used shall comply with and be placed in accordance with Section 210. The geotextile shall be buried to a depth of 300 mm at the edges of beaching and placed under and around the excavation for the toe wall and for any other perimeter walls provided. The geotextile shall be laid evenly with no kinks or folds, and joints shall be formed by overlapping the geotextile by not less than 300 mm and not more than 500 mm.

Type 2 beaching shall not require bedding unless specified or shown on the drawings.

Bedding for Type 3 beaching shall consist of at least 30 mm depth of mortar, comprising one part portland cement and nine parts sand.

Bedding for Type 4 beaching shall consist of a 50 mm minimum layer of bedding sand or stabilised sand with a slow setting binder.

Type 5 beaching shall be developed in conjunction with Melbourne Water. The rock used for the granular filter layer is to be well graded and where a granular bedding is required, limited to 0-100 mm in size. The thickness of the granular filter will depend on site and hydraulic conditions but shall not be less than 100 mm. Sites composed of sandy, dispersive soils may require the use of a geotextile filter layer beneath the granular filter/embedment layer.

Armour stone shall not require bedding unless specified or shown on the drawings.

713.04 PREPARATION OF UNDERLYING SURFACE

Areas on which beaching is to be placed shall be compacted and trimmed as required to provide a finished surface level of beaching in accordance with the drawings. Any scours or hollows in the surface shall be filled with compacted Class 4 crushed rock.

Trimmed material shall be removed from the site.

For treatment of scours and hollows on or near Melbourne Water assets, contact Melbourne Water for the necessary treatment.

713.05 BEACHING PLACEMENT

(a) General

Wherever practicable, the placement of beaching materials shall be by mechanical means. For beaching materials with a mass greater than or equal to 12 kg, placement by mechanical means is mandatory.

~~Prior to commencement of any work where placement of rock beaching is proposed, a detailed job safety assessment shall be undertaken by a suitably qualified and experienced professional and a suitable Safe Work Method Statement developed to cover all necessary elements.~~

~~The completed job safety assessment and the Safe Work Method Statement shall be submitted to the Superintendent for review.~~

~~The documentation submitted must demonstrate compliance with the Occupational Health and Safety Regulations 2017, in particular, Part 3.1 – Manual Handling, Part 3.3 – Prevention of Falls and Part 5.1 – Construction.~~

Beaching materials shall be firmly bedded on the prepared embankment and/or bedding if required and laid in courses commencing from the bottom of any slope.

Un-grouted beaching and armour stone when placed shall form a tight 'interlocking grid', which shall prevent the removal of individual rocks.

The general surface of the finished beaching shall not vary from a 3 metre straight edge laid across the surface of the beaching by more than:

- 100 mm for Type 1 Beaching
- 75 mm for Type 2 Beaching
- 30 mm for Type 3 Beaching
- 20 mm for Type 4 Beaching
- 75 mm for Type 5 Beaching (unless otherwise specified by Melbourne Water Authority)

Finished surface levels of rock beaching placed in open drains shall be flush with adjacent soil levels to allow mowing and maintenance. Rock beaching shall not protrude more than 50 mm above the surrounding ground levels.

The finished rock surface shall be stable to allow public access and shall comply with the requirements of Section 28 of the OH&S Act 2004 'Design for Safe Workplaces'.

(b) Type 1 Beaching

Gaps between rocks shall be as narrow as practicable and not exceed 60 mm on average. Voids shall be filled to at least mid-height of the rocks with topsoil.

The level of the topsoil shall be increased where planting is required within Type 1 rock beaching. The topsoil depth shall be increased to finish flush with the general rock surface and adjacent ground level.

(c) Type 2 Beaching

Width of joints may vary between 10 mm and 60 mm, with an average not exceeding 40 mm. Level difference between edges of adjacent rocks shall not exceed 40 mm. The joint pattern shall be random and the joints kept free from debris before grouting.

(d) Type 3 Beaching

Beaching material shall be thoroughly cleaned and saturated with water before being bedded on fresh mortar as specified in Clause 713.03(b).

The joint pattern shall be random and the joints kept free from debris prior to grouting. Width of joints may vary between 10 mm and 60 mm, with an average not exceeding 40 mm. Level difference between edges of adjacent stones shall not exceed 25 mm.

(e) Type 4 Beaching

The blocks shall be placed on the specified bedding sand and laid in accordance with the manufacturer's recommendation. Edge blocks shall be neatly cut to establish straight edges. Dry sand shall be broomed into the joints on completion and lightly watered. The sand used in this mixture shall all pass a 1.18 mm AS sieve and 10-20% shall pass a 0.075 mm AS sieve.

(f) Type 5 Beaching

Rocks shall be placed to allow for the formation of a tightly interlocked rock mass in which the larger rocks are not free to move. All voids are to be sealed with smaller graded rock for stability and sufficient for water to flow over the top and not within or underneath the beaching. All leading and edge rocks shall finish flush with the surrounding ground level.

The following photos are typical examples of Melbourne Water accepted rock beaching and armour stone showing well graded rock including the proportion of 'fines'.

Photo 1: Melbourne Water accepted Type 5 rock beaching



Photo 2: Melbourne Water accepted Armour Stone**713.06 GROUTING**

Grouting with mortar shall be carried out when the air temperature is above 5°C and work shall be kept moist for three days after grouting.

Joint mortar shall consist of one part portland cement and three parts sand by volume, and be thoroughly mixed with water to produce grout of suitable consistency. Propriety cementitious mortars with equivalent performance may be used if approved by the Superintendent Council.

Grouted rock beaching (Type 2) and grouted flat stone beaching (Type 3) shall be initially placed on a bed of mortar which infiltrates joints and final grouting shall ensure that mortar is firmly tamped into joints to fill the joints to 20 mm below the general top of beaching level.

The joints shall be neatly finished by filling with mortar. The final level of the mortar shall not be within 10 mm of the finished rock surface. Care shall be taken to keep the exposed rock face clean. Brooming of mortar across the face of the rocks will not be permitted.

713.07 PERIMETER AND TOE WALLS

Perimeter and toe walls shall be constructed where shown on the drawings.

For Type 1 Beaching, toe walls 600 mm wide by 600 mm deep shall be constructed. They shall be lined with geotextile fabric and filled with hand packed rock, the larger voids between rocks being filled with smaller stones. Where Type 1 beaching is used in streams, similar walls 600 mm wide by 600 mm deep shall also be constructed across the upstream end of the beaching.

For Types 2, 3 and 4 Beaching, concrete perimeter walls shall be constructed around exposed edges of the beaching. Concrete used for this purpose shall be N20 strength grade complying with Section 703.

Toe walls shall be 300 mm wide by 400 mm deep at the front face and reinforced with L8TM trench mesh top and bottom. The upper surface of the toe wall shall slope upwards at either the slope of the rock beaching or the adjacent verge as shown on the drawings. Side walls and other perimeter walls shall be 150 mm wide by 250 mm deep. The top of the walls shall be continuous with the beaching.

For Type 5 Beaching, perimeter and toe edge rocks will depend on site and hydraulic conditions and shall be constructed in conjunction with Melbourne Water. Perimeter and toe edge rocks shall be trenched into in situ ground before bedding placement. Such rocks shall have a minimum embedment depth of 600 mm and shall finish flush with the surrounding ground.

Perimeter and toe edge rocks may require a granular bedding and an underlying geotextile filter layer, if warranted by the site and hydraulic conditions. All rocks shall be carefully placed into position, rather than dumped directly, so as to avoid segregation of the rock sizes.

713.08 DRAINAGE

- (a) Where specified or shown on the drawings, a 100 mm diameter PVC pipe shall be laid down the batter in a trench beneath the bedding to discharge immediately above the top of the toe wall. The pipe shall be securely bedded within the backfilled compacted crushed rock or natural gravel trench.
- (b) Weepholes consisting of 75 mm diameter PVC pipes shall be placed through the beaching at 2 m centres immediately above the top of the concrete toe wall and cut off flush with the face of beaching. Weepholes and other drainage lines shall not directly discharge onto areas of public access or shared user pathways.

713.09 CLEANING

On completion of the work, the beaching shall be cleaned to remove all foreign materials and discolouration from the beaching surface. Any joint mortar adhering to the surrounding rock surfaces shall be removed.

Draft

SECTION 714 - SIGN INSTALLATION

~~##This section cross references Sections 631 and 703.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

714.01 SCOPE

This section covers the installation of signs and sign supports that comply with:

- the VicRoads Supplement to AS 1743
- Australian Standard AS 1742 Manual of uniform traffic control devices and AS 1743 Road Signs – Specifications
- the VicRoads Traffic Engineering Manual Volume 2 – VicRoads Supplements to Australian Standards.

Cantilever sign structures and sign gantries are outside of the scope of this document.

714.02 SUPPLY OF MATERIALS AND COMPONENTS

All materials shall be supplied by the Contractor.

714.03 TRANSPORT, HANDLING AND STORAGE OF SIGNS

~~The Contractor shall collect signs and sign components from the specified storage location and transport them to the specified sign location.~~

Signs shall be transported, handled stored in a manner that prevents damage to and deterioration of sign components.

If any damage or deterioration should occur to sign components, the Contractor shall repair or replace the affected item. Repairs shall restore the sign to the original condition using proprietary materials obtained from the sign manufacturer or alternative materials compatible with the original.

714.04 CONFORMITY WITH DRAWINGS

The sign installation shall be as described in the sign schedule and as shown on the ~~contract~~ drawings.

If the Contractor proposes to use an alternative method of installation, the Contractor shall submit full details to the Superintendent Council for approval not later than four weeks before the commencement of sign installation.

714.05 TOLERANCES

(a) Foundations

The finished surface of concrete foundations shall be between 50 mm and 100 mm above the finished surface at the base of the sign and shall be shaped to ensure free drainage of water away from the base of the post.

(b) Posts

- (i) Posts shall be straight
- (ii) Posts shall be vertical with a maximum deviation of 1 in 100
- (iii) Post tops shall be 50 mm \pm 10 below the top edge of the sign

(c) Signs

- (i) Signs shall be mounted level with a maximum deviation of 1 in 100.
- (ii) Signs shall be mounted symmetrically on their posts unless the drawings indicate that an offset is required or if directed by the Superintendent Council.
- (iii) Where the sign comprises two or more signs above each other, the individual sign faces shall be mounted with the adjacent edges touching unless otherwise shown on the sign drawings.
- (iv) Sign faces shall present an even surface free from twists, cracks, indentations or any other faults after erection.

714.06 POSTS AND FOUNDATIONS

~~HP The required positions of all posts and signs shall be as directed by the Superintendent who shall confirm the positions before the erection of posts commences.~~

Post details shall be as shown on the ~~Sign and Post Schedule~~ Drawings and in accordance with the VicRoads Traffic Engineering Manual Volume 2. Refer to VicRoads Road Design Note RDN 06-09 for a list of VicRoads accepted frangible post systems.

If the Contractor proposes the use of an alternative post and sign installation, full details of the proposals shall be supplied to the Superintendent Council for review not later than four weeks before installation.

(a) ~~Steel and Timber Posts~~

The Contractor shall conform to the requirements of Clause 714.04. ~~and the Sign and Post Schedule.~~

Steel posts shall be manufactured from steel complying with AS/NZS 1163, AS 1397 or AS 1450, and having a minimum yield strength of 250 MPa.

Where posts are to be mounted in sockets, the post shall be securely fixed into the socket by an approved vandal-proof method.

Signs to be mounted on two or more posts shall have posts positioned such that the sign face is rotated away from the approaching traffic to avoid direct reflection. Posts shall be positioned such that the sign is rotated away from the cross section by an amount equal to one tenth of the width of the sign (approximately 5°).

Posts specified as frangible hardwood shall be set at a level such that the centre of the lower hole of each post is 75 mm above the finished surface at the base of the post.

(b) Coatings for Sign Supports

Steel posts shall be either:

- Hot dipped galvanised in accordance with AS/NZS 4680; or
- Pre-galvanised prior to forming in accordance with Z275 coating class to AS 1397 (total minimum coating mass on both surfaces of 275 g/m²). The finished tube must be equivalent to AS/NZS 4792 ZB135/135. The weld seam made during forming of pre-galvanised steel post sections shall be repaired in accordance with AS/NZS 4792, Section 3, by applying a coating using a metal spraying system employing a suitable zinc or zinc-alloy wire/powder.

Sign supports shall be unpainted unless otherwise shown on the drawings. Any paints shall be in accordance with Section 631.

(c) Foundations

All posts shall be set in concrete foundations to the depths shown in the Sign and Post Schedule and with the following hole diameters:

Foundation Hole Diameter	
Post size and type (mm)	Diameter (mm)
32 mm and 50 mm nominal bore steel	300 225
80 mm to 150 mm nominal bore steel	300
180mm x 100 mm frangible hardwood	300

Concrete used in foundations shall be ~~20~~ 25 MPa complying with the requirements of Section 703.

(d) Posts in Sockets

If a sign is located in a paved area or in a location where the sign may be struck by a vehicle, e.g. at the end of an urban median or where it may be necessary to remove the sign to accommodate the swept path of over-dimensional vehicles, the post should be inserted into a socket cast into concrete foundation. Suitable socket sizes for posts are as follows:

Socket Size	
Post size (mm)	Socket Size (mm)
32 mm nominal bore tube	50 mm nominal bore tube
50 mm nominal bore tube	65 mm nominal bore tube

The depth of the socket should be the same as the depth in ground nominated in Table 22 of the VicRoads Supplement to AS 1742.2:2009.

The socket should protrude ~~50~~ 75 mm above an earth surface or ~~25 mm above a paved surface~~.

The sign post must penetrate a minimum 450 mm into the socket.

The sign post should be securely fixed into the socket by an approved vandal-proof method.

(e) Backfilling of Post Holes

(i) 32 and 50 mm Nominal Bore Steel Posts

- posts holes shall be back-filled with concrete with a nominal strength of 10 MPa.

(ii) 180 mm x 100 mm Frangible Hardwood Timber Posts

- frangible Hardwood Posts shall be erected in accordance with the drawings;
- post-holes for frangible hardwood posts shall be filled with a mixture of gravel and cement (4% by weight).

(f) VicRoads Approved Sign Support Systems

Other VicRoads approved proprietary supports systems may be used and shall be installed in accordance with the manufacturer's specifications.

714.07 INSTALLATION OF SIGNS

Installation of signs shall be in accordance with the Drawings. ~~Sign and Post Schedule.~~

Fittings shall be appropriate to the size and type of sign and shall ensure that the sign face is securely connected to the post.

- (a) Signs shall be attached to the post(s) or structures using the type and number of fittings as specified in the schedule or as follows:

Size of Sign	Number of Fittings per Post
Signs up to 200 mm in depth	One
Signs 201 to 900 mm in depth	Two
Signs 901 to 1200 mm in depth	Three
One extra fitting shall be provided per post for each 400 mm increment or part thereof above 1200 mm.	

- (b) For braced signs, the sign shall be attached to the post at every intersection point between the sign bracing member and the post.
- (c) Where a sign assembly consists of two or more signs, the signs shall be mounted in accordance with the sign assembly drawings.
- (d) Signs shall be positioned in accordance with the following tolerances:
- ± 40 mm of the height specified in on the Drawings the ~~Sign and Post Schedule~~ measured from the bottom of the sign or sign assembly to the lip of the kerb or edge of shoulder nearest the sign;
 - ± 100 mm of the pegged sign location or specified location.
- (e) When a sign is to be mounted on frangible posts on a cut batter having a slope steeper than or equal to 2:1, the mounting height at the shorter post may be reduced providing that:
- the uphill corner of the sign is a minimum of 800 mm above the ground;
 - the sign at the longer post is 2200 mm minimum above the ground.
- (f) ~~If required on the drawings sign faces shall be mounted on existing roadside poles, lighting columns, traffic signal pedestals. Where a sign is to be mounted with stainless steel straps, the brackets shall be attached to the pole using stainless steel straps of 12 mm minimum width and a minimum tensile strength 6.5 kN.~~
- ~~Small signs with an area of not exceeding 0.3 m² shall be attached to steel or concrete electricity distribution poles, tramway poles, lighting columns and signal pedestals or mast arms by banding or other proprietary fittings.~~
- ~~Signs exceeding 0.3 m² in area may be attached to existing poles (other than electricity distribution poles) provided that the pole has sufficient strength to support the additional loading due to the sign and that special joint-use supports are used.~~
- ~~**If the Contractor proposes to mount a sign on an existing pole, the strength of the pole and any other effects of mounting the sign in this way such as fatigue and durability shall be checked by an experienced structural engineer. Evidence of the structural checking shall be submitted to the Superintendent for review. The Contractor shall obtain permission shall for use of structures which are not VicRoads property.**~~

~~The maximum signboard areas which may be attached to joint-use structures are:~~

- ~~• standard 114 mm OD signal pedestal – 1.0 m²~~
- ~~• special 165 mm OD signal pedestals – 2.7 m²~~
- ~~• joint use traffic signal/lighting column or traffic signal mast arm – 1.6 m² less the area of any traffic signal target boards facing in the same direction.~~

~~Minimum lateral and vertical clearances adjacent and under the sign shall be maintained.~~

- (g) Where the drawings indicate that a sign is to face oncoming traffic, it shall be mounted on posts which have been rotated in accordance with the requirements of Clause 714.06(a), with the exception of signs mounted on structures over traffic lanes.
- (h) Where signs are to be removed or relocated, as specified on the Drawings in the schedule, the Contractor shall dismantle and transport the signs, posts and fittings to the specified new location or as directed by ~~the Superintendent~~ Council. Post holes shall be backfilled and compacted to the finished surface. Relocated signs shall be erected in their new position as specified.
- (i) After erection of each sign all stiffening bars are to be removed.
- (j) Single post mounting for large signs shall be provided if required on the drawings and the schedule. Single post mountings shall be designed in accordance with the VicRoads Traffic Engineering Manual Volume 2. Such supports are not to be made as breakaway supports.
- (k) Installation of proprietary signs approved by coordinating road authority VicRoads shall be in accordance with the supplier's recommendations. ~~as modified by VicRoads conditions of approval.~~

714.08 MASKING OF SIGNS

Where required indicated in the schedule, the Contractor shall mask the nominated sign(s) by placing a porous cloth or similar covering that conceals the sign text under both wet and dry conditions and does not void the sign material warranty. The masking material shall be held in position by wire mesh over the sign.

Adhesive material shall only be applied to the masking material and not be applied to either the front or rear face of the signboard.

~~Signs marked 'm' in the Sign and Post Schedule shall be masked.~~

The size of the masking material and its method of attachment shall be such that the sign is:

- effectively and securely covered;
- wholly or partly covered, as required;
- covered at all times and under all conditions.

714.09 REFERENCES

VicRoads Traffic Engineering Manual Volume 2

SECTION 715 - GABIONS AND ROCK MATTRESSES

~~##This section cross-references Sections 173, 175, 204, 210, 702, 801 and 812.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

715.01 DESCRIPTION

This section covers the requirements for the supply of materials, assembly, installation and filling of rock filled gabions and rock mattresses.

This section also covers specific requirements for gabion retaining structures, and specific requirements for the use of gabions and rock mattresses in waterways and coastal waters.

715.02 DEFINITIONS

Gabion

A container manufactured from hexagonal mesh wire netting or square welded mesh, partitioned into maximum 1 m³ cells, interconnected with other units and filled with rock. Gabions may be used for landscaping, erosion control, noise attenuation walls, facing panels for reinforced soil structures and retaining structures.

Gabion fill material and rock mattress fill material

Rock used to fill gabions and rock mattresses.

Gabion retaining structure

A mass retaining structure constructed from gabions, 1.5 m or greater in height and steeper than 0.66(H):1(V), or which would result in a traffic or pedestrian hazard or damage to neighbouring property upon failure.

Prefilled gabion

A gabion assembled and filled with gabion fill material, and then lifted and transported prior to installation.

Rock mattress

A container manufactured from hexagonal mesh wire netting, partitioned into maximum 2 m² cells with a maximum height of 300 mm and filled with rock, used for landscaping and erosion control.

715.03 GABIONS

(a) Hexagonal mesh wire netting shall have the following properties:

- (i) wire and selvedge wire shall have a minimum tensile strength of 380 MPa and a minimum diameter of 2.7 mm and 3.4 mm respectively
- (ii) wire and selvedge wire shall be coated with a minimum of 240 g/m² zinc/5% aluminium alloy and a minimum 0.5 mm of grey coloured extruded PVC, prior to netting manufacture
- (iii) netting shall be manufactured by winding two wires around each other through three 180° rotations to form a tight, helical twist with a nominal mesh size of 80 mm x 100 mm.

Gabions manufactured from hexagonal mesh wire netting shall be partitioned into maximum 1 m³ cells, and selvedge wires shall be provided on all edges.

(b) Square welded mesh shall have the following properties:

- (i) wire shall have a minimum tensile strength of 380 MPa and a minimum diameter of 5.0 mm
- (ii) welded mesh shall be manufactured with a minimum weld shear strength of 7.5 kN and a maximum mesh size of 75 mm x 75 mm
- (iii) welded mesh shall be coated with a minimum of 240 g/m² zinc/5% aluminium alloy, after mesh manufacture.

Gabions manufactured from square welded mesh shall be partitioned into maximum 1 m³ cells, and shall not be used in noise attenuation walls, facing panels for reinforced soil structures and retaining structures.

