Master Specification

Part RD-PV-D1

Pavement Investigation and Design

September 2024

Government of South Australia
Department for Infrastructure and Transport

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Document Management

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Contents

RD-PV-D1 Pavement Investigation and Design

1 General

a) This Master Specification Part sets out the requirements for the investigation and design of new pavements and rehabilitation of existing pavements, including:

i) the documentation requirements, as set out in section 2;

ii) the road pavement design system requirements, as set out in section 3;

iii) the requirements for design traffic, as set out in section 4;

iv) the requirements for site investigation, as set out in section 5;

v) the requirements for subgrade, as set out in section 6;

vi) the requirements for pavement surfacing, as set out in section 7;

vii) the requirements for pavement materials, as set out in section 8;

viii) the requirements for structural design of flexible pavements, as set out in section 9;

ix) the requirements for shoulder pavements, as set out in section 10;

x) the requirements for bikeway pavements, as set out in section 11;

xi) the requirements for pavement detailing and documentation, as set out in section 12; and

xii) the Hold Point requirements, as set out in section 13.

b) This Master Specification Part does not apply to:

i) the design of rigid concrete pavements for roads, refer to RD-PV-D3 “Concrete Road Pavements”;

ii) the design of maintenance treatments;

iii) the design of minor pavements, refer to RD-PV-C5 “Construction of Minor Pavements”;

iv) the design of pavements in trench reinstatements, refer RD-EW-C2 “Trench Excavation and Backfill”; or

v) the detailed design of sprayed seals, refer to RD-BP-D2 “Design and Application of Sprayed Bituminous Surfacing”.

c) The investigation and design of pavements must comply with the Reference Documents, including:

i) AGAM Technical Information Part 15: Technical Supplements;

ii) Austroads Test Method AGAM-T006 Pavement Deflection Measurement with a Falling Weight Deflectometer (FWD);

iii) Austroads Test Method AGAM-T017 Pavement Data Collection with a Traffic Speed Deflectometer (TSD) Device;

iv) AGAM-T017-16 Pavement Data Collection with a Traffic Speed Deflectometer (TSD) Device;

v) AGPT Part 2: Pavement Structural Design;

vi) AGPT Part 4B: Asphalt;

vii) AGPT Part 4D: Stabilised Materials;

viii) AGPT Part 4K: Selection and Design of Sprayed Seals;

ix) AGPT Part 5: Pavement Evaluation and Treatment Design;

x) AGPT Part 6: Unsealed Pavements;

xi) AGPT Part 10: Subsurface Drainage;

xii) Austroads Test Method AGPT-T301 Determining the Foaming Characteristics of Bitumen;

xiii) Austroads Test Method AGPT-T302 Mixing of Foamed Bitumen Stabilised Materials;

xiv) Austroads Test Method AGPT-T303 Compaction of Test Cylinders of Foamed Bitumen Stabilised Materials Part 1: Dynamic Compaction using Marshall Drop Hammer;

xv) Austroads Test Method AGPT-T305 Resilient Modulus of Foamed Bitumen Stabilised Materials;

xvi) Austroads Test Method AGPT-T053 Determination of Permanent Deformation & Resilient Modulus Characteristics of Unbound Granular Materials Under Drained Conditions;

xvii) AS 1289 Methods of testing soils for engineering purposes;

xviii) AS 1141.23 Methods for sampling and testing aggregates, Method 23: Los Angeles value;

xix) AS 3706.2 Geotextiles - Methods of test, Method 2: Determination of tensile properties - Wide-strip and grab method;

xx) AS 5101.4 Methods for preparation and testing of stabilized materials, Method 4: Unconfined compressive strength of compacted materials;

xxi) AS 1726 Geotechnical site investigations;

xxii) Clegg (1980) - An Impact Soil Tester as an Alternative to California Bearing Ratio;

xxiii) Concrete Masonry Association of Australia PA01 Concrete Segmental Pavements - Detailing Guide;

xxiv) Concrete Masonry Association of Australia PA02 Concrete Segmental Pavements - Design Guide for Residential Accessways and Roads;

xxv) Concrete Masonry Association of Australia PA03 Concrete Segmental Pavements - Guide to Specifying;

xxvi) Department Operational Instruction 20.1 Care, Control & Management of Roads (Highways) by the Commissioner of Highways (Section 26 of the Highways Act) (available from: https://dit.sa.gov.au/standards/standards_and_guidelines);

xxvii) Department Pavement Design Procedures (available from: https://dit.sa.gov.au/standards/standards_and_guidelines);

xxviii) Department Drawing Presentation RD2.1 Example Drawings for Large Project;

xxix) Department Drawing Presentation RD2.2 Example Drawings for Small Project;

xxx) Department Guide to Bikeway Pavement Design, Construction and Maintenance for South Australia;

xxxi) Department Test Procedure TP133 Method of Estimation of CBR from Classification Test (available from: https://dit.sa.gov.au/standards/test_procedures);

xxxii) Department Test Procedure TP183 Determination of a Characteristic Value of Resilient Modulus and Rate of Deformation for Unbound Granular Pavement Materials (available from: https://dit.sa.gov.au/standards/test_procedures);

xxxiii) Department Test Procedure TP226 Sampling of Soil, Aggregates and Rocks (available from: https://dit.sa.gov.au/standards/test_procedures); and

xxxiv) Department Pavement Joint Details (available at https://dit.sa.gov.au/standards/standards_and_guidelines).

d) Construction of pavement designs must comply with the Master Specification. Conformance with the Master Specification is a fundamental prerequisite to achieving the design parameters, the required acceptable pavement life and performance requirements provided in the Master Specification.

e) Projects that interface with the Principal's existing road assets, as well as new works that will become the Principal's assets, must be investigated, designed, and constructed in accordance with the Master Specification and to the Principal's standards.

f) Where the Works include indented concrete bus bays or mountable concrete roundabouts, the Contractor must review and amend the relevant Department Standard Drawings for Project specific needs.

2 Documentation

In addition to the requirements of PC-EDM1 "Design Management", the Design Documentation must include:

a) details of the Contractor's proposed alternative pavement configurations (if applicable), including analysis of the benefit to the Principal, as required by section 3.1e);

b) ball penetration values, as required by section 7.2.1d)vii);

c) details of non-conforming granular materials (where applicable), as set out in section 8.2.4;

d) details of additional fully-bound materials (where applicable), including details of laboratory testing, as required by section 8.3.4b);

e) the Pavement Design Report required by section 12.2.1; and

f) the pavement Design Drawings, required by section 12.2.2.

3 Pavement design systems

3.1 Pavement type selection

a) The pavement types to be used on rural and urban roads are summarised in Table RD-PV-D1 3-1.

b) For the purposes of this Master Specification Part, the traffic loading categories are as follows:

i) lightly trafficked roads, which includes roads with design traffic loading (DESA) $< 1 \times 10^5$ ESA;

ii) moderately trafficked roads, which includes roads with design traffic loading (DESA) $\geq 1 \times 10^5$ ESA and $< 1 \times 10^7$ ESA; and

iii) heavily trafficked roads, which includes roads with design traffic loading (DESA) $\geq 1 \times 10^7$ ESA.

c) In selecting the appropriate pavement type, the Contractor must consider factors including:

i) traffic loading;

ii) differential settlement predictions;

iii) scale of works;

iv) construction of works under traffic (greenfield or brownfield site);

v) required surfacing type, including consideration of noise, drainage, texture, durability, etc.;

vi) maintenance requirements;

vii) acceptable pavement performance outcomes, including roughness, rutting, texture, skid resistance and cracking, in accordance with RD-BP-D4 “Surface Characteristics of Flexible Pavements” or as otherwise specified in the Contract Documents;

viii) economics, including whole-of-life costing;

ix) Sustainability in Design requirements;

x) Safety in Design requirements; and

xi) operating environment.

d) The Contractor must detail and justify its pavement type selection in the Pavement Design Report.

e) Where the Contractor proposes alternate pavement configurations not stated in Table RD-PV-D1 3-1, the Contractor must submit details of such alternatives as part of the Design Documentation, including an analysis of the benefit to the Principal including:

i) reduced greenhouse gas emissions; or

ii) reduced whole of life cost.

f) Where an alternate pavement configuration is approved by the Principal as part of the Design Documentation, the Contractor must propose additional testing, design, construction monitoring and post-construction monitoring requirements for that alternate pavement configuration in the Pavement Design Report.

3.2 Heavy-duty pavements

3.2.1 General

Heavily trafficked roads as defined in section 3.1b) must adopt a heavy-duty pavement type as nominated in Figure RD-PV-D1 3-1, Table RD-PV-D1 3-1 and Table RD-PV-D1 3-2 for urban and rural locations.

3.2.2 Heavy-duty pavement support

a) To increase the founding strength and uniformity of pavement support, heavy-duty pavements must be founded on an engineered subgrade, comprising either:

i) engineered fill designed in accordance with RD-EW-D1 “Design of Earthworks for Roads” and constructed in accordance with RD-EW-C1 “Earthworks”; or

ii) in situ stabilised subgrades in accordance with RD-PV-C3 “In situ Pavement Stabilisation”.

b) Minimum support requirements for heavy-duty pavement supporting layers are shown in Table RD-PV-D1 3-3 and illustrated in Figure RD-PV-D1 3-1.

c) The minimum support requirements set out in section 3.2.2a)ii) must be reviewed based upon site specific geotechnical investigation and design considerations, as required to achieve the performance criteria outlined in RD-EW-D1 “Design of Earthworks for Roads” and RD-EW-C1 “Earthworks”.

d) The Contractor must apply the greatest standard of support requirements for heavy-duty pavements resulting from the review undertaken pursuant to section 3.2.2c).

Figure RD-PV-D1 3-1 Typical heavy-duty flexible pavements

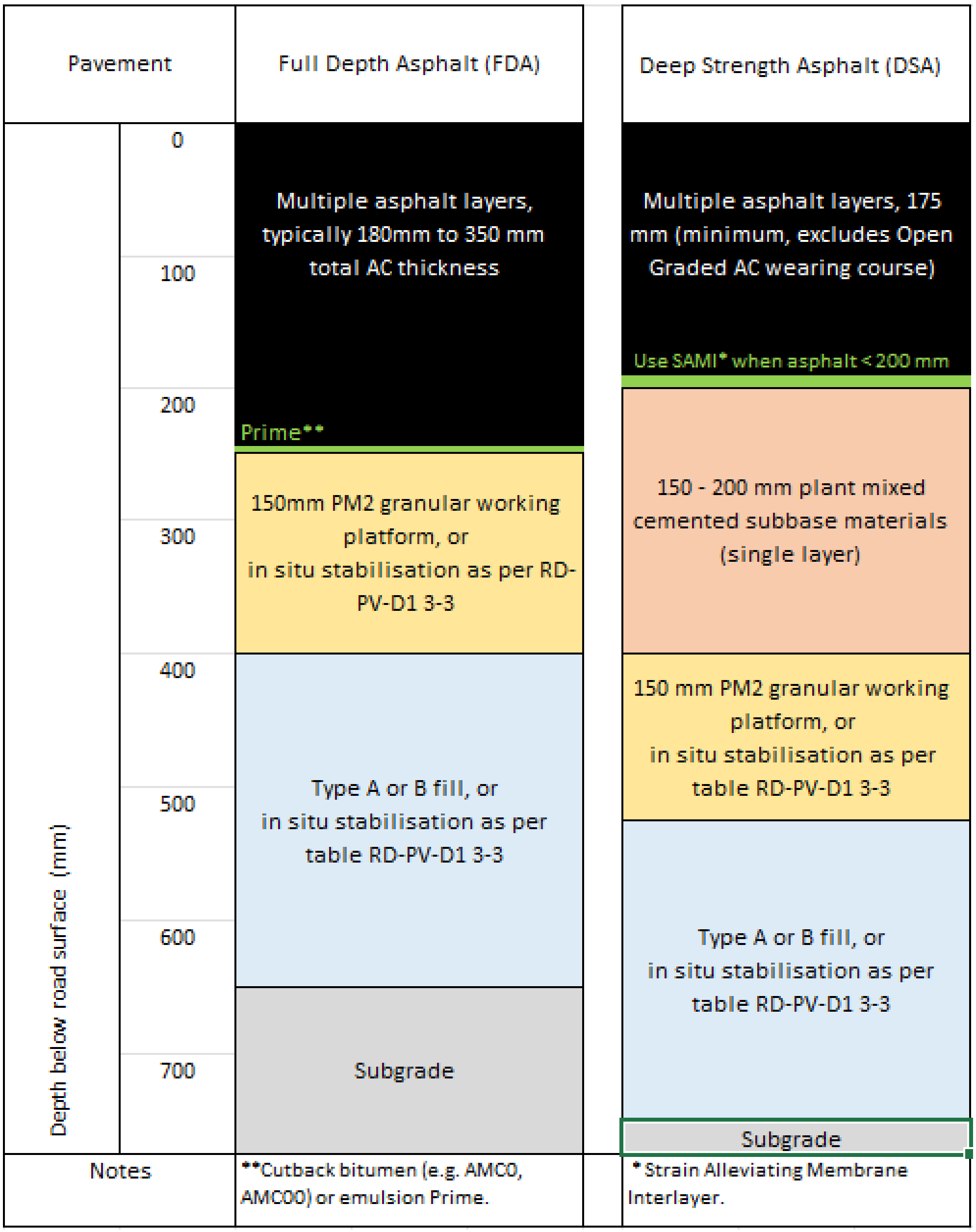


Table RD-PV-D1 3-1 New pavement types

Pavement type	Traffic loading category[(1)]	Details	Urban	Rural	Heavy-duty	Notes
Unsealed unbound granular (U-GR)	Lightly trafficked to moderately trafficked	Unbound granular material, typically PM2 on unsealed shoulders adjacent sealed traffic lane pavements, or materials meeting AGPT Part 6 Unsealed Pavements on unsealed roads.	No[(a)]	Yes	No	a) May be used on lightly trafficked, urban-fringe and other low road class locations.
Unbound granular with sprayed seal surfacing (SS-GR)	Lightly trafficked to heavily trafficked	Sprayed seal[(b)], prime, on class PM1 unbound granular basecourse and class PM2 subbase. Possibly class PM3 lower subbase.	No[(c)]	Yes	Rural: yes[(d)] Urban: no	b) The use of asphalt should be considered at intersections and other high stress locations, subject to meeting asphalt fatigue criteria requirements. c) May be used on light to moderate temporary pavements, lower class roads and urban-fringe locations. d) Extensively used on heavily trafficked rural roads with DESA exceeding 10^7 ESA, with due consideration of Project location, existing pavement types, available materials, available construction plant, climate, acceptable performance standards and maintenance / whole of life cost considerations by the Contractor.
Unbound granular with thin asphalt surfacing (AC-GR)	Lightly trafficked to moderately trafficked	One or 2 layers of asphalt, possible sprayed seal, prime, over class PM1 basecourse and class PM2 subbase materials. Typically for lightly trafficked roads, with full depth asphalt needed at higher traffic loadings to satisfy fatigue criterion as per section 9.4.	Yes	Yes[(e)]	No	e) Asphalt surfacing typically reserved for junction treatment where sprayed seal stripping and tearing is an issue, and full depth asphalt is not achievable. Refer section 9.4.
Full depth asphalt with unbound	Moderately trafficked to heavily trafficked	Multiple asphalt layers (typically 3 to 6 layers, depending on traffic loading), on a single class PM2 subbase layer, and type A select fill.	Yes	Yes[(f)]	Yes	f) Reserved for strategic projects only, due to logistics and cost of asphalt on rural sites.

Pavement type	Traffic loading category[1]	Details	Urban	Rural	Heavy-duty	Notes
granular subbase (FDA)						
Asphalt surfaced cemented subbase (AC-CTSB)	Lightly trafficked to moderately trafficked	Also referred to as an asphalt cemented composite pavement, comprising thick asphalt on 2 cemented subbase layers placed on the same day. Minimum asphalt thickness designed to inhibit reflection cracking (refer section 8.3.10).	Yes	No	No	-
Deep strength asphalt pavement (DSA)	Moderately trafficked to heavily trafficked	Deep strength asphalt pavements - minimum 175 mm thickness of asphalt on a single 150 - 200 mm cemented (fully-bound) subbase on a single class PM2 subbase layer, and type A select fill, when heavily trafficked.	Yes	No	Yes	-

Table notes:

(1) As per section 3.1b).

Table RD-PV-D1 3-2 Existing pavement rehabilitation treatments

Pavement type	Traffic loading category[(1)]	Details	Urban	Rural	Heavy-duty	Notes
Unbound granular overlay / inlay, with sprayed seal surfacing (SS-GR OL, SS-GR IL)	Lightly trafficked to heavily trafficked[(a)]	Granular overlay or inlay, utilising existing pavement as lower structural layers, with prime, sprayed seal surfacing.	No	Yes	Rural: yes Urban: no	a) Extensively used on heavily trafficked rural roads with DESA exceeding 10^7 ESA, with due consideration of project location, existing pavement types, available materials, available construction plant, climate, acceptable performance standards and maintenance / whole of life cost considerations by the Contractor.
Unbound granular overlay / inlay, with thin asphalt surfacing[(c)] (AC-GR OL, AC-GR IL)	Lightly trafficked to moderately trafficked[(c)]	Granular overlay or inlay, utilising existing pavement as lower structural layers, with asphalt surfacing.	Yes[(b)]	Yes	No	b) Rare in urban environments due to construction constraints. c) Asphalt surfacing must satisfy fatigue criterion for nominated Design Life.
Asphalt overlay or patching (AC OL, AC IL or AC P&R)	Moderately trafficked to heavily trafficked	Asphalt overlay or patching, with number of AC layers varying with strengthening requirements. May be constructed as overlay directly onto existing pavement surface with increase in surface level, or as plane and reinstatement (patching), reinstated to existing pavement surface levels.	Yes	Yes[(d)]	Yes	d) Typically, only used on strategic projects due to cost and logistics on rural sites.

