vicroads

Code of Practice

Selection and Design of Pavements and Surfacings

RC 500.22

July 2018

1. Scope

This Code sets down VicRoads procedures for the selection and design of new road pavements and surfacings. Parts of the Code are 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 heavy vehicle 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.

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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	Technical Report AP-T68/06 Update of Austroads Spray Seal Design excluding Sections 6, 7, 8 and 12. Technical Report AP-T236/13 Update of Double/Double Design for Austroads Sprayed Seal Method Technical Report AP-T310/16 Selection and Design of Initial Treatments for Sprayed Seal Surfacings	2006 2013 2016
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 January 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.

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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 percentage < 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.

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.

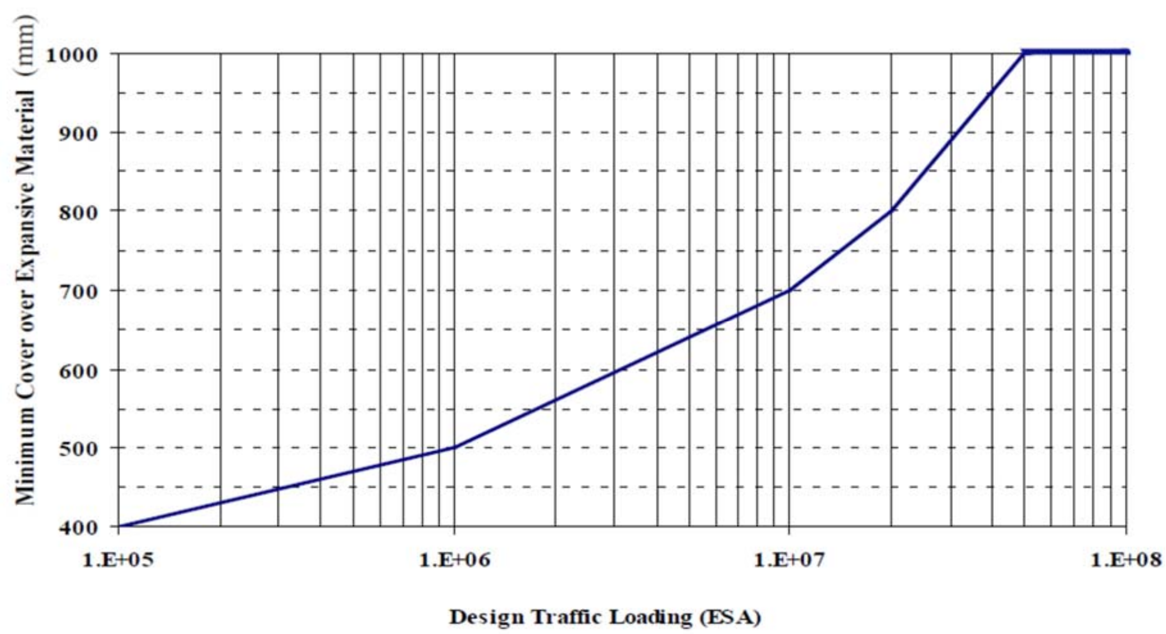
(c) Landscape Design

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 contain a minimum of 4% by mass of cement with a maximum of 3.5% by mass of water added to avoid cement slurry drain off.

If a Type 4 subsurface pavement drain is used in lieu of a Type 2 drain, Grade A1, 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:

- shall 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];
- A Grade B4 granular filter material shall be used;
- shall 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.

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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 x 10^6 ESA.
- ≤ 15% for any other road with a DESA ≤ 1.0 x 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 of this Code 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.*

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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.

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 primer 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 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) and Ultra Thin Asphalt 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 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.

(e) The selection of surfacing type for roads with an operating speed 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.

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 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

The requirements as for Section 10.2.2 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 SMA 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 SMA is used, the design thickness shall be 35 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 Stone Mastic Asphalt) 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 minimum design thickness of 70 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.

