vicroads

Code of Practice

Selection and Design of Pavements and Surfacings

RC 500.22

December 2018

1. Scope

This Code sets down VicRoads procedures for the selection and design of new road pavements and surfacings. The Code is also applicable to the design of pavement rehabilitation treatments.

The Code shall be read in conjunction with any associated contract documentation prepared for the works.

Included within this Code is information relating to construction requirements which has been provided to aid the development of appropriate pavement designs. The Code does not override VicRoads specification requirements.

2. Reference Documents

Table 2.1 lists reference documents applicable to this Code.

Where a discrepancy exists between various parts of the reference documents, the following descending order of precedence shall apply:

- Contract Documents
- VicRoads Codes of Practice
- VicRoads Test Methods
- VicRoads Design Guides
- Standards Australia Test Methods
- Austroads Design Guides
- Other Design Guides

3. Appendices

Appendix A - Average Annual Rainfall of Victoria

Appendix B - Traffic Characteristics Information

Appendix C - Guide to Selection of Initial Seal Treatments on Pavements Constructed Clear of Traffic

Appendix D - Guide For Selection of Dense Graded Asphalt Types

Appendix E - Typical Characteristics of Asphalt Used by VicRoads

Appendix F - Design Chart for Unbound Flexible Pavements

4. Definitions

For the purpose of this Code the following definitions shall apply:

4.1. Unbound Flexible Pavement

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

4.2. Deep Strength Asphalt Pavement

A pavement comprising asphalt wearing, intermediate and base courses placed on a cementitiously treated subbase.

4.3. Full Depth Asphalt Pavement

A pavement comprising asphalt wearing, intermediate and base courses placed directly on unbound subbase material.

4.4. Rigid Pavement

A Portland cement concrete pavement.

4.5. Mechanistic - Empirical Pavement Design Procedure

A pavement design procedure used for pavements consisting of one or more bound layers based on determination of strain and use of material performance relationships to calculate the number of allowable load repetitions.

4.6. Heavy Vehicle Axle Groups (HVAG)

A set of closely spaced axles acting as a unit, including a single axle on a heavy vehicle (HV), whereby a HV is:

(a) A two-axle vehicle with the minimum axle spacing greater than 3.2 m, or a three or more axle vehicle configured at least with two axle groups (excluding short towing vehicles, e.g. trailer, caravan, boats, etc.); or

(b) A vehicle having a gross vehicle mass exceeding 4.5 tonne; or

(c) A Class 3 or higher classification vehicle.

VICTORIA State Government

Table 2.1 - Pavement & Surfacing Design References

Number *	Reference	Year of Release#
A. VicRoads Publications & Information		
A1	Job Specific Clauses and other Contract Documentation	Current
A2	Standard Specifications for Roadworks and Bridgeworks	Current
A3	VicRoads Codes of Practice	Current
A4	VicRoads Test Methods	Current
A5	VicRoads Supplement - Standard Drawings for Roadworks	Current
A6	Technical Report No. 75 The Influence of Trees and Shrubs on Pavement Loss of Shape	1986
B. Austroads Publications		
B1	Guide to Pavement Technology Part 2: Pavement Structural Design	2017
B2	Guide to Pavement Technology Part 4K: Selection and Design of Sprayed Seals	2018
B3	Guide to Pavement Technology Part 3: Pavement Surfacings	2009
B4	Technical Report AGPT/T190:2014 Specification Framework For Polymer Modified Binders	2014
B5	Catalogue of Test Methods	Current
B6	Guide to Pavement Technology Part 10: Subsurface Drainage	2009
C. Other Publications		
C1	Roads and Maritime Services - New South Wales (NSW) – Rigid Pavement Standard Details - Construction • Plain concrete pavement MD.R83.CP • Jointed concrete pavement MD.R83.CJ. • Continuously reinforced concrete pavement MD.R83.CC	Current
C2	RTA NSW ^ – Concrete Roundabout Pavements – A Guide to Their Design and Construction	2004
C3	CIRCLY -Computer Program for the Analysis of Multiple Complex Circular Loads on Layered Anisotropic Media	Current
C4	AustPADS (Austroads pavement design software)	Current

* The numbering used to identify reference documents applies to this Code of Practice only to aid referencing within this Code. The documents are identified in superscript text where the abbreviated title of the reference is used in this Code.

\# The year of release is current as at December 2018.

^ Roads and Traffic Authority (RTA) NSW renamed Road and Maritime Services (RMS) NSW

4.7. Standard Axle

Single axle with dual tyres applying a load of 80 kN.

4.8. Equivalent Standard Axles (ESA)

The number of repetitions of a standard axle that are equivalent in damaging effect on a pavement for a given axle group type and loading calculated with a load damage exponent of 4.

4.9. Design Traffic Loading (DTL)

Design Traffic Loading is equivalent to Design Traffic when expressed in terms of ESA.

4.10. Design Traffic

For the mechanistic - empirical design of pavements containing bound materials the Design Traffic is:

- characterised by the cumulative HVAG together with the traffic load distribution (TLD) when considering fatigue damage to asphalt and cemented materials

- expressed in terms of ESAs when considering rutting and loss of surface shape.

For the empirical design of unbound granular pavements with thin bituminous surfacing, the Design Traffic is expressed in terms of ESAs.

For the design of rigid pavements, the Design Traffic is characterised by the cumulative HVAG together with the TLD and load safety factor.

4.11. Assigned CBR

The California Bearing Ratio (CBR) assigned to the insitu material at or below subgrade level, to Type A or Type B fill material or to a pavement material. The Assigned CBR is determined from CBR testing in accordance with VicRoads Codes of Practice RC 500.20[A3], RC 500.23[A3] and RC 301.04[A4].

4.12. Design CBR

The Design CBR is the CBR value given to an imported earthworks layer in fills or to prepared insitu material in cuts, at or below subgrade level, which is used to determine the structural thickness of a pavement.

4.13. Insitu Material at or below Subgrade Level

The existing material at or below subgrade level after stripping but prior to earthworks commencing.

4.14. Structural Thickness

Determined from the mechanistic - empirical design of flexible pavements or the design of rigid pavements but excludes construction thickness tolerances.

4.15. Design Thickness

The required structural thickness of pavement including a design allowance for construction thickness tolerances.

4.16. Superintendent

The Superintendent for the Contract as defined in the General Conditions of Contract.

This section intentionally left blank

5. Environmental Considerations

5.1. Swell Potential

A material with a swell ≥ 2.5% as determined in accordance with VicRoads Code of Practice RC 500.20[A3] shall be considered as expansive (high swell potential). For expansive materials, the potential seasonal volume changes and resulting shape loss shall be reduced by undertaking measures discussed in Section 5.3.5 of Austroads[B1] and as described in Section 5.2 of this Code.

5.2. Treatments for Earthworks Materials with High Swell Potential

Earthworks material, with a swell > 1.5% shall not be placed within the minimum cover requirement over expansive material specified in Figure 5.1. The minimum cover includes earthwork material with swell ≤ 1.5% and all pavement materials except thin bituminous surfacings and Open Graded Asphalt.

In addition to the above requirement, project specifications may require material within 400 mm below Cut Floor Level (as defined in VicRoads[A2] Section 204) to have a swell < 2.5%. Refer VicRoads[A2] Section 204 for further detail.

Where expansive materials are utilised in the formation, the following shall be undertaken:

(a) Provision of a Capping Layer

A capping layer shall be placed immediately above the high swell or expansive subgrade material for the full formation width to protect it from moisture variations.

The capping layer shall be a Type A material as per Section 204 of VicRoads[A2]. The capping material shall have a swell ≤ 1.5% determined in accordance with VicRoads Code of Practice RC 500.20[A3].

Lime stabilised material meeting the requirements of Type A Capping Layer and Section 7.2.2 of this Code may be used as a capping layer. Cementitiously stabilised materials shall not be used as capping layer.

Unless otherwise specified, the minimum thickness of the capping layer shall be the greater of 150 mm or 2.5 times the maximum particle size of the capping material.

The width of the capping layer shall extend to the edge of the embankment or, in the case of cuttings, a distance ≥ 1.5 m behind the back of kerb and channel or edge of pavement.

Any separately constructed Shared Footway/Bicycle Path shall have a capping layer over any expansive insitu or fill material to provide a minimum cover of 400 mm of pavement and capping material. The thickness of capping layer shall be ≥ 150 mm.

(b) Location of Subsurface Pavement Drains

Subsurface pavement drains shall be designed to function wholly within the capping layer. No part of the subsurface drainage trench shall be located within 150 mm of the expansive material. The capping layer may be thickened in the vicinity of the subsurface pavement drain to satisfy this requirement.

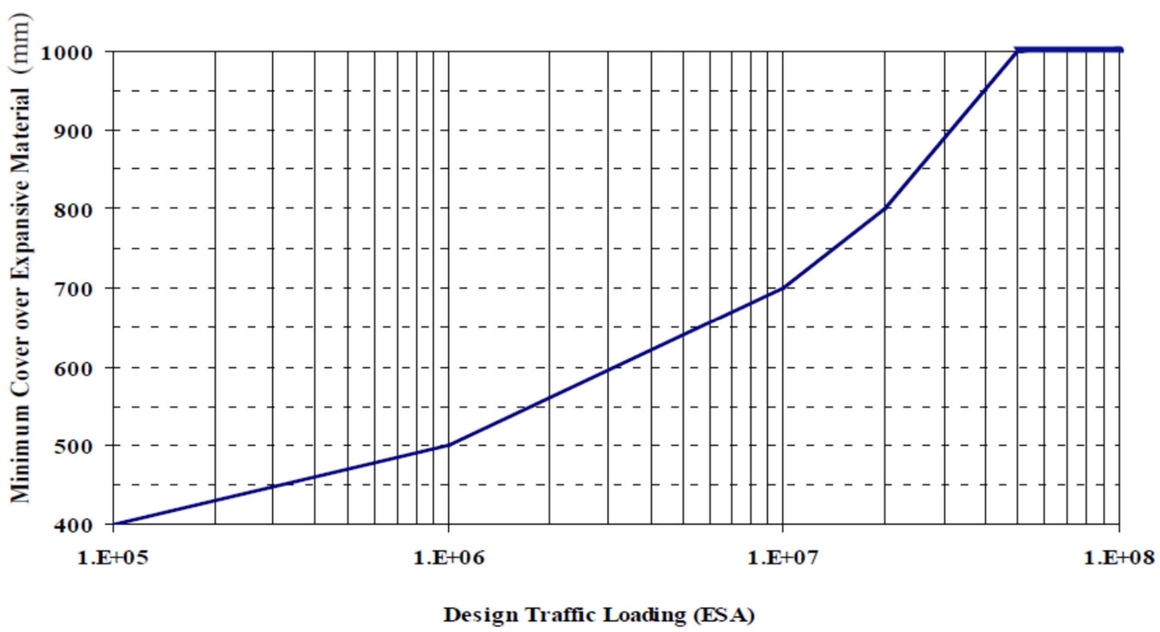
(c) Landscape Design

Trees and large shrubs can draw moisture via their root systems resulting in the removal of soil water. The effect on expansive material can be significant and lead to localised drying resulting in shrinkage and cracking. Pavement shape loss and cracking can result.