(c) Fasteners shall have the following properties:

- (i) wire shall have a minimum tensile strength of 1500 MPa and a minimum diameter of 3.0 mm
- (ii) wire shall be stainless steel wire.

Fasteners shall be able to be folded around four selvedge wires with a minimum overlap of 25 mm.

(d) Braces shall have the following properties:

- (i) wire shall have a minimum tensile strength of 380 MPa and a minimum diameter of 3.4 mm
- (ii) wire shall be coated with a minimum of 240 g/m² zinc/5% aluminium alloy and a minimum 0.5 mm of grey coloured extruded PVC, prior to brace forming.

Braces shall be formed by folding one wire to form a U shape with strands of nominal length 1000 mm and a span of nominal length 200 mm; returns of nominal length 100 mm shall also be provided at the open end of the brace.

(e) Certificate of compliance

HP Prior to the commencement of work, the Contractor shall supply a certificate of compliance from the manufacturer confirming that the gabions, fasteners and braces comply with this specification., for approval by the Superintendent.

715.04 ROCK MATTRESSES

(a) Hexagonal mesh wire netting shall have the following properties:

- (i) wire and selvedge wire shall have a minimum tensile strength of 380 MPa and a minimum diameter of 2.0 mm and 2.4 mm respectively
- (ii) wire and selvedge wire shall be coated with a minimum of 210 g/m² zinc/5% aluminium alloy and a minimum 0.5 mm of grey coloured extruded PVC, prior to netting manufacture
- (iii) netting shall be manufactured by winding two wires around each other through three 180° rotations to form a tight, helical twist with a nominal mesh size of 60 mm x 80 mm.

Rock mattresses manufactured from hexagonal mesh wire netting shall be partitioned into maximum 2 m² cells, and selvedge wires shall be provided on all edges.

(b) Fasteners shall have the following properties:

- (i) wire shall have a minimum tensile strength of 1500 MPa and a minimum diameter of 3.0 mm;
- (ii) wire shall be stainless steel wire.

Fasteners shall be able to be folded around four selvedge wires with a minimum overlap of 25 mm.

(c) Certificate of compliance

HP Prior to the commencement of work, the Contractor shall supply a certificate of compliance from the manufacturer confirming that the gabions and fasteners comply with this specification., for approval by the Superintendent.

715.05 GABION FILL MATERIAL AND ROCK MATTRESS FILL MATERIAL**(a) General**

Gabion fill material and rock mattress fill material shall consist of rock with not less than two broken or angular faces. The rock shall be resistant to weathering action of air, wind and water and shall be free from staining, laminations, cracks and other structural defects which may reduce its mechanical strength.

All rock used for gabion fill material and rock mattress fill material shall comply with the material requirements for 'sound' rock as specified in Section 801 and the Los Angeles Value (LAV) requirements of Table 801.033. The rock shall have a minimum apparent particle density of 2.5 t/m³ when tested in accordance with AS 1141.6.1. In addition, the rock shall have a minimum wet strength of 100 kN and a wet/dry strength variation not exceeding 35% when tested in accordance with AS 1141.22.

Rock from a quarry or non-quarry site shall not be used until the source has been investigated and accredited in accordance with VicRoads Code of Practice for Source Rock Investigations as listed in Section 175.

HP

Prior to the commencement of work, the Contractor shall nominate the proposed source of rock and supply the specified test results. ~~for approval by the Superintendent.~~

(b) Dimensions

The dimensions of gabion fill material and rock mattress fill material shall comply with the relevant requirements of Table 715.051.

Table 715.051 Dimensions of Gabion Fill Material and Rock Mattress Fill Material

Material	Minimum Dimension (mm)	Maximum Dimension (mm)
Gabion fill material	100	250
Rock mattress fill material	75	Two-thirds the thickness of the rock mattress, or 200 mm, whichever is the lesser.

(c) Testing

The Contractor shall sample and test gabion fill material and rock mattress fill material at a frequency of at least one test per 100 tonnes or part thereof to ensure that the material consistently complies with the dimensions shown in Table 715.051. Samples shall be obtained from stockpiles in accordance with AS 1141.3.2. Tests shall be undertaken by passing the samples through rigid screens with round holes with a diameter of the relevant dimension.

715.06 GABION ASSEMBLY, INSTALLATION AND FILLING**(a) Foundation preparation**

Areas upon which gabions are to be installed shall be prepared and test rolled as specified in Section 204 and Section 173. Any unstable areas detected by test rolling shall be rectified as specified in Section 204.

The Contractor shall request the ~~Superintendent~~ Council to be present during all test rolling.

(b) Assembly

Gabions shall be laid out on a hard, flat surface and stretched to remove all kinks and bends. Individual gabions shall be assembled by raising the sides and partitions and connecting selvedge wires at all abutting edges with fasteners at maximum 150 mm intervals. Gabions may be cut into two segments and spliced by a minimum length of 200 mm to form nonstandard dimensions. Fasteners shall be installed at both edges of the splice at maximum 150 mm horizontal and vertical intervals.

(c) Installation

Gabions shall be installed in the positions shown on the drawings and each gabion shall be connected to all adjacent gabions by connecting all abutting edges with fasteners at maximum 150 mm intervals. Temporary supports, permanent supports consisting of galvanized star pickets or galvanized steel structural sections, or tensioning shall be used as required to ensure the sides of the installed gabions do not vary by more than 50 mm from a 3 metre straight edge laid across the surface prior to, during and after filling with gabion fill material.

(d) Filling

Gabions shall be filled with gabion fill material by mechanical means aided by hand sorting to ensure that exposed surfaces are free from excessive bulges and depressions. Gabions shall be one third filled and braces installed at evenly distributed nominal 330 mm horizontal centres. Gabions shall then be two thirds filled and additional braces installed at evenly distributed nominal 330 mm horizontal centres. Gabions shall then be fully filled, the selvedge wires on the lids connected to selvedge wires at all abutting edges with fasteners at maximum 150 mm intervals, and any temporary supports or tensioning removed.

Where bulges and depressions greater than 50 mm are present after filling, the gabions shall be refilled. Square welded mesh that is buckled by impacts during filling shall be replaced.

(e) Prefilled gabions

HP The use of prefilled gabions is not permitted without the prior written approval of the Superintendent Council.

The Contractor shall submit a procedure for filling, lifting and transporting prefilled gabions for approval by the Superintendent Council. The procedure shall demonstrate that the prefilled gabions will not vary by more than 75 mm from a 3 metre straight edge laid across the surface after installation. Where required by the Superintendent Council, a test prefilled gabion shall be filled, lifted, transported and lifted again to confirm the suitability of the procedure.

Prefilled gabions shall be installed in the positions shown on the drawings and each prefilled gabion shall be connected to all adjacent prefilled gabions by connecting accessible abutting edges only with fasteners at maximum 150 mm intervals. The exposed sides of the prefilled gabions after installation shall not vary by more than 75 mm from a 3 metre straight edge laid across the surface after installation. Where bulges and depressions greater than 75 mm are present after installation, the prefilled gabions shall be replaced.

715.07 ROCK MATTRESS ASSEMBLY, INSTALLATION AND FILLING

(a) Foundation preparation

Areas upon which rock mattresses are to be installed shall be prepared and test rolled as specified in Section 204 and Section 173. Any unstable areas detected by test rolling shall be rectified as specified in Section 204.

The Contractor shall request the Superintendent Council to be present during all test rolling.

A separation/filtration geotextile layer shall be placed on the prepared surface. The geotextile shall comply with the requirements of Section 210, and shall have a classification of very robust, an overlap of 300 mm, and shall be a non-woven type geotextile. The geotextile shall be placed as specified in Section 210, and shall be buried to a depth of 300 mm at the edges of the areas upon which rock mattresses are to be installed.

(b) Assembly

Rock mattresses shall be laid out on a hard, flat surface and stretched to remove all kinks and bends. Individual rock mattresses shall be assembled by raising the sides, ends and partitions and connecting selvedge wires at all abutting edges with fasteners at maximum 150 mm intervals. Rock mattresses may be cut into two segments and spliced by a minimum length of 200 mm to form nonstandard dimensions. Fasteners shall be installed at both edges of the splice at maximum 150 mm horizontal and vertical intervals.

(c) Installation

Rock mattresses shall be installed in the positions shown on the drawings. Rock mattresses installed on slopes shall be arranged with the longest dimension of the rock mattress in the direction of the slope. Each rock mattress shall be connected to all adjacent rock mattresses by connecting selvedge wires at all abutting edges with fasteners at maximum 150 mm intervals. Permanent anchors consisting of galvanized star pickets shall be installed on a minimum 1 m by 1 m centre grid. The galvanized star pickets shall be driven into the foundation to a minimum depth of 500 mm and shall be connected to the base of the rock mattress with a fastener.

(d) Filling

Rock mattresses shall be filled with rock mattress fill material by mechanical means aided by hand sorting to ensure that exposed surfaces are free from excessive bulges and depressions. Rock mattresses shall be fully filled and the lids connected to all abutting edges with fasteners at maximum 150 mm intervals. The lids of the rock mattresses shall not vary by more than 50 mm from a 3 metre straight edge laid across the surface. Where bulges and depressions greater than 50 mm are present after filling, the rock mattresses shall be refilled.

715.08 GABION RETAINING STRUCTURES

(a) General

Gabions manufactured from square welded mesh and rock mattresses shall not be used in gabion retaining structures.

(b) Design

Gabion retaining structures shall be designed in accordance with AS 5100.3, and the following requirements:

- (i) the design life shall be 100 years
- (ii) the gabions shall lean backward into the retained material and the base of the gabions shall have a slope of 10(H):1(V)
- (iii) the gabion fill material design source rock unit weight shall be 24.5 kN/m³, unless demonstrated otherwise by nominating the source rock and supplying apparent particle density test results in accordance with Clause 715.05(a)
- (iv) the gabion fill material design porosity shall be 20% for design for bearing failure and global failure ultimate limit states, and shall be 40% for design for sliding, rotation and structural failure ultimate limit states, unless demonstrated otherwise by determining the porosity using a sacrificial test gabion
- (v) the Type A structural material, permeable fill material or no fines concrete design effective cohesion shall be 0 kPa, the design effective friction angle shall be 40°, and the design unit weight shall be 20 kN/m³.

~~##(strike through the remainder of this clause if not required):~~

In addition, for gabion retaining structures with a retained height of 6 m or more:

- (i) the gabion fill material design source rock unit weight shall be determined by nominating the source rock and supplying test results demonstrating the minimum apparent particle density
- (ii) the gabion fill design porosity shall be determined by preparing a sacrificial test gabion and measuring the mass of gabion fill material in the test gabion, in tonnes to the nearest 0.1 tonne, and the volume of the test gabion, in m³ to the nearest 0.1 m³. The gabion fill design porosity shall then be determined using:

$$1 - \frac{(\text{mass of gabion fill material in test gabion, t}) / (\text{apparent particle density, t/m}^3)}{\text{volume of test gabion, m}^3}$$

- (iii) the design shall be proof-engineered by a Proof Engineer who shall be prequalified at Level PE in accordance with the VicRoads prequalification scheme.

(c) Foundation preparation

In addition to the requirements of Clause 715.06(a), the prepared surface shall have a slope of 10(H):1(V).

(d) Installation

In addition to the requirements of Clause 715.06(c), temporary supports, permanent supports or tensioning shall be used as required to ensure the top of the first layer of gabions has a slope of 10(H):1(V) prior to filling with gabion fill material. For subsequent layers of gabions, the placement of a screed layer of gabion fill of nominal dimension 70 mm on the underlying layer may also be used as required to ensure the top of the gabions has a slope of 10(H):1(V) prior to filling with gabion fill material.

~~##(strike through the remainder of this clause if not required):~~

In addition, for gabion retaining structures with a retained height of 6 m or more:

- (i) in addition to the requirements of Clause 715.06(d), internal braces shall be installed at evenly distributed nominal 250 mm horizontal centres
- (ii) gabions shall be installed in a stretcher bond pattern, so that the ends of the gabions are staggered vertically from the ends of the gabions in the layers above and below
- (iii) **the Contractor shall request the Superintendent Council to be present during the installation of gabions to ensure the top of the gabions have a slope of 10(H):1(V) prior to filling with gabion fill material.**

(e) Material placed behind gabion retaining structures

Prior to placing material behind gabion retaining structures:

- (i) a separation/filtration geotextile layer shall be placed on the rear of the gabion retaining structure. The geotextile shall comply with the requirements of Section 210, and shall have a classification of very robust, an overlap of 300 mm, and shall be a non-woven type geotextile
- (ii) a subsurface drainage pipe shall be placed at the base of the rear of the gabion retaining structure. The subsurface drainage pipe shall comply with the requirements of Section 702, and shall be a category 2 pipe, shall have a minimum diameter of 100 mm, shall have a perforation size of 2 mm and shall be fitted with a knitted seamless sleeve.

Material placed behind gabion retaining structures shall consist of:

- (i) Type A structural material, consisting of 20 mm Class 3 crushed rock which shall comply with the requirements of Section 812 and shall have a minimum permeability of 1×10^{-8} m/s. Type A structural material shall be placed and compacted as specified in Section 204 Clause 204.11, and testing and acceptance of compaction and moisture content shall be undertaken as specified in Section 204 Clause 204.13 Scale A compaction requirements, Section 204 Clause 204.14(c) and Section 173
- (ii) permeable fill material, consisting of Grade A4, A5, A6, B1, B2, B3 or B4 granular filter material which shall comply with the requirements of Section 702. Permeable fill material shall be placed and compacted as specified in Section 204 Clause 204.11;
- (iii) no fines concrete, which shall comply with the requirements of Section 702. Permeable fill material shall be placed as specified in Section 204 Clause 204.11.

715.09 GABIONS AND ROCK MATTRESSES IN WATERWAYS

HP Gabions and rock mattresses shall not be installed below the 1:50 annual recurrence interval flood level of waterways with a permanent flow of water without the prior approval of the Superintendent Council or the relevant Catchment Management Authority.

The Contractor shall submit a proposal for protecting gabions and rock mattresses from damage from debris impact, and written consent from the relevant Catchment Management Authority, for approval by the Superintendent Council.

715.10 GABIONS AND ROCK MATTRESSES IN COASTAL WATERS

Gabions and rock mattresses shall not be installed below the highest astronomical tide level of tidal waterways or coastal waters, or within the splash zone of coastal waters.

SECTION 721 - PAVEMENT MARKINGS

~~##This section cross references Sections 175 and 853.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

PART 721.A - GENERAL

PART 721.B - PAVEMENT MARKINGS FOR NEW WORKS

~~PART 721.C - PAVEMENT MARKINGS FOR MAINTENANCE WORKS~~

PART 721.D - PAINTED PAVEMENT MARKINGS

PART 721.E - LONG LIFE PAVEMENT MARKINGS

PART 721.A – GENERAL

721.A01 GENERAL

This section covers the requirements for materials and application of pavement markings including:

- (a) supply and application of pavement marking paint and glass beads, longitudinal lines, intersection markings and other markings on the road surface for all new installations and maintenance of pavement markings;
- (b) supply and application of thermoplastic or cold-applied plastic material and glass beads, and pliant polymer tape for all new installations and maintenance of pavement markings;
- (c) fixing of both reflective and non-reflective raised pavement markers to asphalt, concrete or sealed pavements using epoxy adhesive or hot melt bitumen adhesive.

721.A02 DEFINITIONS

Pavement Marking

The term used to define all linemarking, roadmarking and raised pavement markers.

Linemarking

The term used to define all longitudinal lines such as centre, lane, edge, turn and continuity lines.

Roadmarking

The term used to define all transverse lines and markings applied by hand such as Stop/Give Way lines, pedestrian lines, arrows, and legends.

Maintenance of Pavement Markings

Refers to the refreshing or replacement of an already existing pavement marking.

New Pavement Markings

Refers to applying pavement markings to a new surface where no pavement marking exists i.e. after reseals, asphalt resurfacing, newly constructed pavements, and modifications to existing pavement markings.

Initial Coat

The term used to define initial coat of painted markings placed prior to the final coat.

Final Coat

The term used to define the final application of paint.

Raised Pavement Marker

A device placed on a pavement which may be a:

Non Reflective Marker

A device to provide a degree of delineation during daylight owing to the contrasting colour, reflection and profile with respect to the pavement surface. Also a device which reflects ambient light during the day-time and to a limited degree when illuminated at night.

Reflective Marker

A device which produces an effective point source of light at normal highway viewing distances by reflecting incident light in directions close to the direction from which it came. Also a device to provide a degree of delineation during daylight owing to the contrasting colour, reflection and profile with respect to the pavement surface.

Temporary Reflective Marker

A temporary device performing the same function as a Reflective Marker but with an intended life of not more than two weeks under average traffic conditions.

Retroreflectivity

A property of some materials, such as solid glass beads, to reflect incident light in directions close to the direction from which it came. Retroreflectivity is the value of reflected light measured in millicandella / lux / square metre and is used as a measure of light reflected by pavement markings.

Retroreflectometer

A device used to measure retroreflectivity. For the purpose of this contract the geometry of the retroreflectometer shall be based on 30 m observation geometry.

Urban Area

An area in which:

- (a) a speed limit of 60 kilometres per hour or less applies and is not a speed limit which applies only because of a temporary reason such as roadworks or a street event; or
- (b) there are buildings on land next to the road or where the street lighting poles are not more than 100 m apart for -
 - (i) a distance of at least 500 m; or
 - (ii) if the length of the road is less than 500 m, over the full length of the road.

Rural Area

An area that is not an Urban Area.

721.A03 STANDARDS

The dimensions and colour of pavement markings shall conform to the following standards unless otherwise shown on the Drawings:

- (a) VicRoads Traffic Engineering Manual Volume 2 as listed in Section 175;
- (b) the linemarking drawings ~~included in Section ##.~~

Paint and long life material shall be white, except in snow areas and Fairway tramline markings which shall be yellow or as otherwise specified or required in the VicRoads Traffic Engineering Manual Volume 2.

721.A04 INCLUSION AND DELETION OF JOB ITEMS

- ~~(a) The Superintendent may delete any work, subject to notice of deletion being given one month prior to the proposed programmed date. The Contractor will be notified in writing of such deletion and the contract sum adjusted by the price tendered in Schedule 1 for the job item(s) deleted.~~
- ~~(b) No additional payment will be made as a result of the deletion of any work or job item. However, where the deletion of job items results in a contract sum reduction of more than 20 per cent of the original contract sum, the deletion of job items in excess of this amount will be treated as a variation in accordance with the General Conditions of Contract.~~
- ~~(c) The Superintendent may request the Contractor to undertake additional pavement marking works at sites not listed in Schedule 1. These works will be treated as a variation in accordance with the General Conditions of Contract, except that the work shall be valued using Schedule 2 – Rates for Variation Purposes.~~

721.A05 MATERIALS

Pavement marking materials shall conform to the following standards.

(a) Raised Pavement Markers

- (i) Raised pavement markers shall comply with the relevant requirements of AS 1906, Part 3 as listed in Section 175.
- (ii) Temporary raised reflective pavement markers shall comply with the relevant requirements of AS 1906 as listed in Section 175, and shall be at least 100 mm in width and to a height of 50 mm with white reflective material on both sides and include protective covers for the reflective material.

(b) Adhesive

Hot melt bitumen adhesive shall comply with Section 853 - Hot Melt Bitumen Adhesive for Raised Pavement Marker Installation.

Other types of adhesive materials shall only be used with the approval of the Superintendent Council.

(c) Linemarking and Roadmarking Paint

All paints shall be approved under the Australian Paint Approval Scheme (APAS). Paint shall comply with the requirements of AS 4049.1 for solvent-borne paint or AS/NZS 4049.3 for water-borne paint as listed in Section 175.

(d) Glass Beads

- (i) Glass beads shall be used on all applications of material and for all pavement markings and shall conform to the requirements in AS/NZS 2009 and the Australian Paint Approval Scheme (APAS) Specification 0042 as listed in Section 175.
- (ii) Intermix glass beads for use in long life material applications shall conform to AS/NZS 2009 and the Australian Paint Approval Scheme (APAS) Specification 0042.
- (iii) The amount of heavy metals in the beads shall not be greater than that specified in Specification 0042.
- (iv) Pristine glass beads (Type B-HR)
Type B-HR glass beads shall comply with the properties of Type B (AS 2009:2006) drop-on glass beads, with an additional high performance retroreflectivity requirement, requiring the delivery of a minimum 450 mcd/lux.m², when tested in accordance with a modified Appendix M* of AS 2009:2006 (described below).

Section M4 Apparatus clause a) Dry film thickness of paint will be 200-250 µm

Section M5 Procedure clause b) Weigh 24 +/- 0.5 grams of glass beads

Section M5 Procedure clause e) Wet film thickness of paint will be 375 µm +/- 25 µm.

(e) Thermoplastic Pavement Marking Material

Thermoplastic pavement marking material used ~~under this Contract~~ shall comply with the requirements of Clause 721.A13 and shall provide a functional service life of a least six years allowing for fair wear and tear.

(f) Cold-applied Plastic Pavement Marking Material

Cold-applied plastic pavement marking material used ~~under this Contract~~ shall be a Poly Methyl Methacrylate resin based pavement marking material conforming with the colour, luminance and bead content requirements of Clause 721.A13 and shall provide a functional service life of at least six years allowing for fair wear and tear.