Pavement type	Traffic loading category[(1)]	Details	Urban	Rural	Heavy-duty	Notes
Cementitious stabilisation (SS-CS, AC-CS)	Lightly trafficked to heavily trafficked[(e)]	In situ stabilisation of existing granular pavement materials, with cementitious binder, surfaced with a sprayed seal or asphalt. Modified, lightly-bound or heavily-bound material.	Yes[(f)]	Yes[(f)]	Yes[(g)]	e) Design thickness may be limited by stabilisation machinery capability or available compactive effort, which must be considered in the design. f) Protection of materials during curing periods and traffic management restrictions is a key consideration, besides structural design. g) Subject to project specific performance and risks assessment.
Foamed bitumen stabilisation (SS-FBS, AC-FBS)	Lightly trafficked to heavily trafficked[(h)]	In situ stabilisation of existing granular pavement materials, with foamed bitumen and/or lime, surfaced with a sprayed seal or asphalt.	Yes[(i)]	Yes[(i)]	Yes[(j)]	h) Design thickness may be limited by stabilisation machinery capability, available compactive effort which must be considered in the design. i) Protection of materials during curing periods and traffic management restrictions is a key consideration, besides structural design. j) Subject to project specific performance and risks assessment.

Table notes:
(1) As per section 3.1b).

Table RD-PV-D1 3-3 Minimum support requirements for heavy-duty pavements

Subgrade design CBR (%)	Support treatment options and material quality treatments(1) (CBR)	Minimum thickness (mm)
>10	PM2 or characteristic strength(2) ≥30	150
3 ≤ CBR ≥ 10	In situ lime stabilisation(3)	250
	150 mm PM2 or characteristic strength(2) ≥30 over 150 mm Type A or B and characteristic strength(2) ≥15	300
<3	150 mm PM2 or characteristic strength(2) ≥30 over 250 mm in situ lime stabilisation(3)	400
	150 mm PM2 or characteristic strength(2) ≥30 over 350 mm Type A or B and characteristic strength(2) ≥15	500

Table notes:

(1) Must comply with RD-EW-C1 “Earthworks” and RD-PV-S1 “Supply of Pavement Materials”.

(2) Characteristic strength defined in section 6.3 (i.e. equal to 10th percentile of 4 day soaked CBR).

(3) Laboratory investigation of binder content to ensure long term characteristic strength >30.

3.3 Other design considerations

3.3.1 General

The Contractor must ensure that the pavement design satisfies the Principal's requirements for pavement construction and maintenance as set out in the Contract Documents, such that the modulus, thickness or other critical properties assumed in the design model are achieved.

3.3.2 Drainage

a) The Contractor must ensure that the pavement material and subgrade is well-drained. The pavement design must assess the need for subsoil drainage, considering as a minimum to include:

  i) soil moisture and groundwater conditions, soil type, etc identified in the geotechnical site investigation in accordance with section 5.2, with due consideration of the time of year of investigation;

  ii) local climate;

  iii) road geometry and surface drainage; and

  iv) other risk factors, including presence of hillside cuttings, areas where the median or verge irrigation may lead to water entering the pavement, proximity to rivers or beaches, water service integrity, and other potential moisture sources.

b) Where the Works constitute motorway class projects, as nominated in the Contract Documents, subsurface drains must be used along the full length of the main alignment.

c) The Contractor must ensure that the pavement design complies with the drainage requirements of:

  i) AGPT Part 10: Subsurface Drainage; and

  ii) RD-DK-D1 “Road Drainage Design”.

3.3.3 Volumetric change

The Contractor must ensure that the pavement design complies with all volumetric change requirements of RD-EW-D1 “Design of Earthworks for Roads”.

3.3.4 Environment

The pavement design must consider the local climate and the impact on pavement and subgrade design characteristics and performance.

3.3.5 Sustainability

The Contractor must ensure that the pavement design complies with all Sustainability in Design requirements of PC-ST1 “Sustainability in Design”.

3.3.6 Overtaking or auxiliary lanes

a) Where an overtaking or auxiliary lane is being constructed as a widening of an existing carriageway pavement the design must consider the interaction between the existing pavement and new widening to ensure that:

i) any defects in the existing pavement are treated; and

ii) new Works are able to achieve all requirements of this Master Specification Part.

b) A detailed pavement condition survey must be completed in accordance with section 5.3 to identify any defects in the existing pavement, including a review of available automated pavement condition data.

c) Where the existing pavement is sound and will achieve the nominated Design Life by having low roughness and no other defects, and no level changes are needed to achieve road geometric design requirements, then the existing pavement must be treated with a resurfacing.

d) Where the existing pavement has existing defects impacting the nominated Design Life or poor shape, the pavement design must address the defects, including:

i) shape correction works, as necessary to ensure that:

A. drainage is achieved across the entire carriageway; and

B. the existing pavement shape is corrected to achieve roughness criteria in “RD-BP-D4 “Surface Characteristics of Flexible Pavements” on both the new widening and existing carriageway; and

ii) repair of pavement defects to achieve the nominated Design Life.

e) Where geometric changes to the existing pavement will occur, the design must consider the interaction of the current and future levels, and resulting remnant pavement thicknesses, such that the existing pavement will achieve the nominated Design Life.

4 Design traffic

4.1 Selection of design period

The Contractor must ensure that the pavement design satisfies the Design Life set out in:

a) the Contract Documents; or

b) Table RD-PV-D1 4-1,

whichever is the longer.

Table RD-PV-D1 4-1 Pavement Design Life periods for new pavements

Road classification	Flexible pavements, Design Life (years)	
	New	Rehabilitation
Motorway - main alignment and ramps	40	30 or 40(1)
Urban and rural arterial, urban and rural connector	30	20 or 30(1)
Access	30	20 or 30(1)

Table notes:
(1) The Contractor may propose the alternative Design Life for rehabilitation pavement designs as a Design Departure where constructability limitations exist.

4.2 Procedure for determining total heavy vehicle axle groups

4.2.1 Initial daily heavy vehicles in the design lane

a) The Pavement Design Report must clearly document the source of traffic data applied and calculations for each pavement design.

b) The following traffic data must be considered in developing the pavement design traffic loading, where available:

  i) traffic data provided by the Principal;

  ii) Principal operated weigh in motion (WIM) data (located on major freeways and interstate freight routes across South Australia);

  iii) detailed traffic load distributions (TLDs), including NHVAG, ESA/HVAG, ESA/HV and percent HV for each site (see Table RD-PV-D1 4-2);

  iv) urban and rural traffic estimate map (available from: https://location.sa.gov.au/viewer);

  v) intersection turning count surveys;

  vi) mid-block classification counts; and

  vii) traffic modelling and forecasts.

c) The Principal has a substantial database of traffic data which the Contractor may request from the Principal. The Contractor may not place any reliance on the traffic data provided by the Principal. The use of any aspect of the legacy traffic data is entirely at the Contractor's risk.

d) The Contractor must consider the value of completing Project specific traffic counts where available data is limited and these counts will improve optimised pavement design outcomes.

e) The Contractor must ensure that the pavement design adopts the AADT, HV counts or percentages, and design traffic growth rates if included in the Contract Documents.

4.2.2 Short-term heavy loadings

a) The design of short-term heavy loadings must be considered in the pavement design including:

  i) temporary pavements with an operational period of less than 5 years;

  ii) temporary bus lanes for community and sporting events; and

  iii) roads with seasonal grain haulage.

b) The design traffic loading of short-term heavy loadings must be calculated using a 5 year Design Life with zero traffic growth rate using the maximum daily HV volume. The adopted Design Life must consider the following risk factors and acceptable performance outcomes including:

  i) the consequences of failure during the temporary pavements use, which may include safety risks, reputational damage and contractual penalties if maintenance works need to be undertaken to provide a serviceable pavement;

  ii) the intensity of traffic loading immediately upon opening to traffic;

  iii) the temporary pavement operating speed; and

  iv) the inspection regime when in service.

c) Presentation of the technical basis of the selected design traffic loading of short-term heavy loadings must be documented in the Pavement Design Report.

4.2.3 Cumulative number of heavy vehicles when below capacity

a) The following minimum HV growth rates over the Design Life must be adopted:

  i) motorway and interstate freight routes: 3.9%; and

ii) arterial and connector: 3.0%.

b) Different values to these presumptive values may be appropriate, based upon a review of Project specific data, and subject to approval by the Principal.

4.3 Estimation of cumulative heavy vehicle axle groups (NHVAG) and traffic load distribution (TLD)

4.3.1 General

a) Table RD-PV-D1 4-2 summarises the traffic characteristics at the Principal's WIM sites. The corresponding traffic load distributions are available for download at: https://www.dit.sa.gov.au/standards/standards_and_guidelines.

b) The WIM data included in Table RD-PV-D1 4-2 must be used to select NHVAG and TLD, where suitable with respect to the proximity to the WIM site and similarity of traffic characteristics.

c) Where a suitable WIM site cannot be established, the TLD must be selected based upon the Principal's road categories and the largest Austroads vehicle class that uses the road, as stated in Table RD-PV-D1 4-3.

d) The presumptive urban general access TLD is applicable for moderately trafficked urban arterial and urban connector roads meeting the following criteria:

i) maximum Austroads vehicle class 9;

ii) the percentage of long articulated vehicles (class 6 to 9) vehicles is ≤20% of the total HV count; or

iii) Wingfield - WI1 as per Table RD-PV-D1 4-2 must be used where greater than 20% of long articulated vehicles are present.

e) Lightly trafficked roads must use the presumptive NHVAG and TLD values provided in AGPT Part 2 Pavement Structural Design, unless more specific Project data is available in accordance with section 4.2.1b).

f) The Contractor must develop a Project specific NHVAG and TLD where a pavement carries a high proportion of a particular HV type and loading, including:

i) busways and lanes, carrying a high proportion of rigid and articulated buses; and

ii) quarries, refuse facilities, other industrial facilities, carrying a high proportion of a particular truck type, potentially with a high proportion of vehicles loaded at legal load limits.

Table RD-PV-D1 4-2 Traffic characteristics of South Australian WIM sites

ID	Road	Location	Direction	Lane	Year	NHVAG	ESA/ HVAG	ESA /HV	Percent HVs
BTE	Dukes Highway	Bordertown	E	OL	2018	3.52	1.139	4.01	26.6
BTW	Dukes Highway	Bordertown	W	OL	2018	3.54	1.421	5.03	28.6
DUE	Sturt Highway	Dutton	E	OL	2021/22	3.81	1.986	7.57	26.8
DUW	Sturt Highway	Dutton	W	OL	2021/22	3.80	1.741	6.61	27.1
IKE	Eyre Highway	Iron Knob	E	OL	2018	4.06	1.231	5.00	29.0
IKW	Eyre Highway	Iron Knob	W	OL	2018	4.04	1.126	4.55	31.3
MOE	South Eastern Freeway	Monarto	E	OL	2016	3.22	1.171	3.77	15.9

ID	Road	Location	Direction	Lane	Year	NHVAG	ESA/ HVAG	ESA /HV	Percent HVs
MOW	South Eastern Freeway	Monarto	W	OL	2016	3.18	1.160	3.68	12.8
NAN	Riddoch Highway	Naracoorte	N	OL	2021/22	3.37	1.383	4.67	14.3
NAS	Riddoch Highway	Naracoorte	S	OL	2021/22	3.33	0.863	2.87	19.8
OWN	Barrier Highway	Oodla Wirra	N	OL	2021/22	4.01	1.237	4.95	36.7
OWS	Barrier Highway	Oodla Wirra	S	OL	2021/22	4.03	1.375	5.54	34.9
PIN	Stuart Highway	Pimba	N	OL	2020	4.72	2.008	9.47	22.6
PIS	Stuart Highway	Pimba	S	OL	2018	4.59	1.366	6.27	19.8
WI1	Port River Expressway	Wingfield	E	OL	2021/22	3.06	1.053	3.22	14.3
WI2	Port River Expressway	Wingfield	E	IL	2021/22	2.63	0.907	2.63	2.3
WI3	Port River Expressway	Wingfield	W	IL	2021/22	3.17	1.001	3.17	5.3
WI4	Port River Expressway	Wingfield	W	OL	2021/22	2.94	1.035	3.04	12.7
UGA	Department Urban Presumptive	N/A	N/A	N/A	2023	2.16	0.719	1.55	N/A

Table RD-PV-D1 4-3 Presumptive heavy vehicle characteristics for the Principal's roads

	Urban roads		Rural roads		
Largest Austroads vehicle class allowed on road(1)	Class 9 (PBS level 1A)	Class 10 or Class 11 (PBS level 2A to 3B)	Class 9 or Class 10 (PBS level 1A to 2B)	Class 11 (PBS level 3A or 3B)	Class 12 (PBS level 4A)
Design TLD	Presumptive UGA(2)	Wingfield - WI1	Bordertown - BTW	Oodla Wirra - OWS	Pimba - PIN

Table notes:

(1) Federal and State Government regulations set the largest allowable vehicle on a particular route, as shown on the National Heavy Vehicle Regulator (NHVR) online map system, refer National Network Map | NHVR Portal.

(2) Department urban presumptive, see ID in Table RD-PV-D1 4-2.

4.3.2 Perpetual pavement traffic loading

a) The Principal accepts the perpetual pavement concept and use of the upper limits on design traffic for asphalt fatigue. This corresponds to a design traffic loading of 2×10^8 ESA for the Adelaide urban region (WMAPT of 28°C).

b) The Contractor must consider the whole of life cost benefits of constructing the perpetual pavement thickness corresponding to 2×10^8 ESA, when the design traffic loading is approaching this value and include these considerations in the Pavement Design Report.

4.3.3 Shoulder pavement traffic loading

The Contractor must ensure that the shoulder pavement design adopts the design traffic loadings determined in accordance with section 10.

4.3.4 Turn lanes

a) Turn lane traffic loadings must utilise turn count data where available.

b) Where no turn count data is available, the following presumptive values must be adopted and stated in the Pavement Design Report:

   i) for intersecting arterial roads the value must be selected based on a conservative proportion of through lane traffic on each road; and

   ii) for mid-block turn lanes into council roads the value must be selected based on the council road class and AGPT Part 2 Pavement Structural Design.

5 Site investigation

5.1 General

a) The Contractor must undertake all Site investigations required to assess the existing pavement and subgrade conditions to inform the design.

b) The Site investigation scope must be developed by a suitably experienced engineer, in accordance with the requirements of this section 5.1. The Site investigation scope must include:

   i) identification types and relevant standards and test procedures;

   ii) requirements for the design of new pavements on greenfield sites;

   iii) requirements for the design of rehabilitation treatments of existing pavements; and

   iv) as a minimum, all Site investigations included in Table RD-PV-D1 5-1.

c) The scope of Site investigations and associated laboratory testing must be developed to:

   i) provide sufficient data to allow optimised pavement design, including existing pavement layer materials and thickness, layer moduli and subgrade design CBR;

   ii) for rehabilitation treatment design, identify and confirm the causes of the pavement distress and deficiencies in the existing pavement, and their spatial variability, or validating the presence of sound pavement;

   iii) meet Sustainability in Design and construction criteria outlined in PC-ST1 “Sustainability in Design” and PC-ST2 “Sustainability in Construction”; and

   iv) identify potential construction issues and risks including:

      A. wet subgrades and shallow groundwater;

      B. weak or expansive subgrades;

      C. strongly, weak or cracked cemented layers;

      D. coarse macadam layers; and

      E. uncontrolled fill.

d) The scope of the Site investigation must be sufficient to minimise the risk of design uncertainty, to meet the requirements of section 5.1c) and provide:

   i) selection of pavement design parameters and inputs;

   ii) test data directly used in design methods;

   iii) information for the design of other details like pavement joints and subsurface drains and expansive clay subgrade treatments; and

   iv) identifying potential construction issues and risks.

e) The site investigations must be included in the Pavement Design Report.

Table RD-PV-D1 5-1 Site investigation requirements

Investigation	New pavements	Rehabilitation treatments	Further details
Geotechnical site investigation			
Boreholes / test pits	Mandatory	Mandatory	See section 5.2.1a)
Diamond coring	N/A	Project specific	See section 5.2.2
Dynamic cone penetrometer (DCP)	Mandatory	Mandatory	See section 5.2.2
Laboratory testing	Mandatory	Mandatory	See section 5.2.3
Non-invasive manual or automated testing			
Site inspection	Mandatory	Mandatory	See section 5.3
Skid resistance testing	N/A	Project specific	See section 5.5.2
Deflection testing	N/A	Project specific	See section 5.5.6
Surface texture	N/A	Project specific	See section 5.5.2
Surface rutting	N/A	Project specific	See section 5.5.4
Cracking	N/A	Project specific	See section 5.5.5
Ground penetrating radar	N/A	Project specific	-

5.2 Intrusive Site investigation

5.2.1 Pavement and subgrade data

a) The Site investigation must identify the existing pavement composition and subgrade conditions through boreholes or test pits.

b) Table RD-PV-D1 5-2 provides required borehole or test pit investigation frequencies.

c) Works to be undertaken at each borehole or test pit location is provided in Table RD-PV-D1 5-3.

d) Assessment of existing asphalt and other bound materials in pavements must be supplemented with diamond coring, as outlined in Table RD-PV-D1 5-2 and Table RD-PV-D1 5-3.

e) Existing pavement and subgrade samples must be collected for laboratory testing.

f) The Contractor must undertake Site specific investigation techniques where necessary to evaluate unusual or unique existing pavement and subgrade conditions.

g) An appropriately experienced pavements or geotechnical engineer, or geotechnician, must be present full-time during the Site investigation to direct the testing and sampling, prepare engineering logs, and ensure best quality data outcomes.

5.2.2 Investigation locations

a) The Site investigation frequency and locations must be determined by the Contractor considering Project specific requirements, including as a minimum:

i) the Project scope and desired performance outcomes (acceptable pavement performance risk);

ii) the investigation cost versus the Project scope and the impact on pavement design and construction cost;

iii) candidate rehabilitation treatment options, and the data required for further assessment of their suitability and detailed design;

iv) observed or inferred variability or uniformity of:

A. existing pavement condition;

B. road geometry, including number of lanes, curves, grades and presence of cut or fill;

C. general topography and vegetation;

D. likely subgrade soils and regional geology, source from publicly available geological maps;

E. drainage and moisture conditions;

F. underground Utility Services;

G. construction and maintenance history, including widenings and service works; and

H. deflection or other pavement condition test data (skid resistance, rutting, texture, cracking, etc.); and

v) anticipated number of pavement treatment types and their extents.

