DESIGN SPECIFICATION

D2

PAVEMENT DESIGN

SPECIFICATION D2 – PAVEMENT DESIGN

CLAUSE CONTENTS PAGE

CITATION

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VERSIONS, D2 – Pavement Design

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DESIGN SPECIFICATION D2 PAVEMENT DESIGN

GENERAL

D2.01 SCOPE

Design Criteria

1. This Specification sets out criteria for the design of road pavement to meet the required design life, based on the subgrade strength, traffic loading, environmental factors, and the selection of appropriate materials for select subgrade, sub base, base and wearing surface.

Surfaced Pavement Types

2. The Specification contains procedures for the design of the following forms of surfaced road pavement construction:

(a) flexible pavements consisting of unbound granular materials;

(b) flexible pavements that contain one or more bound layers, including pavements containing asphalt layers other than thin asphalt wearing surfaces; and

(c) rigid pavements (ie. cement concrete pavements)

Unsealed Pavements

3. Consideration to the design of unsealed (gravel) pavements will only be given for minor rural subdivisions/developments in isolated rural areas where the access to the subdivision is via an existing unsealed road.

D2.02 OBJECTIVES

Pavement Performance

1. The objective in the design of the road pavement is to select appropriate pavement and surfacing materials, types, layer thicknesses and configurations to ensure that the pavement performs adequately and requires minimal maintenance under the anticipated traffic loading for the design life adopted.

D2.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

D1	-	Geometric Road Design
D4	-	Subsurface Drainage Design
C213	-	Earthworks
C230	-	Subsurface Drainage
C231	-	Subsoil and Foundation Drains
C233	-	Drainage Mats
C241	-	Stabilisation
C242	-	Flexible Pavements
C244	-	Sprayed Bituminous Surfacing
C245	-	Asphaltic Concrete
C247	-	Mass Concrete Sub base
C248	-	Plain or Reinforced Concrete Base
C255	-	Bituminous Micro surfacing

(b) Australian Standards

AS 1141	Methods for Sampling and Testing Aggregates
AS 1289	Methods of Testing Soils for Engineering Purposes
AS 1726	Geotechnical Site Investigations

(c) State Authorities

Roads and Maritime Services, NSW – Standard Test Methods

EPA – NSW Road Noise Policy 2011 (DECCW 2011/236)

(d) Other

AUSTROADS	-	Guide to Pavement Technology
ARRB	-	Sealed Local Roads Manual 2005 (USR004)
CCAA	-	Guide to Residential Streets and Paths 2004 (C&CAA T51)
CCAA	-	Reinforced Concrete Design Handbook 2011 (C&CAA HB 71)
AUSTROADS	-	Standard Test Methods

(e) Standard Drawings

D2.04 ABBREVIATIONS

AGPT02-17	AUSTROADS Guide to Pavement Technology, Part 2: Pavement Structure Design – Fourth edition published in December 2017.
UCS	Unconfined Compressive Strength
ESA	Equivalent Standard Axles
CBR	California Bearing Ratio
CVAG	Commercial Vehicle Axle Groups

D2.05 DEFINITIONS

Bound material	are produced by the addition of cement, lime, slag, bitumen or other binders sufficient to produce significant tensile strength. Lightly bound materials have a UCS value between 1-1.5MPa and heavily bound materials have a UCS greater than 2MPa. Typically bound gravels may contain greater than 3% cementitious binder by mass and are designed to limit tensile strain at the base of the cemented pavement layer to a pre-determined criteria through a mechanistic design process.
Modified material	small addition of stabilising material (binder) to improve performance in properties such as wet strength. Typically modified gravels may contain between 1 and 3% cement or lime by mass and have an unconfined compressive strength (UCS) less than 1MPa. Modified pavements are designed to limit the vertical strain at the top of the subgrade as an

unbound pavement layer. If selecting cement binder, laboratory testing must be carried out to ensure a UCS result less than 1MPa.

PAVEMENT DESIGN CRITERIA

D2.06 DESIGN VARIABLES

1. Regardless of the type of road pavement proposed, the design of the pavement shall involve consideration of the following five input variables:

Design Variables

(a) Design Traffic

(b) Subgrade Evaluation

(c) Environment

(d) Pavement and Surfacing Materials

(e) Construction and Maintenance Considerations

D2.07 DESIGN TRAFFIC

1. The design traffic shall be calculated based on the following minimum design lives of pavement:

Minimum Pavement Design Life

(a) Flexible, Unbound Granular or Modified Pavement - 30 years

(b) Flexible, Containing one or more bound layers - 30 years

(c) Rigid (Concrete) - 40 years

2. Design traffic shall be calculated in equivalent standard axles (ESAs) for the applicable design life of the pavement, taking into account present and predicted commercial traffic volumes, axle loadings and configurations, commercial traffic growth and street capacity. For new subdivisions, the design traffic shall take account of both the construction traffic associated with development and the in-service traffic.

