

NEW SOUTH WALES

DEVELOPMENT DESIGN
SPECIFICATION

D2

PAVEMENT DESIGN

Amendment Record for this Specification Part

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
1	Surface type – Rural Roads. Refer Clause D2.22	D2.22	A	IA	Initial

DESIGN SPECIFICATION D2 - PAVEMENT DESIGN

GENERAL

D2.01 SCOPE

- The work to be executed under this Specification consists of the design of the road pavement to meet the required design life, based on the subgrade strength, traffic loading and environmental factors, and including the selection of appropriate materials for select subgrade, subbase, base and wearing surface.

Design Criteria

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

**Surfaced
Pavement
Types**

- (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;
- (c) rigid pavements (ie. cement concrete pavements);
- (d) concrete or clay segmental pavements.

D2.02 OBJECTIVES

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.

**Pavement
Performance**

D2.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

This Document:

- D1 - Geometric Road Design
- D4 - Subsurface Drainage Design

AUS-SPEC #2 Document:

- 242 - Flexible Pavements
- 244 - Sprayed Bituminous Surfacing
- 245 - Asphaltic Concrete
- 246 - Rolled Concrete Subbase
- 247 - Mass Concrete Subbase
- 248 - Plain or Reinforced Concrete Base
- 249 - Steel Fibre Reinforced Concrete Base
- 250 - Continuously Reinforced Concrete Base
- 254 - Segmental Paving
- 255 - Bituminous Microsurfacing

(b) State Authorities

The relevant State Road Authorities' Sprayed Sealing or Bituminous Surfacing Manual.

(c) Other

- AUSTROADS - Design of Sprayed Seals, 1990.
- AUSTROADS - Pavement Design, A Guide to the Structural Design of Road Pavements, 1992.
- AUSTROADS - Guide to Control of Moisture in Roads.
- ARRB-SR41 - Australian Road Research Board, Special Report No. 41 - A Structural Design Guide for Flexible Residential Street Pavements, 1989.
- Cement and Concrete Association of Australia.
CACA - T51 - Concrete Pavement Design for Residential Streets, 1997.
- Concrete Masonry Association of Australia.
CMAA - T44 - Concrete Segmental Pavements - Guide to Specifying, 1997
CMAA - T45 - Concrete Segmental Pavements - Design Guide for Residential Access Ways and Roads, 1997.
CMAA - T46 - Concrete Segmental Pavements - Detailing Guide, 1997.
- Clay Brick and Paver Institute
 - Design Manual 1 - Clay Segmental Pavements, A Design and Construction Guide for Sites Subjected to Vehicular and Pedestrian Traffic, 1989.
- [RESOURCE NSW - Specification for Supply of Recycled Materials for Pavements, Earthworks and Drainage, 2003.](#)

PAVEMENT DESIGN CRITERIA

D2.04 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:

- (a) Design Traffic
- (b) Subgrade Evaluation
- (c) Environment
- (d) Pavement and Surfacing Materials
- (e) Construction and Maintenance Considerations

D2.05 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 - 25 years
- (b) Flexible, Containing one or more bound layers - 25 years
- (c) Rigid (Concrete) - 40 years
- (d) Segmental Block - 25 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 interlocking concrete segmental pavements, the simplification of replacing ESA's with the number of commercial vehicles exceeding 3 tonne gross contained in CMAA - T45 is acceptable up to a design traffic of 10^6 . Beyond this, ESAs should be calculated.

**Equivalent
Standard
Axles**

3. The pavement design shall include all traffic data and/or assumptions made in the calculation of the design traffic.

Traffic Data

4. In general, reference should be made to ARRB-SR41 for the calculation of design traffic volumes up to 10^6 ESAs and AUSTROADS Pavement Design for design traffic volumes approaching or exceeding 10^6 ESAs.

**Design Traffic
Volumes**

5. In the absence of other traffic data, the following traffic values (in ESAs) may be taken as a guide to the design traffic, but shall be subject to variation depending on the circumstances for the particular project.