Table RD-PV-D1 5-2 Borehole / core / test pit scope

Project scope(2)(3)(4)	Investigation type	Urban site(1)	Rural site(1)	Notes
New pavement	Boreholes or test pits, with DCP, PP	1.5 m boreholes, typically, 200 to 250 m, maximum 300 m spacing.	1.5 m boreholes typically 200 m to 300 m spacing, maximum 350 m spacing.	Nominally 1.5 m depth, plus 3 m boreholes for RD-EW-D1 “Design of Earthworks for Roads” shrink-swell calculation.
Pavement rehabilitation	Diamond cores	Typically, 150 m to 200 m, maximum 250 m spacing.	Typically, not applicable with sprayed seal surfacings.	a) Consider need to core each lane on multi-lane roads. b) Suitable for asphalt surfacings, and other bound materials (cement treated, foamed bitumen stabilised).
	Boreholes or test pits, with DCP, PP	Typically, 300 m to 400 m spacing, maximum 500 m spacing.	1.5 m boreholes typically at 250 m to 300 m spacing, maximum 500 m spacing.	a) Closer investigation spacing may be warranted for basecourse material sampling where in situ stabilisation is a candidate treatment or high pavement variability is anticipated. b) Shoulders must be drilled adjacent to each traffic lane boreholes on rural sites. c) Use of hydro-vacuum excavation techniques may be required based on underground service risk, with due consideration of the benefit-cost of this more expensive investigation type.

Project scope(2)(3)(4)	Investigation type	Urban site(1)	Rural site(1)	Notes

Table notes:

(1) These spacings apply to the main road pavement only and additional investigations must be completed at intersections, turn lanes, widenings and other road elements, where different pavement and subgrade conditions may be present.

(2) Available historical, asset and pavement condition data must be considered as part of scoping and may allow reduced frequency of testing, or similar justify increased scope.

(3) Investigations must be completed to inform joint design between new and existing pavements. This is mandatory on lane widenings, overtaking lanes, turn lanes and similar works where substantial longitudinal joints are present.

(4) Comparison of areas of sound and distressed pavement must be considered in the scope, to determine whether variations in the pavement composition or support conditions have contributed to the difference in performance.

Table RD-PV-D1 5-3 Borehole / core / test pit site requirements

Geotechnical and pavement investigation requirement	Notes
Exposure of the pavement and subgrade materials by borehole(a) to a minimum depth of 1.5 m(c) with a minimum natural subgrade penetration of 0.5 m, at the nominated test locations(b). Asphalt pavements to be diamond cored at regular intervals(d), cores to be retained, numbered and forwarded to the Principal, if nominated by the Principal. Coring may also be required on other fully-bound materials, e.g. foam bitumen stabilised or cement treated layers. Sprayed seals may be auger drilled rather than cored, unless a specific seal issue warrants coring.	a) A borehole excavated with a drill rig is preferred on existing roads due to reduced disturbance of the existing pavement and easier reinstatement. However, test pits excavated with a backhoe or excavator may be more appropriate in some situations, e.g. shoulder investigations or greenfield sites. Larger diameter boreholes are necessary where coarser pavement materials are present, e.g. macadams or to obtain larger bulk samples for laboratory testing. b) The Principal may assign investigation locations in the Contract Documents, or otherwise the Contractor should implement a scope of works adequate to inform optimised pavement design, and also meet minimum requirements in Table RD-PV-D1 5-2. c) Extending some boreholes to 3 m depth is also required to inform RD-EW-D1 “Design of Earthworks for Roads” shrink-swell calculations, unless shallow rock or sand soils are present. d) To determine the thickness and quality of the asphalt layers for design and construction planning purposes. Coring increases investigation time and cost and may not add value and be necessary when the results won’t affect the treatment assessment and design. However, cores are invaluable when assessing issues with fully-bound materials, like potential debonding of asphalt layers, the quality and age of asphalt layers, depths of cracking and identifying lower density zones in asphalt or cement treated layers.

Geotechnical and pavement investigation requirement	Notes
Engineering logging of: Pavement layers(e), including identification of sprayed seal surfacings, asphalt layers, granular layers, fully-bound layers and any primes, or other interlayers, fabrics, grids etc. Soil strata, including the distinction between natural or fill materials, in accordance with AS 1726 Geotechnical site investigations. Identification of moisture conditions in each layer.	e) Identification of different pavement layers and material types is a critical requirement of the investigation and must be done with due care. Failure to identify materials like marginal materials, macadam, fully-bound layers, wet subgrades, etc, may lead to inappropriate design and construction outcomes at increased cost.
Sampling as appropriate for laboratory testing and identification.	f) See below section 5.2.3 for further comment on laboratory testing requirements.
Dynamic cone penetrometer (DCP) testing of fill / subgrade materials at each bore hole location to 1.5 m(g) measuring penetration per blow, in accordance with AS 1289 Methods of testing soils for engineering purposes. The in situ CBR must be calculated as per AGPT Part 2: Pavement Structural Design Figure 5.5, relationship and presented on the bore logs or pavement report.	g) Deeper DCP testing may be required in deeper deposits of weaker material, to identify the depth to sound strata.
Hand pocket penetrometer (PP) readings of cohesive soils, with test results and inferred consistency shown on the logs at the relevant depth, and maximum of 0.5 m spacing where possible.	

5.2.3 Laboratory testing

a) Sufficient sampling and laboratory testing of the pavement and subgrade materials must be undertaken to attain adequate representation of the pavement, subgrade, and any fill materials.

b) Samples for laboratory CBR testing must be concentrated on the governing subgrades and fills (i.e. those most likely to provide the poorest support that govern selection of design CBR), allowing for the anticipated pavement founding level.

c) The Contractor must adjust the nominal investigation scope and sampling depths where necessary during the site investigation in response to observed ground conditions during the investigation.

d) Testing must be undertaken in a NATA accredited laboratory in accordance with the relevant parts of AS1289 - Methods of testing soils for engineering purposes, or the other relevant test standard stated in this Master Specification Part.

e) Table RD-PV-D1 5-4 states test types and conditions applicable on the Principal's projects, which the Contractor must comply with.

f) The Contractor must undertake other laboratory testing appropriate depending on the pavement issues and site conditions being investigated.

g) The Contractor must vary test conditions as needed to better align testing conditions with anticipated field conditions in-service or meet other Project needs.

Table RD-PV-D1 5-4 Typical laboratory test types

Laboratory test	Test conditions and notes	Requirement
4-day soaked CBR on remoulded samples	a) As per AS 1289 Methods of testing soils for engineering purposes. b) Subgrade: Test specimens remoulded to 98% Standard compaction, OMC with 4.5 kg surcharge during soak and swell and penetration testing phases.(1) c) Pavement materials: As set out in the Contract Documents.	Mandatory
Estimated CBR	Subgrade: Department Test Procedure TP133 Method of Estimation of CBR from Classification Test, where an estimate of the CBR is obtained from Atterberg limit and particle size distribution tests (AS 1289 Methods of testing soils for engineering purposes).(2)	Mandatory
Atterberg limits and particle size distribution	Granular pavement materials or subgrade: As per AS 1289 Methods of testing soils for engineering purposes.	Rural: mandatory Urban: Project specific
Moisture content	Granular pavement materials or subgrade: As per AS 1289 Methods of testing soils for engineering purposes.	Project specific
Los Angeles value(3)	As per AS 1141.23 Methods for sampling and testing aggregates, Method 23: Los Angeles value.	Project specific
Stabilisation mix design(4)	a) Granular pavement materials (e.g. FBS, CT, other binder), or subgrade (lime, CT): May involve unconfined compressive strength testing (UCS), lime demand testing, soaked CBR testing and modulus and fatigue testing, depending on binder and project scope. b) Refer AGPT Part 5: Pavement Evaluation and Treatment Design, AGPT Part 4D - Stabilised Materials and corresponding to RD-BP-C2 “Construction of Foamed Bitumen Stabilised Pavement” and RD-PV-C3 “In situ Pavement Stabilisation” for test details.	Project specific
Asphalt testing	a) Air voids, binder content, gradings are not typically tested on routine rehabilitation designs, but may be appropriate when evaluating asphalt quality issues. b) Refer AGPT Part 4B: Asphalt and RD-BP-S1 “Supply of Bituminous Material”, RD-BP-S2 “Supply of Asphalt” and RD-BP-C3 “Construction of Asphalt Pavement” for further information.	Project specific
Sprayed seal testing	Coring may be considered, as well as binder testing if evaluating seal quality issues.	Project specific

Laboratory test	Test conditions and notes	Requirement

Table notes:

(1) This surcharge and target density aligns with AGPT Part 2 Pavement Structural Design Guide to classification of expansive soil. The Contractor must consider other densities and surcharges where appropriate.

(2) This test is useful in providing both a soil classification and estimate of CBR based on statistical analyses from a single sample, but a lower weighting in the selection of a design CBR must be given to these CBR results versus the 4-day soaked CBR values. The importance of field moisture contents in clayey materials is stressed particularly as a ratio of the plastic limit.

(3) Los Angeles value is typically of interest when evaluating granular materials for stabilisation, breakdown and aggregate quality.

(4) Laboratory mix design of stabilisation treatments typically requires collection of a large volume of pavement materials. Testing requirements are determined based on proposed depth, stabilisation binder and parent materials, and corresponding test methods.

5.2.4 Using laboratory test data with granular materials

a) The quality of existing granular pavement materials must be compared to the pavement material requirements of RD-PV-S1 “Supply of Pavement Materials”.

b) Conformance with these specifications must be considered with the assignment of design parameters like elastic modulus in mechanistic empirical modelling.

5.3 Site inspection and pavement condition survey

5.3.1 General

The Contractor must complete a site inspection as per PC-SI2 “Site Investigations” as part of preparing the design of new or existing pavement treatments, which must identify:

a) general site conditions, including topography, vegetation, drainage and other environmental considerations, existing roads and other structures, and more, as relevant to the design, construction and future performance of the pavement; and

b) a visual pavement condition survey where existing pavements are present and within the Project scope.

5.3.2 Visual pavement condition survey

a) The Contractor must undertake a visual pavement condition survey including the description and assessment of visual distress as described in AGPT Part 5: Pavement Evaluation and Treatment Design.

b) The pavement condition survey must be provided in the Pavement Design Report and be presented as either:

   i) a mark-up of aerial photographs, identifying the extent and severity of distress present onsite, and nominal treatment requirements;

   ii) a table of conditions by chainage or road running distance (RRD), where a consistent road geometry and conditions are present; or

   iii) general description in the report text, for simpler sites and conditions.

c) Photographs of the pavement condition must be provided as part of the Pavement Design Report to illustrate conditions.

5.4 Historical data

Available historical data must be sourced, reviewed, and considered as part of the evaluation of site conditions and to inform pavement design. This may include Principal supplied information including existing pavement drawings, traffic data, previous site investigation results and more.

5.5 Pavement condition data

5.5.1 General

a) This section 5.5 presents requirements for different types of pavement condition data commonly utilised in existing pavement treatment design which, where available, must be incorporated in the Pavement Design Report including the:

i) skid resistance - automated measurement;

ii) surface texture - automated or manual measurement;

iii) pavement roughness - automated measurement;

iv) wheel path rutting - automated or manual measurement;

v) cracking - automated or manual measurement; and

vi) pavement surface deflection - automated.

b) The Contractor must comply with AGAM Technical Information Part 15: Technical Supplements when undertaking the pavement survey and preparing the pavement condition survey report.

c) The Contractor must comply with RD-BP-D4 “Surface Characteristics of Flexible Pavements” which provides test methods and acceptance criteria for skid resistance, roughness, surface texture, rutting and cracking that apply to completed asphalt surfaced pavement works, for both new and rehabilitation treatments.

d) The Contractor must comply with RD-BP-D2 “Design and Application of Sprayed Bituminous Surfacing” which provides acceptance criteria for surface texture for sprayed seal surfaced pavement works, for both new or rehabilitation treatments.

e) The criteria in section 5.5.2 and section 5.5.3 are provided for the assessment of existing pavement condition data. The Contractor must consider this data within the context of overall conditions and Project objectives described in the Contract Documents.

5.5.2 Skid resistance and surface texture depth data

a) Wearing course skid resistance acceptance limits from RD-BP-D4 “Surface Characteristics of Flexible Pavements” must be considered as investigatory level values below which engineering assessment or risk assessment is required to establish treatment needs.

b) The wearing course skid resistance treatments established pursuant to section 5.5.2a) must achieve the requirements of RD-BP-D4 “Surface Characteristics of Flexible Pavements” or RD-BP-D3 “Surface Characteristics of Spray Seals” (as applicable).

5.5.3 Pavement roughness

a) Existing pavement roughness must be evaluated, in accordance with the following:

i) RD-BP-D4 “Surface Characteristics of Flexible Pavements”;

ii) AGPT Part 5: Pavement Evaluation and Treatment Design; and

iii) AGAM Technical Information Part 15: Technical Supplements.

b) Treatments must be designed to restore pavement roughness and meet RD-BP-D4 “Surface Characteristics of Flexible Pavements” requirements.

5.5.4 Wheel path rutting

a) The extent and depth of wheel path rutting must be evaluated in accordance with the following:

i) RD-BP-D4 “Surface Characteristics of Flexible Pavements”;

ii) AGPT Part 5: Pavement Evaluation and Treatment Design; and

iii) AGAM Technical Information Part 15: Technical Supplements.

b) Treatments must be designed to restore pavement rutting to achieve RD-BP-D4 “Surface Characteristics of Flexible Pavements” requirements.

c) Any rut depth of greater than 20 mm requires treatment.

5.5.5 Cracking

a) The type, extent and size of surface cracking identified in automated condition data (e.g. laser crack mapping survey) and visual observation and measurement must be reviewed to inform assessment of pavement and subgrade deficiencies and appropriate treatment design.

b) The assessment of pavement and subgrade deficiencies and appropriate treatment design must include consideration of:

i) environmental cracking, likely related to ageing, subgrade movements, construction joints, vegetation, shrinkage of cemented layers (CT), etc.;

ii) structural cracking, occurring in the wheel paths and typically related to accumulated damage under trafficking, material breakdown and so on; and

iii) the depth of cracking within the pavement and how this relates to required treatments.

5.5.6 Surface deflection of flexible pavements

a) Methods of testing

i) Deflectograph (DFL), falling weight deflectometer (FWD) and traffic speed deflectometer (TSD) test data must be utilised in accordance with relevant Austroads and Department test methods including:

A. Austroads Test Method AGAM-T006 Pavement Deflection Measurement with a Falling Weight Deflectometer (FWD);

B. Austroads Test Method AGAM-T007 Pavement Deflection Measurement with a Deflectograph; and

C. Austroads Test Method AGAM-T017 Pavement Data Collection with a Traffic Speed Deflectometer (TSD) Device.

b) Selection of test sites

i) For projects where FWD deflections are not complemented by detailed DFL data, the spacing of individual test sites must be arranged so that the general variability or deflection trends can be identified.

ii) For Projects less than 2 km in length, FWD measurements must be taken at 10 m spacings in both wheel paths of each test lane.

iii) For Projects greater than 2 km in length, the spacing of test points may be increased to 20 m to 50 m, with closer spacings required where the existing pavement condition, known pavement types, support conditions, traffic loading, road geometry, etc are more variable.

iv) If the Contractor proposes to stagger testing in each lane of undivided rural roads, it must submit its proposal as part of the Pavement Design Report including evidence that each lane has the same pavement composition and conditions and details of the nominated test spacings.

v) Testing intervals for rural road shoulders may be increased further, subject to review of shoulder variability along the project section.

6 Subgrade

6.1 General

As per Austroads definitions, subgrade refers to the supporting materials below pavement layers, which can comprise select fill (engineered fill, earthworks) or natural soils or rock.

6.2 Selection of design CBR

6.2.1 General

The design CBR must be selected based upon, where available:

a) the results of the site investigation, and identified geotechnical and groundwater conditions;

b) the laboratory testing, including soaked CBR, estimated CBR, PSD and AL;

c) the field testing, including in situ CBR from DCP;

d) the anticipated moisture changes during Design Life;

e) the current and future design levels and materials at future subgrade level;

f) the requirements of RD-EW-D1 “Design of Earthworks for Roads” and RD-EW-C1 “Earthworks”; and

g) engineering design conservatism.

6.2.2 Laboratory determination of subgrade CBR and elastic parameters

a) The Contractor must determine the vertical design modulus of a subgrade from its design CBR and Equation 2 of the AGPT Part 2 Pavement Structural Design.

b) The vertical modulus of soil subgrades must not exceed 100 MPa.

c) The vertical modulus of sound rock formations must not exceed 150 MPa.

d) In situ stabilised subgrade that has been designed and constructed in accordance with the Master Specification Parts must be characterised as selected subgrade materials, as per section 6.3.

6.2.3 Adoption of presumptive design CBR values

a) The use of presumptive design CBR values is not acceptable without the Principal’s approval in the Pavement Design Report.

b) Where presumptive design CBR values are approved, the adopted presumptive values must not exceed the lowest per drainage category of the range of values given in AGPT Part 2 Pavement Structural Design.

6.3 Selected subgrade materials (earthworks)

a) Select fill or selected subgrade materials must be considered above the in situ subgrade where necessary to:

   i) provide a working platform on which to compact pavement layers, particularly over soft subgrades;

   ii) increase the strength and uniformity of the supporting pavement substrate, including uniform permeability and drainage conditions;

   iii) meet the requirements of section 3.2.2;

   iv) increase the height of pavements on embankments; and

   v) mitigate expansive clay movements as per RD-EW-D1 “Design of Earthworks for Roads”.

b) Select fill materials must meet the requirements of Type A or B Fill from RD-EW-C1 “Earthworks” and the following:

   i) the characteristic strength of a fill material is defined as the tenth percentile value (i.e. mean - 1.3 × standard deviation) of the laboratory 4-day soaked CBR results from at least 6 samples. The samples must be taken in accordance with Department Test Procedure TP226 Sampling of Soil, Aggregates and Rocks with at least one sample from each of 6 Work Lots. The design CBR of any particular fill material must not be greater than two-thirds of the characteristic strength; and

   ii) the top 150 mm of fill must have a minimum characteristic strength of CBR 15% and a maximum vertical design modulus of 100 MPa.

c) Presumptive design parameters for conforming Type A and B Fill for use in pavement mechanistic modelling are provided in Table RD-PV-D1 6-1. These values may only be used subject to approval by the Principal.

d) Major projects as defined in the Contract Documents require testing as per section 6.3b) to select and verify design parameters.