The selection and planting of trees and shrubs shall be undertaken such that the performance of the pavement is not adversely affected.

Guidance on landscaping and planting of trees and shrubs is provided in VicRoads[A6].

Figure 5.1 – Minimum Cover over Expansive Material



6. Subsurface Pavement Drains

6.1. General

The design and location of subsurface pavement drains or filter blankets shall be carried out in accordance with the requirements of Austroads[B6].

Details of subsurface pavement drains to be used are shown on Standard Drawing SD 1601 VicRoads[A5].

Filter material meeting the requirements of Section 702 of VicRoads[A2] shall be used.

6.2. Types of Subsurface Pavement Drains

Unless otherwise specified or shown on the drawings, the type of subsurface drain shall be selected in accordance with Table 6.1.

Materials with Emerson Class Numbers of E2 or E1 are considered dispersive. The design of subsurface drains in dispersive material requires careful consideration. Where subsurface drains are proposed to be located in materials with Emerson Class Numbers of E2 or E1, the dispersive material requires treatment such that it becomes non-dispersive.

6.3. Subsurface Pavement Drains placed Beneath Pavements

Subsurface pavement drains placed immediately under or within the trafficked pavement shall be a Type 2 subsurface pavement drain with a Grade B4 no-fines concrete filter material.

No-fines concrete filter material shall meet the requirements of Section 702 of VicRoads[A2]. If a Type 4 subsurface pavement drain is used in lieu of a Type 2 drain, Grade A2 or A3 filter sand shall be used up to a level of 50 mm above the top of the geocomposite drain. Filter sand shall be watered in by fully saturating the material after placement to ensure that it completely surrounds the drain.

6.4. Drainage Blanket

A drainage blanket shall only be considered as a structural layer when the drainage blanket is placed on material which has passed test rolling in accordance with VicRoads[A2].

Unless otherwise specified, a drainage blanket forming a lower subbase of the pavement or as a separate layer beneath the pavement or embankment shall conform to the following requirements:

- Consist of a geotextile first stage filter, placed at the top and bottom of the drainage blanket, and a Grade B4 granular filter material as a second stage filter;
- The geotextile shall consist of a separation/filtration, very robust, non-woven geotextile as specified in Section 210 of VicRoads[A2], with an equivalent opening size and minimum elongation as specified in Section 702 of VicRoads[A2];
- Have a minimum thickness of 300 mm unless otherwise specified; and
- Have a design vertical modulus value at the top of the layer not exceeding 150 MPa and shall be sublayered in accordance with the Section 8.2.3 Austroads[B1] sublayering procedure with a Poisson's Ratio value of 0.35 and degree of anisotropy of 2.

.

Table 6.1 Selection of Type of Subsurface Drain & Filter Type

Sugrade Type	Permeability Range m/sec	Type of Pavement Drain (SD 1601)	Grades of Granular Filter Material
Homogenous clay with very low permeability	$< 10^{-9}$	Type 3 or Type 4	Sand (Grade A2 or A3)
Silty or sandy clays and stratified clays with moderately low permeability	10^{-9} to 10^{-5}	Type 2, Type 3 or Type 4	Sand (Grade A4 to A6)
Clean sand or gravel with high permeability	$> 10^{-5}$	Type 1 or Type 2	Aggregate (Grade B1 or B2)
Solid rock or clean broken rock with high permeability or permeable fissures	Not applicable	Type 1	Aggregate (Grade B3 or B4)

7. Earthworks Layers at or below Subgrade Level

7.1. Design CBR

If the Design CBR, for the undisturbed insitu material and/or Type A and/or Type B earthworks layers used at or below subgrade level are not specified, the Design CBR for each earthworks layer shall be determined from the following information:

- The Assigned CBR of earthworks material intended to be used at or below subgrade level as specified or in accordance with the procedures described in VicRoads Codes of Practice RC 500.20[A3], RC 500.23 [A3] and RC301.04[A4];
- Information given in the geotechnical Site Conditions Investigation report;
- Additional post tender site conditions investigation information such as insitu CBR tests and material properties;
- Past construction experience in the use of the material and past performance of pavements constructed over similar earthworks materials and subgrade;
- Consideration of improvements to drainage and location of subgrade level.

The Design CBR Value given to a Type A or Type B earthworks layer, or the insitu material at or below subgrade level shall be as follows unless otherwise specified or stated:

- ≤ 10% for any Freeway or National Arterial - Highway or any other road with a DESA > 1.0×10^6 ESA;
- ≤ 15% for any other road with a DESA ≤ 1.0×10^6 ESA.

For Type A material, the Design CBR Value shall be ≤ Assigned CBR.

7.2. Design of Flexible Pavements with One or More Bound Layers

7.2.1. General

The Austroads[B1] mechanistic - empirical pavement design procedure shall be used for the design of pavements comprising one or more bound layers.

Earthwork materials excluding Type A and Type B material at or below subgrade level shall be given a vertical modulus of up to 10 times the Design CBR value.

The limiting subgrade strain criterion is given in Section 5.8 of Austroads [B1] and shall be used for predicting the number of repetitions of a Standard Axle before an unacceptable level of permanent deformation develops.

A Poisson's Ratio value of 0.45 shall be used for all materials at or below subgrade level, including Type A fill.

For pavement designs undertaken using the mechanistic - empirical procedure, Type A and Type B fill shall be sublayered in accordance with Section 8.2.2 of Austroads [B1].

For the design of granular pavements with thin bituminous surfacing using empirical procedures i.e. Appendix F, Type A and Type B fill shall be sublayered in accordance with Section 8.3 of Austroads [B1].

The modulus values determined for the Type A and Type B sublayers shall be ≤ 10 times the Assigned CBR for the material.

7.2.2. Lime Stabilisation

Lime stabilisation may be used to improve the strength and/or reduce the swell potential of clay at or below subgrade level. The depth of stabilisation shall be ≥ 150 mm.

Lime stabilised material shall be sublayered in accordance with Section 7.2.1. The modulus values determined for the lime stabilised material sublayers shall be ≤ 10 times the Assigned CBR for the material.

The lime stabilised material shall only be considered a structural layer where the design distribution rate of Available Lime to be added to the material to be stabilised and the Assignment of CBR and Percent Swell of the lime stabilised material have been determined in accordance with VicRoads Codes of Practice RC 500.23[A3] and RC 301.04[A4].

8. Design Traffic

8.1. Design Period

Where the Design Traffic has not been specified or stated, Table 8.1 shall be used to define the pavement design period for determination of the Design Traffic for new pavements.

Table 8.1 Pavement Design Periods

Road Type / Classification	Design Period* (Years)
Urban Roads	
Freeways & Arterials (Highways only) National Road Network including ramps	30
All other roads	20
Rural Roads	
Freeways & National Road Network / Class M including ramps	30
All other roads / Class A, B & C	20

*Notes to Table 8.1: * Where the Design Period corresponding to the road type and classification differ, the higher design period shall be used.*

8.2. Traffic Data

The Design Traffic may be based on traffic predictions in the case of new road alignments or on actual traffic or a vehicle classification count at or near the site. If not specified or provided, the traffic load distribution shall be obtained from a Weigh in Motion site on the same road or on a road carrying a similar traffic load distribution. If Weigh in Motion data is not available or specified, data as provided in Appendix B for the appropriate road class shall be used. The traffic load distribution providing the highest ESA per heavy vehicle for the range provided in Table B4 shall be used.

8.3. Unbound Flexible Pavements

Unless otherwise specified or stated, the DTL (DESA) used for the design of unbound flexible pavements shall be determined in accordance with the procedures set down in Austroads[B1] and the data provided in Appendix B of this Code.

8.4. Bound Flexible Pavements

Unless otherwise specified or stated, pavements with one or more bound layers (asphalt or cementitiously treated layers) shall be designed for the Design Traffic as described in Austroads [B1], particularly Section 7.6.

8.5. Rigid Pavements

Unless otherwise specified or stated, rigid pavements shall be designed for the Design Traffic as determined in accordance with Austroads[B1], particularly Section 7.7.

8.6. Project Reliability Levels

The Project Reliability level shall be determined from Table 8.2 unless otherwise specified or stated.

Table 8.2 – Project Reliability Levels

Road Type / Classification	Project Reliability * %
Urban Roads	
Freeways / National Road Network including ramps	97.5
Arterials / Highways	95
All other roads	90
Rural Roads	
Freeways & National Road Network / Class M including ramps	97.5
Class A & B	95
Class C & all other roads	90

*Notes to Table 8.2: * Where the Project Reliability for the road type and classification differ, the higher Project Reliability shall be used.*

.

9. Bituminous Surfacing

9.1. General

If the type of surfacing is not specified, Austroads[B3] shall be used to select a suitable road surfacing to meet the specification requirements.

The traffic volume for design of sprayed sealed surfacing shall be determined from predicted or actual traffic counts.

The surfacing selected for roads with a posted speed limit greater than 80 km/h and with more than 1000 vehicles per day (2-way) shall provide a minimum initial sand patch surface texture, for long term surfacing treatments, of 1.2 mm. Typically Size 10 Stone Mastic Asphalt, Open Graded Asphalt and appropriately sized sprayed seals will meet this requirement.