Design Traffic

3. The pavement design shall include all traffic data and/or assumptions made in the calculation of the design traffic. Notwithstanding, the minimum design traffic for rural and urban road networks design shall be as per the following table assuming a 30 year design life.

Traffic Data

Table D2.1
Minimum Design Traffic in Urban Road Networks

Road Level	Design Traffic (ESA)
Shareway	1.0×10^4
Access Place	1.0×10^5
Access Street	1.0×10^6
Collector Road	7.5×10^6
Commercial/Industrial Access Road	7.5×10^6
Commercial/Industrial Collector Road	2.0×10^7
Sub Arterial Road	3.0×10^7
Arterial Road	5.0×10^7

Table D2.2
Minimum Design Traffic in Rural Road Networks

Road Level	Design Traffic (ESA)
Right of Carriageway (Private Property)	1.0×10^4
Rural Laneway	1.0×10^4
Rural Minor	1.0×10^5
Rural Major	5.0×10^5
Rural Collector	1.0×10^6
Arterial Road	1.0×10^7

4. In general, reference should be made AGPT02-17 for the calculation of design traffic volumes.

Design Traffic Volumes

D2.08 SUBGRADE EVALUATION

1. Evaluation of subgrade conditions shall be in accordance with Section 5 and 12.5 of AGPT02-17 for light traffic pavements.

2. Except where a mechanistic design approach is employed using AGPT02-17, the measure of subgrade support shall be the California Bearing Ratio (CBR), with testing undertaken in accordance with AS 1289. Where a mechanistic design approach using linear elastic theory is employed for flexible pavements, the measure of

California Bearing Ratio

subgrade support shall be in terms of the elastic parameters (modulus, Poisson's ratio).

3. The following factors must be considered in determining the design strength/stiffness of the subgrade: *Design Considerations*

(a) Sequence of earthworks construction

(b) The compaction moisture content and field density specified for construction

(c) Moisture changes during service life

(d) Subgrade variability

(e) The presence or otherwise of weak layers below the design subgrade level.

4. The road pavement design shall be divided into "homogenous areas" of similar traffic loading, subgrade material, moisture conditions and subgrade support. Pavement design shall be carried out for each homogenous area. *Homogenous Areas*

5. The maximum spacing of test sites for field inspection pits is to be: *Sampling Frequency*

(a) 100m for urban projects, minimum of two tests

(b) 250m for rural projects, minimum of three tests

6. The calculation of the Design CBR shall be based on a minimum of three 4 day soaked CBR or 10 day soaked CBR laboratory samples for each subgrade area, compacted to the relative density specified for construction, and corrected to allow for the effects of subsurface drainage (or lack of), climatic zone, and soil type if appropriate to give an estimated equilibrium in-situ CBR. A 4 day soaked CBR is applicable to locations that are not low lying which are unlikely to hold subgrade moisture for extended periods of time. Conversely a 10 day soaked CBR may be deemed applicable in low lying terrain. The Design CBR for each subgrade area is computed by using the appropriate formulae as follows: *Calculation of Design CBR*

(a) Less than five (5) results

Design CBR = Least of estimated equilibrium CBRs

(b) Five (5) or more results

Design CBR = 10^{th} percentile of all estimated equilibrium CBRs

= C-1.3S

Where C is the mean of all estimated equilibrium CBRs and

S is the standard deviation of all values

7. Where practicable, the Design CBR obtained from laboratory testing should be confirmed by testing performed on existing road pavements near to the job site under equivalent conditions and displaying similar subgrades. *Field Confirmation*

8. Where soft and/or wet subgrades occur and the in situ density is less than minimum subgrade compaction requirements specified in construction standards, the subgrade support adopted for pavement design shall be determined at the in situ *Soft Subgrade*

density or a higher density, not exceeding minimum compaction requirements detailed in Construction Specification C213 EARTHWORKS that may reasonably be achieved in construction.

9. Subgrade Separation

Subgrade Separation

Where any of the following conditions occur, a separation membrane shall be provided:

(a) Soft subgrade – CBR less than 5%

(b) Water table – less than 300mm below subgrade level

(c) Expansive soils – Swell greater than 2.5%

A separation membrane shall consist of a select fill, stabilised subgrade or approved alternative permeable membrane.

Summary of Results

10. The pavement design shall include a summary of all laboratory and field test results and assumptions and/or calculations made in the assessment of Design CBR.