(g) Pliant Polymer Pavement Marking Tape

Pliant polymer pavement marking tape intended for use ~~under this Contract~~ shall be approved by the ~~Superintendent~~ Council.

721.A06 SITE PREPARATION

Site preparation shall be the sole responsibility of the Contractor as part of the works, including:

- (a) the removal of existing unsound, obsolete or redundant pavement markings
- (b) the removal of any foreign materials and debris within reasonable limits.

721.A07 PLACING RAISED PAVEMENT MARKERS

Markers shall be placed in accordance with the manufacturer's specification for pavement markers and the adhesives used shall be in accordance with Clause 721.A05(b).

Adhesive on the exposed surfaces of the marker shall be removed.

Where a new or replacement marker is not positioned correctly it shall be removed and a new marker placed.

Markers shall be protected from traffic after placing and any marker dislodged by traffic shall be removed and replaced with a new marker.

On concrete and asphalt pavements, wherever possible, markers shall be placed clear of longitudinal or transverse joints and on all pavements markers shall be placed clear of any surface cracks or positions from which markers have been removed and the surface is damaged.

721.A08 REMOVAL OF PAVEMENT MARKINGS

Where required the Contractor shall remove existing pavement markings to the standard approved by the ~~Superintendent~~ Council and appropriate to the marking being removed.

Any pavement damage caused by the installation or removal of pavement markings included in the works shall be the Contractor's responsibility. Rectification of any pavement damage to line and level shall be completed on the same day in accordance with the ~~Superintendent~~ Council's requirements.

On sections of road on which the Contractor has been directed to replace or remove raised pavement markers, the Contractor shall also repair damage to the pavement caused by the loss of pavement markers.

721.A09 LAYOUT OF MARKINGS

The Contractor shall be responsible for the layout of and spotting out for markings in accordance with the VicRoads Traffic Engineering Manual Volume 2.

721.A10 TOLERANCES ON PAVEMENT MARKINGS

The Contractor shall comply with the tolerances as shown in Table 721.A101 when installing pavement markings.

Table 721.A101 Tolerances on Pavement Markings

Markings	Tolerance
(A) Pavement Markings ⁽¹⁾	
Distance between the centreline of the marking and the centreline of the set out mark	<30 mm
Distance between the centreline of the completed marking and the centreline of the previous marking	<15 mm
Width of completed painted markings	±10 mm of the specified dimensions
Width of completed markings for long life materials	0 mm to +10 mm
Length of completed stripes and blocks	0% to +10% of the specified length
Gap between double lines	-10 mm to +0 mm of the required 100 mm gap ⁽²⁾
(B) Raised pavement markers	
(i) Markers in line with broken segments	
Transverse position	±25 mm of the centreline of segments
Longitudinal position	±0.5 m of the specified position
(ii) Markers in a longitudinal group	
Transverse position	±25 mm of specified position and ±10 mm of a line joining the centres of the end markers
Longitudinal position	±0.5 m
Spacing of markers within the group	±50 mm of specified spacing
(iii) Markers adjacent to an unbroken line	
Clearance to edge line	±5 mm of the specified dimensions
Longitudinal mismatch between markers in transverse pairs	<25 mm
Longitudinal position	Lesser of: 0.5 m or 10%
(iv) Orientation of reflective markers	Lower edge of the reflective face at 85° to 95° to centreline of roadway or adjacent line
(C) Thermoplastic profiled lines	
(i) Tolerances on dimension	
Line width	+20 mm, -5 mm
Line height	+2 mm, -0 mm
Extrusion breadth	+10 mm, -0 mm
Extrusion spacing	±15 mm
Extrusion shape	±25 mm at any point from rectangular shape
(ii) Tolerances on position	
Distance between the centreline of the marking and the centreline of the setout	<30 mm
Length of the completed lines	-0% to +5% of the specified length
Longitudinal position of individual extrusions	±50 mm of any previously applied profiled lining
⁽¹⁾ Apparent line of the markings is a smooth, continuous alignment when viewed in the direction of the line.	
⁽²⁾ Maintenance of pavement markings: If the gap between the existing lines is 90 mm or less the gap shall not be reduced by the maintenance application.	

721.A11 PROTECTION OF WORK

The Contractor shall be responsible for protecting the work by an appropriate means until the work can be trafficked without the glass beads being disturbed from their embedded position, or the paint being picked up and/or spread by passing traffic. If paint pick-up or glass bead disturbance does occur, ~~the Superintendent~~ Council may direct that the marking be re-applied, and paint or long life material spread by traffic be removed.

721.A12 ACCEPTANCE OF WORK

Pavement marking shall comply with the specified requirements as detailed in the following clauses:

- (a) 721.A05 Materials
- (b) 721.A10 Tolerances on Pavement Marking
- (c) 721.A13 Acceptance of Retroreflectivity
- (d) 721.A14 Acceptance of Colour
- (e) 721.D02 Minimum Requirements (for painted markings)
- (f) 721.E02 Minimum Requirements (for long life markings)

Where a particular item fails to satisfy any of the above requirements:

- (a) the Contractor shall rectify the failed sections within 4 weeks of testing at the Contractor's expense
- *** ~~(b) subject to approval by the Superintendent, reduced payment for out-of-tolerance markings may be made in accordance with Clause #:-.~~

HP Where removal of unsuitable pavement marking is required, the method of removal shall be subject to the approval of the Superintendent Council before removal works commence.

721.A13 ACCEPTANCE OF RETROREFLECTIVITY

The Contractor shall measure the level of retroreflectivity using the procedure set out in the current revision of VicRoads Test Method RC424.01 – Determination of Retroreflectivity of Pavement Markings as listed in Section 175. Acceptance of the retroreflectivity of any line or road marking will be based on a lot basis.

The average of the six test site Site Retroreflectivity Values (SRV) shall be calculated for each lot. Each lot shall achieve an average minimum level of retroreflectivity as specified in Table 721.A131 Acceptance of Retroreflectivity.

Table 721.A131 Acceptance of Retroreflectivity

	Initial Measurement	Additional Measurement
Testing Period ⁽¹⁾	3 – 5 weeks	5 – 6 months
Minimum level of retroreflectivity on sprayed seal surfaces	350 mcd/lux/m ²	220 mcd/lux/m ²
Minimum level of retroreflectivity on asphalt and all other surfaces	350 mcd/lux/m ²	250 mcd/lux/m ²
⁽¹⁾ Measured after application of the second/final coat of material.		

Measurements shall be forwarded to ~~the Superintendent~~ Council no later than five days from when the measurements were taken.

721.A14 ACCEPTANCE OF COLOUR

White markings - the colour match test for white materials shall be based on luminance factor and conducted in accordance with AS 4049.4, using Field Method 2 of AS 4049.4 Appendix H4.3 as listed in Section 175. All markings shall have a colour difference detected as whiter than Natural Colour System (NCS) swatch S 2000-N, at all times during the Defects Liability Period.

Yellow markings – the colour match test for non-white (yellow) materials shall be conducted in accordance with AS 4049.4 using Field Method 2 of AS 4049.4 Appendix H4.3, using the reference swatch sample NCS S 1070-Y20R. All yellow markings shall be an approximate match to Natural Colour System (NCS) swatch S 1070-Y20R, at all times during the Defects Liability Period.

Measurements shall be forwarded to the Superintendent Council upon request no later than five days from when the measurements were taken.

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PART 721.B – PAVEMENT MARKINGS FOR NEW WORKS

~~## strikethrough this Part B for Maintenance Contracts:~~

721.B01 GENERAL

This section covers the requirements for new pavement markings.

721.B02 SCOPE OF WORK

The scope of work includes the supply of all materials and placement of pavement markings in accordance with this specification.

For new pavement marking the following works shall be undertaken as part of the works:

- (a) immediately prior to resurfacing, removal of any existing reflective and non reflective markers
- (b) placement of temporary reflective pavement markers including removal of protective covers after surfacing works
- (c) initial placement of pavement markings, including reinstatement of any adjoining pavement markings blackened but not necessarily covered by the surfacing activity, comprising –
 - reinstatement and/or placement of initial coat of painted pavement markings
 - reinstatement and/or placement of other long life pavement markings
 - reinstatement and/or placement of raised pavement markers and removal of temporary raised reflective pavement markers
- (d) final coat of all painted pavement markings
- (e) reinstatement and/or placement of profiled lines after the final coat of paint.

721.B03 LIMIT OF WORK

*** For new pavement markings the limit of pavement marking works shall be the same as the limit of the new surfacing or as shown on the Drawings. ~~in Section ##: – Schedule of Drawings.~~

721.B04 PROGRAM

For new pavement markings the Contractor shall undertake pavement marking works in accordance with the following requirements.

- (a) After Surfacing Works

The initial coat of paint, long life pavement markings (other than profiled linemarking) and raised pavement markers (reflective and non-reflective) on newly surfaced pavements shall be installed in accordance with the following timeframes:

AADT ≥5,000 and M class roads	within 24 hours of opening to traffic
AADT ≥1,000 and ≤4,999	within 3 days of opening to traffic
AADT < 1000	within 5 days of opening to traffic

- (b) All new painted pavement markings shall receive two applications of paint. The second/final application shall be applied between 2-6 weeks after the initial application.
- (c) The Contractor shall apply profiled linemarking between 2–6 weeks after the final coat.
- (d) For new works constructed clear of traffic, all pavement markings shall be completed prior to opening of traffic.

721.B05 POSITION OF MARKINGS

All markings are to be set out in accordance with the dimensions and spacings as required by the appropriate standard in Clause 721.A03.

HP **Painting/application of material shall not commence until the Superintendent Council has inspected the set out and given consent to proceed, unless an exemption has been granted in writing by the Superintendent Council.**

- (a) New pavement markings shall be positioned in accordance with the following requirements:
 - (i) set out by the Contractor in conformance with the appropriate standard required by Clause 721.A03
 - (ii) applied within the tolerances listed in Table 721.A101.

- (b) Temporary Reflective Markers

Temporary reflective markers for new works shall be placed at the following minimum spacings on all longitudinal lane lines, except that on any curve less than 500 m in radius the spacing shall not be more than 12 metre centres:

AADT $\geq 5,000$ and M class Roads	12 metre centres
AADT $\geq 1,000$ and $< 5,000$	24 metre centres
AADT $< 1,000$	48 metre centres

721.B06 RECORDS AND REPORTING

- (a) Job Completion Report

For New Markings the Contractor shall complete and forward to the Superintendent Council a Job Completion Report (Pavement Markings).

- (b) Retroreflectivity Report

The Contractor shall complete and forward to the Superintendent Council a Retroreflectivity Report in a form approved by the Superintendent Council showing the level of retroreflectivity determined for each test lot in accordance with the requirements of Clause 721.A12.

PART 721.C – PAVEMENT MARKINGS FOR MAINTENANCE WORKS

~~## strikethrough this Part C for New Pavement Markings:~~

721.C01 GENERAL

~~This section covers the requirements for maintenance of pavement markings.~~

721.C02 SCOPE OF WORK

~~The scope of work includes the supply of all materials and placement of pavement markings in accordance with this specification.~~

~~Maintenance works shall entail preparing the site in accordance with Clause 721.A06 and refreshing the existing pavement markings with the same material as the existing markings in accordance with this specification.~~

~~Existing markings which are in 'Longlife' i.e. thermoplastic, cold-applied plastic, pliant polymer roadmarking tape, or other long durability non-paint product shall not be maintained in paint, unless prior approval has been given by the Superintendent. Missing or badly worn long life markings shall be reported to the Superintendent who may direct the Contractor to maintain the markings in paint.~~

721.C03 LIMIT OF WORK

~~*** For the maintenance of existing pavement markings the works shall include all existing tapers, bell mouths at intersecting roads, pavement widening and traffic lanes. The limits of work at typical intersections are shown in Section ##: – Schedule of Drawings.~~

721.C04 EXCLUSION OF ROADWORKS

~~For works involving the maintenance of pavement markings, the Contractor will not be responsible for maintaining pavement markings unless otherwise directed by the Superintendent where it is evident that roadworks are taking place or will shortly take place which will interfere with the installation of the markings or which will damage the completed markings.~~

~~The Contractor shall record the location of any road lengths not maintained and notify the Superintendent. The Contractor shall state the reason as to why the location is not maintained prior to the pavement marking work being undertaken.~~

~~Long Life Pavement Markings that could result in thicknesses greater than 5mm shall not be applied and shall be brought to the attention of the Superintendent.~~

721.C05 PROGRAM

~~(a) For the maintenance of pavement markings the Contractor shall submit the following programs as specified for review by the Superintendent as part of the works.~~

- ~~(i) Within two weeks of the Date of Award of Contract, a pavement marking program for the whole of the works that complies with Section ##: – Road Inventory Information. This program shall be reviewed and updated at least annually.~~

- (ii) Based on the list of jobs requested by the Superintendent, the Contractor shall submit a monthly detailed program of planned pavement marking jobs at least five working days in advance of the following month.

The detailed program shall be in bar chart form or other suitable form approved by the Superintendent, including specific jobs to be undertaken with a time scale shown in days. The program shall be in sufficient detail to identify dates covering the following activities:

— date of linemarking

— date of roadmarking

— dates of placement of raised pavement markers

— date of retroreflectivity testing.

- (iii) The Contractor shall submit a weekly program confirming the crew locations for work that will be undertaken in the following week.

All pavement markings on individual Job Items shall be completed in the programmed month as specified in Section ##: — Road Inventory Information.

*** — Failure to meet this requirement may result in a reduced payment on that item in accordance with Clause ##:.

- (iv) The Works, and the requirements for the Works, undertaken between the months of June and July shall be agreed between the Contractor and the Superintendent.

721.C06 INSPECTION AND REPLACEMENT REQUIREMENTS FOR MAINTENANCE OF RAISED PAVEMENT MARKERS

For maintenance of raised pavement markers, the Superintendent will conduct a routine program of inspections of the condition of raised pavement markers.

From the routine program of inspections, requests for replacement of raised pavement markers will be made. For the purpose of replacing raised pavement markers, the Contractor may program this based on a minimum run of 250 markers on urban road sections and M and A class roads, and a minimum run of 125 markers on other road sections. Valuation of these works will be based on rates submitted in Schedule 2 – Rates for Variation Purposes. The Contractor shall replace these markers within one month of the issue of a request from the Superintendent.

721.C07 RECORDS AND REPORTING

(a) Job Completion Report

— For maintenance of pavement markings the Contractor shall complete and forward to the Superintendent a Job Completion Report (Pavement Markings) using the proforma included as Attachment A to this Section 721, for each job item in Schedule 1.

— The Contractor shall hold all records on electronic media in a form approved by the Superintendent. One electronic and one hard copy of each month's completed work shall be forwarded to the Superintendent together with the statement for payment under the Contract.

(b) Retroreflectivity Report

— For both new work and maintenance of pavement markings, the Contractor shall complete and forward to the Superintendent a Retroreflectivity Report in a form approved by the Superintendent showing the level of retroreflectivity determined for each test lot in accordance with the requirements of Clause 721.A12.

PART 721.D - PAINTED PAVEMENT MARKINGS**721.D01 GENERAL**

Linemarking shall be applied by a self propelled machine, and stencils shall be used with all roadmarking.

All work must be undertaken by a contractor eligible for accreditation under the Painting Contractors Certification Programme (PCCP). This programme is administered by the CSIRO.

Completed markings shall be uniform in appearance from all angles of observation, texture, width and thickness and the surface shall be free from streaks, overlaps, unbeaded areas, tyre marks, stencil breaks or other defects. Edges and cut-offs should be neat and sharp, and there shall be no visible run-off, overspray, dribbles, splash or spillage on to the surrounding area, or on to parked or passing vehicles. The Contractor shall be responsible for the cost of removal of paint from such vehicles.

Glass beads shall be applied to the paint to produce a uniform coverage and be properly embedded and bonded over the whole painted surface. Glass beads shall be applied to all markings.

The Contractor shall be responsible for any spillage on to the surrounding area, and cost of any remedial action required.

721.D02 MINIMUM REQUIREMENTS

The minimum requirements of paint and glass beads shall be as shown in Table 721.D021. The Contractor shall allow for any extra material required when placing on coarse chip seals. This includes the retained quantity of glass beads, to counter the phenomenon of reduced retroreflectivity due to road surface texture and directional visibility limitations.

Table 721.D021 Minimum Requirements – Paint and Glass Beads

	Paint ⁽¹⁾	Glass Beads ⁽²⁾
Linemarking		
New Markings (initial application only)	0.38 mm dft on sprayed seals 0.35 mm dft on asphalt and all other surfaces	Type D-HR ⁽³⁾
Re-marking (including second application on new markings)	0.38 mm dft on sprayed seals 0.35 mm dft on asphalt and all other surfaces	Type D-HR ⁽³⁾
Roadmarking		
All Marking	0.35 mm dft on sprayed seals 0.30 mm dft on asphalt and all other surfaces	Type B-HR
<p>⁽¹⁾ The minimum dry paint film thickness (dft) specified above shall be the end product thickness measured on a 200 mm x 100 mm sheet metal test plate without beads. Consideration shall be given to the texture of the road surface and the method of application used to achieve the requirements of this section.</p> <p>⁽²⁾ A minimum of 400 g/m² shall be retained in the painted marking for all glass beads.</p> <p>⁽³⁾ An alternative glass bead application rate shall be 300 g/m² of D-HR with a separate drop of 200 g/m² of B-HR provided that 75% minimum of the D-HR beads is retained at the 5 to 6 month testing undertaken Table 721.A131. Retention of the D-HR beads shall be demonstrated by photographs at each test site.</p>		

PART 721.E – LONG LIFE PAVEMENT MARKINGS

721.E01 GENERAL

Long life pavement marking materials shall be prepared and used in accordance with the manufacturer's specification.

All linemarking shall be applied using a self-propelled ride-on machine including Statcon marking unless otherwise recommended by the marking manufacturer and approved by the ~~Superintendent~~ Council.

Glass beads shall be applied to all long life markings. Glass beads shall be sprinkled or sprayed on to the long life material while it is in a fluid state immediately after it has been applied to the pavement to ensure that the beads are embedded by a nominal 60%. The surface beads shall be distributed to give a uniform coverage over the whole surface of the long life material.

Completed markings shall be uniform in appearance, texture, width and thickness and the surface shall be free from blisters, air bubbles, tears, lumps, streaks, overlaps, unbeaded areas, tyre marks or other defects. Edges and cut-offs shall be neat and sharp, and there shall be no visible run-off, overspray, dribbles, splash or spillage on to the surrounding area, or on to parked or passing vehicles. The Contractor shall be responsible for the removal of pavement marking material from such vehicles.

721.E02 MINIMUM REQUIREMENTS

The minimum requirements of long life materials and glass beads shall be as shown in Table 721.E021. The Contractor shall allow for any extra material required when placing on coarse chip seals. This includes the retained quantity of glass beads, to counter the phenomenon of reduced retroreflectivity due to road surface texture and directional visibility limitations.

Table 721.E021 Minimum Requirements – Long Life and Glass Beads

Material	Applied Minimum Thickness, Glass Bead and Other Requirements
Thermoplastic	
sprayed markings	2.0 mm minimum thickness on longitudinal lines containing intermix beads and with a minimum of 400 g/m ² of Type D-HR or Type B-HR ⁽³⁾ drop-on glass beads retained on the marking surface
extruded line markings ⁽¹⁾	2.0 mm minimum thickness on longitudinal lines containing intermix beads and a minimum of 400 g/m ² of Type D-HR or Type B-HR drop-on glass beads retained on the marking surface
extruded road markings ⁽¹⁾	3.0 mm minimum thickness on intersections containing intermix beads and a minimum of 400 g/m ² of Type D-HR or Type B-HR drop-on glass beads retained on the marking surface
preformed markings	2.3 mm with a minimum skidding resistance value of 45 BPN (British Pendulum Number) and retroreflective properties agreed with the Superintendant
profiled lines ⁽¹⁾	8.0 mm minimum thickness with a minimum of 400 g/m ² of Type D-HR or Type B-HR drop-on glass beads retained on the marking surface

(Table 721.E021 continued next page)

Table 721.E021 Minimum Requirements – Long Life and Glass Beads (continued)

Material	Applied Minimum Thickness, Glass Bead and Other Requirements
Cold-applied Plastic	
sprayed line markings ⁽²⁾	1.0 mm minimum thickness for longitudinal line markings only with a minimum of 400 g/m ² of Type D-HR or Type B-HR glass beads retained in and on the marking surface
sprayed road markings ⁽²⁾	2.0 mm minimum thickness for all road markings containing intermix beads and a minimum of 400 g/m ² of Type D-HR or Type B-HR drop-on glass beads retained on the marking surface
trowelled, screeded, or extruded markings ⁽¹⁾	2.0 mm minimum thickness of markings containing intermix beads and a minimum of 400 g/m ² of Type D-HR or Type B-HR drop-on glass beads retained on the marking surface
Pliant Polymer Tape	as approved by the Superintendent Council
<p>(1) The minimum thickness specified shall be the height above the upper road surface level or above the existing marking as appropriate.</p> <p>(2) The minimum thickness specified shall be the height of the material between the glass beads on a metal test plate. All other thicknesses shall be as measured on a metal test plate including glass beads.</p> <p>(3) Pristine drop-on Type B glass beads (Type B-HR), as per Clause 721.A05.</p>	

721.E03 ADDITIONAL REQUIREMENTS FOR PROFILED LINES

The Contractor shall provide measurements of rib height, length, width, and spacing of profiled lines at a minimum of 10 evenly spaced readings per kilometre or part thereof. For lengths of less than 500 metres, a minimum of 2 evenly spaced readings per 100 metres shall be provided.