9.2. Sprayed Seal Treatments

9.2.1. Selection & Design

Unless otherwise specified, sprayed seal treatments shall be designed in accordance with Austroads [B2] with the following exceptions or additions:

(a) The Class of aggregate shall be selected in accordance with Section 831 Guide Notes to VicRoads Standard Specification[A2];

(b) VicRoads Test Method RC 317.01[A4] may be used to measure surface texture to determine binder allowances for surface texture in lieu of the Austroads method of measuring surface texture;

(c) Primed surfaces on granular pavements shall be cured prior to applying the final surfacing in accordance with Austroads [B2];

(d) All concrete bridge decks and concrete pavements to be surfaced with asphalt or a sprayed seal treatment shall be primed first with very light cut-back bitumen primer in accordance with Section 408 of VicRoads[A2] at an application rate of between 0.2 - 0.3 l/m^2, depending on the surface texture and finish of the concrete surface. The primer shall be allowed to cure prior to application of the final surfacing. If the use of a proprietary grade of bitumen emulsion primer in lieu of very light cut-back bitumen primer is approved for use, the rate of application of bitumen emulsion shall be such as to deliver an application rate of residual binder of 0.1 - 0.15 l/m^2 to the surface;

(e) A cutback bitumen initial seal shall be cured for a minimum of 6 months with a minimum exposure of 3 months over the period from November to March, before retreating with a sprayed seal or an asphalt surfacing less than 100 mm thick;

(f) Polymer Modified Binder (PMB) shall be selected in accordance with Austroads [B4] unless otherwise specified;

(g) Appendix C may be used as a guide for proposing prime, initial seal and sprayed seal treatments in cases where initial treatments are to be applied on pavements constructed clear of traffic.

9.2.2. Environmental Considerations

Unless approved by the Superintendent, priming shall not be proposed as part of a surfacing treatment on pavements where the prime would be required to be applied from April to September inclusive, except for very light priming of concrete surfaces as specified in Section 9.2.1(d).

9.3. Asphalt Surfacing

The type of dense graded asphalt wearing course, where permitted for use, shall be selected in accordance with Appendix D unless otherwise specified. Other types of asphalt surfacing may be selected in accordance with Austroads[B3] unless otherwise specified.

All asphalt mixes shall be designed in accordance with relevant VicRoads Test Methods[A4] and VicRoads Codes of Practice[A3] and shall meet the mix design requirements specified in VicRoads[A2].

If asphalt surfacing is proposed which is not included in Appendix D, the following shall apply:

(a) For Deep Strength Asphalt or Full Depth Asphalt pavements, Open Graded Asphalt (OGA) surfacing shall be considered as a non-structural layer;

(b) Stone Mastic Asphalt (SMA), other PMB asphalt or other special mixes may be used as an alternative wearing course to those listed in Appendix D. This is provided that tests are undertaken for modulus (Indirect Tensile Test[A3] in accordance with AS 2891.13.1) and deformation (Wheel Track Test[B5]). The results of these tests shall conclusively demonstrate that the alternative wearing course has equal or superior functional performance and that the relative difference in modulus has been allowed for in the determination of the structural thickness of the asphalt pavement. The number of tests undertaken shall be agreed to by the Superintendent;

(c) For thin asphalt wearing courses over granular pavements, the requirements of Section 10.2 shall be met;

(d) If an alternative asphalt surfacing is proposed for a granular pavement which is not described in Section 10.2, laboratory tests for deformation and fatigue shall be undertaken. The results of these tests shall conclusively show that the alternative asphalt has equivalent or better resistance to deformation (Wheel Track Test[B5]) and fatigue (Repeated Flexural Bending Test[B5]) than the designated asphalt surfacing type. The number of tests undertaken shall be agreed to by the Superintendent.

.

10. Unbound Flexible Pavements

10.1. Unbound Flexible Pavements with Sprayed Seal Surfacing

10.1.1. DESA < 1.0 x 10^5 ESA

For unbound flexible pavements with a DESA < 1.0 x 10^5 ESA, Section 12 of Austroads[B1] shall be used.

A minimum layer of 100 mm of Class 2 crushed rock base shall be provided regardless of traffic loadings. Use of alternative natural gravel or ripped rock base material shall be subject to approval by the Superintendent and compliance with the requirements of Section 10.1.3 of this Code.

The minimum cover over cementitiously treated material shall be as described in Section 11.1.

10.1.2. DESA ≥ 1.0 x 10^5 ESA

All unbound flexible pavements shall be designed to meet the structural requirements of Appendix F and Table 10.1.

Table 10.1 Minimum Assigned CBR For Granular Base for DESA < 7.0 x 10^6 ESA

Pavement Layer	Rainfall (mm/year)	Min 4 Day Soaked CBR	
		1.0 x 10^5 to < 1.0 x 10^6 ESA	1.0 x 10^6 to 7.0 x 10^6 ESA
Top 100 mm Base	< 500	60	80
	500 – 1000	80	120
	> 1000 *	100	**
Remainder of Base	< 500	60	60
	500 – 1000	80	80
	> 1000 *	100	100

Notes for Table 10.1

* *For areas above the snow line, open graded pavement materials should be used to reduce frost damage*

** *Class 2 crushed rock or better.*

All materials should have a history of good performance for the proposed design traffic and environment.

Refer to Appendix A or the Australian Government Bureau of Meteorology web site at www.bom.gov.au for rainfall information.

For a DESA ≥ 1.0 x 10^7 ESA, the lower subbase layer shall comprise a minimum of 100 mm of Class 4 crushed rock or Class CC4 crushed concrete. The Class CC4 shall meet the permeability requirement specified for Class 4 crushed rock.

Granular pavement layer design thickness shall be rounded up to the nearest 10 mm.

The total pavement thickness shall exclude sprayed seals, Strain Alleviating Membrane Interlayers (SAMI), thin asphalt and/or their combination.

10.1.3. CBR & Percentage Swell of Alternative Natural Pavement Materials

Where it is proposed to use a naturally occurring gravel, sand or ripped rock pavement material under Section 811 VicRoads[A2], the procedures set out in VicRoads Code of Practice RC 500.20[A3] shall be followed to show that the Assigned CBR and percentage swell meet the specified requirements.

10.2. Unbound Flexible Pavements with Asphalt Surfacing

10.2.1. General

Asphalt surfacing ≤ 40 mm thick over an unbound flexible pavement shall not be considered as providing any structural contribution to the pavement in terms of total thickness of pavement material. The requirements of Section 9.1 shall apply to the design of all granular flexible pavements with thin asphalt surfacing.

Asphalt thicknesses shall be rounded up to the nearest 5 mm.

All unbound flexible pavements shall be designed to meet the structural requirements of Appendix F and Section 10.1.

The minimum cover over cementitiously treated material shall be as required in Section 11.1.

10.2.2. DESA < 1.0 x 10^6 ESA

A 30 mm thick layer of Size 10 mm asphalt shall be selected in accordance with Section 9.3(e) and Appendix D unless otherwise specified. The prepared pavement surface shall be first treated with a Size 7 mm bitumen emulsion initial seal (not exceeding 60% bitumen content) at a minimum rate of application of residual binder of 0.9 l/m^2.

10.2.3. 1.0 x 10^6 ESA ≤ DESA ≤ 3.0 x10^6 ESA

Section 10.2.2 requirement shall apply, except that the asphalt surfacing shall comprise a 30 mm layer of Size 10 mm Type HP asphalt with a Class A10E PMB meeting the requirements of Austroads[B4] or 35mm Size 10 mm SMAN or SMAH as appropriate.

10.2.4. DESA > 3.0 x 10^6 ESA

Refer Specification or contract design brief if a thin asphalt surfaced unbound flexible pavement type is permitted.

11. Asphalt Pavements

11.1. General

The design of Deep Strength and Full Depth Asphalt pavements shall be based on the mechanistic - empirical design procedures in accordance with Austroads [B1] and this Code.

The pavement response to load shall be calculated using a linear elastic model, such as that provided by the computer programs CIRCLY[C3] and AustPADS[C4]. The program must be able to model anisotropic materials. Regardless of the model used during the design process, final design strains shall be those determined by CIRCLY[C3].

The pavement response to loading as shown in Figure 8.2 of Austroads [B1] shall be determined.

Critical locations in the pavement for the calculation of strains resulting from an axle with:

- dual tyres, shall be on vertical axes through the centre of an inner tyre load and through the point midway between the two tyre loads;
- single tyres, on a vertical axis through the centre of the tyre.

The Weighted Mean Annual Pavement Temperature for Melbourne shall be 24^{0} C unless otherwise specified.

The pavement design shall be based on the traffic lane with the highest Design Traffic and this design shall be applied across the full carriageway width including shoulders.

The assessment of the pavement in terms of asphalt and cemented material fatigue shall be undertaken in accordance with Section 8.2 of Austroads[B1]. The pavement (prior to the addition of construction tolerances) must have a total damage less than or equal to 1.0 for any asphalt or cemented material within the pavement.

Unless otherwise specified or stated, the thickness of dense graded asphalt (including SMA) and/or unbound granular material to be placed over cementitiously treated material shall be ≥ 175 mm and determined in accordance with Austroads [B1] as follows:

Thickness =
(0.75 x thickness unbound granular material overlying cementitiously treated material)
+
(design thickness of dense graded asphalt including SMA)

OGA for the purpose of pavement design shall be considered as non - structural.

The design thickness of each asphalt layer shall be rounded up to the nearest 5 mm.

11.2. Granular Subbase

Full Depth Asphalt pavements shall include a subbase comprising a 150 mm (minimum) layer of Class 4 crushed rock placed immediately below the basecourse asphalt.

For Deep Strength Asphalt pavements 150 mm (minimum) of Class 4 crushed rock or 150 mm (minimum) of Type A material with an Assigned CBR ≥ 10%, shall be included immediately below the cementitiously treated subbase (CTS) where the design modulus for the CTS is:

- > 500 MPa; or
- ≤ 500 MPa and is proposed for major works e.g. new carriageways or for the addition of lane(s) over a significant length located on roads with a DESA ≥ 7.0 x 10^{6} ESA.

Class CC4 crushed concrete meeting the requirements of Section 820 of VicRoads[A2] and the specified permeability requirements of Class 4 crushed rock can be used in lieu of Class 4 crushed rock.

Granular material is defined as material meeting the requirements of Class 1, 2, 3 or 4 crushed rock in accordance with VicRoads[A2]. Granular material proposed as an upper or lower subbase for either a Deep Strength or Full Depth Asphalt pavement shall consist of Class 4 crushed rock or better. The following shall apply:

(a) If Class 1 or 2 crushed rock is proposed as a lower subbase layer, the design vertical resilient modulus value at the top of the layer shall not exceed those described in Table 6.5 of Austroads[B1];

(b) If Class 3 crushed rock is proposed as a lower subbase layer, the design vertical resilient modulus value at the top of the layer shall not exceed those described in Table 6.4 of Austroads[B1];

(c) If Class 4 crushed rock is proposed as a lower subbase layer the design vertical modulus value in the vertical direction at the top of the layer shall not exceed 150 MPa;

(d) Crushed rock shall be sublayered in accordance with the Section 8.2.3 Austroads[B1] sublayering procedure;

(e) A Poisson's Ratio value of 0.35 shall be used for all granular material. Granular materials shall be considered as anisotropic with a degree of anisotropy of 2.