D2.09 ENVIRONMENT

1. The environmental factors that which significantly affect pavement performance are moisture and temperature. Both of these factors must be considered at the design stage of the pavement. Reference should be made to AGPT02-17.

D2.10 PAVEMENT AND SURFACING MATERIALS

Pavement Classification

1. Pavement materials can be classified into essentially four categories according to their fundamental behaviour under the effects of applied loadings:

(a) Unbound granular materials, including modified granular materials

(b) Bound (cementitous) granular materials

(c) Asphaltic Concrete

(d) Cement Concrete

Surfacing Classification

2. Surfacing materials can also be classified into essentially three categories or types:-

(a) Sprayed bituminous seals

(b) Asphaltic concrete and bituminous micro surfacing

(c) Cement Concrete

3. Unbound granular materials, including modified granular materials, shall satisfy the requirements of Construction Specification C242 FLEXIBLE PAVEMENTS.

4. Bound (cementitous) granular materials shall satisfy the requirements of Construction Specification C241 STABILISATION.

5. Asphaltic concrete shall satisfy the requirements of Construction Specification C245 ASPHALTIC CONCRETE.

6. Cement concrete shall satisfy the requirements of Construction Specifications C248 PLAIN OR REINFORCED CONCRETE BASE.

7. Sprayed bituminous seals shall satisfy the requirements of Construction Specification C244 SPRAYED BITUMINOUS SURFACING.

8. Concrete and clay segmental pavers shall not be used on roads. Stencil concrete may be used in approved locations and shall be designed as per requirements for rigid (concrete) pavements.

9. Bituminous micro surfacing shall not be used for new road construction and other applications where approved by Council shall satisfy the requirements of Construction Specification C255 BITUMINOUS MICRO SURFACING.

D2.11 CONSTRUCTION AND MAINTENANCE CONSIDERATIONS

1. The type of pavement, choice of base and sub base materials, and the type of surfacing adopted should involve consideration of various construction and maintenance factors as follows:

(a) Extent and type of drainage, stormwater and subsoil

(b) Use of boxed or full width construction

(c) Traffic characteristics including traffic volumes, heavy vehicles and turning movements

(d) Use of stabilisation

(e) Aesthetic, environmental and safety requirements including noise

(f) Social considerations

(g) Construction constraints including vibration limitations and construction under traffic

(h) Use of staged construction

(i) Ongoing and long-term maintenance costs

These factors are further discussed in AGPT02-17.

PAVEMENT THICKNESS DESIGN

D2.12 PAVEMENT STRUCTURE – GENERAL

Minimum Pavement Thickness

1. The minimum overall pavement thickness including the surfacing, shall be 250 mm.

Sub base Extent

2. The sub base layer shall extend a minimum of 150mm behind the rear face of any kerbing and/or guttering.

Base Extent

3. The base and surfacing shall extend to the face of any kerbing and/or guttering. Where the top surface of the base layer is below the level of the underside of the kerbing and/or guttering, the base layer shall also extend a minimum of 150mm behind the rear face of the kerbing and/or guttering.

4. For un kerbed roads, the sub base and base layers shall extend at least to the nominated width of shoulder. Where subsoil drainage is not provided, the sub base and base layers shall extend the full width of formation or to the table drain unless it its demonstrated that the subgrade is sufficiently well drained to permit boxed construction.

5. The pavement designer shall make specific allowance for traffic load concentrations within car park areas (entrances/exits) and at intersections, including roundabout locations.

D2.13 UNBOUND GRANULAR FLEXIBLE PAVEMENTS (BITUMINOUS SURFACED)

1. Unbound and modified granular flexible pavements with thin bituminous surfacing with design traffic up to 10^5 ESAs shall be designed in accordance with AGPT02-17 using section 12 (85% confidence limit curves).

2. For design traffic above 10^5 ESAs, the design shall be in accordance with AGPT02-17.

3. The minimum thickness of unbound layers shall be 100mm.

4. Full depth asphalt must be underlain by a minimum of 100mm thick granular working platform.

5. A minimum 10mm thick Asphaltic Concrete, consisting of 100mm AC20HD and 50mm AC14HD final layer shall be utilised for high stress intersections, including roundabouts and traffic lights.

Roundabouts & Traffic Lights

D2.14 FLEXIBLE PAVEMENTS CONTAINING BOUND LAYERS (BITUMINOUS SURFACED)

1. Flexible pavements containing one or more bound layers, including cementitous stabilised layers or asphaltic concrete layers other than thin asphalt surfacing (less than 40mm), shall be designed in accordance with AGPT02-17.

2. Bound layers designed as a single layer are required to be placed and compacted as a single layer and notation shall be included on the drawings to this effect.