The Contractor shall carry out remedial work to rectify defective sections of profiled lines where they:

- (a) were not installed to specified dimensions, or distorted in shape or lost shape, such that the height of individual extrusions is less than 8 mm above the top of adjacent road surface aggregate particles, over more than 10 per cent of the profiled edge lining job item; or
- (b) have shattered or no longer adhere to the road surface over more than 1 per cent of the profiled edge lines job item; or
- (c) have shattered or no longer adhere to the road surface over a continuous length exceeding 5 m.

ATTACHMENT A TO SECTION 721

(Page 1 of 6)

JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

Job No.			
Road Name		Map Reference From	
From		Map Type	
To		Map Reference To	
Lane kilometres		Carriageway kilometres	
Responsible Region		Other Region(s)	
Municipality(ies)		Connect Equipment No. VicRoads Use Only	
MABC No. VicRoads Use Only		Road Category	
Comments			

Pavement Marking Maintenance

Paint Maintenance

Treatment	Material	Date of Marking	VicRoads Use Only	
			Next Schedule Date	Next Program Date

RPM, Including RRPM Maintenance

Treatment	Material	Date of Marking	VicRoads Use Only	
			Next Schedule Date	Next Program Date

Long Life, RRPM Special and other Special Treatments Including Part Treatments and other RPM Treatments

Treatment	Material	Date of Marking	VicRoads Use Only	
			Next Schedule Date	Next Program Date

ATTACHMENT A TO SECTION 721

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JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

Performance Reporting

Treatment	Performance Criteria	Date of Testing	VicRoads Use Only Next Schedule Date	VicRoads Use Only Next Program Date
Painted Markings	Tolerances on Pavement Markings			
	Retroreflectivity			
	Daylight visibility			
	Colour			
	Skid Resistance			
Raised Pavement Marker	Tolerances on Pavement Markings			
	Retroreflectivity			
	Daylight visibility			
	Colour			
Long Life Markings	Tolerances on Pavement Markings			
	Retroreflectivity			
	Daylight visibility			
	Colour			
	Skid Resistance			

The Contractor shall include in the Job Completion Report the actual status of the item compared to the specified requirement for that item, including:

tolerances on pavement markings;

retroreflectivity;

daylight visibility;

colour; and

skid resistance.

I, certify the above details as correct.
(Print Name)

.....
(Signed)

ATTACHMENT A TO SECTION 721

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JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

Painted Marking Detail

Pattern	Material	Unit of Measure	Quantity
Standard Stripe 100 mm		km	
Semi Barrier 100 mm		km	
Double Barrier 100 mm		km	
Edgeline 100 mm		km	
Single solid lane line 100 mm		km	
Edgeline 150 mm		km	
Single solid lane line 150 mm		km	
Single solid centreline 150 mm		km	
Continuity line 150 mm		km	
Turn lines 100 mm		m	
Lane lines 100 mm		m	
Chevron, diagonal bars or pedestrian crossing stripes, 600 mm		m	
Straight ahead arrow 1.4 m ² including 150° angle arrow		each	
Turn arrow 1.6 m ²		each	
Combination turn/straight arrow		each	
Double turn arrow 2.7 m ²		each	
Combination straight/double turn arrow 3.6 m ²		each	
U turn 2.7 m ²		each	
Pedestrian lines 150 mm		m	
Stop lines 600 mm		m	
STATCON holding bars 150 mm wide 600/600 line/gap		Per block	
STATCON stop line 300 mm		m	
STATCON give way 300 mm wide 600/600 line/gap		Per block	
STATCON centreline 100 mm wide, usually 30 m long		m	
Freeway exit ramp block 1.5 m wide, usually 6 m long		m	
STATCON Roundabout blocks 400 mm wide 600/600 line/gap		Per block	
Special Legends			
KEEP CLEAR, including 150 mm long clearance bars		each	
Small Bicycle Symbol		each	
Large Bicycle Symbol		each	
Rail X		each	
Transit Lane TL		each	
Bus Lane		each	
Other			

ATTACHMENT A TO SECTION 721

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JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

Raised Pavement Marker Detail

Marker Type	Material	Unit of Measure	Quantity
Raised retroreflective pavement marker white mono or bi-directional		each	
Raised retroreflective pavement marker white mono or bi-directional (glass faced)		each	
Raised retroreflective pavement marker, yellow, red or green, mono or bi-directional		each	
Raised non-reflective pavement marker (ceramic)		each	
Raised non-reflective pavement marker (ultra hard plastic alloy)		each	

Long Life Markings Detail

Pattern	Material ST sprayed thermoplastic ET extruded thermoplastic SCT screeded thermoplastic CA cold applied plastic	Unit of Measure	Quantity
Standard Stripe 100mm		km	
Semi Barrier 100 mm		km	
Double Barrier 100 mm		km	
Edgeline 100 mm		km	
Single solid lane line or centreline 100 mm		km	
Continuity line 100 mm		km	
Edgeline 150 mm		km	
Single solid lane line 150 mm		km	
Single solid centreline 150 mm		km	
Continuity line 150 mm		km	
Profiled lines		km	
Turn lines 100 mm		m	
Lane lines 100 mm		m	
Chevron, diagonal bars or pedestrian crossing stripes, 600 mm		m	
Straight ahead arrow 1.4 m ² including 150° angle arrow		each	
Turn arrow 1.6 m ²		each	
Combination turn/straight arrow		each	
Double turn arrow 2.7 m ²		each	
Combination straight/double turn arrow 3.6 m ²		each	

ATTACHMENT A TO SECTION 721

(Page 5 of 6)

JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

Long Life Markings Detail ... continued

Pattern	Material ST ET SCT CA sprayed thermoplastic extruded thermoplastic screeded thermoplastic cold applied plastic	Unit of Measure	Quantity
U turn 2.7 m ²		each	
Pedestrian lines 150 mm		m	
Stop lines 600 mm		m	
STATCON holding bars 150 mm wide 600/600 line/gap		Per block	
STATCON stop line 300 mm		m	
STATCON give way 300 mm wide 600/600 line/gap		Per block	
STATCON centreline 100 mm wide, usually 30 m long		m	
STATCON Roundabout blocks 400 mm wide 600/600 line/gap		Per block	
KEEP CLEAR including 150 mm long clearance bars		each	
Small Bicycle Symbol		each	
Large Bicycle Symbol		each	
Rail X		each	
Transit Lane TL		each	
Bus Lane		each	
Other			

Traffic Signal Site

Job Item No.			
Principal Road Name			
Intersecting Road			
Other intersecting Road			
Map Reference From		Map Type	
Responsible Region		Other Region(s)	
Municipality(ies)		Connect Equipment No. VicRoads Use Only	
MABC No. VicRoads Use Only		Road Category	
Comments			

ATTACHMENT A TO SECTION 721

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JOB COMPLETION REPORT (PAVEMENT MARKINGS)

CONTRACT NO.

Pavement Marking Maintenance

Paint Maintenance

Treatment	Material	Date of Marking	VicRoads Use Only	
			Next Schedule Date	Next Program Date

RPM, including RRPM maintenance

Treatment	Material	Date of Marking	VicRoads Use Only	
			Next Schedule Date	Next Program Date

Long Life, RRPM Special and Other Special treatments including Part treatments and Other RPM treatments

Treatment	Material	Date of Marking	VicRoads Use Only	
			Next Schedule Date	Next Program Date

I, certify the above details as correct.
(Print Name)

.....
(Signed)

SECTION 801 - MATERIAL SOURCES FOR THE PRODUCTION OF CRUSHED ROCK AND AGGREGATES

~~##This section cross-references Sections 175, 811, 818 and 820.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

~~A number of standard sections are listed in Table 801.033 – if relevant those sections should also be included in the specification:~~

801.01 DESCRIPTION

This section covers the durability, hardness and, where applicable, the polished stone value requirements of sources (including recycled materials) used for the production of crushed rock and aggregates. ~~The requirements for pyroclastic rocks (scoria) are covered in Section 818.~~ The requirements for gravel, sand and soft or ripped rock are covered in Section 811.

Any additional source requirements relevant to specific applications are covered in the applicable Codes of Practice and/or Standard Sections.

801.02 DEFINITIONS

Assigned Los Angeles Value

The assigned Los Angeles Value (LAV) is a hardness rating derived from tests undertaken by VicRoads, which is assigned annually to each source.

Assigned Polished Stone Value

The Assigned Polished Stone Value (PSV) is a friction rating derived from PSV tests undertaken by VicRoads, which is assigned annually to each source.

Electric Arc Furnace (EAF) Slag Aggregate

The processed slag by-product from the production steel using an electric arc furnace. Once cooled, the slag by-product is crushed, graded and suitably conditioned (by weathering to reduce free lime content) to produce a non expansive aggregate.

Glass Fines

Glass fines are recycled glass cullet crushed to a cubic shape and passing the 4.75 mm AS sieve.

Material Source

The raw materials which are used or proposed to be used in the production of crushed rock or aggregate.

Material Type

A material from a particular source and which is distinguishable on the basis of colour, texture, hardness, the degree of weathering and test properties.

Quarry Rock

An insitu rock mass located in an operating quarry or a part of a quarry.

Rock Type

Rock is classified as igneous, metamorphic or sedimentary on the basis of the classification scheme detailed in VicRoads Code of Practice for Source Investigations (RC500.00) as listed in Section 175.

Recycled Materials

Materials utilised in the manufacture of crushed rock or aggregates which are obtained from a location other than a quarry, or within a construction site, including Newer Basalt Surface Spalls (NBSS). These materials are usually processed by an on-site portable plant, but may also be taken to a nearby quarry or recycling plant for processing.

Recycled materials which may be used in the manufacture of crushed rock and aggregates are principally crushed concrete, Electric Arc Furnace (EAF) slag, reclaimed asphalt pavement (RAP), glass and brick (supplementary material only), or other materials as approved by VicRoads.

Reclaimed Asphalt Pavement (RAP)

Reclaimed asphalt pavement is asphalt removed from an existing asphalt pavement, and re-processed by crushing and/or screening for recycling into new asphalt or other approved products.

Rock Durability Classification

Classification of a material type as sound rock, marginal rock or unsound rock in terms of the durability requirements of Clause 801.03.

Unsound Rock and Foreign Materials

Unsound rock and foreign materials are those components, whether in the source or as spalls or as crushed particles or as contaminants, which:

- (a) are denoted as "foreign materials" in Table 9 of VicRoads Code of Practice 500.02;
- (b) are soft, friable, or composed of clay or weathered rock, or which contains matter which degrades when alternately wetted and dried; or
- (c) in the case of igneous (except basic igneous) and metamorphic rock, has a Degradation Factor - Source Rock less than the minimum value for marginal rock specified in Table 801.032; or
- (d) in the case of basic igneous rock, has a Secondary Mineral Content greater than the maximum value or an Accelerated Soundness Index value less than the minimum value for marginal rock specified in Table 801.032; or
- (e) in the case of sedimentary rock, has a Ball Mill value greater than the maximum value for marginal rock specified in Table 801.032.

801.03 SOURCE**(a) General**

Prior to the commencement of work, the Contractor shall nominate the material source from which the crushed rock and aggregate will be obtained.

Crushed rock and aggregates shall only be produced from ~~an accredited~~ a source accredited by VicRoads with a current assigned LAV hardness and, where appropriate, an assigned PSV value.

VicRoads accreditation will include investigation ~~investigate~~ and classification ~~classify~~ of the source rock sources in accordance with VicRoads Code of Practice for Source Investigations (RC500.00) as listed in Section 175.

~~The Superintendent's Council's approval shall be obtained prior to changing the source of material. If at any time the Contractor proposes to obtain material from a source other than the confirmed accredited source, the Superintendent Council shall be notified in sufficient time so that investigations, as may be required, can be carried out before approval is considered.~~

If the Contractor proposes to use a source other than those listed in Tables 801.031 and 801.032, VicRoads will determine whether the source is acceptable and will set applicable test values.

(b) Durability

Rock sources shall be classified as sound or marginal in accordance with the provisions of Tables 801.031 and 801.032. Material which falls outside these limits shall be classified as unsound.

(c) Hardness

The hardness of any source shall be measured by a Los Angeles Abrasion test on the product and the assigned Los Angeles Value shall comply with the test values shown for the different product applications in Table 801.033.

(d) Friction Rating

When applicable, the Polished Stone Value of the source shall be measured by a Polished Stone Value test (RC374.01) on the product and the assigned Polished Stone Value shall comply with the test value shown for the different surfacing applications in Table 801.034.

Sources which do not comply with the specified durability and hardness requirements for crushed rock and aggregates, but have proven satisfactory performance may be accepted for use subject to the written approval of the Superintendent Council.

Table 801.031 Durability Requirements for Sound Rock

Rock Type	Test Value			
	Degradation Factor Source Rock (min)	Secondary Mineral Content (%) (max)	Accelerated Soundness Index (min)	Ball Mill Value (max)
ACID IGNEOUS				
Granitic Rocks	50	-	-	-
Other Acid Igneous	45	-	-	-
INTERMEDIATE IGNEOUS				
Trachyte	50	-	-	-
Other Intermediate Igneous	45	-	-	-
BASIC IGNEOUS	-	25	94	-
METAMORPHIC				
Hornfels	40	-	-	-
Other metamorphic	45	-	-	-
SEDIMENTARY				
Argillaceous Sediments	-	-	-	30
Arenaceous Sediments	-	-	-	45

Table 801.032 Durability Requirements for Marginal Rock

Rock Type	Test Value			
	Degradation Factor Source Rock (min)	Secondary Mineral Content (%) (max)	Accelerated Soundness Index (min)	Ball Mill Value (max)
ACID IGNEOUS				
Granitic Rocks	35-49	-	-	-
Other Acid Igneous	35-44	-	-	-
INTERMEDIATE IGNEOUS				
Trachyte	30-49	-	-	-
Other Intermediate Igneous	35-44	-	-	-
BASIC IGNEOUS	-	26-30	90-93	-
METAMORPHIC				
Hornfels	20-39	-	-	-
Other metamorphic	30-44	-	-	-
SEDIMENTARY				
Argillaceous Sediments	-	-	-	31-40
Arenaceous Sediments	-	-	-	46-55

*** Table 801.033 Los Angeles Value (LAV) for Product Applications

Source Type	Rock Type	Los Angeles Value (max)									
		Standard Specification Sections									
		404 405 407 408 410 417 421 427	501 520 610 619 701	702 703 713	423 715 802	812		815	831		
						Base	Subbase	Subbase	Class A	Class B	Class C
Quarry Rock	ACID IGNEOUS										
	Granitic Rocks	30	35	40	35	35	40	40	25	35	40
	Other Acid Igneous	25	35	35	30	30	35	35	20	25	30
	INTERMEDIATE IGNEOUS	25	35	35	30	30	35	35	20	25	30
	BASIC IGNEOUS	25	35	35	30	30	35	35	20	25	30
	METAMORPHIC	25	35	35	30	30	35	35	20	25	30
	SEDIMENTARY										
	Argillaceous Sediments	(a)	(b)	35	25	(a)	25	25	(a)	25	30
	Arenaceous Sediments	(b)	(b)	35	25	(b)	35	35	(a)	25	30
	River Gravel Pebble	(a)	35	35	(a)	(a)	35	35	(a)	30	35
	Calcrete	(a)	(a)	(a)	(a)	(a)	35	35	(a)	30	30
	PYROCLASTIC										
	Scoria	(a)	(a)	35	(a)	Refer Section 818		(a)	(b)	(b)	35
Recycled Material Sources	Newer Basalt Surface Spalls (NBSS)	(b)	25	35	(b)	(b)	35	35	(a)	(b)	30
	Crushed Concrete	(a)	(b)	(a)	(a)	35	40	40	(a)	(a)	(a)
	EAF Slag	25	(b)	25	25	30	35	35	20	25	30
	Glass Fines	35	(b)	35	(a)	(d)	(d)	(d)	(a)	(a)	(a)
	Reclaimed Asphalt Pavement (RAP) Note (e)	25	(a)	(a)	25	(d)	35	(a)	(a)	(a)	(a)
Notes: (a) Not permitted for this use (b) Not permitted for use unless otherwise accredited by VicRoads (c) 'Non Quarry' Granite or Sedimentary rock shall comply with LAV values listed under quarry source rock (d) Only permitted as a supplementary materials in these applications (e) RAP is not permitted use in VicRoads Standard Sections 404, 410, 417 and 427 applications											

Table 801.034 Polished Stone Values (PSV) for Surfacing Applications

Specification Section	Application	Polished Stone Value (min)
407 Hot Mix Asphalt	Type H, HG and HP wearing course Type V wearing course	48 54
404 Stone Mastic Asphalt	Type H wearing course	48
405 Regulation Gap Graded Asphalt	Type H wearing course	48
408 Sprayed Seal Treatments	Class A	48
410 Ultra Thin Asphalt	Type H wearing course	48
417 Open Graded Asphalt	Type H wearing course	48
421 Bitumen Crumb Rubber Asphalt	Type H wearing course	48
427 Bituminous Slurry Surfacing	Where specified in Clause 427.24 or wearing course where traffic volume per lane exceeds 2000 vpd	48
831 Aggregate for Sprayed Bituminous Surfacing	Class A	48

801.04 MINIMUM TESTING REQUIREMENTS

As a part of the formal VicRoads accreditation of a quarry or recycling facility, VicRoads will carry out all inspections, investigations and testing of sources and source rock material types in accordance with VicRoads Code of Practice for Source Investigations (RC500.00) as specified in Section 175.

VicRoads will provide source type, durability classifications, hardness values, friction ratings and reference specimen sets, where applicable, for the assessment of Coarse Aggregate Quality by Visual Assessment as listed in Section 175.

SECTION 802 - BITUMINOUS COLD AND WARM MIXES

~~##This section cross-references Section 801.~~

~~If Section 801 is relevant, it should be included in the specification.~~

~~If Section 801 is not included in the specification, all references to it should be struck out, ensuring that the remaining text is still coherent.~~

802.01 GENERAL

This section covers the requirements for the manufacture of Sizes 7, 10, 14 and 20 dense graded and open graded bituminous cold and warm mixes. The requirements relate to quality of aggregates and bituminous materials, mix design, and properties of product.

802.02 DEFINITIONS

Bituminous Cold Mix

Bituminous cold mix is a mixture of bituminous binder with fine and coarse aggregates with or without filler. The bituminous binder may be cutback bitumen or bitumen emulsion. The material may be mixed hot or cold but is spread and compacted cold.

Bituminous Warm Mix

A bituminous warm mix is similar to a bituminous cold mix but is manufactured hot from a heavy grade of cutback bitumen and is used on the same day as it is mixed while the material is still warm and workable.

Binder

Binder is the bituminous material used to hold the mixture of aggregates together as a cohesive mass.

Residual Binder

Residual binder is bituminous material including any flux oil or polymer but not cutter.

In the case of bitumen emulsion, it is the binder that remains after the water has separated.

Assigned Los Angeles Abrasion Loss

The assigned Los Angeles Abrasion Loss is a hardness rating derived from Los Angeles Abrasion Loss test results and is assigned to each source by VicRoads on the basis of past test data obtained from testing products.

Coarse Aggregates

Coarse aggregates are aggregates retained on a 4.75 mm AS sieve.

Fine Aggregates

Fine aggregates are aggregates passing a 4.75 mm AS sieve.

802.03 AGGREGATES

(a) General

The combined aggregate mixture shall consist of crushed rock or crushed gravel, or a mixture of crushed rock and sand or crushed gravel and sand.

When aggregates are crushed rock, they shall consist of clean, hard, durable angular rock fragments of uniform quality.

When aggregates are crushed gravel, not less than 75% by mass of all particles shall have two or more faces produced by crushing.

Sand aggregates shall consist of clean, hard durable grains free from lumps, clay, mica and foreign matter.

(b) Source Rock

Source rock shall comply with the requirements of Section 801 - Source Rock for the Production of Crushed Rock and Aggregates.

(c) Crushed Aggregate Products

- (i) The Flakiness Index of each separate sized coarse aggregate shall be as specified in Table 802.031.
- (ii) Unsound rock and marginal rock in that fraction of the combined mixture retained on a 4.75 mm AS sieve shall not exceed the percentages specified in Table 802.031. If no facilities exist at the mixing plant to sample the combined mixture, the unsound rock and marginal rock in that fraction of each aggregate retained on a 4.75 mm AS sieve shall not exceed the percentages specified in Table 802.031.

Table 802.031

Test	Test Value
Flakiness Index % (max)	35
Total of Marginal and Unsound Rock % (by mass) (max)	10
Unsound Rock % (by mass) (max)	5

(d) Crusher Fines

Crusher fines shall:

- (i) consist of a uniformly graded product of separate particles from the crushing of rock which complies with the requirements of Clause 802.03(b);
- (ii) be free from lumps and aggregations;
- (iii) comply with the relevant requirements of Table 802.032.