Table RD-PV-D1 6-1 Presumptive mechanistic design parameters for select fill placed in accordance with RD-EW-C1 “Earthworks”

Material Type	Vertical elastic modulus	Poisson’s ratio
Type A	≤70 MPa	0.45
Type B	≤50 MPa	0.45

6.4 Subgrade lime stabilisation

a) Where minimal or no field and laboratory testing is undertaken with the lime stabilisation occurring as construction expedient, such treatments must not be considered in pavement design calculations.

b) Where site investigations and laboratory testing for lime demand and UCS or CBR testing are completed in accordance with AGPT Part 2 Pavement Structural Design, AGPT Part 5: Pavement Evaluation and Treatment Design and the RD-PV-C3 “In situ Pavement Stabilisation”, the layer may be included in design calculations as per AGPT Part 2 Pavement Structural Design, subject to:

   i) characteristic strength determined and the design CBR calculated as two thirds of this value, with an upper limit of CBR 15%;

   ii) design vertical modulus of the top sublayer equals 10 times the design CBR of the lime stabilised material up to a maximum value of 150 MPa; and

   iii) the Contractor must ensure that the laboratory curing regime aligns with anticipated field conditions and that a suitable construction verification scheme of parameters adopted in the design is implemented.

7 Pavement surfacing

7.1 General

a) This section 7 states the requirements for surfacing selection and detailed surfacing design.

b) Flexible pavement surfacings must satisfy increasing texture requirements with increasing traffic speed, as per Table RD-PV-D1 7-1.

c) Refer to Table RD-PV-D1 8-8 for detailed requirements on wearing course design.

Table RD-PV-D1 7-1 Flexible pavement surfacings

Speed zone	Wearing course(3)	Urban	Rural
≥80 km/h	Stone mastic asphalt (SMA)	Suitable	Not preferred(1)
	Open grade asphalt (OGA)	Suitable	Not preferred(1)
	Sprayed seal	Not preferred(4)	Suitable
<80 km/h	Dense graded asphalt (AC10M)	Suitable	Not preferred(1)(2)
	Sprayed seal	Not preferred(4)	Suitable(2)

Table notes:

(1) Asphalt pavements and surfacings are typically not preferred in rural locations due to material availability and cost, maintenance complications and the short asphalt fatigue life of thin asphalt on granular pavements.

(2) A single layer asphalt wearing course may be considered at rural junctions with significant heavy vehicle turning movements and other high shear locations to provide a more durable surfacing than a sprayed seal. The design of this option must consider asphalt fatigue and clearly document the anticipated design life and consequent performance issues and risks of this treatment, as per section 9.4e). A sprayed seal layer must be present below the asphalt for waterproofing.

(3) Surfacings on granular pavements must incorporate a prime.

(4) Sprayed seal surfacings may be considered for temporary or low class pavements, subject to documentation of related risks and benefits.

7.2 Sprayed seal surfacings

7.2.1 General

a) The design and construction of sprayed seals must be undertaken in accordance with the RD-BP-D2 “Design and Application of Sprayed Bituminous Surfacing”.

b) The Contractor must prepare nominal sprayed seal designs in accordance with:

   i) RD-BP-D2 “Design and Application of Sprayed Bituminous Surfacing”;

   ii) AGPT Part 4K: Selection and Design of Sprayed Seals; and

   iii) the considerations presented in Table RD-PV-D1 7-3.

c) Sealing aggregate must comply with RD-PV-S1 “Supply of Pavement Materials”.

d) The following requirements for sprayed sealed surfacings must also apply:

   i) the size of aggregate selected must be selected in consideration of the expected volume and composition of traffic;

   ii) subject to 7.2.1d)iii), the Contractor must select a 14/7 double seal as an initial surfacing treatment on a granular pavement;

   iii) where traffic volumes exceed 2000 vehicles per lane per day or the percentage of HVs exceeds 15%, the Contractor must select a 16/7 double seal as an initial surfacing treatment on a granular pavement;

   iv) an S20E or equivalent crumb rubber sealing binder must be adopted in both coats on heavily trafficked roads;

   v) aggregate spread rate, binder application rate and industrial diesel fuel precoat rates must be nominated;

   vi) where high traffic volumes require the use of low binder application rates, geotextile reinforced seals may be utilised to minimise the degree of aggregate embedment. However, this treatment must not be applied to areas subject to high shear forces such as intersections, tight corners, and steep climbing lanes;

vii) Table RD-PV-D1 7-2 provides general maximum limits for average ball penetration values at varying traffic volumes, which must be stated on the Design Documentation;

viii) standard notes presented on the example work schedules in Department Drawing Presentation RD2.1 Example Drawings for Large Project and Department Drawing Presentation RD2.2 Example Drawings for Small Project (as applicable) must be included; and

ix) sprayed seal wearing courses must not be given a nominal design thickness in work schedules, with finished surface levels for construction conformance measured on the top of the granular basecourse.

e) The Contractor must present the sprayed seal surfacing design in the format provided in Department Drawing Presentation RD2.1 Example Drawings for Large Project and Department Drawing Presentation RD2.2 Example Drawings for Small Project.

Table RD-PV-D1 7-2 Suggested maximum average ball penetration values

Traffic volumes (AADT/lane/day)	Ball penetration[1] (mm)
AADT/lane/day ≤1500	3.5
1500 < AADT/lane/day ≤2500	3.0
2500 < AADT/lane/day ≤3000	2.5
AADT/lane/day > 3000	2.0

Table notes:
(1) The penetration values are a guide only, determination of an appropriate hardness value will depend on several factors including traffic composition, gradient and curve radii.

Table RD-PV-D1 7-3 Guide to the selection of sprayed bituminous surfacings

<table>
<tr><th>Period when treatment applied</th><th>Open to traffic immediately</th><th>Initial trafficking between April to September</th></tr>
<tr><td>October to March[1]</td><td>Prime[2] pavement with very light prime (AMC00) or medium prime (AMC0) followed in not less than 3 days by 14/7 or 16/7 double seal.</td><td rowspan="2">Apply prime[2] and 7 or 10 mm seal followed the next summer by 14/7 or 16/7 double seal after several weeks of summer trafficking has occurred.</td></tr>
<tr><td>April</td><td>Very light prime followed by 14/7 or a 16/7 seal.
Where a geotextile is required[3] adopt a 7 mm or 10 mm seal. Ensure this seal receives warm weather trafficking for 2 weeks, and then apply 14/7 or 16/7 geotextile double seal.</td></tr>
<tr><td>May to September</td><td colspan="2">7 mm or 10 mm primer seal[4]. Traffic in warm weather for 2 weeks (emulsion) or 3 months (cutback) prior to applying final seal in summer. Preferably postpone surfacing treatment until October and apply prime and double seal.</td></tr>
</table>

Table notes:

(1) In areas north of Port Augusta, October to April may be appropriate.

(2) Selection of prime type depends on type of basecourse material and porosity of surface. Embedment allowances over primed basecourse are determined in accordance with AGPT Part 4K: Selection and Design of Sprayed Seals. Maximum permissible ball penetration values will depend on traffic volume and composition.

(3) Application of geotextile seals should be limited to the period between November to March inclusive.

(4) It is advisable to leave cutback primer seals exposed for 6 to 12 months. Emulsion primer seals may have a final seal applied after several weeks of trafficking in hot weather.

(5) The presence of salt in the basecourse can result in damage to new seals. Where salinity may be an issue, specialist advice must be sought.

(6) Geotextile seals must not be used in areas of high shear forces where they may debond.

7.2.2 Reseal of existing pavements

a) The detailed design of reseals is beyond the scope of this Master Specification Part, requiring specialist expertise and design knowledge, as with new seals.

b) The Contractor must assess the condition of all existing seals within the Site, determine if treatments other than reseals are required to achieve the required Design Life and include all relevant details in the Pavement Design Report.

7.3 Primes

a) A prime must be applied to granular or cement treated bases prior to spray sealing.

b) Cement treated bases must be primed with a very light prime at a rate of 0.4 - 0.6 L/m^2 depending on the surface finish of the pavement.

c) Cutback bitumen primer seals must be trafficked for 3 months between October and March before placing a sprayed seal or asphalt surfacing less than 100 mm thick.

d) If the prime or primer seal time constraints are unfeasible, the Contractor must include details and an alternative in the Pavement Design Report, including proposed curing and trafficking timing for the Principal to approve.

e) Emulsion primer seals must be trafficked for several weeks of trafficking in hot weather before placing a sprayed seal or asphalt surfacing less than 100 mm thick.

7.4 Strain alleviating membrane interlayers (SAMI)

a) To inhibit reflection cracking, a SAMI, generally size 10 mm S25E 1.8 - 2.0 L/m^2, must be applied on top of cemented material subbase layers when the dense mix asphalt cover is less than 200 mm.

b) The design thickness of a SAMI must not be included in the pavement thickness calculations but must be accounted for in the pavement construction schedule levels, based on the ALD of the SAMI aggregate, with 5 mm allowed for an SA10-5 sealing aggregate.

c) A SAMI is required below an OGA wearing course to provide water proofing of underlying asphalt layers. Department Drawing Presentation RD2.1 Example Drawings for Large Project and Department Drawing Presentation RD2.2 Example Drawings for Small Project (as applicable) provide examples of this for an OGA wearing course with a 10 mm SAMI.

d) The aggregate applied with a SAMI is intended to protect the binder from trafficking prior to placing the overlying asphalt and a lower aggregate application rate is acceptable, to be determined by the Contractor at their risk.

7.5 Bridge deck surfacings

a) Bridge decks must have an asphalt wearing and levelling course to allow periodic maintenance, provide a uniform wearing course along the road and accommodate minor shape correction during construction.

b) The detailing requirements applicable to bridge deck asphalt surfacings are:

   i) a prime must be applied to the concrete surface as follows:

      A. a very light prime, AMC00 typically at 0.2 - 0.3 L/m^2; or

      B. a specialised proprietary product, which must be supplied and applied strictly in accordance with the manufacturer's instructions;

   ii) the prime must not react adversely with any concrete curing compounds, or the design must specify removal of curing compound;

   iii) a 10 mm S25E SAMI (1.6 - 1.8 L/m^2) must be applied to the primed concrete bridge deck surface, to assist in bonding and for water proofing;

iv) a dense graded asphalt levelling course must be applied to the SAMI, to provide additional cover over the deck structure for future maintenance works and allow for minor shape correction;

v) the bridge deck wearing course mix should typically match the wearing course on the pavements approaching the bridge, and may therefore be either dense graded asphalt, SMA or OGA. Where OGA is adopted, consideration should be given to surface levels and lateral drainage requirements from the OGA; and

vi) a PMB is required in all asphalt to provide maximum durability.

c) The resulting required minimum bridge deck configurations then are as per Table RD-PV-D1 7-4.

Table RD-PV-D1 7-4 Guide to the selection of bridge deck surfacings

Layer	OGA	SMA	DGA	Design thickness (mm)
Wearing course	OG14(1)	SMA10(1)	AC10(1)	40
Levelling course(2)	AC10	AC10	AC10	40
Spray seal	10 mm SAMI	10 mm SAMI	10 mm SAMI	5
Prime	Very light prime	Very light prime	Very light prime	-
Concrete bridge deck				Total 85

Table notes:

(1) Wearing course selection as per Table RD-PV-D1 7-1 and Table RD-PV-D1 8-8.

(2) More than one layer, possibly with cold planing of initial new AC layers, may be necessary to achieve levels.

7.6 Asphalt wearing course

Asphalt wearing courses must be selected in conformance with Table RD-PV-D1 7-1 and Table RD-PV-D1 8-8.

8 Pavement materials

8.1 General

a) The Contractor must ensure the pavement design uses materials which comply with:

i) AGPT Part 2 Pavement Structural Design, AGPT Part 5: Pavement Evaluation and Treatment Design;

ii) Department Pavement Design Procedures; and

iii) all relevant parts of the Master Specification, including specifications for:

A. unbound granular materials (recycled and quarry based), including pavement materials, sands, ballast, sealing and asphalt aggregates;

B. asphalt, sprayed seals, microsurfacings, and bituminous binders;

C. controlled low strength material;

D. stabilised materials, including cement, lime, and foamed bitumen; and

E. geotextiles.

b) Where the Contractor proposes materials that do not meet the requirements of section 8.1a), the Contractor must include details of the alternative materials in the Pavement Design Report including a risk assessment regarding use of those materials.

8.2 Unbound granular materials

8.2.1 General

Pavement materials must conform to RD-PV-S1 “Supply of Pavement Materials” and be constructed in accordance with RD-PV-C1 “Construction of Unstabilised Granular Pavements”.

8.2.2 New unbound granular pavements

The following requirements apply to the design of unbound granular pavements:

a) materials specification within the pavement structure must conform with Table RD-PV-D1 8-1;

b) the Contractor must undertake a site specific assessment in order to determine the type of unbound granular pavement to be utilised on a specific project including:

  i) consideration of the availability of the materials; and

  ii) providing as part of the Pavement Design Report the modified maximum dry density ratio, OMC dry back and maximum layer thickness of nominated materials;

c) PM1A or PM1B basecourse materials with heavily trafficked unbound granular pavements with thin surfacings, must be designed with the following:

  i) 100% modified maximum dry density ratio;

  ii) 60% OMC dry back; and

  iii) 125 mm maximum layer thickness;

d) the Contractor must not specify size 30 mm and 40 mm materials as base layers due to risk of segregation during placement and poor surface tightness and finish; and

e) layer design thickness must conform with Table RD-PV-D1 8-2.

Table RD-PV-D1 8-1 Granular material selection

Material Class	Primary usage	Source	Size (mm)
PM1A[1], PM1B[1], PM1[2] (Class 1)	a) Basecourse. b) 20 mm size is preferred for easier trimming and tighter surface finish.	Quarried	20
			30
		Recycled	20
			30
PM2[2] (Class 2)	a) Upper subbase, lower subbase. b) Full depth asphalt granular subbase. c) Base for lightly trafficked roads and shoulders.	Quarried	20
			30
			40
		Recycled	20
			30
			40
PM3[2] (Class 3)	a) Working platforms for moderately trafficked roads. b) Lower subbase layers for lightly trafficked roads.	Quarried	20
			40
			55
			75
		Recycled	20
			40

Table notes:

(1) Heavy-duty pavement materials use only a grading based specification.

(2) Grading based or mix design specifications.

(3) Recycled, heavy-duty and mix design products require project-specific consideration and must be included in the Pavement Design Report.

Table RD-PV-D1 8-2 Granular material layer design thickness

Size (mm)	Design thickness range (mm)
20	100 - 175
30	100 - 175
40	100 - 200
55	130 - 220
75	130 - 220

8.2.3 Granular overlay

Table RD-PV-D1 8-3 presents acceptable granular overlay materials.

Table RD-PV-D1 8-3 Granular overlay material types

Material type/class	Primary usage	Source	Size (mm)
PM1A[1], PM1B[1], or PM1[2] (Class 1)	Granular overlay base layer	Quarried	20
			30
PM1[2] (Class 1)		Recycled	20
			30
PM2[2] (Class 2)	Sealed or unsealed shoulders	Quarried	20
			30
			40

Table notes:

(1) Heavy-duty pavement materials use only a grading based specification.

(2) Grading based or mix design specifications.

(3) Recycled, heavy-duty and mix design products require project-specific consideration and must be included in the Pavement Design Report.

8.2.4 Non-conforming granular materials

a) If the Contractor proposes materials that do not comply with RD-PV-S1 “Supply of Pavement Materials”, the Contractor must provide the following information (as a minimum) as a Design Departure, and subsequently included in the Design Documentation if accepted as an Accepted Design Departure by the Principal:

   i) documented performance history of the proposed material;

   ii) costs relative to standard materials;

   iii) predicted traffic loading;

   iv) climate at the site;

   v) moisture sensitivity of the subgrade;

   vi) quality and uniformity of the materials as shown by laboratory testing;

   vii) consequences of poor performance; and

   viii) suitability and cost-effectiveness of mechanical or chemical stabilisation.

b) Non-conforming granular materials may have a lower modulus than conforming granular materials, which must be taken account of in the pavement design.

c) Non-conforming granular materials may have durability, breakdown and internal shear failure mechanisms, which must be accounted for in the pavement design.

d) Specialist materials advice should be sought and documented as part of this risk assessment.

e) Submission of the Design Departure required by section 8.2.4a) is a **Hold Point.** The Contractor must not progress the pavement design until this Hold Point is released.

8.2.5 Determination of modulus of unbound granular materials

a) The Contractor must determine the modulus of granular materials in accordance with AGPT Part 2: Pavement Structural Design and this section 8.2.5.

b) For granular materials characterisation the conditions for testing include:

  i) 80% modified optimum moisture content;

  ii) 98% modified maximum dry density; and

  iii) stress conditions are as documented in Department Test Procedure TP183 Determination of a Characteristic Value of Resilient Modulus and Rate of Deformation for Unbound Granular Pavement Materials.

c) The maximum allowable design modulus from direct measurement must be 350 MPa.

8.2.6 Presumptive values

a) In determining the top vertical moduli of the Class 1 base materials, the typical values in Tables 6.3 and 6.4 of AGPT Part 2: Pavement Structural Design for normal standard crushed rock must be used.

b) For base materials that do not conform to RD-PV-S1 "Supply of Pavement Materials" but have proven performance in the field and have been approved by the Principal for use, the maximum modulus must be 300 MPa under thin bituminous surfacings.

8.2.7 Macadam

Where macadam granular materials (typically 65 mm to cobble sized materials) are present in existing pavements, the design modulus value must give specific consideration to:

a) the depth of any profiling, excavation, and the risk of disturbance of this coarse layer, and construction treatment and resulting characteristics;

b) pavement surface deflection test data, and pavement strength assessments; and

c) opportunity to retain the macadam where it is present as a strong, sound layer, and avoid disturbance issues and risks.