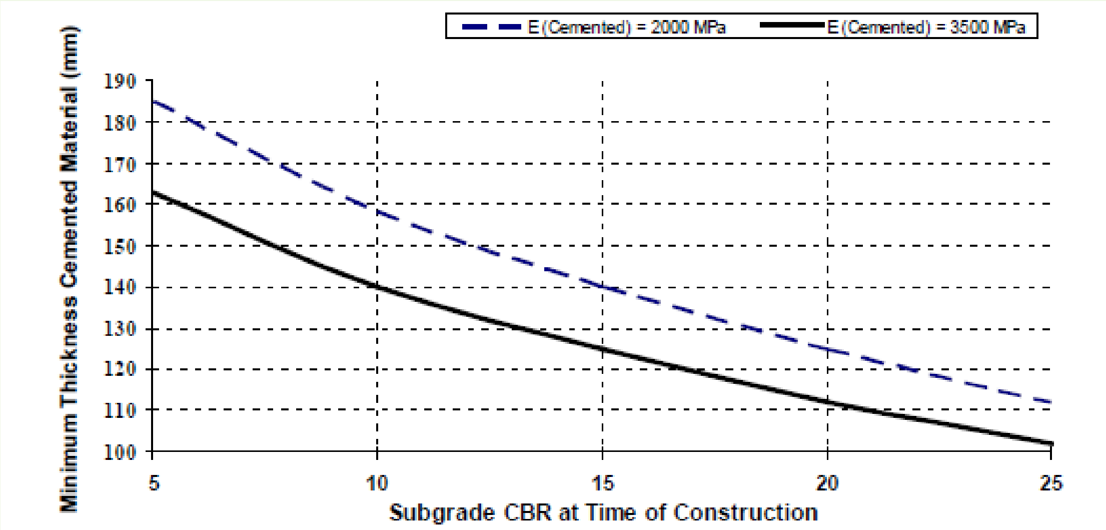
11.4.2. Protection of CTS

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 centreline.

(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);

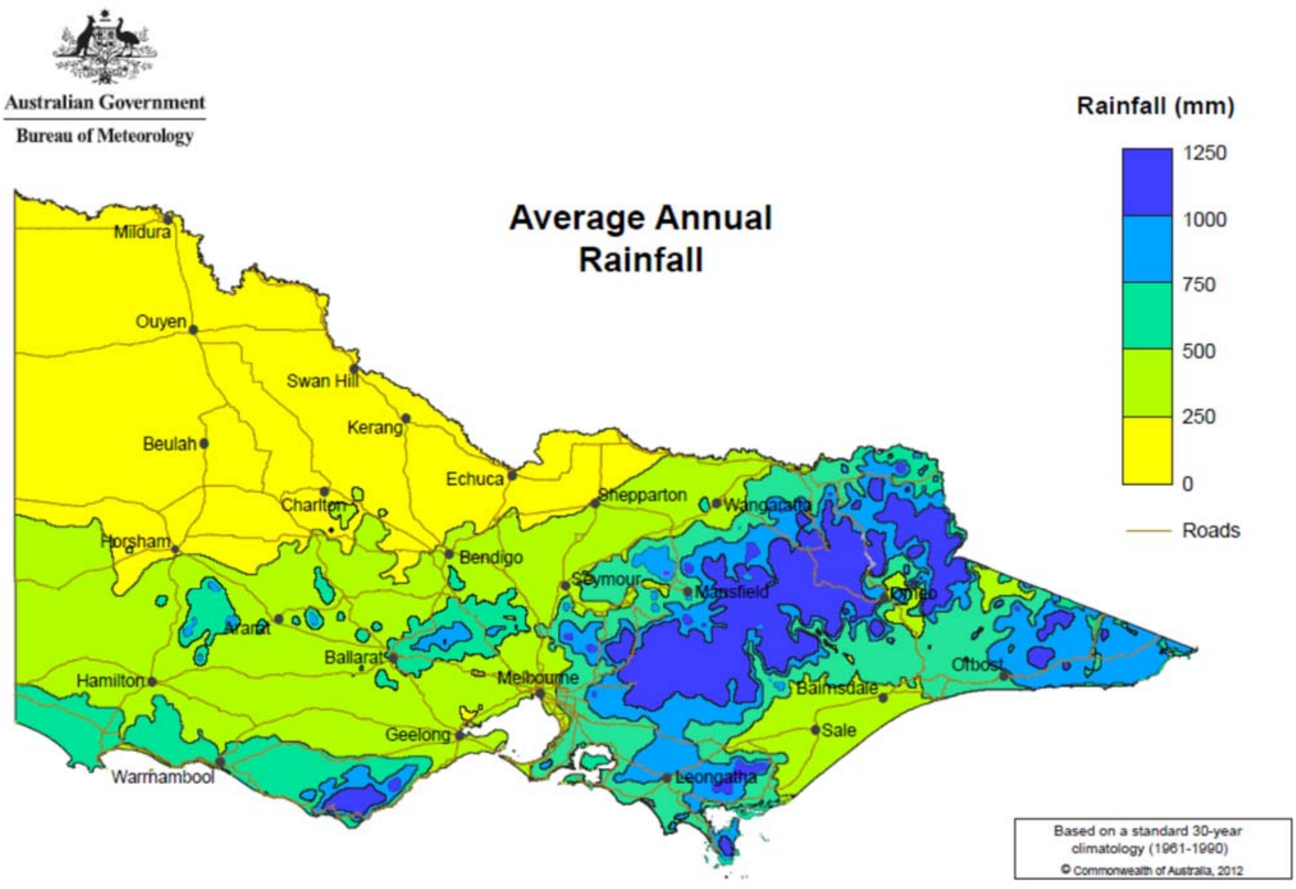
(c) After the prime has fully cured, a SAMI shall be applied to the primed concrete surface. The SAMI shall consist of a Grade S25E PMB meeting the requirements of Austroads[B4] applied at the rate of 2.0 l/m^2. For intersections and high stress locations a lower application rate may be required. The 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.