Table 802.032

Test	Test Value
Degradation Factor - Crusher Fines (min)	60
Plasticity Index (max)	3

802.04 FILLER

Filler shall comply with AS 2150 *Hot mix asphalt – A guide to good practice*.

The added filler required by Clause 802.06 to be included with particular aggregate types shall be hydrated lime, portland cement or cement works flue dust.

802.05 BITUMINOUS MATERIALS

The binder to be used shall be one of the following:

- (a) Medium curing cutback bitumen of grade or equivalent field produced grade as shown in Table 802.051 and complying with the requirements of AS 2157 *Cutback bitumen*.

Bitumen used for field produced cutback bitumen shall comply with AS 2008 *Bitumen for pavements*.
The cutter shall comply with AS 3568 *Oils for reducing the viscosity of residual bitumen for pavements*.

Table 802.051 Grades of Cutback Bitumen

Mix Type	Standard Grade		Field Produced Equivalent		Viscosity Range (Pa.s)
	Grade (AS 2157)	% Residual Binder	Class 170 Bitumen Parts by Volume @ 15°C	Cutter Parts by Volume @ 15°C	
Type 2	AMC 2	73	100	37	0.22 - 0.44
Type 3	AMC 3	79	100	27	0.55 - 1.10
Type 4	AMC 4	84	100	19	2.00 - 4.00
Type 5	AMC 5	89	100	12	5.50 - 11.00
Type 6	AMC 6	93	100	7	13.00 - 26.00

- (b) Bitumen emulsion of Grade CAM manufactured from Class 170 bitumen and complying with the requirements of AS 1160 *Bitumen emulsions for construction and maintenance of pavement*.

802.06 MIX REQUIREMENTS

Unless otherwise directed, the grading of the combined aggregates and the proportion of residual binder shall lie within the limits specified in Tables 802.061 and 802.062 for each size of mix specified in Clause 802.11 Schedule of Details.

Aggregates of coarse or medium grained acidic rocks (e.g. granite, adamellite, granodiorite, quartz porphyry) shall contain not less than 1% filler as specified in Clause 802.04.

The residual binder content shall be expressed as a percentage by mass of the total mix.

The target grading and residual binder content for each size of mix shall be approved by the ~~Superintendent~~ Council.

Table 802.061 Grading of Combined Aggregates (including any filler)

Sieve Size AS (mm)	Percentage Passing (by mass)								
	Dense Graded				Open Graded				
	Size 7	Size 10	Size 14	Size 20	Size 5	Size 7	Size 10	Size 14	Size 20
26.5				100					100
19.0			100	95-100				100	90-100
13.2		100	85-100	77-90			100	90-100	50-90
9.5	100	90-100	70-85	58-74	100	100	90-100	40-75	30-65
6.70	90-100	70-85	57-74	45-60		85-100	30-75	10-35	10-35
4.75	70-90	54-70	45-65	37-50	85-100	30-70	20-55	5-25	5-25
2.36	45-60	35-50	28-45	22-36	10-40	10-40	5-30	0-10	0-10
1.18	26-45	22-38	15-30	12-26	0-10	0-20	0-10		
0.600	15-30	12-27	10-23	6-20		0-10			
0.300	10-20	6-16	5-17	4-15					
0.150	4-14	4-11	3-11	2-10					
0.075	3-8	2-6	2-5	1-5	0-2	0-4	0-4	0-4	0-4

Table 802.062 Proportion of Combined Aggregates and Residual Binder

Sieve Size AS (mm)	Percentage Passing (by mass)								
	Dense Graded				Open Graded				
	Size 7	Size 10	Size 14	Size 20	Size 5	Size 7	Size 10	Size 14	Size 20
Aggregates	95.2-94.2	95.8-94.8	96.0-95.0	96.3-95.3	96.0-95.0	96.0-95.0	96.5-95.5	96.5-95.5	97.0-96.0
Residual Binder	4.8-5.8	4.2-5.2	4.0-5.0	3.7-4.7	4.0-5.0	4.0-5.0	3.5-4.5	3.5-4.5	3.0-4.0
Total Mix	100	100	100	100	100	100	100	100	100

Unless otherwise specified or directed the type of cutback bitumen mix shall be supplied to meet the requirements of Table 802.063.

Table 802.063

Mix Type	Description and Season for Use	Ambient Temperature for Use °C	Minimum Overnight Temperature (°C) for Stockpiling
Type 2	Cold Mix (Winter)	5 - 10	0
Type 3	Cold Mix (Spring/Autumn)	10 - 20	5
Type 4	Cold Mix (Summer) Warm Mix (Winter)	20 - 30 (Cold Mix) 5 - 10 (Warm Mix)	15
Type 5	Cold Mix (Hot weather only) Warm Mix (Spring/Autumn)	>30 (Cold Mix) 10 - 20 (Warm Mix)	Not suitable
Type 6	Warm Mix (Summer)	>20 (Warm Mix)	Not suitable

The Superintendent Council may approve the addition of up to 5 parts of Flux Oil for cutback bitumen mixes required for extended stockpiling periods for up to 4 weeks and for very cold weather conditions.

802.07 BINDER QUALITY

Cutback bitumen that has been stored at elevated temperatures for more than 1 week shall be tested for compliance with Clause 802.05 and if necessary adjusted by the addition of cutter and subsequent circulation to produce a homogeneous mixture.

802.08 MIXING AND MIXING TEMPERATURES

The temperature of the aggregates and cutback bitumen at the time of mixing shall be sufficiently high to permit mixing as specified.

At no time shall temperatures of materials exceed the following:

Class 170 Bitumen	185°C
Cutback Bitumen	See Table 802.081
Aggregates Delivered into Mixer	Shall not exceed the maximum temperatures of the relevant cutback bitumen used or 100°C for bitumen emulsion binder.

At the time of mixing the temperature of the cutback bitumen shall be within the range specified in Table 802.081.

Table 802.081

Grade of Cutback Bitumen	Binder Temperature	
	Mixing Range °C	Maximum Storage Temperature °C
AMC 2	60 - 80	100
AMC 3	75 - 95	115
AMC 4	90 - 115	135
AMC 5	100 - 125	150
AMC 6	120 - 145	160

The combined aggregates, including filler, and binder shall be thoroughly mixed in the correct proportions until at least 90% of the coarse aggregate particles are fully coated.

Except for bitumen emulsion mixes the moisture content of the mix shall not exceed 1.5%.

A maximum moisture content of 2.5% may be permitted by the Superintendent Council provided that an approved adhesion agent is added to the binder at the rate of 0.5% by mass of binder.

802.09 BITUMINOUS COLD OR WARM MIX RECYCLED FROM RECLAIMED ASPHALT PAVEMENT

Unless otherwise specified, Reclaimed Asphalt Pavement may be re-cycled by adding it to new mix during the mixing process subject to the requirements of this clause being met.

All cold and warm mixes Reclaimed Asphalt Pavement shall comply with all aspects of Section 802 for the size and type of mix specified for use.

Reclaimed Asphalt Pavement shall consist of milled or excavated asphalt pavement free of foreign material such as unbound granular base, broken concrete or other contaminants and shall be crushed and screened to a maximum size not exceeding the size of mix produced.

The manufacturing process shall provide for addition of Reclaimed Asphalt Pavement to a batch plant pugmill or drum mixer separately from other mix components by a method that avoids damage to the mix by overheating.

802.10 FREQUENCY OF INSPECTION AND TESTING AT THE MIXING PLANT

The Contractor shall test production at a frequency which is sufficient to ensure that all material supplied under the Contract complies with specified requirements. The frequency shall not be less than that shown in Table 802.101, except that the Superintendent Council may agree to a lower frequency where the Contractor has implemented a system of statistical process control and can demonstrate that such lower frequency is adequate to assure the quality of the product.

Table 802.101

Checks Required	Minimum Frequency
Scrutiny for segregation, uncoated particles, separated bitumen, excess bitumen or overheating before despatch from the plant	Each loaded truck
Temperature of asphalt before despatch from the plant	Each loaded truck or at intervals of 15 minutes if more than one truck is despatched in 15 minutes
Unsound Rock Content	One test on each component of coarse aggregate per day
Degradation Factor - Crusher Fines	At monthly intervals
Plasticity Index of crusher fines	At monthly intervals
Flakiness Index of coarse aggregate 10 mm and larger	At monthly intervals
Bitumen Content and full Sieve Analysis of asphalt (full extraction test)	One test per day

The Contractor shall make available for inspection at the plant all work sheets and results of checks carried out.

802.11 SCHEDULE OF DETAILS

Mix Type	Nominal Size (mm)	Dense Graded (tonne)	Open Graded (tonne)
Cutback Bitumen - Cold/Warm Mixes			
Type 2	##:		
Type 3			
Type 4			
Type 5			
Type 6			
Bitumen Emulsion - Cold Mixes			
CAM			
Other			

SECTION 811 - GRAVEL, SAND AND SOFT OR RIPPED ROCK FOR PAVEMENT BASE AND SUBBASE

811.01 DESCRIPTION

This section covers the requirements for naturally occurring or partly processed gravel, ~~scoria tuff, sand and soft or ripped rock~~, including mixtures thereof and materials to be broken to size on the roadbed.

811.02 DEFINITIONS

Gravel

Gravel is a naturally occurring mixture of angular or rounded rock fragments substantially retained on a 4.75 mm AS sieve, with or without some finer material, and all passing a 75 mm AS sieve.

Scoria and Tuff

~~Scoria and tuff are pyroclastic materials which generally form unconsolidated deposits which are ripable and require minimal processing.~~

Sand

~~Sand is a product of rock weathering substantially passing a 4.75 mm AS sieve, and is generally siliceous and free from appreciable quantities of clay and silt.~~

Soft or Ripped Rock

~~Soft or ripped~~ Ripped rock is rock extracted from a deposit without blasting and not requiring processing through a crushing plant for reduction of size.

811.03 MATERIAL SOURCE

Prior to the commencement of work, the Contractor shall confirm the source from which the material will be obtained.

811.04 PHYSICAL PROPERTIES AND GRADINGS

The material shall meet the relevant requirements of Tables 811.041 and 811.042 and shall be free from vegetable matter and lumps or balls of clay or other deleterious matter.

Where specified by means of a cross (+) in Table 811.042 the Contractor shall supply to the Superintendent Council for approval, grading figures to indicate the average grading of the material proposed for supply.

The approved average grading shall become the target grading for material to be supplied. The permitted range of grading about the target is specified in Table 811.043.

All material supplied shall comply with the grading limits.

*** Table 811.041 Physical Properties

Type of Material and Use (Base or Subbase)	All Passing Sieve Size AS (mm)	Liquid Limit (%/max)	Plasticity Index		Ball Mill (max)	Plasticity Index % passing 0.425 mm (max)	California Bearing Ratio * (%/min)	Swell (max) %	Permeability (max) m/sec
			(min)	(max)					
Ripped Rock			6	30		1000	10	2.5	5x10 ⁻⁹

* Value applicable to material passing 19.0 mm sieve: initially at optimum moisture content and 98% of maximum dry density as determined by test using Modified compactive effort, but then soaked for 4 days prior to the CBR test.

*** Table 811.042 Grading Requirements (percentage passing by mass)

Type of Material And Use (Base or Subbase)	Sieve Size – AS Sieve (mm)										
	150	75	37.5	26.5	19.0	13.2	9.50	4.75	2.36	0.425	0.075
Ripped Rock	100	90 to 100	65 to 100					35 to 70		20 to 45	10 to 30

+ Contractor shall supply to the Superintendent Council for approval, grading figures to indicate the average grading of material proposed for supply.

Table 811.043 Permitted Range of Grading

Sieve Size AS (mm)	Permitted Range of Grading ± (% by mass)
150, 75, 37.5	20
26.5, 19.0, 13.2, 9.50, 4.75, 2.36	15
0.425	10
0.075	5

If the Contractor proposes to use scoria or scoria blends, the source of the scoria shall have an assigned Los Angeles Value not exceeding that specified in Table 811.044.

Table 811.044 Scoria Source Rocks, Hardness Requirements

Pavement Course/Layer	Assigned Los Angeles Value (maximum)
Base	40
Upper Subbase	45
Lower Subbase	50

If at any time the contractor proposes to obtain scoria from another source without an assigned LA value the Superintendent shall be notified in sufficient time to allow a quarry investigation to be completed prior to the commencement of delivery.

811.05 ADDITION OF WATER

Water added to the product shall be clean and substantially free from detrimental impurities such as oils, salts, acids, alkalis and vegetable substances. Water supplied from sources where dissolved salts are known or likely to be present shall be tested for electrical conductivity prior to use. The electrical conductivity shall not be more than 3500 $\mu\text{S}/\text{cm}$. Water sources classified by the relevant Water Authority as potable water shall be exempt from this requirement.

811.06 MATERIAL SUPPLIED TO STOCKPILE

If the Contractor elects or is required to supply the material to stockpile prior to delivery to the roadbed the following requirements shall be met:

- the product, after recovery from the stockpile, complies with this specification;
- the stockpile site is clean, adequately paved, and well drained;
- if a stockpile is constructed in more than one layer, each layer is fully contained within the area occupied by the upper surface of the preceding layer;
- the surface of the stockpile shall be kept damp to prevent a net loss of moisture and to minimise the generation of airborne dust.

811.07 MINIMUM TESTING REQUIREMENTS

The Contractor shall test the material at a frequency which is sufficient to ensure that all material supplied under the contract complies with the specified requirements. The frequency shall not be less than that shown in Table 811.071, except that the Superintendent Council may agree to a lower frequency where the Contractor has implemented a system of statistical process control and can demonstrate that such lower frequency is adequate to assure the quality of the product.

Table 811.071 Minimum Frequency of Testing

Test	Minimum Frequency of Testing
Grading	##: One test per 1000 tonne or part there of
Plasticity Index	##: One test per 10,000 tonne or part there of
Ball Mill	##: -
California Bearing Ratio	##: Prior to the commencement of work and when in the opinion of the Council the nature of the material has changed

SECTION 812 - PRODUCTION OF CRUSHED ROCK FOR PAVEMENT BASE AND SUBBASE

~~##This section cross-references Sections 175, 304, 801 and 818.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If they are not included, all references to those sections should be struck out, to ensure that the remaining text is still coherent.:~~

812.01 DESCRIPTION

This section covers the production requirements for crushed rock produced from a variety of raw feed sources including quarries, crushed concrete, Newer Basalt Surface Spalls (NBSS) and blended crushed rock mixes containing supplementary materials.

The section specifies the requirements for plant mixed wet-mix crushed rock products including 20 mm nominal size Classes 1 and 2 base, 20 mm and 40 mm nominal size, Class 3 upper subbase and for Class 4 lower subbase.

The material class, pavement course use and nominal sizes shall be as specified in the special clauses and/or the drawings and/or the schedule.

Sources from which crushed rock can be produced for base and subbase are specified in Section 801 - Source Requirements for the Production of Crushed Rock and Aggregates.

~~Requirements for crushed pyroclastic rocks (Scoria) are covered in Section 818 – Crushed Scoria for Pavement Base and Subbase.~~

Construction requirements for unbound flexible pavements incorporating crushed rock products are covered in Section 304 - Construction of Unbound Flexible Pavements.

Section 175 details the relevant references to Australian Standards (AS), Test Methods and Codes of Practice referenced in this section.

812.02 DEFINITIONS

Crushed Rock

A crushed rock is a material composed of graded coarse and fine aggregate components produced by the crushing, scalping and screening of a raw rock feed source, Newer Basalt Surface Spalls (NBSS) and/or crushed concrete, and may also be a blend of components which includes limited quantities of supplementary materials.

Crushed Rock Class

For the purpose of this specification, Crushed Rock products are to be supplied in various classes broadly defined as follows:

Class 1 is a premium cohesive pavement base material for unbound pavements where a very high standard of surface preparation for a sprayed sealed or thin asphalt surfacing is required. It has a minimum plasticity index requirement and will likely have additional requirement for maximum permeability when used for heavy duty unbound pavements.

Class 2 is a high quality pavement base material for unbound flexible pavements in locations where a very high standard of surface preparation may not be required. Class 2 crushed rock product does not have a minimum plasticity index or a maximum permeability requirement. Recycled materials are permitted for Class 2 crushed rock.

Class 3 is a high quality upper subbase material for heavy duty unbound flexible pavements. It may have a minimum permeability requirement to provide positive drainage to the sub-surface drains and overlying unbound pavement layer. Where specified, Class 3 may be used as base for lightly trafficked pavements provided the material produces sufficient cohesive fines during compaction. Recycled materials are permitted for Class 3 crushed rock.

Class 4 is a lower subbase material for heavy duty unbound and/or bound pavements or a subbase material for most other types of pavements. It may have a maximum permeability requirement. Recycled materials are permitted for Class 4 crushed rock.

Plant Mixed Wet-Mix Crushed Rock (PMWMCR)

Plant mixed wet-mix crushed rock is a mixture of crushed rock and water, produced at a controlled mixing plant to close tolerances of moisture content based on the modified optimum moisture content of the material.

Recycled Material

Materials obtained from a construction and/or demolition site which are crushed and re-processed to produce a crushed rock or a supplementary material.

Supplementary Material

A durable material added to a crushed rock to improve the workability and physical properties.

812.03 MATERIAL SOURCE

Crushed rock manufactured at a quarry or non-quarry site shall not be used until the material source has been investigated and accredited in accordance with VicRoads Code of Practice for Source Investigations RC500.00 as listed in Section 175.

Material sources used in the production of crushed rock shall comply with the relevant requirements of Section 801 - Source Requirements for the Production of Crushed Rock and Aggregates.

812.04 CRUSHED ROCK MIX REGISTRATION

Crushed rock mixes proposed for use on specified works shall be registered in accordance with VicRoads Code of Practice for Registration of Crushed Rock Mixes RC500.02 as listed in Section 175.

All mix designs registered with VicRoads are issued a status according to compliance as:

General	The requirements of VicRoads Code of Practice RC500.02 have been met.
Conditional	Mixes which do not comply in all respects with the requirements of the Code of Practice but which are considered appropriate for use subject to conditions attached to the registration.
Expired	A mix which has passed the expiry date, but mix details are retained for record purposes.
Withdrawn	Withdrawn from use because of unsatisfactory field performance but details are retained for record purposes.

HP All crushed rock proposed for use on VicRoads funded works shall be current registered mixes in accordance with VicRoads Code of Practice RC500.02 and conform to specified requirements applicable to that class of product.

The supplied registered mix shall not be changed unless the Superintendent Council has been advised of the change and given written approval.

Crushed rock mixes registered as "Conditional" shall not be used unless the Superintendent Council has been advised of any mix registration conditions and approved the mix for use.

Approval of a registered crushed rock mix for use under the Contract does not guarantee the handling properties or performance of the mix nor relieve the Contractor from contractual obligations in regards to rectification of defects.

812.05 COMPONENTS**(a) Coarse and Fine Aggregates**

Coarse and fine aggregates shall consist of clean, hard, durable, angular fragments of uniform quality.

If all or part of the fine aggregate is produced from a different source or location and/or is separately added into the production process, the combined fraction of fine aggregates shall be tested for Degradation Factor – Fine Aggregate as listed in Section 175.

The Degradation Factor – Fine Aggregate of a sample of the combined fine aggregates, shall not be less than 60. The frequency of testing shall be as specified in Table 812.121.

(b) Supplementary Materials

Supplementary materials shall only be incorporated in a crushed rock as a part of a registered crushed rock mix. Supplementary materials which are non durable or subject to appreciable breakdown will not be permitted.

The amount of any supplementary materials (e.g. crushed rock/concrete, brick, glass, clayey sand and clay filler etc.) used shall not exceed the maximum allowable percentage of the total dry mass of the crushed product as specified in the registered crushed rock mix.

Supplementary materials included in a registered crushed rock mix shall be:

- (i) non-cementitious in nature except for lime added under the provision of Clause 812.06(d);
- (ii) free of any organic matter; and screened, if necessary to remove all oversize particles, lumps and balls of clay or particles exceeding 4 mm in the case of a clayey filler;
- (iii) stored and maintained in a dry and free flowing state and added to the product as a separate component at any stage after completion of primary crushing;
- (iv) distributed into the product by a method that is capable of verifying that the pre-determined distribution rate has been achieved;
- (v) uniformly mixed through the product by use of a pugmill.

(c) Blending of Products Containing Coarse Aggregates

The blending of two or more crushed rock products containing coarse aggregates from different sources or rock types will only be permitted as a part of a registered crushed rock mix. The submitted crushed rock mix shall clearly state the proportions by mass retained on each sieve for each component type that will be used in the blend.

A crushed rock mix containing a blend of coarse aggregates shall be subject to the following conditions:

- (i) each component of the crushed rock blend shall individually comply with the applicable requirements of VicRoads Standard Section 801 and Code of Practice RC500.02, unless otherwise approved by VicRoads;
- (ii) all material to be blended shall be fully crushed and screened to the maximum aggregate size permitted in the product prior to blending;
- (iii) all coarse and fine aggregates in the blend shall comply with the relevant requirements of Clause 812.05(a);
- (iv) if the blend has not been subjected to field placement and compaction, the Contractor shall prove that the material is capable of consistently meeting all requirements of relevant specifications;
- (v) where a suitable blend has been registered as a crushed rock mix, the total proportions by mass of each rock type in the blend shall not be varied by more than + or - 5% by mass.