8.3 Stabilised materials

8.3.1 General

a) Plant mixed cemented materials must:

  i) comply with RD-PV-S1 "Supply of Pavement Materials", which includes the following binder types:

    A. cement;

    B. fly ash;

    C. lime;

    D. ground granulated blast furnace slag (GGBFS);

    E. bitumen; and

    F. combinations of binders, using parent granular material to pavement material specifications;

  ii) be constructed in accordance with RD-PV-C2 "Plant Mixed Stabilised Pavement"; and

  iii) have their design properties selected in accordance with AGPT Part 2 Pavement Structural Design and this Master Specification Part.

b) In situ stabilisation with cement of existing pavement materials must:

i) have a mix design completed in accordance with AGPT Part 4D - Stabilised Materials;

ii) be constructed in accordance with RD-PV-C3 “In situ Pavement Stabilisation”; and

iii) have their design properties selected in accordance with AGPT Part 2 Pavement Structural Design and this Master Specification Part.

c) Cemented materials must be categorised by the degree of cementation, as modified, lightly-bound or fully-bound materials, as required by AGPT Part 2 Pavement Structural Design.

8.3.2 Modified materials

a) Modified materials with a UCS of less than 1.0 MPa must be designed as normal standard unbound granular materials by AGPT Part 2 Pavement Structural Design definitions.

b) Adoption of an improved design modulus can be considered if validated by laboratory testing and this testing is provided in the Pavement Design Report.

8.3.3 Lightly-bound materials

Noting that AGPT Part 2 Pavement Structural Design does not provide design procedures for lightly-bound materials, the Contractor must specify additional testing, design, construction monitoring, and post-construction performance monitoring associated with this approach in the Pavement Design Report.

8.3.4 Fully-bound materials

a) The RD-PV-S1 “Supply of Pavement Materials” materials listed in Table RD-PV-D1 8-4 are considered fully-bound materials.

b) Other materials may also be accepted in this category, upon completion of corresponding laboratory testing outlined in AGPT Part 2 Pavement Structural Design and the testing is included in the Design Documentation.

Table RD-PV-D1 8-4 Fully-bound material types(1)

Specification type	Binder(3)	Min 28 day UCS	20 mm Class 2(2) (PM 2/20)	30 mm Class 2(2) (PM 2/30)	40 mm Class 2(2) (PM 2/40)
Binder control	Target binder 4% Type GB cement	-	SPM2/20C4	SPM2/30C4	SPM2/40C4
	Target binder 5% Type GB cement	-	SPM2/20C5	SPM2/30C5	SPM2/40C5
Strength control	Cement, fly ash GGBFS, or lime	4MPa	SPM2/20C4MPa	SPM2/30C4MPa	SPM2/40C4MPa
		5MPa	SPM2/20C5MPa	SPM2/30C5MPa	SPM2/40C5MPa

Table notes:

(1) Materials with a 28 day UCS less than 4 MPa (AS 5101.4 Methods for preparation and testing of stabilized materials, Method 4: Unconfined compressive strength of compacted materials) must not be used in cemented designs because of durability concerns.

(2) Class 1 materials may be substituted for Class 2.

(3) Naming conventions for binders other than cement can be found in RD-PV-S1 “Supply of Pavement Materials”.

8.3.5 Determination of design modulus

a) The design modulus for fully-bound materials detailed in Table RD-PV-D1 8-4 must be no greater than 3500 MPa, unless justified by flexural modulus measurement as per AGPT Part 2: Pavement Structural Design.

b) The Contractor must nominate use of a primer seal following initial curing to provide a stable moisture regime, based upon assessment of climatic conditions. For cemented materials not complying with RD-PV-S1 “Supply of Pavement Materials” but which have proven field performance, the design moduli may be determined from UCS test results as follows:

$$EFLEX = 1000 \times UCS \quad \text{(Equation 6.1)}$$

where:

i) EFLEX = flexural modulus (MPa) of field beams at 28 days moist curing, and

ii) UCS = unconfined compressive strength (MPa) of laboratory specimens at 28 days.

c) The maximum design modulus for these non-standard materials must not exceed 3500 MPa.

8.3.6 Determining in-service fatigue characteristics from laboratory fatigue measurements

If the Contractor proposes to adopt the content of AGPT Part 2: Pavement Structural Design, in determining in-service fatigue characteristics from laboratory fatigue measurements, the Contractor must include an assessment of all additional risk factors from such proposal as part of the Pavement Design Report.

8.3.7 Determining in-service fatigue characteristics from laboratory measured flexural strength and modulus

If the Contractor proposes to adopt the content of AGPT Part 2: Pavement Structural Design, in determining in-service fatigue characteristics from laboratory measured flexural strength and modulus, the Contractor must include an assessment of all additional risk factors from such proposal as part of the Pavement Design Report.

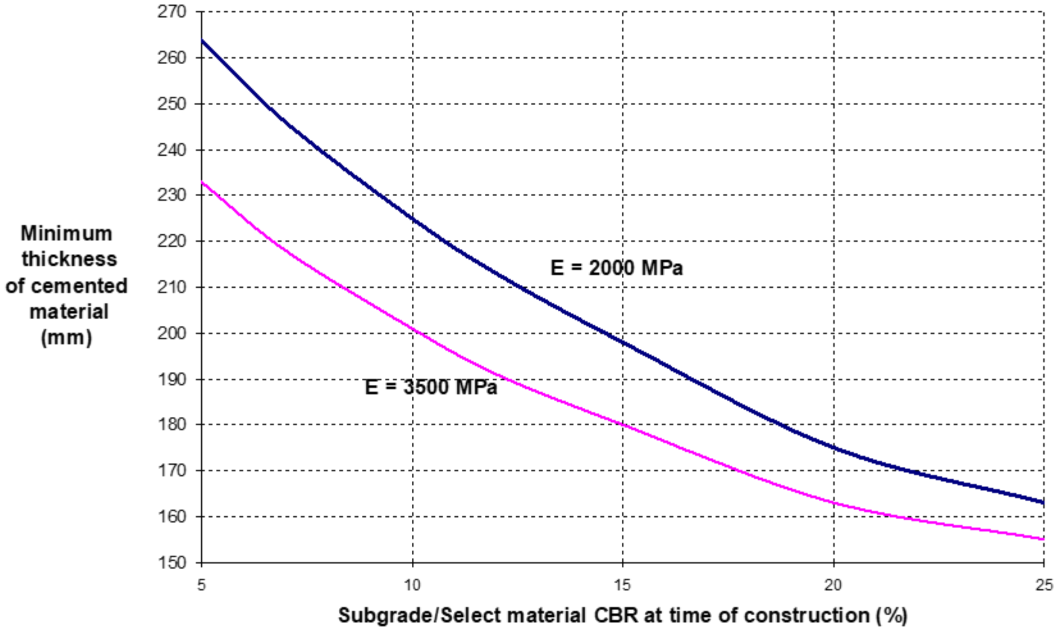
8.3.8 Single layer plant mixed cemented materials

a) For the construction of new pavements, the maximum single layer cemented thickness is 200 mm.

b) The Contractor must evaluate whether the maximum thickness required by section 8.3.8a) will be inhibited by the operating constraints of construction equipment where the Site falls within an urban area. If the Contractor believes such constraint exists, the Pavement Design Report must state the minimum thicknesses of cemented material necessary to avoid fatigue damage during construction are given in Figure RD-PV-D1 8-1 and depend on the strength of the underlying material at the time of construction.

c) For thicknesses less than those given in Figure RD-PV-D1 8-1, the fatigue damage during construction must be considered in assessing the fatigue life of the cemented material.

Figure RD-PV-D1 8-1 Minimum thicknesses of cemented materials to avoid fatigue damage during construction



8.3.9 Dual layer plant mixed cemented materials

a) For Works involving the provision of multi-layered cemented materials, layers designed to be fully bonded need to perform structurally as a single layer, otherwise they must be modelled as 2 unbonded layers.

b) Rehabilitation investigation and design of pavements including a dual layer plant mixed cemented material must:

   i) give special consideration to the risk of debonding of the 2 layers; and

   ii) account for the need to extend the depth of profiling to remove the full thickness of the upper cement treated layer to eliminate debonding related issues.

c) The Contractor must include coring of CT layers to examine the interface, with profiling of larger test pits required on major rehabilitation works.

8.3.10 Reflection cracking

a) The minimum required cover of dense graded asphalt to inhibit reflection cracking must be determined using Figure RD-PV-D1 8-2.

b) The use of a SAMI between the asphalt and cement treated layers is required where the asphalt cover is less than 200 mm.

c) Granular materials may be used as cover either solely or in conjunction with asphalt subject to the following criterion, as also shown on Figure RD-PV-D1 8-3.

d) Equivalent thickness of dense graded asphalt = (0.75 × thickness of granular material cover) + (thickness of asphalt cover).

Figure RD-PV-D1 8-2 Minimum cover to inhibit reflection cracking

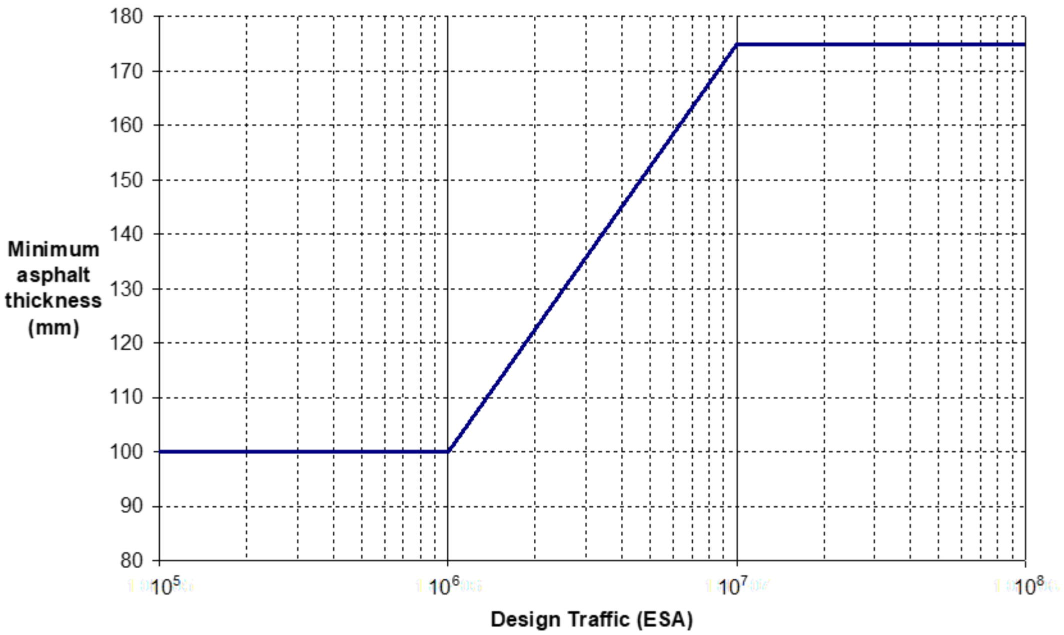
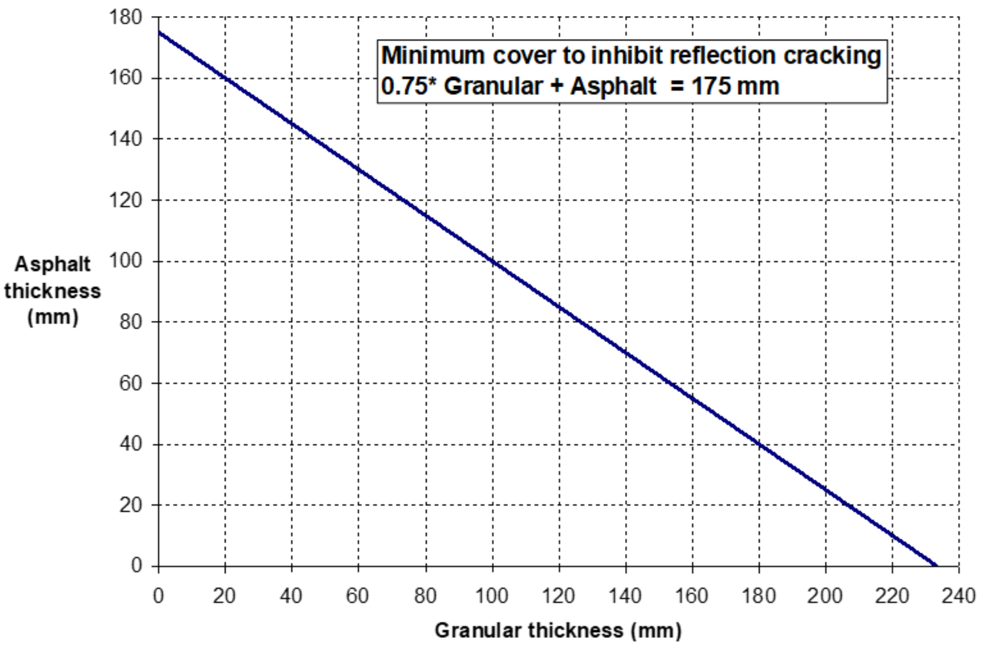


Figure RD-PV-D1 8-3 Asphalt and granular thicknesses to inhibit reflection cracking



8.3.11 Post cracking phase life

a) When the design traffic exceeds 1×10^7 ESA, the asphalt thickness must be determined without allowing for a cemented post-cracking phase.

b) For other road pavements where the design traffic is less than 1×10^7 ESA, designs may include the post-cracking phase of cemented materials and detailed in the Pavement Design Report.

8.3.12 Plant mixed cement stabilised layer design thickness

Plant mixed cement stabilised layer design thickness must conform with Table RD-PV-D1 8-5.

Table RD-PV-D1 8-5 Plant mixed cement stabilised layer thickness

Material	Nominal size (mm)	Typical standard materials	Design thickness range (mm)
Plant mixed cement stabilised - single layer construction	All sizes	SPM2C4	125 - 200
Plant mixed cement stabilised - multiple layer construction	All sizes	SPM2C4	125 - 175

8.3.13 In situ stabilisation of existing pavements

a) Rehabilitation of granular pavements using in situ stabilisation with cement must comprise of these main steps:

i) initial assessment of parent material for suitability for stabilisation using the criteria in AGPT Part 4D - Stabilised Materials;

ii) where considered viable, preliminary thickness design calculations must be undertaken to allow comparison with other candidate treatments, using typical properties stated in section 8.3.13b);

iii) where in situ stabilisation with cement is selected as the rehabilitation treatment, detailed mix design must be completed in accordance with AGPT Part 4D - Stabilised Materials to:

A. optimise the binder content;

B. confirm design modulus and fatigue properties; and

C. finalise thickness calculations using design parameters derived from the mix design, subject to the restrictions of this Master Specification Part.

b) For preliminary design of fully-bound, in situ stabilised with cement pavements, the following parameters must be adopted:

i) maximum single layer stabilisation thickness is 360 mm;

ii) layer thickness of 200 mm, or less, the maximum design modulus 5000 MPa, for material with minimum UCS of 5.0 MPa; and

iii) layer thickness greater than 200 mm, the maximum design modulus:

A. upper 1/3 = 5000 MPa;

B. middle 1/3 = 3500 MPa; and

C. bottom 1/3 = 2000 MPa.

c) If the subgrade CBR at the time of construction is less than 5%, a minimum 100 mm unbound granular material must be retained over the subgrade to improve compaction, and additional material may be needed to meet this requirement.

d) Minimum surfacing treatments on in situ stabilised cementitious material must comply with the Figure RD-PV-D1 8-2 and Figure RD-PV-D1 8-3.

e) For roads with design traffic loading less than 1×10^7 ESA, a geotextile reinforced seal can be considered in place of asphalt.

8.4 Asphalt

8.4.1 Introduction

a) Asphalt supply and construction must conform to RD-BP-S2 “Supply of Asphalt” and RD-BP-C3 “Construction of Asphalt Pavement”.

b) The Contractor must adopt the asphalt pavement course descriptions in Table RD-PV-D1 8-6 throughout the design.

c) Asphalt wearing courses must be selected and designed in accordance with:

i) Table RD-PV-D1 7-1;

ii) Table RD-PV-D1 8-7;

iii) Table RD-PV-D1 8-8; and

iv) Table RD-PV-D1 9-4.

Table RD-PV-D1 8-6 Asphalt pavement course descriptions

Layer number	course name	Notes
1	Wearing course	Surface layer.
2	Intermediate course	Directly below wearing course. Sometimes referred to as levelling course.
3	Base course	a) All asphalt layers below the intermediate course are referred to as base courses. There may be more than one base course for thicker asphalt pavements, with each base course numbered sequentially (i.e. base course 1, base course 2, base course 3, etc.). b) The bottom base course layer may be a high binder AC14HB layer in some configurations.
4	Subbase	Granular subbase or cement treated subbase.

Table RD-PV-D1 8-7 Asphalt design thickness(1)

Mix specification	Nominal size (mm)	Design thickness range (mm)	Notes
FineAC7	7	25 - 35	-
FineAC10	10	35 - 50	-
AC10M, AC10L	10	40 - 55	-
AC14M	14	50 - 80	-
AC14HB(b)	14	60 (55,65)(a)	a) 55 mm or 65 mm thickness is acceptable where 60 mm would introduce the need for an additional layer of asphalt, otherwise must be 60 mm. b) a minimum thickness of cover of 125 mm of dense-graded asphalt is required over this mix to inhibit rutting. An SMA wearing course counts towards this requirement, but OGA does not.
AC20M	20	60 - 100	Mix withdrawn from RD-BP-S2 "Supply of Asphalt", included for historical reference.
OG10	10	30 - 35	Design must incorporate a 10 mm S25E SAMI below OGA.
OG14	14	35 - 40	Design must incorporate a 10 mm S25E SAMI below OGA.
SMA10	10	40 - 50 with water proofing seal	40 mm minimum thickness applies when a water proofing spray seal interlayer is placed below the SMA.
	10	45 - 50 without water proofing seal	Where no spray seal is provided, a minimum SMA thickness of 45 mm must apply and the in-situ specification RD-BP-C3 "Construction of Asphalt Pavement" voids target maximum of 5.0% must not be exceeded.
SMA7	7	30 - 35	-

Table notes:

(1) Also referred to as "nominal compacted thickness" on pavement work schedules.

(2) Consecutive layers of asphalt in a multiple asphalt layer pavement structure should not vary by more than one mix size.