Bound Layer Design

Deep Lift Compaction

Consideration to compaction requirements shall be given to deep lift bound layers. Deep lift layers shall not be included in designs for built up areas due to vibration effects during construction.

Bound layers to be constructed as two or more layers shall be designed as separate debonded layers with corresponding reduction in design strength from single layer construction.

3. The thickness of bound layers is critical to achieving design life and small reductions in thickness can result in significant reductions in pavement life. An additional thickness of 20mm shall be added to the design pavement thickness of bound pavement layers to allow for construction tolerances.

Bound Layer Thickness

D2.15 RIGID PAVEMENTS

1. Rigid (concrete) pavements, with a commercial vehicle axle groups up to $3x10^6$ CVAGs shall be designed in accordance with Guide to Residential Streets and Paths or AGPT02-17.

Rigid (Concrete)

2. Rigid (concrete) pavements with a commercial vehicle axle groups above $3x10^6$ CVAGs, the design shall be in accordance with AGPT02-17.

SURFACING DESIGN

D2.16 CHOICE OF SURFACE TYPE

1. Shall be as follows:- *Bitumen Wearing Surface*

(a) All Urban Residential streets

(i) asphaltic concrete

or

(ii) two coat bitumen seal

or

(iii) concrete

(b) Rural and Rural Residential streets

(i) two coat bitumen seal

or

(ii) asphaltic concrete

(c) Commercial and Industrial streets:

(i) asphaltic concrete

or

(ii) concrete

(d) Sub-arterial and Arterial roads:

(i) asphaltic concrete

or

(ii) concrete

However a two coat flush seal may be accepted if it is demonstrated that noise and surface life will meet required service level

(e) Roundabouts, traffic lights:

(i) asphaltic concrete

or

(ii) concrete

2. Variations to these requirements may be approved by Council in special circumstances. *Approval*

D2.17 SPRAYED BITUMINOUS SEALS

1. The design of sprayed bituminous seals, including primer seals, shall be in accordance with the AUSTROADS Guide to Pavement Technology, Technical Report: Update of the Austroads Sprayed Seal Design Method (AP-T68/06). *Seal Design*

2. Two-coat bituminous seals shall be double-double seals, comprising a minimum of two coats of bitumen binder and two coats of aggregate. The preferred seal types are: *Two- Coat Flush Seals*

	Rural Residential	Rural Roads and Arterial/Sub-Arterial Roads
1st coat	10mm or 14mm	14mm
2nd coat	7mm	7mm (check compliance for noise)

D2.19 ASPHALTIC CONCRETE

1. In lightly trafficked residential, rural or commercial streets (design traffic up to approximately 10^5 ESAs), the asphalt mix design shall be either a 'high-bitumen content', gap graded or soft grade binder mix in accordance with section 12 of AGPT02-17 and the Construction Specification C245 ASPHALTIC CONCRETE. *Light to Medium Traffic*

2. In moderate to heavily trafficked residential, rural or commercial roads and in all industrial and classified roads (design traffic above approximately 10^5 ESAs), the asphalt mix design shall be a dense graded mix in accordance with the Construction Specification C245 ASPHALTIC CONCRETE. *Medium to Heavy Traffic*

3. Asphaltic concrete surfacing shall be designed to provide a nominal compacted layer thickness of not less than specified in Table D1.7 of Design Specification D1 GEOMETRIC ROAD DESIGN. *Minimum Thickness*

4. A 10mm primer seal shall be provided and indicated on the Drawings below the asphaltic concrete pavement. The percentage of cutter in the primer seal should be considered relative to how soon the asphalt concrete pavement is applied and prevailing weather conditions. A high percentage of cutter will have a detrimental impact on the asphalt if paved too soon after the primer seal. *Primer Seal*

SPECIAL REQUIREMENTS

D2.20 NOISE POLICY

1. Road surfacing choices shall give consideration to the requirements of the NSW Road Noise Policy 2011 (DECCW 2011/236). Choice of road surfacing materials shall be made in conjunction with other design options for mitigation of traffic noise where required by the policy.

D2.21 GEOTEXTILES

1. Geotextiles including geofabrics and geogrids can provide options for design problems such as construction over poor subgrades and reinforcement of soft spots. Where geotextiles are included in the design, the design shall:

(a) be in accordance with design and construction requirements provided by the manufactures

(b) have sufficient overlaps shall be provided to development length for stresses

(c) include documentation of the design including manufacturer's design details shall be submitted to Council with the pavement design

(d) not include any geotextiles in the first 450mm of granular pavement layers

D2.22 SUBSOIL DRAINAGE

2. Subsoil drainage shall be provided in accordance with Specification D4 SUBSURFACE DRAINAGE DESIGN.