812.06 CRUSHED ROCK PRODUCT**(a) Crushed Rock in Stockpile**

Crushed rock in stockpile shall comply with all applicable test requirements for that class of crushed rock product, as set out in VicRoads Code of Practice RC500.02 and this standard section. Crushed rock shall be tested in accordance with the frequencies specified in Table 812.121.

(b) Permeability

Where permeability values are specified; the crushed rock shall comply with the values listed below in Table 812.061.

Table 812.061 Permeability Test Requirements ##(in the table below, delete # symbols and insert required value - if not applicable insert 'not applicable', refer Guide Notes Clause 812.06 for further information):

Test	Test Value			
	Class 1	Class 2	Class 3	Class 4
Permeability (m/sec) (+)	5×10^{-8} (max.)	-	(*****) (min.)	# (max.)
(+) Value applicable to material passing 19.0 mm sieve: initially at optimum moisture content and 98% of maximum dry density as determined by test using Modified compactive effort. The Contractor shall provide to the Superintendent Council the target grading and Plasticity Index required to satisfy the specified permeability requirement. (*****) The permeability of Class 3 crushed rock shall be a minimum value which complies with conditional formula presented below.				

The maximum permeability values for Class 1 and Class 4 crushed rock as specified in Table 812.061 shall not be exceeded, unless otherwise approved by the Superintendent Council.

The minimum permeability value (m/sec), p_3 , for the Class 3 crushed rock shall comply with the following:

$$p_1 < p_3 \leq 5 \times p_4$$

where: p_1 is the permeability value (m/sec) for the Class 1 crushed rock based on the lowest of either the value provided in Table 812.061 or that submitted in the registered crushed rock mix; and

p_4 is the permeability value (m/sec) for the Class 4 crushed rock based on the lowest of either the value provided in Table 812.061 or that submitted in the registered crushed rock mix.

Where the grading of the supplied crushed rock varies by more than + or – 2% of the nominated target grading in the crushed rock mix, the Contractor will provide any additional information requested by VicRoads to demonstrate that specified requirements (e.g. permeability) are still being met.

(c) Plant Mixed Wet Mix Crushed Rock

~~Where specified in Table 812.062, crushed rock shall be supplied as Plant Mixed Wet Mixed Crushed Rock (PMWMCR).~~

For PMWMCR, the aggregates and water shall be mixed in a pug mill. PMWMCR shall be supplied at the moisture content as nominated by the Contractor to suit the weather conditions and the methods used for spreading and compaction of the material in the roadbed.

PMWMCR shall be supplied to the roadbed as specified in on the Drawings. ~~Table 812.062~~. If not specified, material may either be supplied as PMWMCR or as crushed rock.

Table 812.062 Material to be Supplied as PMWMCR ~~###(delete all # symbols and insert 'yes' as applicable):-~~

Location	Material			
	Class 1	Class 2	Class 3	Class 4
##:	##:	##:	##:	##:

(d) Sulphide Mineralisation

Crushed rock manufactured from sources containing sulphide/sulphate mineralisation shall not be used unless the fraction of the crushed rock passing the 2.36 mm sieve complies with the pH and conductivity test requirements specified in Table 812.063.

Table 812.063 pH and Conductivity Test Requirements

Test	Test Value	Soil to Water Ratio
pH (units)	6.0 (min)	1 : 2.5
Conductivity (µS/cm)	1500 (max)	1 : 1

~~The Superintendent Council may only accept a non-conforming material by exception and agreement, if it is treated with hydrated or quick lime.~~

~~The Contractor is required to specify the method and amount of hydrated or quick lime to be combined with the product to meet the requirements of Table 812.063 and Table 812.064.~~

Table 812.064 pH of Material after Addition of Lime

Test	Test Value
pH (units)	10.0 (minimum)

~~The lime stabilising agent shall be added at the time of production of the crushed rock and prior to stockpiling.~~

812.07 GRADING OF UNCOMPACTED CLASSES 1, 2, 3 AND 4 CRUSHED ROCK AND PMWMCR BASE/SUBBASE

After completion of manufacture, but before compaction, Classes 1, 2, 3 and 4 crushed rock and PMWMCR base/subbase shall comply with the relevant grading requirements (% passing and where specified retained on each sieve) of VicRoads Code of Practice RC500.02 as listed in Section 175.

The crushed rock grading shall not extend from the coarse limit on one sieve to the fine limit on the following sieve or vice versa.

Unless otherwise advised as a part of the crushed rock mix registration process, the initial target grading shall be at or near the centre of the specified grading envelope. The target grading may be varied from time to time to achieve the specified post compaction grading contained in Section 304. The specified grading limits shall remain unchanged regardless of the target grading.

Class 4 subbase of a different nominal size to that specified may be accepted by the Superintendent Council, provided it meets the grading requirements for the nominal size as described in VicRoads Code of Practice RC500.02.

812.08 ADDITION OF WATER

Water added to the crushed rock products either onsite or in PMWMCR shall be clean and substantially free from detrimental impurities such as oils, salts, acids, alkalis and vegetable substances. Water sources shall be tested for electrical conductivity and pH, in accordance with the current Australian Standards as listed in Section 175. The electrical conductivity shall not be more than 3500 $\mu\text{S}/\text{cm}$ and pH within the range of 6 to 10, unless otherwise approved by VicRoads.

The use of reclaimed water will require the approval of the Superintendent Council and shall conform to VicRoads guidelines for reclaimed water – *Integrated Water Management Guidelines* as listed under other referenced documents in Section 175.

Water sources added to crushed rock shall be tested at a maximum of twelve monthly intervals during the course of supply or when the nature of the water source has changed.

Water sources classified by the relevant water authority as potable water shall be exempt from the above requirements.

812.09 MOISTURE CONTENT

(a) Crushed Rock in Stockpile

Crushed rock manufactured and placed in stockpile at the quarry or processing plant shall have a minimum moisture content of 3.5% by mass.

(b) Plant Mixed Wet Mixed Crushed Rock

~~Where the Contract includes supply and delivery only, the~~ The moisture content of the crushed rock at the point of delivery, expressed as a percentage by dry mass, shall be within +0.5% to - 1.0% of the target nominated from time to time by the Superintendent Council.

812.10 MATERIAL SUPPLIED TO STOCKPILE

Where the Contractor is required to supply PMWMCR or crushed rock to stockpile prior to delivery to the roadbed to the following requirements:

- (a) the product, after recovery from the stockpile, complies with this specification;
- (b) the stockpile site is clean, adequately paved, and well drained;
- (c) if a stockpile is constructed in more than one layer, each layer is fully contained within the area occupied by the upper surface of the preceding layer;
- (d) crushed rock supplied to stockpile shall have a minimum moisture content of 3.5% by mass;
- (e) all PMWMCR delivered to stockpile shall be supplied at a moisture content of not less than OMC unless the material is to be wet mixed again prior to delivery to the roadbed where the minimum moisture content in stockpile shall be not less than 3.5% by mass;
- (f) the surface of the stockpile shall be kept damp to prevent a net loss of moisture and to minimise the generation of airborne dust.

812.11 HANDLING OF CRUSHED ROCK PRODUCTS

Handling of crushed rock including stockpiling and loading of trucks shall be undertaken to minimise segregation.

812.12 MINIMUM TESTING REQUIREMENTS

The Contractor shall test crushed rock products and PMWMCR at such a frequency to ensure that the supplied material consistently complies with the specified requirements of VicRoads Standard Sections, Code of Practice 500.02 and any additional testing specified as a condition of registration of the crushed rock mix.

The test frequency shall initially not be less than that shown in Table 812.121, except that the test frequency for Grading, Plasticity Index, Unsound Rock Content, pH and Conductivity, and Degradation Factor, may be halved where the most recent ten successive test results meet the specified requirements. If any subsequent test result fails, another test shall be immediately undertaken. If the second test fails the test frequency shall revert to the minimum test frequency specified in Table 812.121 and the Contractor shall not return to half the test frequency until a further ten successive test results comply with the specified requirements.

Table 812.121 Minimum Frequency of Testing

Test	Minimum Frequency of Testing
Grading - Final Product	On each production day - One per 500 tonnes or part thereof.
Unsound Rock Content (1)	One per production day of a sample taken from the final product.
Foreign Material Content (3)	On each day - one per 500 tonnes
Moisture Content - Crushed Rock (2) - PMWMCR	One per production day On each production day - One per 500 tonnes.
Plasticity Index	Class 1 Base In each production week - One test per 2500 tonnes. Class 2 Base and Classes 3 and 4 Subbase In each production month - One test per 5000 tonnes.
California Bearing Ratio (4)	CBR values shall be re-tested annually for each registered mix during supply or when the Superintendent <u>Council/VicRoads</u> judges, the physical properties of the crushed rock have changed.
Degradation Factor - Fine Aggregate (1)	One per 1000 tonnes on each production day, where specified as a condition of the crushed rock mix.
Permeability	Permeability values, where specified, shall be re-tested annually for each registered mix during supply or when the Superintendent <u>Council/VicRoads</u> judges the physical properties of the crushed rock have changed.
Los Angeles Value (3)	Once per month or when the Superintendent <u>Council/VicRoads</u> judges the physical properties of the crushed rock has changed.
pH and Conductivity (5)	One per production month
Flakiness Index	One per production month
Crushed Particles (6)	One per production month
Supplementary Materials	One per 1000 tonnes on each production day, where specified as a condition of the crushed rock mix
(1) Not applicable to Class 4 subbase, unless otherwise specified (2) Applicable only when payment is to be made on a mass basis (3) Applicable to Crushed Concrete products only. (4) Applicable to Crushed Concrete and all Class 4 subbase products. (5) Applicable only to sources containing sulphide/sulphate mineralisation (6) Applicable to crushed rock manufactured from river gravel only	

SECTION 815 - CEMENTITIOUS TREATED CRUSHED ROCK FOR PAVEMENT SUBBASE

~~##This section cross-references Sections 175, 306, 801 and 812.~~

~~If any of the above sections are relevant, they should be included in the specification.~~

~~If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent.~~

815.01 DESCRIPTION

This section covers the production requirements of 20 mm nominal size for pavement subbase treated with a cementitious binder to produce a bound material.

Crushed rock produced from a variety of raw feed sources including quarries, crushed concrete and Newer Basalt Surface Spalls (NBSS) can be utilised for this application, along with registered crushed rock blends containing supplementary materials.

Construction requirements for cementitious treated pavement subbase is covered by Section 306.

Sources from which crushed rock can be produced for cementitious treated subbase are specified in Section 801 - Source Requirements for the Production of Crushed Rock and Aggregates.

Section 175 details the relevant references to Australian Standards (AS), Test Methods and Codes of Practice referenced in this section.

815.02 DEFINITIONS

Crushed Rock

A crushed rock is a material composed of graded coarse and fine aggregate components produced by the crushing, scalping and screening of a raw rock feed source, Newer Basalt Surface Spalls (NBSS) and/or crushed concrete, and may also be a blend of components which includes limited quantities of supplementary materials.

Cementitious Binder

A cementitious material capable of being uniformly mixed into a granular pavement material to bind the particles together to increase its strength. Cementitious binders include Portland cement Type GP or blended cement Type GB, or a blend of ground granulated blast furnace slag (GGBFS), hydrated lime, fly ash, alkali activated slag or other pozzolanic material supplied in accordance with this specification.

Cement Treated Crushed Rock

Cement Treated Crushed Rock (CTCR) is a registered mixture of crushed rock, cement and water produced at a controlled mixing plant to close tolerances of grading, moisture content and binder content.

Fly Ash

A fine powder of pozzolanic material extracted from the flue emissions produced from the burning of black coal complying with requirements of AS 3582.1 - *Supplementary cementitious materials for use with portland and blended cement – fly ash* as listed in Section 175.

Pozzolan

A siliceous or aluminosiliceous material when finely ground can be mixed with lime or Portland cement to form a cementitious material.

Recycled Material

Materials obtained from a construction and/or demolition site which are crushed and re-processed to produce a crushed rock or a supplementary material.

Slag (Ground Granulated Iron Blast Furnace Slag)

Ground Granulated Iron Blast Furnace Slag (GGBFS) complying with requirements of AS 3582.2 - *Supplementary cementitious materials for use with portland and blended cement* - GGBFS as listed in Section 175 is a pozzolan produced by fine grinding of slag produced as a by product from the smelting of iron ore.

Supplementary Material

A durable material added to a crushed rock to improve the workability and physical properties.

815.03 MATERIAL SOURCE

CTCR manufactured at a quarry or non-quarry site shall not be used until the source has been investigated and accredited in accordance with VicRoads Code of Practice RC500.00 Source Investigations as listed in Section 175.

Material sources used in the production of cement treated crushed rock shall comply with the relevant specified requirements of Section 801 - Source Requirements for Production of Crushed Rock and Aggregates.

815.04 CEMENT TREATED CRUSHED ROCK MIX REGISTRATION

CTCR mixes proposed for use on specified works shall be registered in accordance with VicRoads Code of Practice for Registration of Crushed Rock Mixes RC500.02 as listed in Section 175.

All mix designs registered with VicRoads are issued a status according to compliance as:

General	The requirements of VicRoads Code of Practice RC500.02 have been met.
Conditional	Mixes which do not comply in all respects with the requirements of the Code of Practice but which are considered appropriate for use subject to conditions attached to the registration.
Expired	A mix which has passed the expiry date, but mix details are retained for record purposes.
Withdrawn	Withdrawn from use because of unsatisfactory field performance but details are retained for record purposes.

HP Cement treated crushed rock proposed for use on VicRoads funded works shall be current, registered mixes in accordance with VicRoads Code of Practice RC500.02 and conform to specified requirements applicable to that class of product.

The supplied registered mix shall not be changed unless the Superintendent Council has been advised of the change and given written approval.

Mixes registered as "Conditional" shall not be used unless the Superintendent Council has been advised of any mix registration conditions and approved the mix for use.

Approval of a registered CTCR mix for use under the Contract does not guarantee the handling properties or performance of the mix nor relieve the Contractor from contractual obligations in regards to rectification of defects.

815.05 COMPONENTS

Components of the cement treated crushed rock shall comply with the requirements of VicRoads Standard Section 812.05 (a), (b) and (c).

815.06 CEMENT TREATED CRUSHED ROCK PRODUCT

Prior to the addition of any binder, the crushed rock shall comply with relevant specified requirements for Class 3 crushed rock, as set out in VicRoads Code of Practice RC500.02, Section 801, Section 812 and this specification.

The crushed rock shall be tested in accordance with the frequencies specified in Table 815.141.

815.07 CEMENTITIOUS BINDER**(a) Cement**

Portland and blended cements shall be Type GP (rapid setting binder) or GB (medium setting binder) and comply with the requirements of AS 3972 *General purpose and blended cements* as listed in Section 175. It shall be stored in weatherproof structures, and any cement damaged by moisture shall not be used.

If Type GB cement is proposed, only the following blends are permitted:

- (i) Cement/Slag blend (50% to 60% cement content)
- (ii) Cement/Fly Ash blend (70% to 80% cement content)
- (iii) Cement/Slag/Fly Ash blend (55% to 65% cement content).

(b) Slag and Lime Blends

Slag and hydrated lime may be used in blended combination as a slow setting cementitious binder. The requirements for hydrated lime shall be as specified in AS 1672.1 - Limes and limestones as listed in Section 175. Slag used shall be Ground Granulated Iron Blast Furnace Slag (GGBFS) meeting the requirements of AS3582.2 - *Supplementary cementitious materials for use with portland and blended cements* - GGBFS as listed in Section 175. The Contractor shall nominate the type, brand and source of the GGBFS to be used.

Slag/lime shall be blended uniformly in the ratio of 85% slag to 15% hydrated lime unless laboratory testing indicates that superior strength of the CTCR is achieved by using a different ratio. If the blend is to be varied, the proportion of lime shall not be less than 10%. The Contractor shall provide evidence that the blend ratio has been met for all material supplied. Slag/lime blend shall have a mortar bar 7 day compressive strength of 10 MPa and 28 day mortar bar compressive strength of 16 MPa. The test shall be the same test specified for portland and blended cement except that the cement to water ratio shall be adjusted to match the consistency of mortar produced for the compressive strength test for GB cement in accordance with AS 2350.11.

(c) Slow Cementitious Blends Incorporating Alkali-activated Slag or Fly Ash

Special blends of slow setting cementitious stabilising agents incorporating alkali-activated slag or fly ash which do not meet mortar bar strength requirement specified in AS 3582.1 – *Supplementary cementitious materials for use with portland and blended cement* may be used subject to the blend satisfying the mortar bar test requirement specified in Clause 815.07(b). The maximum binder working time shall be determined in accordance with the VicRoads Test Method RC330.02 – *Determination of the Maximum Allowable Working Time for a Cementitious Binder* as listed in Section 175 to confirm that the binder is a slow setting binder.

Fly ash shall be supplied to meet the requirements of AS 3582.1 - *Supplementary cementitious materials for use with portland and blended cements – fly ash* as listed in Section 175.

815.08 ADDITION OF WATER

Water added to the crushed rock products either onsite or in PMWMCR shall be clean and substantially free from detrimental impurities such as oils, salts, acids, alkalis and vegetable substances. Water sources shall be tested for electrical conductivity and pH, in accordance with the current Australian Standards as listed in Section 175. The electrical conductivity shall not be more than 3500 µS/cm and pH within the range of 6 to 10, unless otherwise approved by VicRoads.

The use of reclaimed water will require the approval of the Superintendent Council and shall conform to the VicRoads guidelines for reclaimed water – *Integrated Water Management Guidelines* as listed under other referenced documents in Section 175.

Water sources added to crushed rock shall be tested at a maximum of twelve monthly intervals during the course of supply or when the nature of the water source has changed.

Water sources classified by the relevant water authority as potable water shall be exempt from the above requirements.

815.09 MIXING

The crushed rock, supplementary materials (if any), cementitious binder and water shall be combined via a controlled process utilising hopper bins, cement dispensing silo and a pugmill.

The mixing period and the time of addition of water shall be such as to produce a uniform mixture of the components.

815.10 CEMENTITIOUS BINDER CONTENT AND UNCONFINED COMPRESSIVE STRENGTH (UCS) REQUIREMENTS**(a) Cementitious Binder Content**

The Contractor shall determine the content of cementitious binder required to meet the minimum 7 day UCS specified in Table 815.101 using modified compaction. The cementitious binder content may be further increased to allow for the effects of production variability. The binder content so determined shall become the Design Cementitious Binder Content which shall not be less than the minimum cementitious binder content specified in Table 815.101. During manufacture, the cementitious binder content shall be determined in accordance with AS 5101.3.3 *Cement content of cement stabilized materials* as listed in Section 175.

Cementitious binder shall be added and mixed into the crushed rock to produce a uniform binder content.

After mixing, the cementitious binder content of the mixture, expressed as a percentage by mass of the dry crushed rock, shall be within $\pm 0.3\%$ of the Design Cementitious Binder Content.

(b) Unconfined Compressive Strength Test

The Contractor shall carry out UCS testing in accordance with the test frequency specified in Table 815.141. The UCS test result shall be the mean UCS determined from a pair of specimens tested in accordance with AS 5101.4 *Unconfined compressive strength of compacted materials* as listed in Section 175 and compacted using modified compactive effort.

For the purposes of UCS testing, one representative sample of fully mixed cement treated material shall be taken either from the plant or at the point of delivery in accordance with AS 5101.2.2 *Sampling – Preparation of stabilised pavement materials* as listed in Section 175 and compacted in the mould within two hours of mixing.

The UCS during production shall be assessed on a 'rolling average' basis where the average of the most recent three UCS test results shall not be less than the minimum value specified in Table 815.101.

Table 815.101 Cementitious Binder Content and Unconfined Compressive Strength

Pavement Design Modulus (MPa)	Minimum Design Cementitious Binder Content (% by mass)	Minimum 7 day Mean UCS (MPa)		
		Rapid Setting (GP Cement)	Medium Setting (GB Cement)	Slow Setting (Supplementary Cementitious Blends)
≤ 500	3	4	#	#
> 500 or ≤ 3500	3	5	3.5	3

815.11 MOISTURE CONTENT

~~Where the Contract includes supply and delivery only, the moisture content of the mixture at the point of delivery, expressed as a percentage by mass, shall be within $\pm 0.5\%$ to $\pm 1.0\%$ of the target nominated by the Superintendent.~~

815.12 STOCKPILING OF MIXTURE

Where CTCR is temporarily stockpiled, prior to loading, the batching time shall be recorded on the delivery docket.

815.13 HANDLING OF MIXTURE

Handling of the mixture, including discharging from mixing plant and loading of trucks, shall minimise segregation.

815.14 MINIMUM TESTING REQUIREMENTS

The Contractor shall test CTCR products at such a frequency and within the relevant time limits to ensure that the supplied material consistently complies with the relevant specified requirements of VicRoads Standard Sections, Code of Practice 500.02 and any additional testing specified as a condition of registration of the crushed rock mix.