Appendix A - Average Annual Rainfall of Victoria



Source - http://www.bom.gov.au

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 B5.1 - Traffic Load Distribution
Rural National Roads - Highways and Freeways

N_{HVAG} = 3.3 ESA/HV = 2.2

Axle Group Load (kN)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
10	0.003	2.097		0.055	
20	5.488	11.622		0.429	0.005
30	6.138	25.591	0.074	0.656	0.019
40	17.617	17.773	0.111	0.414	0.026
50	65.048	14.63	0.037	0.940	0.036
60	5.647	12.498	0.776	3.231	0.056
70	0.054	7.962	5.582	6.171	0.984
80	0.005	5.674	12.976	7.482	2.748
90		1.870	20.074	7.362	4.363
100		0.242	27.875	7.217	5.576
110		0.038	17.338	7.874	5.174
120		0.003	10.536	9.246	4.538
130			3.512	13.98	4.775
140			0.924	18.856	5.014
150			0.111	11.849	5.426
160			0.074	3.568	6.077
170				0.527	7.688
180				0.108	11.365
190				0.029	13.926
200				0.006	12.013
210					6.947
220					2.509
230					0.593
240					0.115
250					0.014
260					0.005
270					0.003
280					0.002
290					0.001
300					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 B5.2 - Traffic Load Distribution Rural National Roads - Highways and Freeways					
N_{HVAG} = 3.2			ESA/HV = 2.8		
Axle Group Load (kN)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
10	0.312	2.474		0.484	0.049
20	2.909	10.594		1.128	0.043
30	5.583	19.566	0.100	2.668	0.246
40	5.713	18.451	1.105	2.378	1.385
50	15.242	14.131	3.448	3.414	3.037
60	53.821	10.995	14.427	5.170	4.753
70	15.743	10.324	8.084	5.450	4.378
80	0.629	6.919	15.197	5.627	4.422
90	0.046	3.513	20.25	6.758	4.936
100	0.002	2.010	19.364	7.818	5.357
110		0.773	12.937	7.496	6.058
120		0.170	3.883	7.566	6.107
130		0.060	1.021	8.147	5.898
140		0.020	0.067	9.556	5.537
150			0.100	11.152	5.645
160			0.017	9.947	6.446
170				4.126	7.868
180				0.814	9.254
190				0.182	9.020
200				0.069	5.634
210				0.032	2.483
220				0.012	0.934
230				0.004	0.299
240				0.002	0.114
250					0.053
260					0.022
270					0.011
280					0.005
290					0.005
300					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 B5.3 - Traffic Load Distribution Rural National Roads - Highways and Freeways					
N_{HVAG} = 3.4			ESA/HV = 3.4		
Axle Group Load (kN)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
10	0.383	7.391		1.211	0.121
20	2.736	20.533	0.344	4.573	1.515
30	4.011	20.463	2.921	5.134	4.526
40	8.664	17.349	10.137	6.981	4.938
50	37.071	12.034	20.447	6.314	3.774
60	37.951	7.910	15.464	4.710	2.748
70	8.034	5.007	14.605	3.145	2.183
80	1.023	4.278	9.966	2.608	1.964
90	0.108	2.861	6.701	2.563	1.926
100	0.019	1.318	7.904	2.859	2.012
110		0.505	6.873	3.132	2.294
120		0.210	1.890	3.900	2.719
130		0.084	1.890	4.940	2.883
140		0.056	0.687	6.383	3.380
150				8.188	4.684
160			0.172	8.894	6.432
170				8.819	9.189
180				6.935	11.196
190				4.612	11.165
200				2.432	8.873
210				1.045	5.819
220				0.449	3.132
230				0.139	1.523
240				0.035	0.599
250					0.233
260					0.097
270					0.041
280					0.014
290					0.014
300					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 B5.4 - Traffic Load Distribution
Rural Arterial - Highways & Other Arterial Roads