**Guide to
Design ESAs**

Street Type:		Design ESA's - 25 year design life
Urban Residential	- Access Street	6×10^4
	- Local Street	3×10^5
	- Collector Street	1×10^6
	- Local Sub-Arterial	2×10^6
Rural Residential	-	3×10^5
Commercial and Industrial		5×10^6

D2.06 SUBGRADE EVALUATION

1. Except where a mechanistic design approach is employed using AUSTROADS Pavement Design (or software designed for this purpose), the measure of subgrade support shall be the California Bearing Ratio (CBR). Where a mechanistic design approach using linear elastic theory is employed for flexible pavements, the measure of subgrade support shall be in terms of the elastic parameters (modulus, Poisson's ratio).

**California
Bearing Ratio**

2. 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.

3. The subgrade Design CBR adopted for the pavement design must consider the effect of moisture changes in the pavement and subgrade during the service life, and hence consideration must be given to the provision of subsurface drainage in the estimation of equilibrium in-situ CBRs, and hence in the design of the pavement structure. Warrants for the provision of subsurface drainage are given in Specification for SUBSURFACE DRAINAGE DESIGN. If subsurface drainage is not provided, then the Design CBR adopted must allow for a greater variability in subgrade moisture content during the service life of the pavement, and hence a Design Moisture Content above the Optimum Moisture Content.

Design CBR Considerations

4. The calculation of the Design CBR shall be based on a minimum of three 4 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 (as per the guidelines in ARRB SR41) to give an estimated equilibrium in-situ CBR. The Design CBR for each subgrade area is computed by using the appropriate formulae as follows:

Calculation of Design CBR

Design CBR = Least of estimated CBRs, for less than five results

Design CBR = 10th percentile of all estimated CBRs, for five or more results
= $C - 1.3S$

Where C is the mean of all estimated CBRs, and
S is the standard deviation of all values.

5. 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

6. 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.

Summary of Results

D2.07 ENVIRONMENT

1. The environmental factors 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 AUSTROADS Pavement Design, ARRB-SR41, and to NAASRA (Now AUSTROADS) - Guide to Control of Moisture in Roads.

Moisture and Temperature

2. The following factors relating to moisture environment must be considered in determining the design subgrade strength/stiffness and in the choice of pavement and surfacing materials:

Moisture Considerations

- (a) Rainfall/evaporation pattern
- (b) Permeability of wearing surface
- (c) Depth of water table and salinity problems
- (d) Relative permeability of pavement layers
- (e) Whether shoulders are sealed or not
- (f) Pavement type (boxed or full width)

3. The effect of changes in moisture content on the strength/stiffness of the subgrade shall be taken into account by evaluating the design subgrade strength parameters (ie. CBR or modulus) at the highest moisture content likely to occur during the design life, ie the Design Moisture Content. The provision of subsurface drainage may, under certain circumstances, allow a lower Design Moisture Content, and hence generally higher Design CBR.

Evaluate Design CBR

4. The effect of changes in temperature environment must be considered in the design of pavements with asphalt wearing surfaces, particularly if traffic loading occurs at night when temperatures are low, thus causing a potential reduction in the fatigue life of thin asphalt surfacing. The effect of changes in temperature environment should also be considered for bound or concrete layers.

**Temperature
Change**

5. The pavement design shall include all considerations for environmental factors, and any assumptions made that would reduce or increase design subgrade strength, or affect the choice of pavement and surfacing materials.

D2.08 PAVEMENT AND SURFACING MATERIALS

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

**Pavement
Classification**

- (a) Unbound granular materials, including modified granular materials
- (b) Bound (cemented) granular materials
- (c) Asphaltic Concrete
- (d) Cement Concrete

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

**Surfacing
Classification**

- (a) Sprayed bituminous seals (flush seals)
- (b) Asphaltic concrete and bituminous microsurfacing (cold overlay)
- (c) Cement Concrete
- (d) Concrete Segmental Pavers
- (e) Clay Segmental Pavers

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

4. Bound (cemented) granular materials shall satisfy the requirements of the Construction Specification for FLEXIBLE PAVEMENTS.