The test frequency shall initially not be less than that shown in Table 815.141, except that the test frequency for Grading, Unsound Rock Content, Plasticity Index, UCS and Degradation Factor – Fine Aggregate may be halved, where the most recent ten successive test results have met the specified requirements. If any subsequent test result fails, another test shall be immediately undertaken. If the second test fails, the test frequency shall revert to the minimum frequency specified in Table 815.141 and the Contractor shall not return to half the test frequency until a further ten successive test results comply with the specified requirements.

Table 815.141 Minimum Frequency of Testing

Test	Minimum Frequency of Testing
Grading	On each production day: One per 500 tonnes or part thereof except where the total production on any day less than 100 tonnes.
Unsound Rock/Foreign Materials Content	One per production day of a sample taken from the crushed rock product prior to addition of cementitious binder.
Cementitious Binder Content	On each production day: One per 500 tonnes or part thereof except where the total production on any day is less than 100 tonnes.
Moisture Content	On each production day: One per 500 tonnes or part thereof except when total production on any day is less than 100 tonnes.
Plasticity Index	In each production month: One per 5000 tonnes or part thereof.
Degradation Factor - Fine Aggregate	One per production day for crusher fines imported from another source or location within the source to that of the course aggregates. Or where specified as a condition of a crushed rock mix.
Mean Unconfined Compressive Strength	In each week: One per 2000 tonnes or part thereof. If production in any week is less than 500 tonnes, the quantity may be added to the total production in the following week(s) until a total of 500 tonnes is reached.

SECTION 831 - AGGREGATE FOR SPRAYED BITUMINOUS SURFACING

~~##This section cross-references Sections 175, 408 and 801 and these sections should be included in the specification. If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent:~~

831.01 DESCRIPTION

This section covers the requirements for Classes A, B and C aggregate produced by crushing and screening for use in sprayed bituminous surfacing.

The classes and sizes of aggregate to be supplied and stacksite requirements are specified in Section 408.

831.02 DEFINITIONS

Aggregate

Aggregate consists of substantially one-sized mineral particles used as a cover material applied to a thin membrane of bituminous material.

Assigned Los Angeles Value

The assigned Los Angeles Value (LAV) is a hardness rating derived from Los Angeles Value test results, which is assigned annually to each source by VicRoads as per Code of Practice for Source Rock Investigations as listed in Section 175.

Assigned Polished Stone Value

The assigned Polished Stone Value (PSV) is a friction rating derived from Polished Stone Value test results which is assigned annually to each source (where applicable) by VicRoads as per Code of Practice for Source Rock Investigations as listed in Section 175.

Average Least Dimension

The Average Least Dimension (ALD) is the average height of the aggregate particles when they are spread as a single layer with their least dimension vertical.

Crushed Aggregate

An aggregate produced by crushing and screening of rock spalls or other material approved by the ~~Superintendent~~ Council which has fully (or 100%) crushed faces.

Partly Crushed Aggregate

An aggregate produced by washing, crushing and screening of a suitable material (e.g. coarse gravel), which may not have fully crushed faces.

831.03 SOURCE ROCK

Source rock used for the production of aggregates shall comply with the requirements specified in Section 801 and shall be obtained from a VicRoads accredited source, with a current assigned LAV and where required a current assigned PSV.

Synthetic or blended aggregates from different sources shall only be used with the approval of the ~~Superintendent~~ Council.

831.04 AGGREGATE REQUIREMENTS AND TESTING

Sampling and testing of aggregates shall be undertaken in accordance with VicRoads Codes of Practice 500.16 and 500.09.

(a) General Requirements

- (i) Crushed aggregate shall consist of clean, hard, durable, angular fragments of rock and shall be free from clay and organic matter. River gravel, and calcrete and other sedimentary rocks shall not be used for the production of Class A sealing aggregate.
- (ii) Partly crushed aggregate shall be produced by crushing clean, hard, durable particles of gravel and shall be free from clay and organic matter. The aggregate shall have a minimum of 75% by mass of aggregate particles having two or more faces produced by crushing. Partly crushed aggregate shall only be used for the production of Class B and C sealing aggregate.

(b) Sampling of Aggregate

The sampling of aggregate for specified testing shall be based on lots. A lot shall consist of not more than 350 tonnes of aggregate of the same class and size. The lot shall be uniform in appearance and be produced from the same source and under the same conditions.

VicRoads may agree to increased lot sizes up to 700 tonnes, where the supplier demonstrates that the source rock is of consistent quality and there is a history of satisfactory test results and performance.

Each lot of aggregate shall be assigned a unique identification number and/or unique stockpile location. Lots shall be stockpiled separately to ensure aggregate testing is fully traceable.

A representative sample shall be taken at random from each lot and tested for compliance with the requirements specified in Clauses 831.04(d), (e) and (f) not more than 90 days prior to delivery.

(c) Testing of Aggregate

HP The results of all testing as required by this section shall be provided to the Superintendent Council prior to delivery.

(d) Unsound and Marginal Rock

Unsound and marginal rock in that fraction of a sample retained on a 4.75 mm AS sieve shall not exceed the values specified in Table 831.041. Notwithstanding the requirements of Clause 831.04(b) regarding lot size, where daily production of the same source and class of aggregate exceeds 350 tonnes per day, the lot testing for unsound and marginal stone can be reduced to one lot per day.

Table 831.041 Marginal and Unsound Rock Content Limits

Class of Aggregate	Total of Marginal and Unsound Rock (max % by mass)	Unsound Rock (max % by mass)
	Individual Test	Individual Test
A	10	3
B	18	5
C	24	10

(e) Flakiness Index

Flakiness Index tests shall be undertaken on aggregate sizes of 10 mm or above.

- (i) For all source rock with an assigned Los Angeles Value of 25 or less, the Flakiness Index of aggregate shall not exceed the values specified in Table 831.042.

Table 831.042 Flakiness Index Requirements (LAV ≤25)

Class of Aggregate	Flakiness Index (max % by mass)
	Individual Test
A	25
B	30
C	40

- (ii) For all source rock with an assigned Los Angeles Value of more than 25, the Flakiness Index of aggregate shall not exceed the values in Table 831.043.

Table 831.043 Flakiness Index Requirements (LAV >25)

Class of Aggregate	Flakiness Index (max % by mass)
	Individual Test
B	25
C	30

(f) Grading

The grading by mass of one sized aggregate shall conform to the relevant requirements of Tables 831.044 and 831.045.

Table 831.044 Grading Envelopes and Minimum ALD Requirements for Class A and B Aggregate

Sieve Size (mm)	Percentage Passing AS Sieve (by mass)				
	Nominal Size of Aggregate				
	20 mm	14 mm	10 mm	7 mm	5 mm
26.5	100				
19.0	85-100	100			
13.2	0-35	85-100	100		
9.50	0-5	0-30	85-100	100	
6.70	0-2	0-5	0-40	85-100	100
4.75			0-5	0-35	85-100
2.36				0-5	0-35
0.075	0-1.0	0-1.0	0-1.0	0-1.0	0-1.0
Minimum ALD	10.0	7.0	5.0	3.5	

Table 831.045 Grading Envelopes and ALD Requirements for Class C Aggregate

Sieve Size (mm)	Percentage Passing AS Sieve (by mass)				
	Nominal Size of Aggregate				
	20 mm	14 mm	10 mm	7 mm	5 mm
26.5	100				
19.0	85-100	100			
13.2	0-35	85-100	100		
9.50	0-7	0-40	85-100	100	
6.70		0-7	0-40	85-100	100
4.75			0-10	0-55	85-100
2.36	0-1.0	0-1.0	0-2.0	0-10	0-40
0.075	0-1.0	0-1.0	0-1.0	0-1.0	0-1.0
ALD	To be reported				

(g) Average Least Dimension

For 7 mm aggregate and larger, testing of ALD values is required for each lot of aggregate supplied under the Contract in accordance with the relevant ALD test methods contained in Section 175 (refer Codes of Practice 500.09 and 500.16) and based on lot requirements as specified in Clause 831.04(b).

831.05 ACCEPTANCE OF AGGREGATE

If all of the specified test results comply with the relevant requirements of Clauses 831.04(d), (e) and (f) the aggregate represented by the lot will be accepted.

If any of the individual test results do not comply with the relevant requirements of this clause the lot will be rejected.

Aggregate which does not meet the above acceptance criteria shall not be supplied or delivered.

831.06 PRECOATING OF AGGREGATE

Aggregate shall be precoated with suitable precoating material and each particle shall be uniformly coated to the satisfaction of the Superintendent Council.

Only aggregates which have been tested and meet the requirements of Clause 831.05 to the Superintendent Council's satisfaction shall be precoated.

Precoating of aggregate for primer sealing shall be at the discretion of the Contractor.

A typical precoating material shall have a viscosity in the range 0.003 to 0.020 Pa.s at 60°C and contain a bitumen residue of between 25% and 40% by mass and an adhesion agent of 1% by volume at normal concentration.

The use of alternative precoating materials will be considered. Specific proposals shall be submitted to the Superintendent Council for review not less than 10 business days prior to use.

831.07 DELIVERY

Aggregate shall not be delivered directly from stockpiled lots at the quarry to the stacksites unless the aggregate has been tested and meets the acceptance of all test requirements to the satisfaction of the Superintendent Council.

Where delivery of aggregate is made to stacksites at or near the site of the sealing works, delivery shall be made to separate identifiable stacks for each lot of aggregate tested. Once delivery is commenced the Contractor shall continue to promptly complete the delivery of the entire lot.

SECTION 832 - SANDS FOR SPRAYED BITUMINOUS SURFACING

832.01 DESCRIPTION

This section covers the requirements relating to quality and supply of Classes 1 and 2 sands for use in sprayed bituminous surfacing.

The classes of sands to be supplied shall be as specified in the special clauses and/or the drawings and/or the schedule and/or the order.

832.02 DEFINITION

Sand

Sand is a product of rock weathering, substantially passing a 4.75 mm sieve, is generally siliceous, and is free from appreciable quantities of clay and silt. Sands used as cover material applied to a layer of bituminous binder consist mainly of particles between 5 mm and 0.075 mm in size.

832.03 MATERIALS SOURCE

Prior to commencement of work, the Contractor shall confirm the source from which the material will be obtained.

The Superintendent Council's approval shall be obtained prior to changing the source of material.

Source material which does not comply with specified requirements but from which sands of proven satisfactory performance have been produced may be accepted for use subject to the written approval of the Superintendent Council.

832.04 TESTING AND ACCEPTANCE OF SANDS

(a) General

Unless otherwise specified, testing of sands shall be based on lot testing. One sample shall be taken at random from each lot prior to delivery to stack sites. A lot shall consist of not more than 100 m² of sand which is uniform in appearance and is from the one source. Each lot shall be assigned a unique identification. The samples shall be taken not more than 30 days prior to delivery of material in the lot and tested for compliance with the specified requirements in Clause 832.04(b).

(b) Quality of Sands

- (i) Sands shall consist of hard, durable particles and shall be free from mica, clay lumps and organic matter.
- (ii) Sands shall have a Sand Equivalent value of not less than 80.
- (iii) Sands shall conform to the relevant grading requirements of Table 832.041.

Table 832.041 Grading Requirements for Sands (by mass)

Class	Percentage Passing						
	Sieve Size AS (mm)						
	9.50	4.75	2.36	1.18	0.600	0.15	0.075
1	100	85-100	55-80	25-50	0-20	0-5	0-2
2	100	85-100	70-95	50-85	20-50	0-10	0-2

832.05 DELIVERY

Delivery shall be made to stack sites as specified and shall be completed for each site by the date specified for that site, or by the date shown on the order, as appropriate. The Contractor shall give the Superintendent Council written notification of the identity of the lot from which delivery is made for each stack.

832.06 STACKS

Stacks shall be so placed that they do not unduly reduce sight distance at locations such as intersections and curves. Stacks shall not be placed under or immediately adjacent to electric power lines or under trees or structures where the overhead clearance is less than 6 m. Stacks shall be placed clear of the road formation, drains, gateways and side tracks and the toes of the stacks shall be not less than 1 m from any obstructions which could impede the operation of mechanical loading equipment.

Where sands from more than one lot are delivered to the same stack site, separate stacks shall be made for sands from each lot.

832.07 STACKING TO TEMPLATE

Unless otherwise directed or approved by the Superintendent Council, sand shall be stacked to one of the following templates.

Bed width 4.0 m, top width 1.0 m, vertical height 0.8 m (nominally 2.0 m² per metre run).

Bed width 5.0 m, top width 2.0 m, vertical height 1.0 m (nominally 3.5 m² per metre run).

832.08 MINIMUM TESTING REQUIREMENTS

The Contractor shall test the sands at a frequency which is sufficient to ensure that all materials supplied under the contract complies with the specified requirements but which is not less than that shown in Table 832.081.

Table 832.081

Test	Minimum Frequency of Testing
Grading	One per 1000 tonnes or part thereof
Sand Equivalent	At monthly intervals

SECTION 853 - HOT MELT BITUMEN ADHESIVE FOR RAISED PAVEMENT MARKER INSTALLATION

853.01 DESCRIPTION

This section covers the requirements for hot melt bitumen adhesive for use in bonding raised pavement markers complying with the requirements of AS 1906 Part 3, to bituminous and concrete road surfaces.

The requirements relate to physical properties and packaging.

853.02 PHYSICAL PROPERTIES

Hot melt bitumen adhesive is a homogeneous mixture of bitumen and mineral filler.

Component Properties

(a) Bitumen

	Min.	Max.	Method
Penetration, 100 g, 5 s, 25°C	15	-	ASTM D5
Viscosity, 135°C, Poise	12	-	ASTM D2171

(b) Filler

	Min.	Max.
Filler content % by dry mass of adhesive	65	75
Filler grading % passing AS 0.150 mm sieve	100	
% passing AS 0.075 mm sieve	85	

Adhesive Properties

	Min.	Max.	Method
Softening Point, °C	100	116	ASTM D36
Penetration	7	16	ASTM D5
Flow, mm	-	5	ASTM D3407 as modified
Heat Stability Flow, mm	-	5	ASTM D3407 as modified
Viscosity, 205°C, Poise	-	75	ASTM D2669 as modified
Flash Point, C.O.C., °C	250	-	ASTM D92
Shelf Life, years from date of delivery	2	-	
Recommended Pouring Temperature, °C	185	220	

Strength Requirements

Bond Strength Development

When tested in accordance with Appendix E of AS 3554 (as modified to allow use of hot melt adhesive), the adhesive shall attain a bond strength of 1.4 MPa within the times specified in Table 853.021.

Table 853.021 Maximum Times for Bond Strength Development (minutes)

Adhesive	Bond Curing at 23°C	Bond Curing at 10°C	Bond Curing at 0°C
Bitumen Hot Melt	35	35	35

Bond Strength in Slant Shear

When tested in accordance with Appendix F of AS 3554 (as modified to allow use of hot melt adhesive), the adhesive shall have minimum slant shear bond strengths as specified in Table 853.022.

Table 853.022 Slant Shear Failure Stress

Substrate	Condition	Minimum Slant Shear Stress MPa
Dry Steel	Adhesive bond cured for 24 ± 2 h at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$	7
Dry Steel	Adhesive bond cured for 24 ± 2 h at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and water soaked for 7 days	6.7
Wet Hardened Concrete	Adhesive bond cured for 24 ± 2 h at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$	5
Wet Hardened Concrete	Adhesive bond cured for 24 ± 2 h at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and water soaked for 24 h	2.2
Wet Hardened Concrete	Adhesive bond cured for 24 ± 2 h at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and water soaked for 7 days	3

Bond Strength in Shear

When tested in accordance with Appendix G of AS 3554 (as modified to allow use of hot melt adhesive), the adhesive shall have a minimum bond strength in compressive shear as specified in Table 853.023.

Table 853.023 Bond Strength in Shear

Substrate	Minimum Bond Strength in Compressive Shear MPa
All ceramic and reflective markers in accordance with AS 1906.3, Types A, B and A/B, dry or bond cured for 24 ± 2 h at $23 \pm 1^{\circ}\text{C}$ and 7 days soak	4.0

Bond Behaviour Under Impact Shear

When the adhesive is tested in accordance with Appendix H of AS 3554 (as modified to allow use of hot melt adhesive), there shall be no relative displacement of a slant shear block assembly when subjected to a drop impact energy of 150 J.

853.03 PACKAGING AND IDENTIFICATION

Each container shall display the following information:

Manufacturer's Identification of Product

Manufacturer's Name

Supplier's Name

Date of Manufacture

Batch Number

Directions for Using

SECTION 860 - MANUFACTURE OF ROAD SIGNS

860.01 DESCRIPTION OF SIGN TYPES

This section covers the requirements for the manufacture and packaging of all road signs, both permanent and temporary, which are made with steel or aluminium substrates. The sign types to which this section applies are categorised and defined as follows:

Category A - Flat Sheet Permanent or Temporary Signs - Unbraced

This category is comprised of signs with the following dimensions:

- (a) rectangular and square signs less than 750 mm nominal horizontal width;
 - (b) triangular signs less than 900 mm side;
 - (c) diamond signs less than 750 mm side;
 - (d) signs of other shapes including circular, octagonal, trapezoidal, less than 750 mm nominal width;
 - (e) rectangular temporary signs less than 900 mm width, and less than 600 mm depth;
- but excludes any sign whose width to height ratio exceeds 2.5 to 1 (refer Category B below).

This category also comprises overlay panels intended to be fitted to the face of a Category B sign.

Category B - Flat Sheet Permanent or Temporary Signs - Braced

This category comprises all flat sheet signs larger than those described in Category A above.

Category C - Folded Box Edge Temporary Signs

Category D - Extruded Aluminium Section Signs

This category comprises fingerboards, road/street name signs and the like made from extruded aluminium sections.

860.02 SUBSTRATE MATERIALS

Each sign blank shall be manufactured from a material selected from Table 860.021 according to the corresponding category for that sign. The manufacturer shall supply a certificate of compliance in respect of metal grades, alloys and tempers if requested.

Table 860.021

Material Description	Material to comply with:	Appropriate Sign Categories (refer clause 860.01)								
Aluminium sheet, 1.6 mm thick	AS 1734 in the following grades and tempers: <table><tr><td><u>Alloy</u></td><td><u>Temper</u></td></tr><tr><td>5052</td><td>H36 or H38</td></tr><tr><td>5251</td><td>H36 or H38</td></tr></table>	<u>Alloy</u>	<u>Temper</u>	5052	H36 or H38	5251	H36 or H38	A, B		
<u>Alloy</u>	<u>Temper</u>									
5052	H36 or H38									
5251	H36 or H38									
Zinc/Aluminium coated steel sheet, 1 mm thick	AS 1397	C								
Extruded aluminium section	AS 1734 in the following grades and tempers: <table><tr><td><u>Alloy</u></td><td><u>Temper</u></td></tr><tr><td>6063</td><td>T5</td></tr><tr><td>6061</td><td>T6</td></tr><tr><td>6351</td><td>T5</td></tr></table>	<u>Alloy</u>	<u>Temper</u>	6063	T5	6061	T6	6351	T5	D
<u>Alloy</u>	<u>Temper</u>									
6063	T5									
6061	T6									
6351	T5									

860.03 BLANK MANUFACTURE**(a) General Requirements****(i) Manufacturing Tolerances**

Dimensional tolerances shall be as follows:

(1) Overall dimensions of blank:

± 5 mm or 0.5% of dimension, whichever is the greater.

(2) Holes:

Size, tolerance -0, +1 mm

Hole centre dimension (geometric position):

mating hole centres, tolerance ± 1 mm

non-mating hole centres, tolerance ± 3 mm

(3) Maximum allowable warp, twist or departure from flatness:

5 mm/metre

Blanks shall be free from undulations or ripples which may result in noticeable ripples or distortions on the sign face.

(4) Blank squareness:

In the case of a single panel sign, no corner of the panel shall be more than 2 mm from its theoretical position relative to other corners.

In the case of multi-panel signs, adjacent panels shall fit together so that any gap between panels is not more than 1.5 mm wide and parallel to within 1.0 mm over the length of the panel.

(5) General fabricating dimensions:

the greater of ± 5 mm or 2% of dimension.

(ii) Fixings**(1) Rivets**

Rivets shall be monel or stainless steel and shall have a shank diameter of 4.8 to 5 mm and a head diameter of 8.5 to 9.5 mm. Where the rivet head bears on a cellular type retro-reflective sheeting an 11 mm OD nylon washer shall be placed under the rivet head. Rivets placed on coloured sign face material shall have the rivet heads coloured to match the sign face material. All rivets shall be installed after sheeting and legend have been applied to the blank.

Note: Guide signs are preferred to be braced using a flushed rivet system with no exposed rivet to reduce the risk of the sign sheeting being damaged.

(2) Adhesive Fixings

Adhesive fixings intended by the manufacturer for the purpose of fixing cover strips or stiffening sections and used in accordance with the current manufacturers specification, may be used for making a horizontal or vertical joint pursuant to clause 860.03(b)(ii)(2) and for fixing stiffening sections pursuant to clause 860.03(b)(iii).

(3) Other Fixings

Acceptance of fixings other than as specified above, may be by type approved methods or techniques of individual contractors or approved by the Superintendent Council.