Subject to approval by the Superintendent, some naturally occurring gravel pavement materials may be considered as a granular material for use as lower subbase in lieu of crushed rock. However the maximum design vertical resilient modulus value at the top of a gravel layer shall be ≤ 150 MPa.

11.3. Asphalt

11.3.1. Selection of Asphalt Types & Layer Thickness

Dense graded asphalt types shall be selected in accordance with Appendix D.

Dense graded asphalt layer thickness shall meet the requirements of Appendix D.

The uppermost layer of dense graded asphalt or SMA (refer Section 9.3) designed to match the design pavement surface level (excluding OGA) shall conform to the requirements of a wearing course selected to suit the predicted traffic volume, regardless of whether the pavement is to be surfaced with OGA.

Where Size 10 mm SMA is used, the design thickness shall be 35 mm.

Where Open Graded Asphalt is used, the design thickness shall be 30 mm.

Where Type SF asphalt is proposed, the thickness of the Type SF asphalt layer shall be ≥ 75 mm and the cover of dense graded structural asphalt (including SMA) over the Type SF layer shall be ≥ 100 mm. Type SF is required to cool (cure) in accordance with Section 407 of VicRoads[A2] prior to the placement of further asphalt layers.

High Modulus Asphalt (EME2) shall have a design thickness of 70 mm to 130 mm. It shall not be used as a wearing course.

11.3.2. Asphalt Pavement Design Criteria

Asphalt design modulus (E) values and fatigue (K) values shall be assigned in accordance with Appendix E for the types of asphalt proposed.

The pavement design speed used to select asphalt moduli values shall be in accordance with Table 11.1.

The designated speed limit is either the posted speed limit on the existing road or the proposed speed limit for a new road.

The asphalt fatigue relationship given in Section 6.5.10 of Austroads[B1] shall be used for predicting the number of repetitions of the load induced strain.

The Reliability Factor (RF) shall be as described in Table 6.16 of Austroads[B1] for the desired project reliability specified. Where not specified, the desired project reliability shall be determined from Table 8.2 of this Code.

A Shift Factor (SF) of 6 as described in Section 6.5.10 of Austroads[B1] shall be used.

All asphalt shall be assigned a Poisson's Ratio of 0.4 and shall be considered isotropic.

Table 11.1 Pavement Design Speed

Designated Speed Limit (V) (km/h)	Pavement Design Speed (km/h)
V ≥ 100	80
60 < V < 100	60
40 < V ≤ 60	40
Signalised Intersections / Roundabouts / V ≤ 40	10

11.4. Cementitiously Treated Subbase

11.4.1. Characterisation for Pavement Design

The modulus assigned to Cementitiously Treated Subbase (CTS) shall be either 500 MPa or less, 2,000 MPa or 3,500 MPa unless approved otherwise by the Superintendent.

Where a design modulus value for the cemented material of greater than 500 MPa is proposed, the design modulus and design flexural strength shall be determined in accordance with Sections 6.4.3 and 6.4.4 of Austroads[B1]. The in-service fatigue characteristics of the cemented material shall be determined in accordance with Sections 6.4.6 or 6.4.7 of Austroads[B1].

Testing of specimens shall be undertaken in accordance with Section 6.4 of Austroads[B1] and referenced documents. Test specimens shall be prepared at the minimum density ratio permitted under VicRoads[A2] Section 306.

The number of tests undertaken to determine design modulus and design flexural strength shall be sufficient to provide a statistically significant value to limit the 95% confidence limits about the mean modulus and flexural strength to 10% of the mean values.

The number of fatigue results shall be sufficient to achieve a representative and statistically significant value for the mean strain with a fatigue life of 10^5 load repetitions.

The determination of in-service fatigue characteristics using presumptive values is not permitted.

The design modulus assigned to the CTS will also depend on whether the construction requirements specified in Section 306 of VicRoads[A2] can be met. The provisions of Section 306 limits the values of assigned modulus depending on the site conditions, methods of curing, protecting the layer from moisture and traffic. Load restrictions may also apply. The thickness of CTS for modulus design values of 2,000 MPa and 3,500 MPa shall not be less than that shown in Figure 11.1.

In assigning a modulus to the CTS, the likely site conditions and protective methods permitted to be used at the time of construction must be allowed for.

A Shift Factor (SF) of 1.55 as described in Section 6.4.6 of Austroads[B1] shall be used.

The Reliability Factor (RF) shall be as described in Table 6.8 of Austroads[B1] for the desired project reliability specified. Where not specified, the desired project reliability shall be determined from Table 8.2 of this Code.

CTS shall consist of cementitiously treated crushed rock or cementitiously treated crushed concrete meeting the requirements of Section 815 and Section 821 of VicRoads[A2] respectively, unless otherwise specified.

Cemented materials in the post–fatigue phase shall be modelled in accordance with Austroads[B1] with a vertical modulus of 500 MPa, Poisson's Ratio of 0.35 and be considered as cross-anisotropic with a degree of anisotropy of 2. Sublayering of this material is not required. CTS with a design modulus of ≤ 500 MPa shall be considered as having no fatigue life and shall be modelled as CTS in the post-fatigue phase.

The total thickness of CTS shall be between 100 and 180 mm and shall be placed in a single layer. For narrow pavement widening (less than 3 m width), the CTS thickness shall not exceed 150 mm.

The CTS layer design thickness shall be rounded up to the nearest 10 mm.

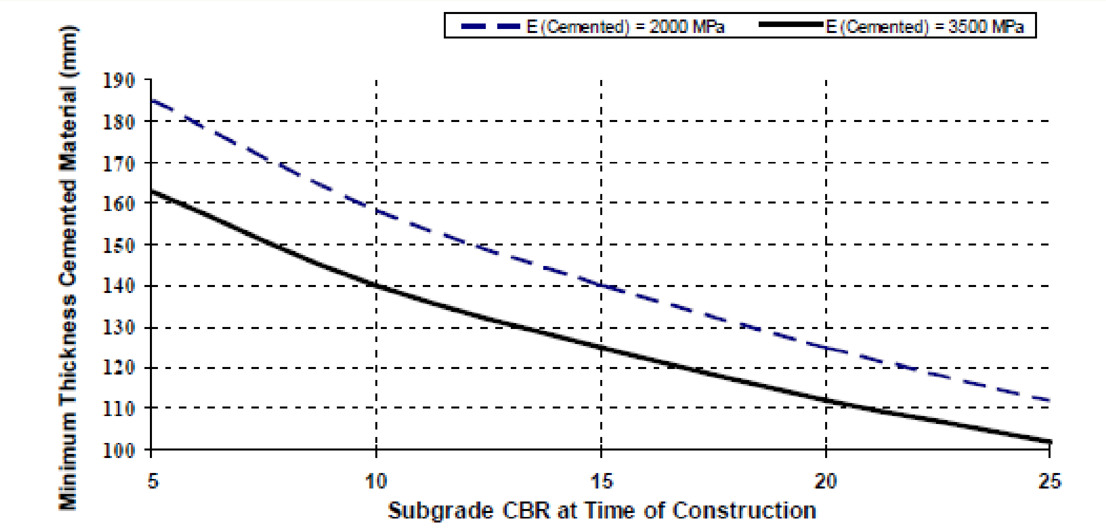
11.4.2. Protection of CTS

Where Section 306 of VicRoads[A2] requires an initial seal to be applied to the surface of the CTS, the rate of application of a medium primer binder shall be such that the residual binder shall range between 0.9 and 1.1 l/m^2 depending on absorption characteristics of the CTS. If the Superintendent permits the use of a prime to protect the CTS, the minimum rate of application of a light primer shall be such that the residual binder shall range between 0.3 and 0.5 l/m^2, depending on the absorption characteristics of the CTS.

11.5. Design Thickness

The structural thickness determined in accordance with Section 11.1 shall be increased by adding a further 15 mm to the thickness of the intermediate asphalt layer, or for pavement compositions without an intermediate asphalt layer to the total asphalt thickness. This adjusted thickness of pavement is referred to as the Design Thickness and shall be rounded up to the nearest 5 mm.

Figure 11.1 Minimum Thicknesses of Cemented Materials to Avoid Fatigue Damage During Construction



12. Rigid Pavements

12.1. General

The thickness of the base and subbase shall be designed in accordance with Section 9 of Austroads[B1]. The minimum characteristic design concrete flexural strength for concrete pavements with a Design Traffic ≥ 1 x 10^6 HVAG shall be 4.5 MPa at 28 days, except for Steel Reinforced Concrete Pavements where it shall be 5.5 MPa.

The detailed design shall meet all the relevant functional requirements for the particular type of rigid pavement to be constructed as required by RMS NSW[C1]. Jointing and reinforcement requirements shall be consistent with RMS NSW practice.

Concrete pavements for roundabouts shall be designed in accordance with RTA NSW[C2].

A continuously reinforced concrete pavement shall be provided if the pavement is to be surfaced with asphalt.

The Load Safety Factor (LSF) shall be as described in Table 9.2 of Austroads[B1] for the desired project reliability specified. Where not specified, the desired project reliability shall be determined from Table 8.2 of this Code.

Pavement layer and design thicknesses shall be rounded up to the nearest 5 mm.

12.2. Base

12.2.1. Minimum Thickness

Regardless of the structural thickness produced by application of Section 9 of Austroads[B1], the minimum thickness of concrete base shall not be less than specified in Table 9.7 of Austroads[B1].

12.2.2. Structural Edge Support To Base

Where the requirements of Section 9.3.5 of Austroads[B1] are met, concrete shoulders or integrally cast kerb and channel may be designed to provide structural edge support so that the thickness reduction for the concrete base can be applied. The reduced base thickness shall not be less than the minimum thickness specified in Table 9.7 of Austroads[B1].

Extruded kerb and channel shall not be considered as providing structural edge support to the concrete base.

Tie bars shall be installed between the concrete base and the kerb and channel in accordance with the requirements of the RMS NSW[C1].

12.3. Subbase and Type A Fill Requirements

On roads with a Design Traffic ≥ 1.0 x 10^7 HVAG, a 150 mm (minimum) thick layer of Class 4 crushed rock or CC4 crushed concrete is required immediately above subgrade level. This layer may be considered in the calculation of Effective Subgrade CBR, as defined in Austroads[B1].

On other roads, the top 150 mm of material directly below subgrade level shall have a minimum Assigned CBR ≥ 10% as determined in accordance Section 7.1 of this Code.