N_{HVAG} = 2.8 ESA/HV = 1.3

Axle Group Load (kN)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
10	0.765	4.020	0.103	0.639	0.059
20	10.888	10.148	0.183	1.989	0.446
30	16.095	27.989	1.923	5.273	1.513
40	19.740	20.921	2.884	6.551	4.442
50	39.592	13.653	7.919	9.001	9.085
60	12.208	9.487	17.693	10.912	10.475
70	0.645	7.001	11.341	8.805	8.295
80	0.055	3.939	17.590	6.563	5.862
90	0.008	1.811	17.178	5.311	5.044
100	0.004	0.722	15.404	5.025	4.242
110		0.224	5.035	5.056	3.755
120		0.066	1.350	5.214	3.520
130		0.016	0.687	5.693	3.504
140		0.003	0.252	6.659	3.572
150			0.366	7.770	3.904
160			0.092	6.219	4.541
170				2.428	5.379
180				0.627	5.952
190				0.177	6.141
200				0.058	4.956
210				0.018	3.144
220				0.007	1.404
230				0.004	0.495
240				0.001	0.164
250					0.065
260					0.026
270					0.008
280					0.005
290					0.001
300					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 B5.5 - Traffic Load Distribution
Rural Arterial - Highways & Other Arterial Roads

N_{HVAG} = 2.8 ESA/HV = 1.9

Axle Group Load (kN)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
10	0.990	7.271	1.710	0.798	0.034
20	7.559	11.631	0.791	1.169	0.076
30	13.151	28.293	2.348	3.542	0.145
40	12.353	19.288	2.552	4.974	1.591
50	33.062	12.665	4.467	7.856	6.081
60	29.489	8.151	12.302	11.032	10.845
70	3.197	5.696	14.523	10.816	11.088
80	0.187	3.950	17.559	7.900	7.322
90	0.011	1.924	18.785	5.851	5.255
100	0.001	0.806	13.936	4.519	4.103
110		0.235	6.534	3.904	3.279
120		0.075	2.476	3.974	2.724
130		0.013	1.123	4.304	2.763
140		0.002	0.689	4.871	2.750
150			0.179	5.889	3.117
160			0.026	7.452	3.647
170				6.233	4.248
180				3.057	4.954
190				1.137	5.919
200				0.449	6.830
210				0.171	5.977
220				0.068	3.886
230				0.026	1.832
240				0.008	0.809
250					0.358
260					0.206
270					0.096
280					0.040
290					0.020
300					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 B5.6 - Traffic Load Distribution
Rural Arterial - Highways & Other Arterial Roads