(iii) Preparation

Sign components shall be prepared prior to painting and/or the application of sheeting backgrounds and/or legends and/or adhesive fixings as follows:

- (1) All burrs shall be removed and all rough edges shall be dressed. Blanks shall be smooth and free from fabrication defect and chemical residue.
- (2) All unpainted sign components and sign face blanks shall be prepared to satisfy the current surface preparation requirements of the sheeting manufacturer and/or paint manufacturer and/or adhesive fixing manufacturer.

(b) Specific Requirements - Signs in Category B

(i) Panel Size and Joint Limitations

- (1) The number of joints, both horizontal and vertical shall be minimised on the basis of a sheet size of 2400 x 1200 mm except that for signs specified as overlay panels a sheet size of 1200 x 900 mm shall apply.
- (2) The width and height of any one panel shall not be less than 30% of the width and height of any other panel.

(ii) Panel Joints

(1) Location

Horizontal panel joints shall not occur through any internal border, or through any word or numeral legend of character height 180 mm or less other than the descenders of any lower case legend, or any numeral and borders on route marker shields. **Vertical** joints shall be so located to minimise the amount of legend directly over the joint.

(2) Making Joints

Each panel shall be painted or covered with sheeting, as appropriate, before the joints are made. Sheeting on either side of a joint shall be colour matched in accordance with the requirements of clause 860.04(a)(ii)(8).

Horizontal Joints

Horizontal joints made with rivets shall coincide with the location of a stiffening section required by sub-paragraph (iii) below.

Horizontal joints made with adhesive fixings shall not coincide with the location of a stiffening section required by sub-paragraph (iii) below and shall be backed by a cover strip of the same material as the blank 60 ± 5 mm wide, terminating 10 ± 5 mm short of the edge of the sign.

Vertical Joints

Vertical joints shall be backed by a cover strip of the same material as the blank 60 ± 5 mm wide, terminating 10 ± 5 mm short of the edge of the sign and discontinued at each horizontal stiffening section with a gap not exceeding 5 mm. A cover strip may be omitted if the length of the cover strip would be less than 120 mm.

The cover strip shall be attached to each blank sheet, either by a single row of rivets evenly spaced across the sign at a spacing not exceeding 200 mm, with an edge distance not exceeding 30 mm from the end of the cover strip, by adhesive fixing or other approved method of fixing. Short cover strips attached by rivets shall be provided with a minimum of two rivets on each side of the panel joint.

(3) Incomplete Joints

For large signs an incomplete joint with provision for field assembly in a manner which ensures structural integrity of the sign pursuant to clause 860.03(a) requires approval by the Superintendent Council. The sign panels shall be numbered, and the manufacturer shall provide assembly details and all rivets or other fixings for field assembly.

(iii) Stiffening Sections

- (1) All sign blanks shall be stiffened by the attachment on the rear face of one or more continuous horizontal lengths of galvanised cold rolled steel channel with 41.3 x 21.0 mm cross-sectional dimensions or aluminium extruded section with 28.5 x 25.5 mm cross-sectional dimensions with internal clamping ridges. Joining of stiffening sections shall only be permitted when the length of the sign exceeds the longest available stiffening section. Where joints are permitted they shall be staggered and made so as to ensure the structural integrity of the sign.
- (2) The number of such stiffening sections shall be as given in Table 860.031.

Table 860.031

Vertical Dimension (mm)	Number of Sections (41.3 x 21.0 mm or 28.5 x 25.5 mm)
Up to 200	1 *
201 to 900	2 **
901 to 1200	3
1201 to 1600	4
1601 to 2000	5
2001 to 2400	6
2401 to 2800	7
2801 to 3200	8
above 3200	one extra section for each extra 400 mm of height
<p>* signs between 600 and 900 mm horizontal dimension shall have two sections with the lower section 150 mm in length and centrally place horizontally.</p> <p>** the lower of the two sections on signs greater than 600 mm horizontal dimension need only be 150 mm in length and centrally placed horizontally.</p>	

- (3) The location of the stiffening sections shall be as follows:

One section - centred vertically.

Two sections - located symmetrically on the blank at a spacing of 0.6 times the height of the blank \pm 50 mm. The maximum spacing shall be 500 mm.

Three or more sections - outer sections to be located between 50 and 200 mm measured from the edge of the blank to the centre line of the section, and both outer and intermediate section(s) located such that no space between any two adjacent section varies by more than 100 mm from any other space. The maximum spacing shall be 500 mm.

The ends of each stiffening section shall terminate 20 mm \pm 5 mm short of the edge of the sign.

- (4) Stiffening sections fixed with rivets shall be attached to the blank, or each blank in the case of a horizontal joint by a single row of evenly spaced rivets at a spacing not exceeding 200 mm with a distance not exceeding 30 mm from the end of the stiffening section or any vertical joint.
- (5) The bearing surface of each stiffening section shall be flat or concave over a substantial part of its width.
- (6) Blanks having a dimension measured at right angles to the stiffening sections in excess of 600 mm shall be fitted with additional transport bracing at right angles to the main stiffening sections as given in Table 860.032.

Table 860.032

Dimension Parallel to Stiffening Sections	No. of Bracings Required	Cross-Sectional Dimensions *
up to 600 mm	0	
601 to 2000 mm	2	41.3 x 21.0 mm
2001 to 2500 mm	3	41.3 x 21.0 mm
2501 to 4000 mm	3	41.3 x 41.3 mm
greater than 4000 mm	4	41.3 x 41.3 mm
* Cross section dimensions refer to galvanised cold roll steel channel. 28.5 x 25.5 mm aluminium extruded section may be substituted for 41.3 x 21.0 mm for galvanised cold roll steel channel.		

Sections or numbers of sections alternative to those specified in Table 860.032 may be used as transport bracing provided they are galvanised steel or aluminium extruded section and at least as strong in bending as the prescribed sections.

The transport bracing sections shall be securely bolted to the stiffening sections at every intersection point in such a way that they may be readily removed after installation of the sign on its supporting posts or structure. Each bracing shall extend 50 ±5 mm beyond the upper and lower edge of the blank to provide edge protection for the finished sign during handling and installation.

(c) Specific Requirements - Signs in Category C

All blanks shall be made from a single sheet of steel, except signs with a smaller overall finished dimension greater than 1050 mm, which may have one joint.

Blanks shall be manufactured in accordance with the drawings.

(d) Specific Requirements - Signs in Category D

- (i) Sign blanks shall be either a single section of nominal vertical dimension 150 mm or 200 mm, or shall be of composite construction comprising separate web and flanges securely attached to one another to provide a nominal vertical dimension in excess of 200 mm but not more than 350 mm.
- (ii) Acceptance of extruded aluminium sections shall be by type approval in individual cases. The current list of approved sections is given in Table 860.033.

Table 860.033

Description of alloy	Overall vertical dimension (mm)	Area cross section (mm ²)	Web thickness (mm)
6061-T6, 6063-T5 and 6063-T6	150 – 200	495 – 725	2.20 – 2.65
Note: The overall vertical dimension of composite sign to be 350 mm maximum.			

860.04 APPLICATION OF SIGN BACKGROUNDS AND LEGENDS**(a) General Requirements****(i) Painted Background, Backs, Edges, etc.**

Painted sign face backgrounds, back and edges, where specified by the drawings shall be achieved either by:

- (1) application of a stoving primer to a dry thickness of 0.008 to 0.012 mm, followed by a stoving enamel in the final specified colour to a dry thickness of 0.035 to 0.045 mm; or,
- (2) application of a yellow oxide/zinc chromate primer to a dry thickness of 0.008 to 0.012 mm, followed by a low gloss polyurethane paint conforming with AS 2709 in the final specified colour, applied in accordance with the manufacturer's instructions; or
- (3) use of pre-painted coil stock in the specified colour comprising galvanised sheet steel factory primed and painted with a weather resistant finish not less than 0.025 mm total paint thickness on one or both sides.

Standard paint colours for traffic signs shall be as specified in AS 1743, Road Signs, for non-reflective colours. Where grey edges or backs are specified on a sign the colour shall be:

AS 2700, Colour No. N52, Mid Grey

Any colour not specified above shall be subject to approval by the Superintendent Council. The Contractor shall, prior to the commencement of manufacture, supply a painted reference panel in the required colour, and such panel may be used in determining compliance.

(ii) Sheeting Backgrounds

Sheeting of a colour or grade which is not covered by the relevant Australian Standard or this paragraph shall be subject to the approval of the Superintendent Council.

- (1) Retro-reflective sheeting shall conform with all of the relevant requirements of AS 1906.1 for the class and colour of the sheeting specified on the drawings. Refer to VicRoads Road Design Note RDN 06-11 for a list of VicRoads accepted retro-reflective sheeting.
- (2) Non-reflective sheeting used as a sign background shall be of a material and finish approved by the Superintendent Council. The Contractor shall prior to commencement of manufacture supply a suitable sample of the material and such sample may be used in determining compliance. Colour of non-reflective sheeting shall conform with AS 1743.
- (3) Sheeting shall be applied in accordance with current manufacturer's specifications and instructions.
- (4) Sheeting splices may be provided parallel to one edge only.
- (5) The number of sheeting splices shall be minimised on the basis of the widest available sheeting roll. The minimum width of any sheeting strip shall be 100 mm.
- (6) Sheeting splices where permitted shall overlap by 5 to 10 mm unless Class 1A material is used where joints shall be butted in accordance with the manufacturers instructions.
- (7) Background sheeting need not be brought to the edge of a sign provided that it can be overlapped by a border made of sheeting by at least 5 mm.
- (8) Separate pieces of any sheeting abutting a splice or abutting a panel joint shall be colour matched when viewed in daylight. Separate pieces of retro-reflective sheeting abutting a splice or abutting a panel joint shall be further matched for retro-reflected colour.
- (9) Any sheeting laid unbroken over a panel joint shall be cut through on the line of the joint using a sharp knife.
- (10) Sheeting shall not be applied over any raised protuberance including bolt and rivet heads.

(iii) Application of Legends, Borders, etc.

- (1) Borders, legends, numerals, internal dividing lines and symbols shall be applied to the sign in accordance with the drawing by either:
 - for reflectorised legends, application of adhesive sheeting or silk screening with an approved transparent ink over a retro-reflective background material or, an approved pressure sensitive coloured overlay film over a retro-reflective background material;
 - for non-reflective legends, application of adhesive sheeting, or by silk screening with an opaque ink or process paint approved by the sheeting manufacturer.
- (2) Sheeting used for the above purpose shall comply with the same requirements as sheeting background, and shall be of the type and colour indicated on the drawings.
- (3) Where silk screened transparent ink or pressure sensitive coloured overlay film is used in the application of a legend, border etc., inks or film shall be applied only as recommended by the ink or film manufacturer and background sheeting manufacturer. The colour and retro-reflective performance of any portion of the sign which is screened using transparent inks or overlay film shall be indistinguishable.
- (4) All letters, numerals, and inter-letter and inter-word spacings shall conform with the size and series indicated on the drawings.
- (5) Tolerances on legends shall be as follows:
 - Tolerance on shape, size and alignment of legend elements, including letters, numerals, arrows, symbols, etc., the spacing between letters in a word, and the width of borders, edge strips and dividing lines shall be ± 2 mm or 1% of dimension, whichever is the greater.
 - Legend Position - Tolerance on legend position shall be as above, except that horizontal location of line of words may vary by up to one half the letter stroke width if necessary to avoid placing a vertical letter stroke over a panel joint.
 - Legend Alignment - Each legend (word or line of words) shall be parallel with other legend, border and sign edge within 3 mm/m.
 - Other dimensions including length of a line of legend, the horizontal spacing between words or groups of legend elements, and the vertical spacing between lines of legend or groups of legend elements shall have a tolerance of ± 5 mm or 2% of dimension, whichever is the greater.
 - Legends which do not meet the tolerance on spacing between letters in a word but meet the tolerance on overall line length and are judged to be acceptably spaced by visual inspection may be accepted.
- (6) Sheeting splices are permitted on sign borders and internal dividing lines. All other legend elements shall be a single piece of sheeting.

(iv) Finish

The whole of the sign shall be free from any significant defect to the satisfaction of the ~~the~~ Superintendent Council.

(b) Specific Requirements - Signs in Categories A and B

- (i) Backs and edges of signs shall be left unpainted unless otherwise shown on the drawings.
- (ii) For multiple panel signs, adjoining panels shall be butted together while the border and legend are applied, following which any of the border and legend crossing a joint shall be cut through on the line of the joint using a sharp knife. The panels shall then be jointed in accordance with the requirements of clause 860.03(b)(ii).
- (iii) For unbraced signs in Category A with a cellular reflective sheeting background, a circle 21 ± 1 mm diameter shall be cut from the sheeting concentrically around each mounting hole.

(c) Specific Requirements - Signs in Category C

(i) Yellow faced signs shall be painted as follows:

- (1) Front face of folded box section - black.
Note: Adhesive sheeting is not acceptable for this purpose.
- (2) Recessed face of sign, non-reflective background - yellow.
- (3) Recessed face of sign, reflectorised background - yellow or black.
- (4) Outer edge of sign - yellow or black.
- (5) Inner box section return - black.
- (6) Back of sign - yellow.

(ii) Red faced signs shall be painted as follows:

- (1) Edges, front face of folded box section, inner box section return, recessed face of sign - red.
- (2) Back of sign - yellow or red.
- (3) Colour red for above purposes to be as follows:

Reflectorised or non-reflective red sign background - AS 2700 Paint Colour No. R13

Fluorescent red sign background - AS 2700 Paint Colour No. R12.

- (iii) Reflective or fluorescent sheeting applied to the recessed face as a sign background shall be not less than the overall nominal dimensions of the signboard in size less 70 mm in both width and height, and shall be placed centrally on the recessed face.

(d) Specific Requirements - Signs in Category D

- (i) Sheeting strips, reflective or non-reflective shall extend to within 12 mm of the top and bottom edge of the sign. The material shall be applied so that it adheres firmly and securely to the web over its full width.
- (ii) Uncovered parts of the web and flanges of the sign shall be left unpainted.

(e) Digital Printing

Digital printing technologies may be used for manufacture of signs.

Only matched component inks and printer devices recommended by the retro-reflective sheeting manufacturer shall be used. The ink and any protective coating must be compatible with the background material, both in application and durability.

860.05 LABELLING

- (a) The following information shall appear on the rear face of signs in clause 860.01, Categories A to C, and on sign in clause 860.01, Category D, on any part of the web not covered by sheeting:

- (i) Designation of the Manufacturer, limited to 3 letters.
- (ii) Four numerals indicating the month and year of manufacture, e.g. 01-86, or 05/87.
- (iii) For guide signs and other signs with site specific legend, the sign reference number shown on the drawing, which will generally be the drawing number.
- (iv) Code designation of the brand and class of the retro-reflective sheeting used, and the brand of the non-reflective or fluorescent sheeting used.

- (b) Information to be stamped into the rear face of the sign shall be stamped prior to application of any sheeting, or be embossed into a separate piece of metal which will be subsequently attached to the sign rear face by the use of an adhesive fixing.

- (c) Letters and numerals used for labelling on the rear of signs shall be a minimum of 7 mm high and shall be capable of being readily discerned after painting with a coat of paint up to 0.15 mm thick. For Category D signs, 4 mm letters minimum shall be used.
- (d) On signboards with both dimensions larger than 750 mm the information shall be located within a 400 mm radius of the lower left hand corner of the rear face of the sign such that it can be read from below the sign.

860.06 — PACKAGING HANDLING AND STORAGE

(a) — Packaging

- If the Contractor is responsible for sign unloading, the packaging of signs in terms of size and mass shall be consistent with the resources provided by the Contractor.
- If VicRoads is responsible for sign delivery and/or unloading, the maximum size and mass of packaged signs shall be in accordance with the Superintendent's requirements.
- Packaging shall protect the signs from damage during handling and transport, taking into account the recommendations of the sheeting manufacturer.
- The outer face of each package shall show information as follows:
 - (i) signs with standard, non site specific legends (e.g. regulatory, warning signs) — the standard sign number and quantity of each type of sign in the package, plus delivery instructions as given on the order or otherwise advised, shall be legibly marked;
 - (ii) guide signs and other signs with site specific information — a copy of the sign drawing or drawings included in each package shall be securely attached to it in a clear weatherproof envelope to the outer face of the package to be readable without opening the envelope;
 - (iii) a notice shall be attached to each package warning of damage that may result from improper storage and handling, and setting out the requirements for storage and handling generally as described in clause 860.06(b).

(b) — Handling and Storage

- Signs shall be handled and transported so as to prevent damage to the sign face or other components.
- Signs shall be stored vertically in such a manner to prevent damage to the sign face, edges or components, taking into account any recommendations of the sheeting manufacturer.

860.07 WARRANTY

(a) Sign Face Material

The Contractor shall give to VicRoads Council a warranty for the periods given in Table 860.071 that all retro-reflective, fluorescent and non-reflective materials used in the manufacture of signs shall remain in good condition in the following respects:

- (i) no evidence of cracking, crazing, peeling or lifting from the substrate, delamination, blistering, chalking, wrinkling or edge shrinkage greater than 2 mm, excepting accidental damage; and,
- (ii) no evidence of fading or gross colour change, except that loss of fluorescence in a fluorescent material will be accepted, provided that the colour change is not significant in comparison with the samples provided in AS 1743 Appendix D; and,
- (iii) in the case of retro-reflective and fluorescent retro-reflective materials, retention of a photometric performance not less than percentage values given in Table 860.071 below at the warranted period based on relevant photometric performance tables in Section 2 of AS 1906, Part 1, when tested at an entrance angle of 4 degrees and an observation angle of 0.2 degrees in accordance with Appendix A. Where a particular colour is not given in those tables, maintenance of an agreed set of photometric performance values which are to be not less than half the values obtained from tests of that material when new.

Table 860.071

Material Class (1)	Warranted Outdoor Durability (2)	Warranted Retained CIL Values (3)
Class 1W retro-reflective material	ten years	80%
Class 1W retro-reflective material (white with overlay)	twelve years	80%
Class 1W retro-reflective material (screen printed)	ten years	80%
Class 1W retro-reflective material (digitally printed)	ten years	80%
Class 1 retro-reflective material	twelve years	80%
Class 1 retro-reflective material (white with overlay)	twelve years	80%
Class 1 retro-reflective material (screen printed)	ten years	80%
Class 1 retro-reflective material (digitally printed)	ten years	80%
Class 2 retro-reflective material	seven years	50%
Class 2 retro-reflective material (white with overlay)	seven years	50%
Class 2 retro-reflective material (screen printed)	seven years	50%
Class 2 retro-reflective material (digitally printed)	seven years	50%
Fluorescent material – Yellow and Yellow-Green	ten years	80%
Fluorescent material – Orange	three years	80%
Non-reflective material	seven years	N/A
NOTES: (1) as specified on the drawings (2) from the date of manufacture as indicated on the sign by stamping in accordance with clause 860.05(a)(ii) (3) CIL = Coefficient of Luminous Intensity as defined in AS 1906.1		

(b) Signboard and Components

The Contractor shall give to ~~VicRoads~~ Council a warranty that the signboard and components shall remain in good condition in all respects other than those covered in paragraph (a) above, accidental damage or vandalism excepted, for an equivalent period to sign background material class specified in Table 860.071.

~~(c) Giving of Warranty~~

~~The execution of a formal instrument of Contract or the submission of a quotation by a Contractor for goods to be supplied in accordance with this Specification shall constitute the giving of the warranties specified herein by the Contractor to VicRoads.~~

(d) Warranty Claims

If any sign or retro-reflective material, fluorescent retro-reflective or non-reflective materials used on a sign deteriorates to a condition poorer than those indicated in sub-paragraphs (a) and (b) above within the time limits specified, either the Contractor shall replace the sign or shall pay to ~~VicRoads~~ Council a sum sufficient for ~~VicRoads~~ Council to obtain a replacement sign on a pro rata basis as follows:

- (i) Failure within the appropriate warranted period as specified in Table 860.071 from the stamped date - total cost of supply, delivery and erection of a new sign to be borne by the Contractor.
- (ii) Failure after more than 1 year from the stamped date - the Contractor to bear the total cost of supply and delivery of a new sign less an allowance equal to that cost multiplied by the ratio of the expired life to the total warranty life.

The Contractor shall be solely responsible for meeting all claims under these provisions and shall not re-assign any such responsibility to any other organisation.

860.08 INSPECTION AND TESTING

- (a) ~~The Superintendent~~Council reserves the right to inspect any phase of the manufacturing process.
- (b) On request at any time during the currency of the Contract, the Contractor shall provide a test panel 200 mm square, typical of any stage of production including unapplied retro-reflective, fluorescent retro-reflective, fluorescent or non-reflective material. For testing silk screened work the Contractor shall supply a testing screen which will print his trade mark or other identification on portion of the panel together with a strip at least 70 mm wide across the panel. ~~The Superintendent~~Council may require proofs to be taken from any silk screen before production commences.
- (c) All tests shall be conducted in accordance with the current test methods used by VicRoads.

860.09 APPROVAL BY THE SUPERINTENDENT COUNCIL

In considering any request for an approval required by this Section, ~~the Superintendent~~ Council will take into account:

- (a) evidence of use in maintenance of similar signs;
- (b) performance under similar service conditions;
- (c) manufacturers specifications and other product details;
- (d) conformance with relevant Australian Standard requirements;

~~The Superintendent~~Council's approval may be conditional and require the Contractor to use materials in a specified manner.