Lime stabilisation may be used to improve the strength and/or reduce the swell potential of clay at or below subgrade level. The depth of stabilisation shall be ≥ 150 mm.

The lime stabilised material shall only be considered a structural layer where the design distribution rate of Available Lime to be added to the material to be lime stabilised and the Assignment of CBR and Percent Swell of the lime stabilised material have been determined in accordance with VicRoads Code of Practice RC 500.23[A3] and RC301.04[A4].

The minimum subbase requirements for rigid pavements shall be in accordance with Table 9.1 of Austroads[B1].

All CTS shall be constructed in accordance with Section 306 of VicRoads[A2] except that the minimum cementitious binder content shall be 5% by mass. The minimum strength requirements specified in Section 306 of VicRoads[A2] shall not apply for subbases for rigid pavements.

The thickness of any debonding layer shall not be considered as part of the Design Thickness of the subbase or base.

The design of edge drainage combined with subsurface drainage shall ensure that the interface between the base and the fully bound or lean mix concrete subbase or CTS is adequately drained.

12.4. Design Thickness

The base thickness determined in accordance with Section 12.2 shall be increased by a further 15 mm and rounded up to the nearest 5 mm. This adjusted thickness, including subbase thickness, is referred to as the Design Thickness.

12.5. Debonding of Subbase to Base

(a) Lean Mix Concrete Subbase

Lean Mix Concrete shall be constructed in accordance with Section 503 of VicRoads[A2].

Curing compound shall be applied to the surface of a lean mix concrete subbase in accordance with Section 503 of VicRoads[A2]. In addition, a Size 7 mm bituminous primerseal shall be applied over the entire lean mix concrete subbase with a residual binder rate of ≥ 1.0 l/m^2.

(b) Fully Bound Cementitiously Treated Subbase

A Size 7 mm initial seal shall be applied over the entire cementitiously treated subbase at a rate of application of medium primerbinder necessary to produce a residual binder rate of ≥ 1.0 l/m^2. The surface shall be kept moist at all times until the initial seal is applied.

12.6. Jointing

The design layout of all pavement joints shall be carried out in accordance with the RMS NSW[C1], and the VicRoads Supplement [A5] except for the following:

(a) The spacing of transverse contraction joints for a plain jointed concrete pavement shall be ≤ 4.2 m. Slabs with dowelled transverse contraction joints shall have a maximum spacing of 4.5 m;

(b) For Jointed Reinforced Concrete Pavement (JRCP), spacing of dowelled transverse contraction joints shall be ≤ 8 m. Joints shall be normal to the centerline;

(c) A skew of 1 in 10 shall be adopted for all transverse contraction joints (excluding JRCP contraction joints) across main carriageways where the posted speed limit is 80 km/h or more unless otherwise specified;

(d) In isolated locations where a joint skew of less than 85° from the longitudinal cannot be avoided, steel fibre or lightly reinforced concrete shall be used;

(e) Tie bars inserted across longitudinal joints shall not be placed within 500 mm of any transverse joint.

Further guidance can be sought from Section 4.5 of RMS NSW *Guide to QA Specifications R83 and R84*.

12.7. Asphalt Surfacing of Continuously Reinforced Concrete Pavements

Where asphalt surfacing, including OGA, is to be applied to a continuously reinforced concrete pavement, the design shall provide for the following:

(a) The concrete base pavement shall be moist cured or cured by the application of an approved hydrocarbon resin based curing compound prior to bituminous surfacing;

(b) The surface of the base shall be primed as specified in Section 9.2.1 (d);

(c) After the prime has fully cured, a SAMI shall be applied to the primed concrete surface. The SAMI shall consist of a Grade S25E PMB meeting the requirements of Austroads[B4] applied at the rate of 2.0 l/m^2. For intersections and high stress locations a lower application rate may be required. The binder shall be lightly covered with a Size 10 bitumen pre-coated aggregate meeting the requirements of Section 831 of VicRoads[A2];

(d) A Grade A10E PMB shall be used in asphalt surfacing. The PMB shall comply with Austroads[B4].

13. Design of Shoulders

All shoulders with bituminous or concrete surfacing shall consist of the same pavement composition as the adjacent traffic lanes unless otherwise specified or stated.

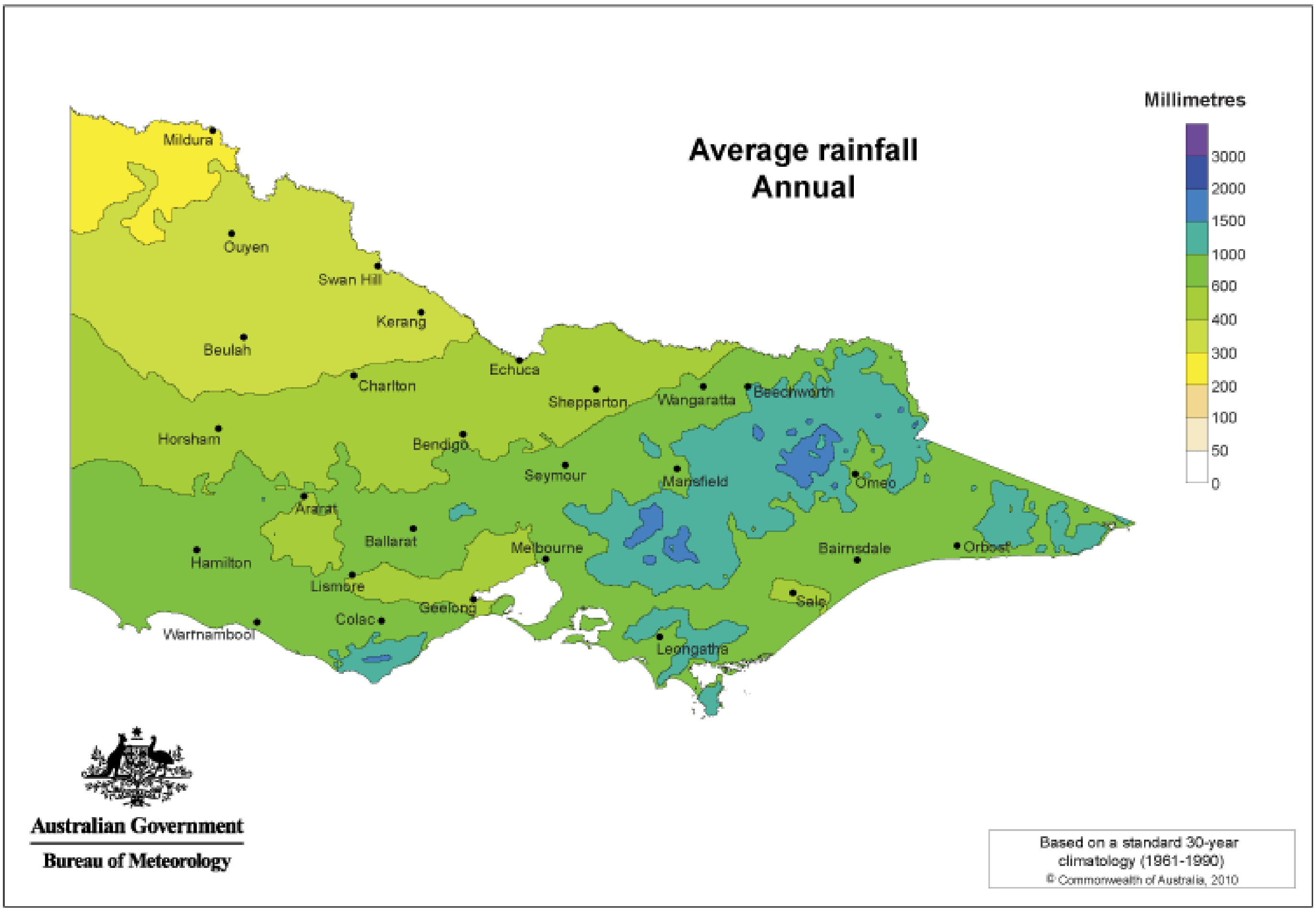
14. Asphalt Surfaced Bridge Decks

Where SMA or OGA surfacing is required, provision shall be made for regulation of the bridge deck with a minimum 30 mm of Size 10 mm Type H dense graded asphalt prior to the placement of the surfacing.

Where dense graded asphalt surfacing is required, the minimum total asphalt thickness shall be 40 mm. Selection of the asphalt type shall be in accordance with Appendix D.

The bridge deck shall be prepared in accordance with the requirements of Section 9.2.1 (d) prior to the placement of asphalt.

Appendix A - Average Annual Rainfall of Victoria



Appendix B - Traffic Characteristics Information

Traffic characteristics information was derived from 2013 – 2016 Victoria weigh-in-motion data.

It is provided for use where site specific design traffic parameters have not been specified or stated.

Table B1 – Average Number of Axle Groups per Heavy Vehicle by Road Class

Road Class	Average Number of Axle Groups per Heavy Vehicle (N_{HVAG})
Rural National Roads - Highways and Freeways	3.2
Rural Arterial - Highways & Other Arterial Roads	2.8
Urban Arterial - Highway & Other Arterial Roads	2.5
Urban Freeway	2.7

Table B2 – Average ESA per Axle Group Type by Road Class

Road Class	Axle Group Type					
	SAST	TAST	SADT	TADT	TRDT	QADT
Rural National Roads - Highways and Freeways	1.03	1.31	0.27	0.73	0.64	1.21
Rural Arterial - Highways & Other Arterial Roads	0.62	1.09	0.23	0.59	0.58	0.75
Urban Arterial - Highways & Other Arterial Roads	0.71	1.35	0.25	0.65	0.49	0.93
Urban Freeways	0.90	1.29	0.27	0.62	0.54	0.81

Table B3 - Average ESA per Heavy Vehicle Axle Group by Road Class

Road Class	Average ESA per Heavy Vehicle Axle Group
Rural National Roads - Highway and Freeways	0.7 – 1.0
Rural Arterial - Highways & Other Arterial Roads	0.5 – 0.9
Urban Arterial - Highways & Other Arterial Roads	0.4 – 0.8
Urban Freeways	0.5 – 1.2

Table B4 - Average Number of ESA per Heavy Vehicle by Road Class

Road Class	Average ESA per Heavy Vehicle
Rural National Roads - Highways and Freeways	2.2 - 3.4
Rural Arterial - Highways & Other Arterial Roads	1.3 - 2.4
Urban Arterial - Highways & Other Arterial Roads	1.1 – 2.1
Urban Freeways	1.3 – 3.1