Table RD-PV-D1 8-8 Guide to the selection of asphalt types[(3)]

Course[(4)]		General mix designations[(5)]	Binder class	Target mix design air voids (%)	Applications/notes
Wearing	Heavy-duty wearing course	AC10M	A5E	4.0	Motorway, significant grades (Table RD-PV-D1 8-10) approaches to heavily trafficked[(8)] signalised intersections (50 m-150 m, but consider level of saturation), roundabouts, bus lanes, bus stops.
	Medium-duty wearing course	AC10M	A15E[(2)]	4.0	Other signalised and non-signalised intersections, mid-block zones with design traffic loading ≥ 5 × 10^5 ESA.
		OG14	A15E	20	Non-signalised intersections, mid-block zones, no high horizontal shear locations.
		SMA10	A5E[(1)]	3.5	Non-signalised intersections, mid-block zones.
Structural	Modified intermediate course	AC10M, AC14M	A5E[(1)]	4.0	Motorway, significant grades, approaches to heavily trafficked[(8)] signalised intersections (50 m-150 m, but consider level of saturation), roundabouts, bus interchanges, dedicated bus lanes and bus stops. AC10M required where wearing course delayed. [(7)]
	Standard intermediate course	AC10M, AC14M	C320	4.0	Other intersections, mid-block zones. AC10M required where wearing course delayed.
	Base course	AC10M, AC14M	A5E	4.0	Bus interchanges and dedicated bus lanes only[(6)].
		AC14M	C320	4.0	Normal works.
		AC14HB	C320	2.5	High binder fatigue resistant bottom asphalt layer for full depth asphalt configurations.
Special surfacings	Medium-duty thin flexible	SMA7	A15E	3.5	Texture, noise reduction, no high horizontal shear locations.
		OG10	A15E	20	Texture, noise and spray reduction, no high horizontal shear locations.
	Footpaths, bikeways, crossovers, carparks and sport recreation courts	FineAC7	C170[(2)]	4.0	Light maintenance vehicle trafficking only.
	Carparks and local roads	FineAC10, AC10L	C170[(2)]	4.0	Medium to heavy maintenance vehicles (mainly rigids), minimal large articulated heavy vehicles.

Course(4)	General mix designations(5)	Binder class	Target mix design air voids (%)	Applications/notes

Table notes:

(1) A15E may also be approved.

(2) C320 acceptable for DTL <5 × 10^5 ESA. C320 may also be approved for special surfacings.

(3) This table reflects asphalt mixes and binders currently available in the South Australian market. Other alternatives available in the Austroads Guide series which are also acceptable, if proposed must be included in the Pavement Design Report.

(4) Table RD-PV-D1 8-6 provides guidance on course descriptions and position within the pavement structure.

(5) Department asphalt mix size designations are based on ensuring there is about 10% of this nominal size material within the mix. (E.g. AC10 specification has between 8 and 20% retained on the 9.5 mm sieve and AC14 has between 8 and 20% retained on 13.2 mm sieve.) These may be coarser than other typical interstate mixes.

(6) All asphalt layers of bus interchanges and dedicated bus lanes to be of this mix/binder type.

(7) Lower asphalt layers that act as temporary wearing courses during construction on heavily trafficked routes should consider use of a polymer modified binder, with due consideration of construction staging.

(8) With ≥500 heavy vehicles per day.

8.4.2 Asphalt design modulus

a) The asphalt design moduli for Department registered asphalt mixes conforming to RD-BP-S2 “Supply of Asphalt” must:

   i) use a C320 binder;

   ii) have a weighted mean annual pavement temperature (WMAPT) of 28°C; and

   iii) be selected using Table RD-PV-D1 8-9.

b) The HV design speed must be selected from Table RD-PV-D1 8-10, referencing the road geometry.

c) Alternative HV design speeds may be proposed by the Contractor, based upon rigorous supporting technical analysis, which must be documented and provided in the Pavement Design Report.

d) Asphalt design moduli for WMAPT’s other than 28°C must be calculated using the following equations:

   i) $SWMAPT = S28°\text{C} \times e^{(A(WMAPT-28))}$ (Equation 6.2)

   ii) $A = (1 + 0.0307 \times (V_b - 11)) \times (0.014 \ln(V) - 0.1579)$ (Equation 6.3)

      A. S_{WMAPT} = asphalt modulus at the WMAPT (MPa);

      B. $S_{28°\text{C}}$ = asphalt modulus at 28°C (Table RD-PV-D1 8-9) (MPa);

      C. V_b = volume of binder in mix (%);

      D. V = heavy vehicle design speed (Table RD-PV-D1 8-10); and

      E. A = mix type and vehicle speed variable.

e) The asphalt design moduli adjusted for WMAPT, calculated in accordance with section 8.4.2d), must not be less than:

   i) 480 MPa for open graded asphalt;

   ii) 830 MPa for stone mastic; and

   iii) 1000 MPa for dense mix asphalt.

f) WMAPT for various South Australian sites are given in Appendix B of AGPT Part 2 Pavement Structural Design for reference.

a) The asphalt design modulus of mixes incorporating a polymer modified binder must be calculated by applying the modulus adjustment factors in Table RD-PV-D1 8-11 to the values for C320 binder mixes given in Table RD-PV-D1 8-9.

Table RD-PV-D1 8-9 Asphalt (C320) design moduli at WMAPT of 28°C

Mix designation	Mix size (mm)	Binder class	Effective binder volume (%)	Design modulus MPa at 28°C			
				10 km/h	30 km/h	50 km/h	80 km/h
AC10M	10	320	12.4	1070	1890	2362	2884
AC10L	10	320	13.3	1070	1890	2362	2884
AC14M	14	320	11.7	1196	2082	2592	3153
AC20M(1)	20	320	11.0	1341	2302	2850	3450
AC14HB	14	320	13.1	1163	2072	2607	3194
SMA10	10	320	15.1	720	1316	1674	2081
OG14	14	320	9.9	425	710	869	1048

Table notes:

(1) Use of AC20M is not allowed on new works due to risk of segregation. AC20M has been included for modelling of historical pavements that used AC20M.

Table RD-PV-D1 8-10 Presumptive heavy vehicle design speeds

Project location	Design speed V (km/h)	
	Flat and up to 5% grade	Over 5% grade
Posted speed limit ≥80 km/h	80	50
50 km/h ≤ posted speed limit < 80 km/h	50	30
Posted speed limit <50 km/h	30	10
Intersections and approaches	30	10
Low radius roundabouts, bus stops	10	10

Table RD-PV-D1 8-11 Factors to estimate the modulus of polymer modified binder asphalts for modulus at WMAPT 28°C (Refer Table RD-PV-D1 8-9)

Austroads binder grade	Description of binder	Softening point - approximately (°C)	Modulus adjustment factor	Binder availability
A10E	Styrene-Butadiene-Styrene (SBS) 6%	95	0.70	Not readily available in SA
A15E	Styrene-Butadiene-Styrene (SBS) 5%	90	0.60	Available
Binder grades				
A5E	Styrene-Vinyl-Styrene (SVS) Min 7.5%	95	1.2	Available

8.4.3 Determination of design modulus and fatigue characteristics from laboratory testing

a) Designs prepared using design moduli based upon laboratory using the methods provided in AGPT Part 2 Pavement Structural Design Section 6.5 Asphalt may be considered, where it can be satisfactorily demonstrated that the alternative provides a benefit including:

   i) reduced greenhouse gas emissions; or

   ii) reduced whole of life cost.

b) The design, construction and performance of pavement treatment types that are first time applications for the Principal are likely to involve additional risk factors that require careful consideration. The Contractor must specify additional testing, design, construction monitoring, and post-construction performance monitoring associated with this approach in the Pavement Design Report.

8.4.4 Recycled asphalt pavement (RAP)

a) The Contractor must consider the use of RAP within its asphalt mixes, as per RD-BP-S2 “Supply of Asphalt” and RD-BP-C3 “Construction of Asphalt Pavement”.

b) Asphalt mixes with RAP must have the same design modulus and fatigue relationship as the equivalent mix with virgin materials.

8.5 Foamed bitumen stabilisation

a) Foamed bitumen stabilised materials must be designed in accordance with AGPT Part 4D - Stabilised Materials, and AGPT Part 5: Pavement Evaluation and Treatment Design, and constructed in accordance with RD-BP-C2 “Construction of Foamed Bitumen Stabilised Pavement”.

b) Lime must be used as a secondary binder.

c) For pavement rehabilitation Works, the initial assessment of the suitability of materials for foamed bitumen stabilisation must reference recommended particle size distribution limits provided in AGPT Part 4D - Stabilised Materials.

d) The following test methods are to be used for laboratory testing and mix design:

   i) AGPT Part 4D - Stabilised Materials;

   ii) AGPT-T301 Determining the Foaming Characteristics of Bitumen;

   iii) AGPT-T302 Mixing of Foamed Bitumen Stabilised Materials;

   iv) AGPT-T303 Compaction of Test Cylinders of Foamed Bitumen Stabilised Materials Part 1: Dynamic Compaction using Marshall Drop Hammer; and

   v) AGPT-T305 Resilient Modulus of Foamed Bitumen Stabilised Materials.

e) Thickness design procedures to be utilised are described in AGPT Part 5: Pavement Evaluation and Treatment Design.

f) The minimum single layer thickness of foamed bitumen stabilisation must not be less than 200 mm and the maximum single layer thickness must not exceed 300 mm.

9 Structural design of flexible pavements

9.1 General

a) Flexible pavements must be designed using the design procedures with:

   i) AGPT Part 2 - Pavement Structural Design;

   ii) AGPT Part 5: Pavement Evaluation and Treatment Design;

   iii) Department Drawing Presentation RD2.1 Example Drawings for Large Project; and

   iv) Department Drawing Presentation RD2.2 Example Drawings for Small Project.

b) Table RD-PV-D1 9-1 summarises accepted design procedures.

c) Design traffic loading must be calculated in accordance with section 4.

d) Subgrade design CBR must be assessed in accordance with section 6, based upon a Site investigation conducted in accordance with section 5.

e) Pavement surfacing must be selected in accordance with section 7.

f) Pavement material design properties must be in accordance with section 8.

Table RD-PV-D1 9-1 Summary of accepted flexible pavement design procedures

Pavement type	Design procedures
New pavement design	
Unsealed unbound granular (U-GR)	Empirical chart (AGPT Part 6 Unsealed Pavements)
Sprayed seal on granular (SS-GR)	a) Empirical chart (AGPT Part 2 Pavement Structural Design) b) MEP (AGPT Part 2 Pavement Structural Design)(1)
Thin asphalt on granular (AC-GR)	a) Empirical chart (AGPT Part 2 Pavement Structural Design) b) MEP (AGPT Part 2 Pavement Structural Design)(2)
Full depth asphalt (FDA)	MEP (AGPT Part 2 Pavement Structural Design)
Asphalt on 2 layer cemented subbase (AC-CTSB)	MEP (AGPT Part 2 Pavement Structural Design)
Deep strength asphalt pavement (DSA)	MEP (AGPT Part 2 Pavement Structural Design)
Pavement rehabilitation treatment design	
Unbound granular overlay / inlay, with sprayed seal surfacing (SS-GR OL, SS-GR IL)	a) Pavement surface deflection(3) based granular overlay method (AGPT Part 5 Pavement Evaluation and Treatment Design and Department Pavement Design Procedures) b) Empirical Charts (AGPT Part 2 Pavement Structural Design)(4) c) MEP (AGPT Part 2 Pavement Structural Design), using inferred moduli from site investigation d) MEP (AGPT Part 2 Pavement Structural Design) using back calculated moduli(5)
Unbound granular overlay / inlay, with thin asphalt surfacing (AC-GR OL, AC-GR IL)	All methods above for unbound granular overlay / inlay with sprayed seal surfacing, plus asphalt wearing course fatigue check using MEP (AGPT Part 2 Pavement Structural Design)(2)
Asphalt overlay or patching (AC OL, AC IL, AC P&R)	a) Pavement surface curvature based design method (Department Pavement Design Procedures)(3) b) MEP (AGPT Part 2 Pavement Structural Design), using design moduli as per section 8.4 for new asphalt, and those inferred from site investigation for existing pavement materials c) MEP (AGPT Part 2 Pavement Structural Design), using design moduli as per section 8.4 for new asphalt, and back-calculated moduli(5)
Cementitious stabilisation (SS-CS or AC-CS)	a) Fully-bound - MEP (AGPT Part 2 Pavement Structural Design) b) Modified - designed as unbound granular pavement
Foamed bitumen stabilisation (SS-FBS, AC-FBS)	MEP (AGPT Part 2 Pavement Structural Design)

Table notes:

(1) MEP is typically reserved for materials non-conforming with RD-PV-S1 “Supply of Pavement Materials” only.

(2) Asphalt fatigue check required as per Table RD-PV-D1 9-4.

(3) Utilising DFL, FWD or TSD test data.

(4) Where the existing granular pavement thickness, quality and CBR are assessed, to allow representation in empirical methods as equivalent subbase or lower subbase materials.

(5) Using FWD testing and numerical back analysis.

(6) Further requirements for specific design procedures are provided in section 9.

9.2 Project reliability

Minimum Project reliability levels which must be used for the design of new pavements and rehabilitation treatments are shown in Table RD-PV-D1 9-2.

Table RD-PV-D1 9-2 Minimum project reliability levels

Road class	Project reliability (%)
Motorways	95
Urban and rural arterial, Urban and rural connector	95
Access	90

9.3 Geogrid reinforcement

a) Pavements incorporating geogrid and other pavement and geotechnical reinforcing products must be designed as per AGPT Part 2: Pavement Structural Design.

b) The Contractor must consider the incorporation of geogrid reinforcement products where required to mitigate construction and performance risks, where pavement and geotechnical conditions warrant it, including:

   i) treatment of a soft subgrade;

   ii) strengthening over narrow service trenches and other localised issues; and

   iii) mitigation of possible reflection cracking.

c) The basis of the need, selection and design of the selected product must be documented in the Pavement Design Report.

d) Design of geogrids and geofabrics must consider minimum anchorage lengths, cover, need for bond coats, product strength and must be used in accordance with manufacturer's recommendations.

9.4 Design of granular pavements with thin bituminous surfacings

a) Thin asphalt or sprayed seal on unbound granular pavements must be designed as per the methods presented in Table RD-PV-D1 9-1, using material design properties presented in Section 8.

b) Granular layer composition must meet the requirements stated in Table RD-PV-D1 9-3.

c) Calculated granular pavement thickness must be rounded up to the nearest 10 mm value, with no other layer thickness adjustments applied.

d) The Principal endorses reduction of the subbase layer thickness by the thickness of a thin asphalt surfacing designed with Figure 8.4 of AGPT Part 2 Pavement Structural Design (2nd paragraph, page 123), subject to meeting the minimum layer thickness stated in Table RD-PV-D1 9-3.

e) Where a single layer asphalt treatment over a sprayed seal granular pavement at a rural intersection, junction or similar, is proposed, the Contractor must:

   i) determine the theoretical fatigue life of the thin asphalt surfacing using the MEP;

   ii) where the thin asphalt surfacing fatigue life is less than the Design Life, develop an alternative heavy-duty pavement design that achieves the Design Life using the MEP; and

   iii) provide option 9.4e)i) and 9.4e)ii) in the Pavement Design Report, with discussion of relative performance issues, risks and costs, and a recommended treatment.

Table RD-PV-D1 9-3 Granular pavement composition

Design traffic loading (ESA)	Minimum base thickness (mm)		Minimum subbase thickness (mm)(1)	
80 mm, or thinner bituminous surfacing (including sprayed seals)(4)				
>1 × 10^7	PM1(2)	300 total(5)	PM2	125
>1 × 10^6 to 1 × 10^7	PM1	250 total(5)	PM2	125
5 × 10^5 to 1 × 10^6	PM1	150	PM2	125
<5 × 10^5	PM1	125	PM2	125
85 mm to 150 mm asphalt(3)				
Any DTL	PM1	125	PM2	125
Greater than 150 mm asphalt(3)				
Any DTL	nil		PM2	150

Table notes:

(1) Lower subbase layers must comprise Class 2 or Class 3 pavement materials, or other granular materials of similar strength complying to Master Specification Parts for Roads.

(2) Refer to section 8.2.2b) on use of Class PM1A, PM1B heavy-duty base materials.

(3) Asphalt thickness must be designed using MEP.

(4) Asphalt thickness must satisfy Table RD-PV-D1 9-4 thin asphalt on unbound granular pavement.

(5) Total base thickness must consist of 2 PM1 layers meeting the requirements of Table RD-PV-D1 8-2.

Table RD-PV-D1 9-4 Thin asphalt on unbound granular pavement

Lane design traffic loading (ESA)	Minimum design	Notes
Thin asphalt on granular pavement		
<5 × 10^5	40 mm(1)	C320 binder acceptable.
5 × 10^5 to 1 × 10^6	80 mm(1)(2)	A polymer modified binder (PMB) must be used in both asphalt layers, with A15E typically preferred due to its superior fatigue characteristics.
>1 × 10^6	Minimum thickness of 80 mm(1)(2)	Asphalt layers must satisfy fatigue criterion with MEP analysis. Greater than 80 mm asphalt may be required, as determined from the mechanical empirical procedure. Polymer modified binders must be specified as Table RD-PV-D1 8-8.
Rural intersections - Asphalt over sprayed sealed granular pavement		
Any traffic loading(3)	40 mm	Single asphalt layers may be considered over sprayed seals to withstand localised high horizontal shear stresses in rural locations. Polymer modified binder strongly preferred.(3)

Table notes:

(1) The design must also incorporate a bituminous prime on the base course surface.

(2) 2 asphalt layers must be adopted to provide a structure with acceptably low risk of premature distress and reduce the likelihood of potholes in locations with higher traffic loadings.

(3) Subject to traffic loading, where the asphalt layers do not achieve the Design Life of the underlying pavement structure (e.g. 30 years) due to expected asphalt cracking the Contractor must comply with section 9.4e).

9.5 Asphalt and granular overlay or inlay design using deflection test data

9.5.1 General

a) The design of asphalt and granular overlays and inlays based upon pavement surface deflection measurements obtained with the FWD, DFL and traffic speed deflectometer TSD must be completed in accordance with the Department Pavement Design Procedures presents design procedures:

i) granular overlays - Department Pavement Design Procedure 1;

ii) asphalt overlays – Department Pavement Design Procedure 2; and

iii) asphalt inlays (also referred to as asphalt plane and reinstatement, AC P&R or heavy patching) – Department Pavement Design Procedure 3.

b) The procedures contemplated by section 9.5.1a) are provided in Department Pavement Design Procedures.