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

6. Cement concrete shall satisfy the requirements of the Construction Specifications for ROLLED CONCRETE SUBBASE, MASS CONCRETE SUBBASE, PLAIN OR REINFORCED CONCRETE BASE, STEEL FIBRE REINFORCED CONCRETE or CONTINUOUSLY REINFORCED CONCRETE BASE, as appropriate.

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

8. Concrete and clay segmental pavers shall satisfy the requirements of the Construction Specification for SEGMENTAL PAVING.

9. Bituminous microsurfacing (cold overlay) shall satisfy the requirements of the Construction Specification for BITUMINOUS MICROSURFACING.

D2.09 CONSTRUCTION AND MAINTENANCE CONSIDERATIONS

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

- (a) Extent and type of drainage
- (b) Use of boxed or full width construction
- (c) Available equipment of the Contractor
- (d) Use of stabilisation
- (e) Aesthetic, environmental and safety requirements
- (f) Social considerations
- (g) Construction under traffic
- (h) Use of staged construction
- (i) Ongoing and long-term maintenance costs

These factors are further discussed in AUSTROADS Pavement Design.

PAVEMENT THICKNESS DESIGN

D2.10 PAVEMENT STRUCTURE - GENERAL

1. The pavement thickness, including the thickness of surfacings, shall not be less than 250mm for roads in which kerb and guttering is to be constructed, 200mm for unkerbed roads and 150mm for carparks.

**Minimum
Pavement
Thickness**

5. Notwithstanding subgrade testing and subsequent pavement thickness design, the thickness of subbase and base layers shall not be less than the following:-

- (a) Flexible pavement: Subbase 100mm, Base 100mm
- (b) Rigid pavement: Subbase 100mm, Base 150mm

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

**Subbase
Extent**

4. The base and surfacing shall extend to the face of any kerbing and/or guttering. Where the top surface of the subbase 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.

Base Extent

5. For unkerbed roads, the subbase and base layers shall extend at least to the nominated width of shoulder.

**Ukerbed
Roads**

6. The pavement designer shall make specific allowance for traffic load concentrations within carpark areas (eg entrances/exits).

Carparks

7. The pavement designer shall make provision for pavement layer drainage on the assumption that during the service life of the pavement ingress of water will occur.

Drainage

D2.11 UNBOUND GRANULAR FLEXIBLE PAVEMENTS (BITUMINOUS SURFACED)

1. Unbound granular flexible pavements with thin bituminous surfacings, including those with cement or lime modified granular materials, with design traffic up to 10^6 ESAs shall be designed in accordance with ARRB-SR41, using Figure 7 (95% confidence limit curves).
2. For design traffic above 10^6 ESAs, the design shall be in accordance with AUSTROADS Pavement Design (or software designed for this purpose).

D2.12 FLEXIBLE PAVEMENTS CONTAINING BOUND LAYERS (BITUMINOUS SURFACED)

1. Flexible pavements containing one or more bound layers, including cement stabilised layers or asphaltic concrete layers other than thin asphalt surfacings, shall be designed in accordance with AUSTROADS Pavement Design (or software designed for this purpose).
2. As an alternative to AUSTROADS Pavement Design for design traffic up to 10^6 ESAs, bound layers may be assumed to be equivalent to unbound layers of the same thickness, and the pavement designed in accordance with ARRB-SR41, using Figure 7 (95% confidence limit curves).

D2.13 RIGID PAVEMENTS

1. Rigid (concrete) pavements, with design traffic up to 10^6 ESAs shall be designed in accordance with either CACA -T51 or AUSTROADS Pavement Design (or software designed for this purpose).
2. Rigid (concrete) pavements for design traffic above 10^6 ESAs, the design shall be in accordance with AUSTROADS Pavement Design (or software designed for this purpose).