Table B5 – Summary of Tables B5.01 to B5.12 - N_{HVAG} & ESA/HV

Road Class	Table	N_{HVAG}	ESA/HV
Rural National Roads - Highways and Freeways	B5.01	3.3	2.2
	B5.02	3.2	2.8
	B5.03	3.4	3.4
Rural Arterial - Highways & Other Arterial Roads	B5.04	2.8	1.3
	B5.05	2.8	1.9
	B5.06	2.6	2.4
Urban Arterial - Highways & Other Arterial Roads	B5.07	2.6	1.1
	B5.08	2.7	1.6
	B5.09	2.6	2.1
Urban Freeways	B5.10	2.6	1.3
	B5.11	2.8	2.1
	B5.12	3.0	3.1

Table B5.01 - Traffic Load Distribution Rural National Roads - Highways and Freeways					
N_{HVAG} = 3.3			ESA/HV = 2.2		
Axle Group Load (tonnes)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
1	0.003	2.097		0.055	
2	5.488	11.622		0.429	0.005
3	6.138	25.591	0.074	0.656	0.019
4	17.617	17.773	0.111	0.414	0.026
5	65.048	14.63	0.037	0.940	0.036
6	5.647	12.498	0.776	3.231	0.056
7	0.054	7.962	5.582	6.171	0.984
8	0.005	5.674	12.976	7.482	2.748
9		1.870	20.074	7.362	4.363
10		0.242	27.875	7.217	5.576
11		0.038	17.338	7.874	5.174
12		0.003	10.536	9.246	4.538
13			3.512	13.98	4.775
14			0.924	18.856	5.014
15			0.111	11.849	5.426
16			0.074	3.568	6.077
17				0.527	7.688
18				0.108	11.365
19				0.029	13.926
20				0.006	12.013
21					6.947
22					2.509
23					0.593
24					0.115
25					0.014
26					0.005
27					0.003
28					0.002
29					0.001
30					0.002
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.304	0.061	0.002	0.308	0.325

Table B5.02 - Traffic Load Distribution Rural National Roads - Highways and Freeways					
N_{HVAG} = 3.2			ESA/HV = 2.8		
Axle Group Load (tonnes)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
1	0.312	2.474		0.484	0.049
2	2.909	10.594		1.128	0.043
3	5.583	19.566	0.100	2.668	0.246
4	5.713	18.451	1.105	2.378	1.385
5	15.242	14.131	3.448	3.414	3.037
6	53.821	10.995	14.427	5.170	4.753
7	15.743	10.324	8.084	5.450	4.378
8	0.629	6.919	15.197	5.627	4.422
9	0.046	3.513	20.25	6.758	4.936
10	0.002	2.010	19.364	7.818	5.357
11		0.773	12.937	7.496	6.058
12		0.170	3.883	7.566	6.107
13		0.060	1.021	8.147	5.898
14		0.020	0.067	9.556	5.537
15			0.100	11.152	5.645
16			0.017	9.947	6.446
17				4.126	7.868
18				0.814	9.254
19				0.182	9.020
20				0.069	5.634
21				0.032	2.483
22				0.012	0.934
23				0.004	0.299
24				0.002	0.114
25					0.053
26					0.022
27					0.011
28					0.005
29					0.005
30					0.001
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.307	0.056	0.006	0.308	0.323

Table B5.03 - Traffic Load Distribution Rural National Roads - Highways and Freeways					
	N_{HVAG} = 3.4		ESA/HV = 3.4		
Axle Group Load (tonnes)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
1	0.383	7.391		1.211	0.121
2	2.736	20.533	0.344	4.573	1.515
3	4.011	20.463	2.921	5.134	4.526
4	8.664	17.349	10.137	6.981	4.938
5	37.071	12.034	20.447	6.314	3.774
6	37.951	7.910	15.464	4.710	2.748
7	8.034	5.007	14.605	3.145	2.183
8	1.023	4.278	9.966	2.608	1.964
9	0.108	2.861	6.701	2.563	1.926
10	0.019	1.318	7.904	2.859	2.012
11		0.505	6.873	3.132	2.294
12		0.210	1.890	3.900	2.719
13		0.084	1.890	4.940	2.883
14		0.056	0.687	6.383	3.380
15				8.188	4.684
16			0.172	8.894	6.432
17				8.819	9.189
18				6.935	11.196
19				4.612	11.165
20				2.432	8.873
21				1.045	5.819
22				0.449	3.132
23				0.139	1.523
24				0.035	0.599
25					0.233
26					0.097
27					0.041
28					0.014
29					0.014
30					0.003
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.290	0.043	0.004	0.313	0.350

Table B5.04 - Traffic Load Distribution
Rural Arterial - Highways & Other Arterial Roads

N_{HVAG} = 2.8 ESA/HV = 1.3

Axle Group Load (tonnes)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
1	0.765	4.020	0.103	0.639	0.059
2	10.888	10.148	0.183	1.989	0.446
3	16.095	27.989	1.923	5.273	1.513
4	19.740	20.921	2.884	6.551	4.442
5	39.592	13.653	7.919	9.001	9.085
6	12.208	9.487	17.693	10.912	10.475
7	0.645	7.001	11.341	8.805	8.295
8	0.055	3.939	17.590	6.563	5.862
9	0.008	1.811	17.178	5.311	5.044
10	0.004	0.722	15.404	5.025	4.242
11		0.224	5.035	5.056	3.755
12		0.066	1.350	5.214	3.520
13		0.016	0.687	5.693	3.504
14		0.003	0.252	6.659	3.572
15			0.366	7.770	3.904
16			0.092	6.219	4.541
17				2.428	5.379
18				0.627	5.952
19				0.177	6.141
20				0.058	4.956
21				0.018	3.144
22				0.007	1.404
23				0.004	0.495
24				0.001	0.164
25					0.065
26					0.026
27					0.008
28					0.005
29					0.001
30					0.001
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.353	0.138	0.010	0.319	0.180

Table B5.05 - Traffic Load Distribution
Rural Arterial - Highways & Other Arterial Roads

N_{HVAG} = 2.8 ESA/HV = 1.9

Axle Group Load (tonnes)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
1	0.990	7.271	1.710	0.798	0.034
2	7.559	11.631	0.791	1.169	0.076
3	13.151	28.293	2.348	3.542	0.145
4	12.353	19.288	2.552	4.974	1.591
5	33.062	12.665	4.467	7.856	6.081
6	29.489	8.151	12.302	11.032	10.845
7	3.197	5.696	14.523	10.816	11.088
8	0.187	3.950	17.559	7.900	7.322
9	0.011	1.924	18.785	5.851	5.255
10	0.001	0.806	13.936	4.519	4.103
11		0.235	6.534	3.904	3.279
12		0.075	2.476	3.974	2.724
13		0.013	1.123	4.304	2.763
14		0.002	0.689	4.871	2.750
15			0.179	5.889	3.117
16			0.026	7.452	3.647
17				6.233	4.248
18				3.057	4.954
19				1.137	5.919
20				0.449	6.830
21				0.171	5.977
22				0.068	3.886
23				0.026	1.832
24				0.008	0.809
25					0.358
26					0.206
27					0.096
28					0.040
29					0.020
30					0.005
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.344	0.133	0.010	0.322	0.191

Table B5.06 - Traffic Load Distribution Rural Arterial - Highways & Other Arterial Roads					
N_{HVAG} = 2.6			ESA/HV = 2.4		
Axle Group Load (tonnes)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
1	0.949	2.994	0.636	0.876	0.118
2	7.893	6.790	0.627	1.308	0.181
3	13.715	21.43	1.415	1.744	0.196
4	10.927	19.997	1.925	2.491	0.317
5	19.359	17.631	1.441	3.163	1.127
6	32.762	13.021	3.322	5.542	3.405
7	12.659	8.141	5.999	8.698	7.355
8	1.508	4.832	8.577	9.311	9.390
9	0.208	2.923	19.518	7.493	8.388
10	0.020	1.445	20.010	5.880	5.580
11		0.571	15.373	5.363	4.177
12		0.174	12.374	5.412	3.492
13		0.046	5.542	5.609	3.317
14		0.005	2.194	5.698	3.307
15			0.877	6.467	3.349
16			0.170	7.464	3.316
17				7.542	3.405
18				5.617	3.618
19				2.724	4.194
20				1.033	5.113
21				0.349	5.780
22				0.150	6.079
23				0.052	5.478
24				0.014	4.187
25					2.732
26					1.339
27					0.635
28					0.260
29					0.131
30					0.034
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.370	0.154	0.013	0.307	0.156

Table B5.07 - Traffic Load Distribution
Urban Arterial - Highways & Other Arterial Roads

N_{HVAG} = 2.6   ESA/HV = 1.1

Axle Group Load (tonnes)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
1	1.065	3.393	0.327	0.627	0.086
2	9.563	9.586	0.094	2.365	0.184
3	17.271	20.237	1.123	12.087	1.947
4	24.609	17.191	3.508	10.626	15.77
5	33.488	12.422	10.524	17.386	23.303
6	11.732	11.989	18.195	13.882	18.02
7	1.713	13.216	19.831	7.946	9.75
8	0.410	7.407	17.727	6.024	7.408
9	0.118	2.992	14.733	4.337	4.638
10	0.031	1.065	8.887	3.544	2.066
11		0.353	2.993	3.179	1.329
12		0.123	1.263	2.772	1.099
13		0.021	0.374	2.849	1.000
14		0.005	0.187	2.772	1.145
15			0.234	3.155	1.000
16				2.923	0.980
17				1.762	1.322
18				0.867	1.572
19				0.431	1.776
20				0.196	1.625
21				0.107	1.454
22				0.086	1.026
23				0.059	0.618
24				0.018	0.355
25					0.178
26					0.112
27					0.079
28					0.072
29					0.053
30					0.033
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.359	0.172	0.020	0.309	0.140

Table B5.08 - Traffic Load Distribution Urban Arterial - Highways & Other Arterial Roads					
N_{HVAG} = 2.7			ESA/HV = 1.6		
Axle Group Load (tonnes)	**Axle Group Type**				
	SAST %	**SADT %**	**TAST %**	**TADT %**	**TRDT %**
1	1.196	3.783	0.036	0.740	0.112
2	8.732	12.304	0.465	3.122	0.374
3	20.899	22.697	3.327	5.877	1.813
4	20.839	17.942	6.762	8.470	4.496
5	26.275	13.491	16.816	9.667	5.333
6	18.702	15.259	18.355	7.180	4.658
7	3.055	9.873	14.776	4.203	1.819
8	0.239	2.868	12.379	2.910	1.099
9	0.051	1.136	11.055	3.217	0.798
10	0.012	0.447	10.268	3.462	0.826
11		0.175	3.900	3.537	1.266
12		0.010	1.181	4.592	1.584
13		0.010	0.429	8.483	2.438
14		0.005	0.107	12.505	3.202
15			0.072	11.994	5.283
16			0.072	6.713	8.758
17				2.366	12.228
18				0.671	14.203
19				0.199	13.154
20				0.064	8.708
21				0.015	4.574
22				0.010	1.992
23					0.764
24				0.003	0.290
25					0.139
26					0.039
27					0.022
28					0.017
29					
30					0.011
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.354	0.159	0.023	0.317	0.147