9.5.2 Asphalt overlays

a) Where a single layer asphalt overlay is being considered, the need for any strengthening or pre-treatment of existing defects to avoid premature failure of the overlay (e.g. reflection cracking) must be assessed, with suitable treatments incorporated into the design.

b) Suitable treatments may include the following, including combinations thereof:

i) crack sealing;

ii) geofabric bandages or full width paving fabric interlayers with bond coat;

iii) asphalt patching;

iv) SAMI; and

v) rutting shape correction with micro surfacing treatment.

c) The nominated treatments must be clearly identified in the Pavement Design Report and Design Drawings, including discussion of anticipated performance.

9.5.3 Design levels

Overlay design, including any edge profiling, must consider the impact of surface level changes and compatibility with existing road infrastructure, including, where present:

a) kerb and gutter levels;

b) service cover plates and top stones;

c) pavement cross-fall, and related road user impacts (e.g. driveway access);

d) drainage;

e) OGA (section 9.5.4a));

f) shoulder and verge levels;

g) safety barrier height above pavement surface; and

h) any other surface features that may be impacted by level changes.

9.5.4 Open graded asphalt overlays

a) Where used, the design must provide edge details showing OGA, SAMI and DGA levelling course levels relative to kerb and gutter, and other relevant infrastructure.

b) Where minimising the edge drop is of high priority for the safety of cyclists etc, edge planing of the existing asphalt to a depth of 10 mm below the water table prior to overlay and "rolling over" the edge of the OGA overlay to reduce the lip, must be considered and documented on the Design Drawings.

c) Rehabilitation works utilising an OGA wearing course also require reinstatement of the SAMI water proofing membrane below the OGA.

d) The SAMI and OGA must be placed on a new DGA levelling course, unless the Contractor can demonstrate and document in the Pavement Design Report a construction procedure that addresses known risks, including:

i) possible variability in any existing OGA and SAMI thickness;

ii) suitability of profiled surface for placing of SAMI to acceptable quality and adequate flatness to drain; and

iii) management of any degradation of the existing levelling course below the existing SAMI.

9.5.5 Ultra-thin asphalt surfacings

a) Ultra-thin asphalt surfacings are only acceptable on lightly to moderately trafficked roads (of less than 5×10^6 ESA) that are determined to be structurally adequate for the expected future traffic loadings, as a wearing course restoration treatment.

b) The Contractor must comply with RD-BP-C4 "Application of Thin Asphalt Surfacings" with respect to acceptable products, their design and application.

9.6 Mechanistic-empirical procedure (MEP)

9.6.1 General

a) Pavements incorporating bound materials must be designed using the software endorsed by AGPT Part 2 Pavement Structural Design MEP.

b) The calculated layer thicknesses must be rounded up to the nearest 5 mm.

c) To allow for variations in the constructed layer thicknesses within the construction tolerances, 10 mm must be added to the pavement layer which governs the overall allowable loading (critical layer).

d) Interlayers, SAMIs, reinforcing grids, fabrics and similar products are assumed to be non-structural and must not be considered in mechanistic modelling procedures.

e) The design of rehabilitation treatments of existing pavements must consider the presence of debonding between pavement layers, notably between asphalt layers, asphalt-granular interfaces and two-layer cement treated subbase configurations.

f) Any debonding anticipated from construction and maintenance activities during the life of the pavement must be considered in the design.

9.6.2 Asphalt overlay and plane and reinstate design using general mechanistic procedures

a) MEPs may be adapted for the design of asphalt overlays and plane and reinstatement treatments.

b) A design model for the remnant pavement materials and subgrade must be developed and must be included as part of the Pavement Design Report. The model must clearly identify:

i) assumed remnant pavement material thickness and type;

ii) material design properties, whether inferred or based on back-calculation methods;

iii) subgrade design CBR; and

iv) impact of pavement design and existing surface levels and pavement treatment thickness on these parameters.

9.7 Pavement rehabilitation treatment selection and design

For the selection of pavement rehabilitation treatments, the Pavement Design Report must document consideration of the following issues with regard to the selection of pavement rehabilitation treatments:

a) granular overlays:

i) the ability to construct the overlay under traffic;

ii) the potential for material to breakdown under repeated reworking and reshaping due to trafficking prior to sealing;

iii) the availability of suitable base materials for the anticipated traffic loading;

iv) the need to remove existing bituminous surfacing for drainage, additional granular material to replace this removed material and any preparation of the existing granular material surface;

v) the use of primer seals rather than prime and seal when sealing under traffic; and

vi) overworking the upper surface in preparation for sealing, creating a slurry of fines and potential seal delamination;

b) modification of existing granular materials:

i) prevention the formation of bound materials with unsatisfactory fatigue or shrinkage cracking performance;

c) cementitious stabilisation of existing granular materials to form fully-bound materials:

i) the uniformity of binder spread rates, mixing uniformity (with depth), and deep compaction for single layers in excess of 250 mm thickness;

ii) the development of debonding between cemented layers leading to premature failure for multi-lift stabilisation;

iii) uncertainty about minimum surfacing requirements to inhibit erosion at construction joints and shrinkage cracks; and

iv) the rate of distress progression after structural failure and the high cost of remediation for heavily trafficked roads; and

d) foamed bitumen stabilisation:

i) uniformity of binder application rates and compaction / density profile of single layers in excess of 250 mm thickness; and

ii) flushing of sprayed seals due to migration of the binder to the surface under trafficking.

10 Shoulder pavements

10.1 General

a) Shoulder pavements outside the traffic lanes are required where no kerb and gutter is present on a road.

b) The Contractor must ensure the greater of the minimum sealed, unsealed and total shoulder widths set by conformance to Austroads requirements and pavement structural design considerations in section 10 are adhered to.

c) The minimum pavement structure requirements in section 10 are applicable.

10.2 Urban fringe / rural environment - sprayed seal or thin asphalt on granular pavements:

The design of shoulders on roads in urban fringes and rural environments must comply to the following:

a) sealed part of shoulder:

i) edge line to 0.5 m outside edge line - same pavement structure as adjacent traffic lane; and

ii) 0.5 m outside edge line - either same pavement structure as adjacent traffic lane, or reduced structure designed in accordance with shoulder thickness design requirements in section 10.4; and

b) unsealed part of shoulder:

i) minimum total thickness of granular materials is 150 mm for rural arterials and 200 mm for national highways; and

ii) a greater thickness may be required from shoulder thickness design requirements in section 10.4.

10.3 Motorways - asphalt surfaced pavements

The design of shoulders on motorways must comply to the following:

a) sealed shoulder:

i) edge line to 0.5 m outside edge line - same pavement structure as adjacent trafficked lane; and

ii) 0.5 m outside edge line - either same pavement structure as adjacent traffic lane, or reduced structure designed in accordance with shoulder thickness design requirements in section 10.4; and

b) unsealed shoulders are not acceptable on motorway class roads.

10.4 Shoulder thickness design

For design of sealed and unsealed shoulders adjoining new pavement, a design traffic value for the shoulders of 0.1% of the adjacent trafficked lane pavement must be adopted, except:

a) where the shoulder will carry substantial construction trafficking, this must be added to the 0.1 % traffic loading; and

b) any other consideration that will increase the design traffic loading above these nominal design values.

10.5 Rural shoulder design

For the design of sealed and unsealed shoulders in rural locations the following applies:

a) the uppermost 100 mm or more of unsealed shoulder on rural roads must be a Class 2 pavement material or similar with plasticity index between 6 and 8 (inclusive) to provide low permeability and good surface integrity (resistance to ravelling);

b) where shoulder traffic loadings are less than 1×10^5 ESA:

i) Class 2 granular pavement materials may be used as the base course layer to match adjacent unsealed shoulder base course materials for constructability;

ii) select fill meeting RD-EW-C1 “Earthworks” Material Classification A and a minimum design CBR of 7% may be used in subbase layers in lieu of Class 2 granular pavement materials; and

iii) Department Standard Drawing 95272, sheet 4 shows a typical cross section for a rural pavement illustrating this arrangement; and

c) matching shoulder layer thicknesses to adjacent trafficked lanes layer thicknesses should be implemented for constructability, where possible.

11 Bikeway pavements

11.1 General

a) This section 11 applies to the design of bikeway pavements for off-road, exclusive-use paths for cyclists or shared paths for pedestrians and cyclists, with either no vehicular trafficking or limited maintenance vehicle trafficking only.

b) This section 11 must not be used to design bikeway lanes formed directly adjacent road pavements which must be designed as either:

i) shoulder pavements as per section 10. The Contractor must account for construction practicality, efficiencies and joints where a lesser bike lane pavement is being considered; or

ii) in accordance with the adjacent road traffic lane pavement, in accordance with this Master Specification Part.

c) This section 11 applies to the design of the following flexible bikeway pavement types:

i) unsealed granular pavements;

ii) bituminous sealed (i.e., sprayed sealed, asphalt, slurry, or micro-surfacing) granular pavements;

iii) concrete block pavements; and

iv) pavements incorporating stabilised materials.

11.2 Bikeway pavement type selection

11.2.1 General

Where the Contract Document do not specify the bikeway pavement type and surfacing, selection must be made based upon:

a) structural criteria; and

b) functional criteria.

11.2.2 Structural criteria

a) Guidance on the selection of bikeway pavement type from structural factors is provided in Figure RD-PV-D1 11-1.

b) The Contractor's bikeway pavement design, selection and surfacing types must consider future management of performance risk and maintenance requirements if likely to be constructed over reactive subgrades.

c) The Contractor must utilise geotextile seals or interlayers with sprayed seal on granular or asphalt on granular pavements likely to be constructed over highly expansive soils to minimise surface cracking and moisture ingress.

d) The Contractor must utilise methods to reduce effects of expansive soils based on structural factors, functional criteria and economic assessment including:

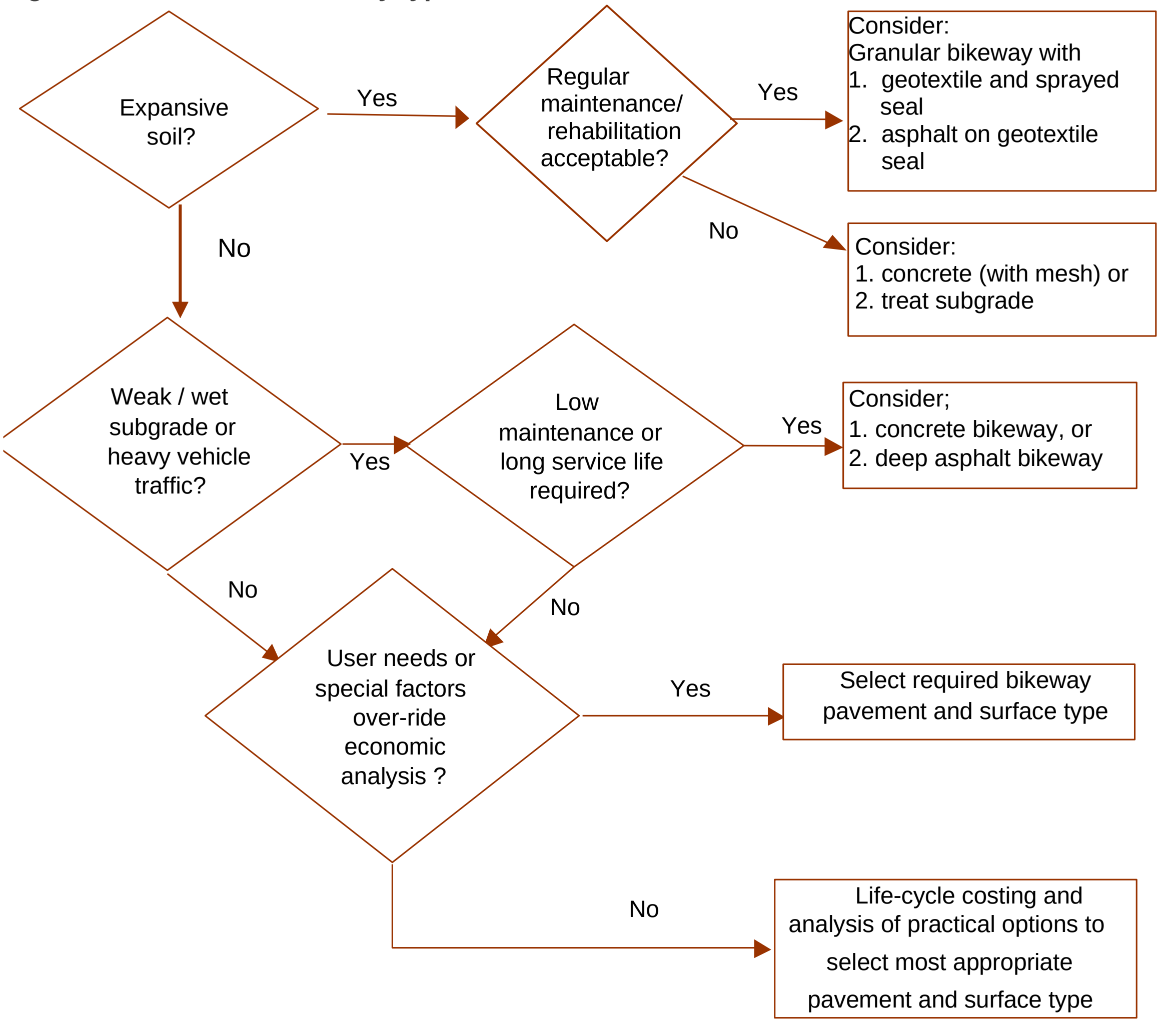
i) removal and replacement of localised expansive soil deposits;

ii) capping with non-expansive fill;

iii) installation of moisture barriers horizontally under the bikeway and vertically at the edge of the seal to a depth of 2 m to 2.5 m; and

iv) lime stabilisation of the expansive subgrade.

Figure RD-PV-D1 11-1 Bikeway type selection - structural factors



11.2.3 Functional criteria

a) The Contractor must consider the following in the selection of bikeway pavement type:

i) surface type and colour: to define usage, crossings or other areas, or to contrast surfaces;

ii) aesthetics: contrast or compatibility with surroundings, boxed in or raised construction (requirement for edge restraint);

iii) ride quality: consideration of surface texture, roughness and presence of joints;

iv) construction: consideration of access, topographical, and environmental constraints that could impact on pavement construction and quality;

v) landscaping: potential impacts from tree roots and irrigation, and related environmental movements;

vi) flooding: risks of inundation; and

vii) future works: requirements for maintenance and potential for widening or alteration.

b) The Department Guide to Bikeway Pavement Design, Construction and Maintenance for South Australia provides further guidance on pavement type and surfacing characteristics for the Contractor's design of the bikeway.

11.3 Design traffic loading

11.3.1 Design period

The Contractor must design bikeway pavements for a Design Life dependent on the pavement type including:

a) flexible and concrete block pavements for 20-years; and

b) rigid pavements for 40-years.

11.3.2 Traffic characterisation

a) Bikeway pavement traffic loading are categorised as:

   i) **bikeway with pedestrian and bicycle traffic only**, where there is no vehicle access or no vehicle heavier than pedestrian or bicycle loading permitted or possible along the bikeway pavement; or

   ii) **bikeway with vehicle loading**, where vehicle access is permitted and expected.

b) The Department Guide to Bikeway Pavement Design, Construction and Maintenance for South Australia provides further clarification on determining which traffic category applies on a Project.

c) As a minimum, bikeway pavements must be designed for vehicle loading as per section 11.3.3 unless specified otherwise by the Contract Documents.

d) Vehicle crossovers in a bikeway pavement designed only for pedestrian and bicycle traffic must be designed as a bikeway pavement with vehicular loading as per section 11.3.3.

11.3.3 Bikeway with vehicle loading

a) The Contractor must utilise Project specific access and usage data provided in the Contract Documents for bikeway pavements with vehicle loading. In the absence of the Project specific data, the Contractor may adopt the following presumptive data:

   i) design vehicle: Austroads vehicle class 3, 2-axle (single axle with single tyres and single axle with dual tyres) rigid truck:

      A. partly laden, with gross mass 12 t (about 80% of fully laden gross mass);

      B. SAST at 5 t giving 0.73 ESA of damage;

      C. SADT at 7 t (68.6 kN) giving 0.54 ESA of damage; and

      D. ESA/HV = 1.27, ESA/HVAG = 0.64; and

   ii) one 2-axle rigid truck pass per week, factored by 3 to account for channelisation of traffic.

b) The design traffic loading must be calculated in accordance with section 4 where the bikeway pavement is expected to receive greater loading.

11.4 Flexible bikeway pavement design

a) Where the wearing course is dense graded asphalt (e.g. FineAC7 or FineAC10L), or comprises concrete block pavers and bedding sand, the wearing course thickness may be considered to contribute to the required total granular pavement thickness, provided a minimum basecourse thickness of 100 mm is provided, and minimum granular layer thicknesses from Table RD-PV-D1 8-2 are applied.

b) For flexible bikeway pavements subject to pedestrian and bicycle traffic only, the Contractor must use presumptive minimum pavement thickness configurations, as follows:

   i) 2% ≤ design CBR < 5%: minimum thickness of granular material must be a total of 200 mm;

ii) 5% ≤ design CBR < 10%: minimum thickness of granular material must be a total of 150 mm;

iii) design CBR ≥ 10%: minimum thickness of granular material must be a total of 100 mm; and

iv) in all scenarios: minimum thickness of basecourse must be 100 mm.

11.5 Bikeway pavement materials

11.5.1 Granular materials

a) The Contractor must design unsealed granular bikeway pavement material acting as the surfacing layer (wearing course) to satisfy the following properties:

i) nominal maximum aggregate size of 20 mm to provide good rideability;

ii) if the bikeway pavement is not required to support any heavy vehicle traffic, the Contractor may use finer gravel or graded crusher sand (e.g. Sa-C sand);

iii) plasticity index between 6 and 10 (inclusive to provide good surface integrity (resistance to abrasive traffic loading and environmental erosion);

iv) minimum soaked CBR of 60%; and

v) for a 20 mm product, LA Abrasion value < 35.

b) A Class 3 granular pavement material (e.g. PM3/20QG or PM3/20RG) will generally meet the requirements of section 11.5.1a).

c) Basecourse and sub-base materials must meet the minimum requirements presented in Table RD-PV-D1 11-1.

d) Select fill meeting RD-EW-C1 “Earthworks” material classification A (Type A fill) and a minimum design CBR of 7% may be used in lieu of Class 2 or Class 3 granular pavement materials in subbase layers (for bikeways trafficked by pedestrians and bicycles) or lower subbase (for bikeways with vehicular traffic).

e) Minimum design (or compacted) layer thicknesses apply to granular pavement materials based on Table RD-PV-D1 8-2. Type A fill used in subbase or lower subbase layers must have a design thickness range of 100 mm to 150 mm.