N_{HVAG} = 2.6 ESA/HV = 2.4

Axle Group Load (kN)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
10	0.949	2.994	0.636	0.876	0.118
20	7.893	6.790	0.627	1.308	0.181
30	13.715	21.43	1.415	1.744	0.196
40	10.927	19.997	1.925	2.491	0.317
50	19.359	17.631	1.441	3.163	1.127
60	32.762	13.021	3.322	5.542	3.405
70	12.659	8.141	5.999	8.698	7.355
80	1.508	4.832	8.577	9.311	9.390
90	0.208	2.923	19.518	7.493	8.388
100	0.020	1.445	20.010	5.880	5.580
110		0.571	15.373	5.363	4.177
120		0.174	12.374	5.412	3.492
130		0.046	5.542	5.609	3.317
140		0.005	2.194	5.698	3.307
150			0.877	6.467	3.349
160			0.170	7.464	3.316
170				7.542	3.405
180				5.617	3.618
190				2.724	4.194
200				1.033	5.113
210				0.349	5.780
220				0.150	6.079
230				0.052	5.478
240				0.014	4.187
250					2.732
260					1.339
270					0.635
280					0.260
290					0.131
300					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 B5.7 - Traffic Load Distribution
Urban Arterial - Highways & Other Arterial Roads

Axle Group Load (kN)	Axle Group Type				
	N_{HVAG} = 2.6		ESA/HV = 1.1		
	SAST %	SADT %	TAST %	TADT %	TRDT %
10	1.065	3.393	0.327	0.627	0.086
20	9.563	9.586	0.094	2.365	0.184
30	17.271	20.237	1.123	12.087	1.947
40	24.609	17.191	3.508	10.626	15.77
50	33.488	12.422	10.524	17.386	23.303
60	11.732	11.989	18.195	13.882	18.02
70	1.713	13.216	19.831	7.946	9.75
80	0.410	7.407	17.727	6.024	7.408
90	0.118	2.992	14.733	4.337	4.638
100	0.031	1.065	8.887	3.544	2.066
110		0.353	2.993	3.179	1.329
120		0.123	1.263	2.772	1.099
130		0.021	0.374	2.849	1.000
140		0.005	0.187	2.772	1.145
150			0.234	3.155	1.000
160				2.923	0.980
170				1.762	1.322
180				0.867	1.572
190				0.431	1.776
200				0.196	1.625
210				0.107	1.454
220				0.086	1.026
230				0.059	0.618
240				0.018	0.355
250					0.178
260					0.112
270					0.079
280					0.072
290					0.053
300					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 B5.8 - Traffic Load Distribution
Urban Arterial - Highways & Other Arterial Roads

N_{HVAG} = 2.7 **ESA/HV = 1.6**

Axle Group Load (kN)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
10	1.196	3.783	0.036	0.740	0.112
20	8.732	12.304	0.465	3.122	0.374
30	20.899	22.697	3.327	5.877	1.813
40	20.839	17.942	6.762	8.470	4.496
50	26.275	13.491	16.816	9.667	5.333
60	18.702	15.259	18.355	7.180	4.658
70	3.055	9.873	14.776	4.203	1.819
80	0.239	2.868	12.379	2.910	1.099
90	0.051	1.136	11.055	3.217	0.798
100	0.012	0.447	10.268	3.462	0.826
110		0.175	3.900	3.537	1.266
120		0.010	1.181	4.592	1.584
130		0.010	0.429	8.483	2.438
140		0.005	0.107	12.505	3.202
150			0.072	11.994	5.283
160			0.072	6.713	8.758
170				2.366	12.228
180				0.671	14.203
190				0.199	13.154
200				0.064	8.708
210				0.015	4.574
220				0.010	1.992
230					0.764
240				0.003	0.290
250					0.139
260					0.039
270					0.022
280					0.017
290					
300					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 B5.9 - Traffic Load Distribution
Urban Arterial - Highways & Other Arterial Roads