Table B5.09 - Traffic Load Distribution
Urban Arterial - Highways & Other Arterial Roads

N_{HVAG} = 2.6 ESA/HV = 2.1

Axle Group Load (tonnes)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
1	0.925	2.335		0.668	0.063
2	8.301	11.478	0.182	2.561	0.184
3	18.301	22.484	0.821	4.110	0.765
4	18.82	17.975	1.156	6.604	4.109
5	21.401	13.148	9.337	9.497	5.291
6	23.542	12.222	17.427	8.489	5.630
7	7.729	12.687	18.431	5.423	3.273
8	0.838	4.885	13.96	3.379	1.542
9	0.120	1.702	13.108	2.636	1.024
10	0.023	0.622	12.652	2.279	0.815
11		0.279	7.451	2.336	0.832
12		0.129	3.741	2.690	0.773
13		0.043	1.004	3.492	0.982
14		0.011	0.426	6.318	1.388
15			0.304	12.355	1.714
16				14.385	2.583
17				8.333	4.731
18				3.006	8.330
19				0.946	14.419
20				0.334	16.453
21				0.102	12.702
22				0.038	6.871
23				0.015	3.235
24				0.004	1.371
25					0.527
26					0.201
27					0.096
28					0.054
29					0.029
30					0.013
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.359	0.167	0.020	0.311	0.143

Table B5.10 - Traffic Load Distribution Urban Freeway

$N_{HVAG} = 2.6$ ESA/HV = 1.3

Axle Group Load (tonnes)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
1	0.356	1.718	0.028	0.530	0.056
2	11.838	5.598		0.852	0.075
3	17.300	29.475	0.037	2.036	0.113
4	25.991	23.297	0.519	5.217	1.531
5	21.949	15.595	3.385	9.403	7.845
6	14.710	10.284	9.255	13.648	13.757
7	6.120	5.864	15.144	11.586	11.781
8	1.425	3.771	19.123	9.188	8.129
9	0.268	2.230	20.329	7.657	5.916
10	0.043	1.177	13.883	6.956	4.791
11		0.599	9.422	6.781	4.266
12		0.280	4.572	6.201	3.956
13		0.091	2.634	5.427	3.986
14		0.021	1.196	4.418	4.134
15			0.390	3.535	4.592
16			0.083	2.622	4.516
17				1.799	4.716
18				1.072	4.319
19				0.576	3.646
20				0.295	2.769
21				0.129	2.044
22				0.042	1.304
23				0.025	0.843
24				0.005	0.447
25					0.244
26					0.112
27					0.072
28					0.027
29					0.011
30					0.002
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.368	0.150	0.016	0.306	0.160

Table B5.11 - Traffic Load Distribution Urban Freeway

N_{HVAG} = 2.8 ESA/HV = 2.1

Axle Group Load (tonnes)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
1	0.202	1.792	0.166	0.489	0.090
2	5.664	5.051	0.099	0.721	0.121
3	9.225	22.329	0.281	0.815	0.189
4	11.545	20.819	1.076	2.754	1.147
5	31.611	16.958	5.728	5.376	5.014
6	34.113	12.483	16.140	9.048	10.523
7	6.841	8.369	16.818	13.470	14.589
8	0.660	5.287	14.104	13.818	12.709
9	0.112	3.587	15.478	10.272	8.163
10	0.026	1.941	12.266	7.345	6.157
11		0.897	7.995	5.163	4.709
12		0.342	4.171	3.917	3.542
13		0.128	2.367	3.496	2.810
14		0.017	1.821	3.414	2.418
15			0.960	3.459	2.238
16			0.530	3.464	2.235
17				3.414	2.232
18				3.252	2.401
19				2.752	2.515
20				1.869	2.677
21				1.044	2.686
22				0.445	2.575
23				0.171	2.410
24				0.034	1.943
25					1.580
26					1.097
27					0.650
28					0.351
29					0.172
30					0.057
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.351	0.105	0.008	0.321	0.215

Table B5.12 - Traffic Load Distribution Urban Freeway

$N_{HVAG} = 3.0$ ESA/HV = 3.1

Axle Group Load (tonnes)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
1	0.553	3.295	0.028	0.362	0.014
2	3.564	9.935		0.632	0.027
3	7.737	28.71		3.062	0.055
4	6.219	18.603	0.594	5.619	1.045
5	13.436	12.319	5.912	6.354	5.213
6	35.000	9.053	14.993	10.714	9.594
7	27.619	6.296	17.822	10.535	11.132
8	5.142	4.098	18.897	9.032	8.116
9	0.665	3.505	15.163	6.685	5.482
10	0.065	2.049	13.267	5.044	4.308
11		1.281	8.034	4.281	3.861
12		0.621	3.395	4.154	3.586
13		0.180	1.188	3.919	3.273
14		0.055	0.424	4.033	3.228
15			0.226	4.228	3.174
16			0.057	4.779	3.377
17				5.178	3.334
18				5.000	3.718
19				3.669	4.098
20				1.769	4.655
21				0.670	4.882
22				0.192	4.774
23				0.069	4.016
24				0.020	2.738
25					1.427
26					0.581
27					0.200
28					0.064
29					0.025
30					0.003
Total	100.00	100.00	100.00	100.00	100.00
Axle Group Proportion	0.329	0.093	0.007	0.329	0.242

Appendix C Guide to Selection of Initial Seal Treatments on Pavements Constructed Clear of Traffic

Period when Initial Treatment is Applied	**Opening to Traffic within 12 months of Application of Initial Bituminous Surfacing (BS) Treatment for roads and highways with >2,000 vehicles/lane/day**			**Opening to Traffic more than 12 months after first sprayed BS treatment**
	Opening from October to March	Opening from April to May	Opening from June to September Should be avoided. The following options may be considered in some circumstances.	
October to March	Prime & Size 14/7 HSS2 or XSS seal	Prime & Size 14 seal with a polymer modified binder followed by a Size 7 emulsion seal (consider polymer modification) at 1-2 weeks before opening depending on condition of surface and weather.	Prime & Size 14 seal using a polymer modified binder, followed by a Size 7 polymer modified emulsion seal at 1-2 weeks before opening depending on condition of surface and weather.	In most circumstances it is undesirable to seal and have long periods without traffic. In some circumstances it may be desirable to apply holding treatments such as a prime and Size 7 seal to protect a prepared pavement surface from construction traffic prior to applying the final surfacing treatment. In such cases specialist advice should be sought.
April to May	Size 7 emulsion initial seal followed by a Size 14/7 HSS2 or XSS 1-2 weeks prior to opening.	Size 10 initial seal followed by a Size 7 emulsion seal (consider polymer modification) at 1-2 weeks before opening. Apply a Size 14/7 HSS2 or XSS final seal in 1 to 3 years.	Size 10 initial seal followed by a Size 7 polymer modified emulsion seal at 1-2 weeks before opening. Apply a Size 14/7 HSS2 or XSS final seal in 1 to 3 years.	
June to September Should be Avoided. Delay pavement preparation until October.	Size 7 emulsion initial seal followed by a Size 14/7 HSS2 or XSS seal 1-2 weeks prior to opening.		Avoid, postpone pavement preparation and sealing works until October	

Notes to Appendix C

- *Location of works, weather and pavement conditions can vary the treatments suggested and this guide should only be used to assist with programming of works and determining potentially suitable treatments which should be confirmed prior to application.*
- *Specialist advice should be obtained to confirm the appropriate selection of the most appropriate treatments. In some cases as described above a HSS2 or XSS seal may not be necessary and could be substituted with a lesser treatment if traffic volumes and characteristics are sufficient to justify. Further guidance can be found in Austroads[B2.]*
- *All Size 7 seals applied as a second or third application are applied at the base rate of application unless designed as a Double/Double seal.*
- *Hatched areas of Table – There are significant risks of poor performance and works should not be planned to occur during these periods. Avoid, postpone pavement preparation and sealing works until October. Specialist advice should be sought.*

Appendix D - Guide For Selection of Dense Graded Asphalt Types

Course		AADT /Lane [2]		Designation [1]	Binder Class	Minimum PSV	Standard Mix Sizes [3]	Remarks
		HV's	Total					
Wearing	Light Duty	< 25	< 500	L	C170 or C320	-	7 & 10	
	Medium Duty	25 – 300	500 - 3000	N	C170 or C320	-	7, 10 & 14	
	Heavy Duty	> 300	> 3000	H	C320	48	7, 10 & 14	
	Heavy Duty	> 500	> 5000	V[4]	C320	54[6]	10 & 14	Restricted to signalised intersections and roundabouts.
	Heavy Duty	> 1000	> 10000	HG[4],[5]	M (500/170)	48[6]	10 & 14	
	High Performance and/or Flexibility	> 200	> 2000	VP[4]	PMB (A10E)	54[6]	14	Specialist advice should be sought
				HP[4]		48[6]	10 & 14	For medium and heavy duty use. Specialist advice should be sought.
Structural	Intermediate	25 - 1000	500 - 10000	SI	C320	-	14 & 20	Standard structural mix. Generally Size 20.
	Heavy Duty Intermediate	> 1000	> 10000	SS	C600	-	20	
		> 1000	> 10000	SG[5]	M (500/170)	-	20	
		> 1000	>10000	SI	C320	-	20	Use Type SS as an intermediate layer within 100 mm of finished surface level (excluding OGA) for freeways and large scale works.
	High Performance Intermediate	> 1000	> 10000	SP	PMB (A10E)	-	20	Alternative PMB Class may be appropriate. Specialist advice should be sought.
	Base	All	All	SI	C320	-	20	
		All	All	SF	C320	-	20	Minimum layer thickness of 75mm and minimum cover of 100 mm of DGA is required.

(1) Standard Types of Dense Graded Asphalt (DGA)

L — A light duty Size 7 or 10 mm wearing course with low air voids and higher binder wearing course for use in very lightly trafficked pavements.

N — A light to medium duty Size 7, 10 or 14 mm wearing course for use in light to moderately trafficked pavements.