Table RD-PV-D1 11-1 Basecourse and sub-base requirements for bikeways

Layer	Pavement material	Traffic scenario
Basecourse	PM2/20QG or RG	Bikeways with vehicular traffic
	PM3/20QG or RG	Bikeways with pedestrians and bicycles only
Subbase	PM2/20QG or RG	All bikeway traffic scenarios
	PM3/20QG or RG	All bikeway traffic scenarios. Not permitted below concrete where vehicle access permitted.

11.5.2 Sprayed seal

a) Sprayed seal surface bikeway pavements must comprise a 10/5 mm double/double seal, with the following nominal application rates:

i) prime: AMC0 at 1.0 l/m^2;

ii) seal bottom coat:

A. C170 at 1.1 L/m^2; and

B. 10 mm aggregate, spread rate 130 m^2/m^3; and

iii) seal top coat:

A. C170 at 1.0 L/m²; and

B. 5 mm aggregate, spread rate 250 m²/m³.

b) Where improved surface performance is required, particularly in subgrades of moderate to high expansivity, the Contractor must design a geotextile reinforced seal, comprising a 10/5 mm double/double seal, with the following preliminary application rates:

i) prime: AMC0 at 1.0 l/m²;

ii) geotextile bond-coat C170 at 0.7 l/m²;

iii) geotextile: refer Table RD-PV-D1 11-2;

iv) seal bottom coat:

A. C170 at 1.3 L/m²; and

B. 10 mm aggregate, spread rate 130 m²/m³; and

v) seal top coat:

A. C170 at 1.0 L/m²; and

B. 5 mm aggregate, spread rate 250 m²/m³.

Table RD-PV-D1 11-2 Key properties of paving fabric for bikeway pavements

Property	Units	Value
Mass / unit area	g/m²	>135
Wide-strip tensile strength in accordance with AS 3706.2 Geotextiles - Methods of test, Method 2: Determination of tensile properties - Wide-strip and grab method	kN/m	>7.0
Maximum elongation range in accordance with AS 3706.2 Geotextiles - Methods of test, Method 2: Determination of tensile properties - Wide-strip and grab method	%	40 - 60
Minimum melt temperature	°C	>195

11.5.3 Asphalt

a) Asphalt mixes for bikeway wearing course pavements must comprise:

i) FineAC10L C320 where vehicular traffic is permitted; and

ii) FineAC7L C170 where pedestrians and bicycles traffic only (no vehicular traffic) is permitted.

b) Stiffer, softer or polymer modified binders may be used for special applications and/or localised climatic conditions.

c) Asphalt design layer thicknesses must comply with Table RD-PV-D1 8-7.

d) The Contractor must apply a prime or initial seal to the granular base to promote adhesion within the surface structure of the granular base and between the granular base and asphalt surface.

11.5.4 Concrete block pavers

The design, specification and detailing of concrete block (or segmental) pavers must conform with:

a) Concrete Masonry Association of Australia PA01 Concrete Segmental Pavements - Detailing Guide;

b) Concrete Masonry Association of Australia PA02 Concrete Segmental Pavements - Design Guide for Residential Accessways and Roads; and

c) Concrete Masonry Association of Australia PA03 Concrete Segmental Pavements - Guide to Specifying.

11.5.5 Concrete bikeway pavements

a) The Contractor must design concrete bikeway pavements in accordance with the following:

   i) bikeway pavements subject to pedestrians and bicycles only must have a minimum unconfined compressive strength (f'c) of 25 MPa; and

   ii) bikeway pavements where vehicular traffic allowed must have a minimum unconfined compressive strength (f'c) of 32 MPa (and minimum flexural strength of 4 MPa at 28 days).

b) The Contractor must consider the use of higher concrete strengths with greater durability and resistance to structural cracking for sensitive situations such as exposed aggregate concrete or more aggressive environments.

c) Concrete aggregate must be limited to a maximum size of 20 mm.

11.6 Rigid bikeway pavement design

a) The Contractor must design rigid pavement type as continuously reinforced concrete pavement (CRCP) with minimum 150 mm thick unbound granular subbase.

b) Rigid pavements on a bikeway with vehicle traffic must be designed using AGPT Part 2 - Pavement Structural Design, subject to the following requirements:

   i) equivalent subgrade design strength (CBRE) must be assessed based on:

      A. AGPT Part 2 - Pavement Structural Design, section 9.3.2 “Effective Subgrade Strength”, assuming the unbound granular subbase has minimum CBR = 15%;

      B. subgrade design CBR assessed in accordance with section 6; and

      C. where subbase thickness is less than 200 mm the subbase is assumed to provide no additional benefit to the subgrade design strength;

   ii) load safety factor (LSF) of 1.05 for CRCP, based on Project design reliability of 85%;

   iii) ‘without concrete shoulders’ criteria applies, unless the Contractor can demonstrate the “with concrete shoulders” criteria applies, with supporting details provided in the Pavement Design Report;

   iv) minimum base concrete thickness of 125 mm; and

   v) additional 10 mm must be added to base concrete thickness determined using above procedures.

c) As a minimum the Contractor must design the reinforcement as:

   i) continuously lapped (200 mm overlaps) SL72 mesh; and

   ii) placed at mid-point or in upper half of the pavement slab, with minimum cover top cover of 40 mm (base thickness <150 mm), or 50 mm (base thickness ≥ 150 mm).

d) The Contractor must design the joints of concrete pavements in accordance with RD-PV-D3 "Concrete Road Pavements" and be compatible with the path geometry, the length of slab, the type of joint, and the construction method and programming to be employed.

e) The Contractor must nominate the surface finish to achieve:

   i) a minimum skid resistance of Grip No. of 0.40 (GripTester) or equivalent British Pendulum No., noting Grip No. = 0.01 x BP; and

   ii) surface texture appropriate to the pavement grade.

f) Where the grade of the bikeway pavement exceeds 5%, or where there are interfacing flexible pavements, other rigid pavement or bridge structures or similar, anchor blocks must be designed at appropriate intervals to prevent slippage of the slab.

11.7 Surface tolerance

a) The finished surface of the bikeway pavement must:

i) match existing site features to within 5 mm; and

ii) not deviate from a 3 m straight edge by more than 5 mm at any point.

b) The pavement surface, including longitudinal and transverse joints, must not pond water.

11.8 Edge restraint

a) All flexible bikeway pavement designs must incorporate lateral restraint to maintain structural integrity.

b) Typical edge restraint systems are presented in Table RD-PV-D1 11-3.

Table RD-PV-D1 11-3 Typical edge restraint systems for flexible bikeway pavements

Restraint type	Dimensions	Applicable bikeway pavement type
Concrete kerbing (chamfered)	125 mm x 255 mm	All flexible types
Timber (bull nosed, standing proud)	50 mm x 150 mm	All flexible types
Additional basecourse width	150 mm minimum 300 mm desirable	All flexible pavement types, except CBP

12 Pavement detailing and documentation requirements

12.1 Pavement joint design and treatment extent

12.1.1 Pavement joints

a) For all asphalt layers other than wearing course joints must not be located in wheel paths.

b) As a minimum, the wearing course must not be located in wheel paths.

c) Where unavoidable, joints in wheel paths must be detailed as appropriate to the pavement configurations and materials, support conditions, traffic loads, Project scope and other factors, to mitigate pavement performance risks (e.g. settlement and shape loss, cracking, stripping etc).

d) Joint details are required for all pavement joints on a project, including:

i) each combination of unique abutting pavement types, which includes joints between new and existing pavements at the extent of works;

ii) at the end and edges of construction runs and processes within the same configuration; and

iii) between pavements and other road elements, such as kerb and gutter, central medians and subsurface drainage.

e) These joint details must be shown on the Design Drawings to be included as part of the Design Documentation.

f) Typical joint details are provided at https://dit.sa.gov.au/standards/standards_and_guidelines. These details illustrate typical requirements and must be adapted and adjusted for project specific pavement configurations.

12.1.2 Pavement treatment extent

Unless proposed in the approved Pavement Design Report, the pavement treatments must extend:

a) preferably, to the edge of lanes, or where unavoidable, to the middle of lanes, to avoid joints in the wheel paths;

b) to the limit of geometric changes;

c) to the extent of pavement marking (traffic control layout) changes to remove all existing pavement marking, noting that the removal of all existing pavement markings must be in accordance with M16 “Application of Pavement Marking”;

d) minimum constructible pavement widths that will:

   i) allow achievement of construction specification quality requirements through access for larger plant;

   ii) promote good productivity;

   iii) minimise use of hand work; and

   iv) avoid steps between pavement layers over short distances; and

e) on intersecting council roads, as a minimum, to the extents of the Commissioner of Highway’s maintenance responsibility, as defined in Section 3.1 of Department Operational Instruction 20.1 Care, Control & Management of Roads (Highways) by the Commissioner of Highways (Section 26 of the Highways Act).

12.2 Documentation of pavement design

12.2.1 Pavement Design Report

a) In addition to the requirements of PC-EDM1 “Design Management”, pavement designs must be presented in a Pavement Design Report, which documents the pavement design basis, Site investigation, all inputs and calculations or methodology, detailed pavement configurations and their use on the Project to be provided as part of the Design Documentation.

b) The Pavement Design Report must include documentation with sufficient detail to allow verification of conformance with the Contract Documents including:

   i) the Project scope;

   ii) references to design standards used;

   iii) basis of selection of each pavement type, including surfacing type;

   iv) subgrade support conditions, including the results of site investigations and geotechnical field and laboratory test data, consideration of any earthworks or select fill or stabilisation treatments, and the basis and nomination of subgrade design CBR value;

   v) identification of any subgrade issues or risks affecting pavement design, construction and performance including:

      A. expansive soils;

      B. weak subgrades;

      C. fill;

      D. collapsing soils;

      E. organic soils;

      F. rock; and

      G. appropriate subgrade treatments;

   vi) the design accounts for existing data, including construction data, pavement condition data, pavement history and previous pavement reports (if available);

vii) assessment of adjacent existing pavements, including their shape and defects, and the need to address these to achieve acceptable road geometry and pavement roughness, and the Design Life from the new Works;

viii) detailed design calculations and methodology, including:

A. pavement Design Life;

B. Project reliability factor;

C. nominated design moduli for each pavement material and basis of selection, including asphalt design speed;

D. the performance relationships used to estimate allowable loadings;

E. design traffic calculations, including data sources and the basis of selection of each input parameter. Note any freight/haul routes or other seasonal or unusual traffic movements. State adopted values as applicable for traffic counts (AADT, HV count (%)), growth rates, traffic load distribution (ESA/HV) and lane distribution factor. Cumulative design traffic loadings must be stated for all considered Design Life;

F. technical basis of the selected design traffic loading of short term heavy loadings as required by section 4.2.2c);

G. thickness design calculations, being, where relevant:

I. CIRCLY Job Summary File (or AustPADs equivalents), with layer thicknesses, elastic properties, critical strains and allowable loadings or Cumulative Damage Factors;

II. workings of application of empirical chart based thickness design;

III. workings of application of deflection based design procedures; or

IV. other pavement design procedures used in design; and

H. rounding up and adjustment of the critical layer thickness;

ix) assumptions, design benefits and limitations must be reported, as well as the preferred design option, construction issues and risks;

x) identify any potential interface issues such as drainage or road design;

xi) a neat summary of each pavement configuration;

xii) a pavement work schedule for each pavement type;

xiii) if required by the Contract Documents, Sustainability in Design requirements, in accordance with PC-ST1 “Sustainability in Design”;

xiv) identify the source of traffic data applied and calculations for each pavement design, as required by section 4.2.1a);

xv) evidence of consideration of the whole of life cost benefits of constructing the perpetual pavement thickness in accordance with section 4.3.2;

xvi) turn count data as required by section 4.3.4b)ii); and

xvii) scope of site investigations and results of such site investigations, as required by section 5.1e).

12.2.2 Pavement drawings

a) Pavement details must be included in the Design Drawings which must be submitted as part of the Design Documentation.

b) The pavement Design Drawings must provide sufficient information on pavement types, extents, joint and other design details, with related notes, as necessary to present the pavement designs for tendering and construction.

c) Drawings must be prepared in accordance with Department Drawing Presentation RD2.1 Example Drawings for Large Project and Department Drawing Presentation RD2.2 Example Drawings for Small Project (as applicable) and include:

   i) pavement treatment plans, showing the extent of each pavement type;

   ii) pavement joint details, for each combination of intersecting pavement types;

   iii) pavement work schedules;

   iv) provision of pavement depths on cross-sections where significant changes in road geometry are occurring as part of the works (e.g. rural projects with widenings and rehabilitation of existing pavements incorporating overlays or inlays); and

   v) any other drawings and details necessary to document the design and avoid uncertainty during tender and construction, such as construction notes or typical cross-sections.

12.3 Pavement work schedule

12.3.1 General

a) A pavement work schedule (or pavement schedule) must be provided for each unique pavement type, in accordance with Department Drawing Presentation RD2.1 Example Drawings for Large Project and Department Drawing Presentation RD2.2 Example Drawings for Small Project (as applicable) specifying:

   i) design level of each layer boundary relative to the finished design levels;

   ii) level tolerances for design level. Table RD-PV-D1 12-1 provides guidance on level tolerances that are applicable in most situations. The Contractor must consider the overall pavement structure and which layer is the critical layer, as well as constructability, quality management systems and other factors, for each specific configuration to ensure these are suitable. Tighter tolerances apply to the surface level and the bottom level of the critical pavement layer, which control the total pavement thickness;

   iii) nominal compacted thickness (of each layer). These must conform to Table RD-PV-D1 12-1 requirements;

   iv) layer description of each pavement layer. A description of the layer function or type, e.g. wearing course, levelling course, base course, sub base, lower sub base, select fill, etc.;

   v) material type for each pavement layer, referencing the relevant Master Specification Part; and

   vi) application rates and additional requirements of the Master Specification.

b) The pavement design surface level is assigned a design level of 0 mm, except for OGA wearing courses proud of water tables, where the levelling course is assigned design level 0 mm.

c) Sprayed seal wearing courses are not given a nominal design thickness in work schedules, with finished surface levels for construction conformance measured on the top of the granular basecourse.

d) Where a sprayed seal is used as an interlayer, e.g. a 10 mm SAMI below an OGA wearing course, or a 7 mm spray seal below an SMA10 wearing course, then the nominal ALD of the aggregate must be nominated as the design thickness in the pavement work schedules (5 mm usually).

12.3.2 Level tolerances

a) Design level tolerances must meet the requirements of Table RD-PV-D1 12-1.

b) For design levels within the pavement profile, a top layer level tolerance and a bottom of layer level tolerance will generally be applicable. The more conservative of the 2 tolerances must be selected for the design level.

Table RD-PV-D1 12-1 Pavement layer level tolerances

Material	Layer	Top of layer level tolerance (mm)	Bottom of layer level tolerance (mm)
Asphalt	Wearing course - AC10 or SMA(1)	+5, -0 adjacent kerb and gutter ±5 elsewhere	+5, -10
	Wearing course - OGA(2)	±5	+5, -0(2)
	Intermediate and base course layers, except bottom asphalt Layer - AC10, AC14	±10	±10
	Bottom asphalt layer(3)	±10	±10 if not critical layer +0, -10 if critical layer(3)
Stabilised materials (fully-bound)	CT, FBS	±15	±15 if not critical layer +0, -15 if critical layer(3)
Unbound granular materials	Top base course layer (PM1)	±10(4)	±15 if not critical layer +0, -40 if critical layer(3)
	Other base course layers and subbase layers	±15	+0, -40(5) if bottom layer(3) ±15 if not bottom layer (i.e. for intermediate layers)

Table notes:

(1) Dense mix and SMA wearing course surface levels must be specified to match or sit slightly proud of the adjacent kerb water table level, to allow surface water to run onto the water table. Where there is no kerb and gutter present, or other adjacent surface level to consider, a greater surface tolerance can be adopted.

(2) OGA typically sits proud of the water table or shoulder surface level to allow water to drain laterally out of this porous mix. The surface level of the underlying AC levelling course is then specified to match the adjacent water table or shoulder surface level.

(3) The bottom of the critical layer governing the pavement Design Life is given a level tolerance of +0 mm to ensure that the as-constructed thickness achieves the thickness used in design calculations. This tolerance typically applies to the bottom asphalt layer with full depth asphalt pavements, the bottom CTSB layer in asphalt - CTSB composite pavements, and either the bottom asphalt layer or bottom CTSB layer in deep strength asphalt pavements, as identified in MEP calculations.

(4) This tolerance would apply where a sprayed seal surfacing is to be applied.

(5) A tighter tolerance of -20 mm (instead of -40 mm) must be adopted on motorway class pavements with low target roughness counts to reduce the potential for longitudinal subgrade level variations that can negatively affect the finished pavement ride quality.

12.3.3 Moisture content of granular materials

a) PM1 materials must not have a moisture content exceeding:

i) 60% of OMC for heavily trafficked roads;

ii) 70% of lightly trafficked and moderately trafficked roads, with traffic categories defined in accordance with section 3.1 b); and

iii) the dry back requirements for the top-most basecourse layer, as required by RD-BP-D3 “Design and Application of Sprayed Seals” prior to sealing.

b) PM2 and PM3 materials must not have a moisture content exceeding 70% of OMC.

c) The pavement design should give consideration to weather conditions at the time of construction and the need for provision of strategies to expedite material dry back, e.g. addition of 1% cement in lower layers, and related construction and performance issues and risks.

12.4 Independent design review

Independent review of calculations and design must be undertaken and recorded in the Pavement Design Report.

13 Hold Points

Table RD-PV-D1 13-1 details the review period or notification period, and type (documentation or construction quality) for each Hold Point referred to in this Master Specification Part.

Table RD-PV-D1 13-1 Hold Points

Section reference	Hold Point	Documentation or construction quality	Review period or notification period
8.2.4a)	Submission of Design Departure	Documentation	10 Business Days review