N_{HVAG} = 2.6 ESA/HV = 2.1

Axle Group Load (kN)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
10	0.925	2.335		0.668	0.063
20	8.301	11.478	0.182	2.561	0.184
30	18.301	22.484	0.821	4.110	0.765
40	18.82	17.975	1.156	6.604	4.109
50	21.401	13.148	9.337	9.497	5.291
60	23.542	12.222	17.427	8.489	5.630
70	7.729	12.687	18.431	5.423	3.273
80	0.838	4.885	13.96	3.379	1.542
90	0.120	1.702	13.108	2.636	1.024
100	0.023	0.622	12.652	2.279	0.815
110		0.279	7.451	2.336	0.832
120		0.129	3.741	2.690	0.773
130		0.043	1.004	3.492	0.982
140		0.011	0.426	6.318	1.388
150			0.304	12.355	1.714
160				14.385	2.583
170				8.333	4.731
180				3.006	8.330
190				0.946	14.419
200				0.334	16.453
210				0.102	12.702
220				0.038	6.871
230				0.015	3.235
240				0.004	1.371
250					0.527
260					0.201
270					0.096
280					0.054
290					0.029
300					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 (kN)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
10	0.356	1.718	0.028	0.530	0.056
20	11.838	5.598		0.852	0.075
30	17.300	29.475	0.037	2.036	0.113
40	25.991	23.297	0.519	5.217	1.531
50	21.949	15.595	3.385	9.403	7.845
60	14.710	10.284	9.255	13.648	13.757
70	6.120	5.864	15.144	11.586	11.781
80	1.425	3.771	19.123	9.188	8.129
90	0.268	2.230	20.329	7.657	5.916
100	0.043	1.177	13.883	6.956	4.791
110		0.599	9.422	6.781	4.266
120		0.280	4.572	6.201	3.956
130		0.091	2.634	5.427	3.986
140		0.021	1.196	4.418	4.134
150			0.390	3.535	4.592
160			0.083	2.622	4.516
170				1.799	4.716
180				1.072	4.319
190				0.576	3.646
200				0.295	2.769
210				0.129	2.044
220				0.042	1.304
230				0.025	0.843
240				0.005	0.447
250					0.244
260					0.112
270					0.072
280					0.027
290					0.011
300					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 (kN)	**Axle Group Type**				
	SAST %	**SADT %**	**TAST %**	**TADT %**	**TRDT %**
10	0.202	1.792	0.166	0.489	0.090
20	5.664	5.051	0.099	0.721	0.121
30	9.225	22.329	0.281	0.815	0.189
40	11.545	20.819	1.076	2.754	1.147
50	31.611	16.958	5.728	5.376	5.014
60	34.113	12.483	16.140	9.048	10.523
70	6.841	8.369	16.818	13.470	14.589
80	0.660	5.287	14.104	13.818	12.709
90	0.112	3.587	15.478	10.272	8.163
100	0.026	1.941	12.266	7.345	6.157
110		0.897	7.995	5.163	4.709
120		0.342	4.171	3.917	3.542
130		0.128	2.367	3.496	2.810
140		0.017	1.821	3.414	2.418
150			0.960	3.459	2.238
160			0.530	3.464	2.235
170				3.414	2.232
180				3.252	2.401
190				2.752	2.515
200				1.869	2.677
210				1.044	2.686
220				0.445	2.575
230				0.171	2.410
240				0.034	1.943
250					1.580
260					1.097
270					0.650
280					0.351
290					0.172
300					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 (kN)	Axle Group Type				
	SAST %	SADT %	TAST %	TADT %	TRDT %
10	0.553	3.295	0.028	0.362	0.014
20	3.564	9.935		0.632	0.027
30	7.737	28.71		3.062	0.055
40	6.219	18.603	0.594	5.619	1.045
50	13.436	12.319	5.912	6.354	5.213
60	35.000	9.053	14.993	10.714	9.594
70	27.619	6.296	17.822	10.535	11.132
80	5.142	4.098	18.897	9.032	8.116
90	0.665	3.505	15.163	6.685	5.482
100	0.065	2.049	13.267	5.044	4.308
110		1.281	8.034	4.281	3.861
120		0.621	3.395	4.154	3.586
130		0.180	1.188	3.919	3.273
140		0.055	0.424	4.033	3.228
150			0.226	4.228	3.174
160			0.057	4.779	3.377
170				5.178	3.334
180				5.000	3.718
190				3.669	4.098
200				1.769	4.655
210				0.670	4.882
220				0.192	4.774
230				0.069	4.016
240				0.020	2.738
250					1.427
260					0.581
270					0.200
280					0.064
290					0.025
300					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