H — A heavy duty Size 7, 10 or 14 mm asphalt wearing course for use in most heavily trafficked pavements.

V — A heavy duty Size 10 or 14 asphalt wearing course for heavily trafficked intersections.

HG — A multi purpose heavy to very heavy duty Size 10 or 14 wearing course asphalt incorporating Multigrade binder where a high resistance to deformation is required, particularly at heavily trafficked intersections.

HP — A high performance Size 10 or 14 heavy to very heavy duty wearing course asphalt incorporating a Polymer Modified Binder (PMB) where a high resistance flexural cracking and/or deformation is required.

VP — A high performance Size 14 mm heavy to very heavy duty wearing course asphalt incorporating a PMB for use in 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.

SS — A very stiff Size 20 structural intermediate course asphalt used to increase pavement deformation resistance and increase stiffness for very large scale heavy duty asphalt pavements.

SG — A multi purpose heavy to very heavy duty Size 20 structural intermediate course asphalt incorporating a Multigrade binder for high resistance to deformation, particularly at very heavily trafficked intersections.

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.

SF — A fatigue resistant Size 20 structural base course asphalt for heavy duty asphalt pavements with a total asphalt thickness in excess of 175 mm.

(2) *Greater priority should be given to the volume of Heavy Vehicles (HVs) if known.*

(3) *The nominal size of asphalt shall be compatible with the layer thickness as follows:*

Size (mm)	Thickness Range (mm)	Recommended (mm)
7	15 - 25	20
10	25 - 35	30
14	35 - 50	40
20	50 - 100	75

(4) *Where Type V, VP, HG or HP is recommended for use at intersections, it should commence at the start of the turn lane taper or a minimum of 80 m from the stop line or from where heavy vehicles are expected to commence braking, whichever is the greater distance and extend through the intersection and the first 30 m of the departure lanes.*

(5) *The supply of Multigrade binder is limited in Victoria. Consider alternatives.*

(6) *PSV ≥ 54 should be used at high accident risk sites if available and economically feasible.*

Appendix E - Typical Characteristics of Asphalt Used by VicRoads

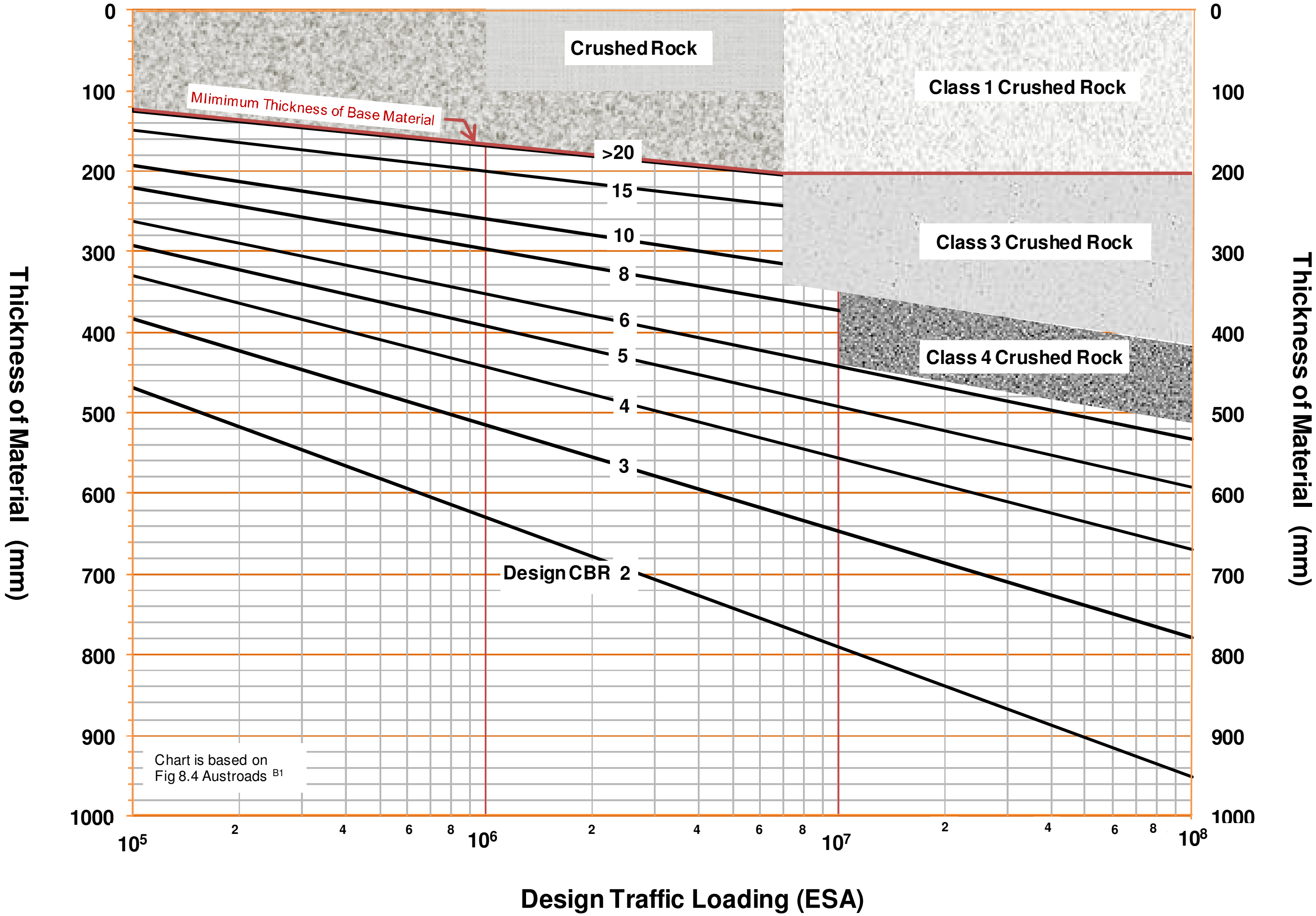
Mix Type	Mix Size	Binder Class	Mix Composition			Modulus (MPa) at WMAPT of 24ºC				Fatigue (K) Values			
			V_{air} (%)	V_b (%)	V_{agg} (%)	10 km/h	40 km/h	60 km/h	80 km/h	10 km/h	40 km/h	60 km/h	80 km/h
L	7	170	6.0	13.7	80.3	1000	1500	1700	1900	7370	6370	6090	5850
	10	170	6.0	12.5	81.5	1000	1700	2000	2200	6780	5600	5280	5100
N	7	170	7.0	12.3	80.7	1000	1600	1900	2100	6680	5640	5300	5110
	10	170	7.0	11.1	81.9	1200	1900	2200	2500	5700	4830	4580	4380
	14	170	7.0	10.5	82.5	1200	2100	2400	2700	5430	4440	4230	4050
V	10	320	8.0	10.2	81.8	1400	2200	2600	2900	5000	4250	4000	3850
	14	320	8.0	10.0	82.0	1600	2600	3000	3300	4680	3930	3740	3610
VP	14	A10E	7.0	10.5	82.5	1200	1800	2000	2300	5430	4700	4510	4290
H	10	320	7.0	11.1	81.9	1500	2500	2900	3200	5260	4380	4150	4010
	14	320	7.0	10.5	82.5	1700	2800	3200	3600	4790	4000	3810	3650
HP	10	A10E	5.0	11.7	83.3	1000	1400	1600	1800	6380	5660	5390	5170
	14	A10E	5.0	11.1	83.9	1000	1600	1800	2100	6090	5140	4930	4660
HG	10	Multigrade	7.0	11.1	81.9	1500	2500	2900	3200	5260	4380	4150	4010
	14	Multigrade	7.0	10.5	82.5	1700	2800	3200	3600	4790	4000	3810	3650
SMAH	10	A10E	6.5	14.5	79.0	1000	1300	1500	1700	7760	7060	6710	6410
SMAN	10	A20E or A25E	6.5	14.5	79.0	1200	1700	1900	2100	7270	6410	6160	5940
SI	20	320	7.0	10.4	82.6	1800	3100	3600	3900	4650	3820	3620	3520
SS	20	600	7.0	10.4	82.6	2400	3900	4500	5000	4190	3520	3340	3220
SF	20	320	4.5	12.8	82.7	1800	2900	3400	3800	5610	4720	4460	4280
SP	20	A10E	5.0	11.0	84.0	1200	1900	2200	2500	5660	4790	4550	4340
SG	20	Multigrade	7.0	10.4	82.6	1800	3100	3600	3900	4650	3820	3620	3520
EME2	-	15/25 or 10/20	5.0	13.3	81.7	2800	4700	5400	6000	4950	4110	3910	3760

Notes to Appendix E:

1 *Insitu mix compositions have been derived from VicRoads registered asphalt mix designs.*

2 *Modulus values provided relate to initial mix design characteristics early in the asphalts service life. They are not suitable for post placement evaluation of asphalt modulus.*

3 *$K = (6918 (0.856 V_b + 1.08)/ E^{0.36})$ where E and V_b are as defined in Section 6.5 of Austroads* [B1].


Crushed Rock
Class 1 Crushed Rock
Mlimimum Thickness of Base Material
>20
15
10
8
6
5
4
3
Design CBR 2
Class 3 Crushed Rock
Class 4 Crushed Rock
Chart is based on
Fig 8.4 Austroads B1
Thickness of Material (mm)
0
100
200
300
400
500
600
700
800
900
1000
10^5
2
4
6
8
10^6
10^7
10^8
Design Traffic Loading (ESA)

If you would like to receive this publication in an accessible format, please contact: vicroadstechnicalservices@roads.vic.gov.au, or request it using VicRoads website feedback form.

VicRoads Code of Practice - Revision Summary

RC 500.22 - Selection and Design of Pavements and Surfacings

Date	Clause	Description of Revision	Authorised by
December 2018	Section 14 Section 2 Sections 9.3, 11.3.1, Appendix A, B, C, D & E & other	New Updated references Minor amendments including addition of Type VP design criteria	Principal Advisor – Pavements, Geotech. & Materials
July 2018	Appendix B	Update to Traffic Load Distributions	Principal Advisor – Pavements, Geotech. & Materials
May 2018	Full document	Changes throughout resulting from publication of the fourth edition of the Austroads Guide to Pavement Technology Part 2: Pavement Structural Design	Principal Advisor – Pavements, Geotech. & Materials
October 2013	Full document	Section 6 updated Appendix B updated Appendix C updated Appendix E - SMA Modulus included Re-styled with minor amendments made	Principal Advisor – Pavements, Geotech. & Materials