<table>
<tr><th rowspan="2">Period when Initial Treatment is Applied</th><th colspan="3">Opening to Traffic within 12 months of Application of Initial Bituminous Surfacing (BS) Treatment for roads and highways with >2000 vehicles/lane/day</th><th rowspan="2">Opening to Traffic more than 12 months after first sprayed BS treatment</th></tr>
<tr><th>Opening from
October to March</th><th>Opening from
April to May</th><th>Opening from
June to September
Should be avoided.
The following options may be considered in some circumstances.</th></tr>
<tr><td>October to March</td><td>Prime & Size 14/7 HSS2 or XSS seal</td><td>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.</td><td>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.</td><td>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.</td></tr>
<tr><td>April to May</td><td>Size 7 emulsion initial seal followed by a Size 14/7 HSS2 or XSS 1-2 weeks prior to opening.</td><td>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.</td><td>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.</td><td></td></tr>
<tr><td>June to September
Should be Avoided. Delay pavement preparation until October.</td><td>Size 7 emulsion initial seal followed by a Size 14/7 HSS2 or XSS seal 1-2 weeks prior to opening.</td><td colspan="3">Avoid, postpone pavement preparation and sealing works until October</td></tr>
</table>

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 Appendix A of the Update of Double/Double design for Austroads Sprayed Seal Design Method (AP-T236/13) and 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) HV's	AADT /Lane (2) Total	Designation (1)	Binder Class	Minimum PSV	Standard Mix Sizes (3)	Remarks
Wearing	Light Duty	< 25	< 500	L	C170 or C320	-	7 & 10	C170 binder must be used if mix contains more than 10% Recycled Asphalt Pavement (RAP).
	Medium Duty	25 – 300	500 - 3000	N	C170 or C320	-	7, 10 & 14	C170 must be used if mix contains more than 10% RAP.
	Heavy Duty	> 300	> 3000	H	C320	48	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	HP(4)	PMB (A10E)	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	
	Heavy Duty Intermediate	> 1000	> 10000	SG(5)	M (500/170)	-	20	
	Heavy Duty Intermediate	> 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	
	Base	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 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.*

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 should 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, Type 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

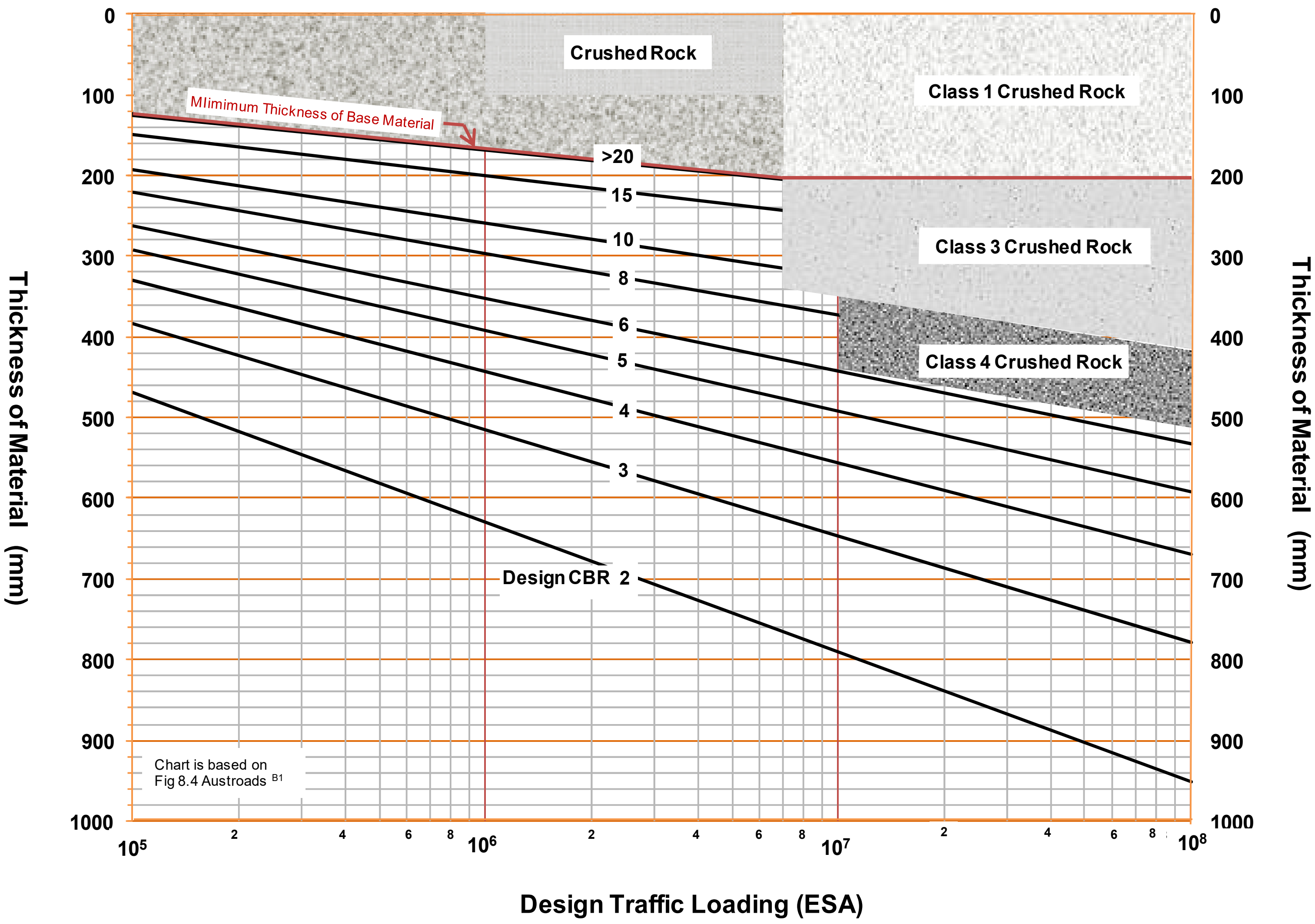
Mix Type	Mix Size	Binder Class	Mix Composition			Modulus (MPa) at WMAPT of 24ºC				Fatigue (K) Values			
			V_{air} (%)	V_b (%)	V_{agg} (%)	10 km/h	40 km/h	60 km/h	80 km/h	10 km/h	40 km/h	60 km/h	80 km/h
L	7	170	6.0	13.7	80.3	1000	1500	1700	1900	7370	6370	6090	5850
	10	170	6.0	12.5	81.5	1000	1700	2000	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
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	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
Class 3 Crushed Rock
Class 4 Crushed Rock
MIimimum Thickness of Base Material
>20
15
10
8
6
5
4
3
Design CBR 2
Thickness of Material (mm)
Design Traffic Loading (ESA)
Chart is based on Fig 8.4 Austroads B1
0
100
200
300
400
500
600
700
800
900
1000
10^5
10^6
10^7
10^8
2
4
6
8

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VicRoads Code of Practice - Revision Summary

RC 500.22 - Selection and Design of Pavements and Surfacings

Date	Clause	Description of Revision	Authorised by
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