D2.14 CONCRETE SEGMENTAL PAVEMENTS

1. Concrete segmental pavements with design traffic up to 10^6 estimated commercial vehicles exceeding 3T gross shall be designed in accordance with CMAA-T45.
2. For design traffic above 10^6 estimated commercial vehicles exceeding 3T gross the design shall be in accordance with AUSTROADS Pavement Design (or software designed for this purpose), with the calculation of design traffic in terms of ESAs.

D2.15 CLAY SEGMENTAL PAVEMENTS

1. Clay segmental pavements with design traffic up to 10^6 ESAs shall be designed in accordance with Design Manual 1 - Clay Segmental Pavements.
2. For design traffic above 10^6 ESAs and up to 10^7 ESAs the design shall involve consideration of both Design Manual 1 - Clay Segmental Pavements and AUSTROADS Pavement Design, with the thicker and more conservative design of each of the two methods adopted.
3. For design traffic above 10^7 ESAs, the pavement shall be designed in accordance with AUSTROADS Pavement Design (or software designed for this purpose).

SURFACING DESIGN

D2.16 CHOICE OF SURFACE TYPE

1. Except where the pavement is designed for concrete or segmental block surfacing, the wearing surface shall be a bituminous wearing surface as follows:-

**Bitumen
Wearing
Surface**

- (a) Urban Residential streets - Access Street and Local Street, and Rural Residential streets:
 - primer seal plus two coat flush seal
 - or
 - primer seal, plus one coat flush seal, plus bituminous microsurfacing
 - or
 - primer seal, plus asphalt.
- (b) Urban Residential streets - Collector and Local Sub-Arterial:
 - primer seal, plus one coat flush seal, plus bituminous microsurfacing
 - or
 - primer seal, plus asphalt.
- (c) Commercial and Industrial streets:
 - primer seal, plus asphalt.

2. At intersection approaches and cul-de-sac turning circles on residential streets with flush seals, either bituminous microsurfacing or asphalt surfacing shall be provided within the vehicle braking and turning zones.

**Braking and
Turning Zones**

3. Variations to these requirements may be approved by Council's Design Manager in special circumstances.

Approval

D2.17 SPRAYED BITUMINOUS SEALS (FLUSH SEALS)

1. The design of sprayed bituminous (flush) seals, including primer seals, shall be in accordance with the AUSTROADS – Design of Sprayed Seals or the relevant State Road Authorities' Bituminous Surfacing Manual.

Seal Design

2. 7mm primer seals shall be indicated on the Drawings below all flush seals, bituminous microsurfacing, and asphalt surfacings. Where a 7mm primer seal is impractical, a 10mm primer seal shall be indicated in lieu.

Primer Seal

3. Two-coat flush seals shall be double-double seals, comprising a minimum of two coats binder and two coats of aggregate. The preferred seal types are:

**Two- Coat
Flush Seals**

1st coat	14mm
2nd coat	7mm

4. Single coat flush seals shall be allowable if bituminous microsurfacing (or asphaltic concrete) is to be applied as the finished surface. The preferred seal type is either 14mm or 10mm.

**Single Coat
Flush Seal**

D2.18 BITUMINOUS MICROSURFACING (COLD OVERLAY)

1. Bituminous microsurfacing, also referred to as 'cold overlay', shall be designed to provide a nominal compacted thickness of not less than 8mm.

Minimum Thickness

2. As a minimum, a 7mm primer seal and a single coat flush seal shall be indicated on the Drawings below the bituminous microsurfacing.

Primer Seal and Single Coat Seal

D2.19 ASPHALTIC CONCRETE

1. In urban residential access and local streets, rural or light trafficked commercial streets (design traffic up to approximately 3×10^5 ESAs), the asphalt mix design shall be either a 'high-bitumen content' mix or the ARRB Gap-graded mix in accordance with ARRB-SR41 and the Construction Specification for ASPHALTIC CONCRETE.

Light to Medium Traffic

2. In urban residential collector and sub-arterial roads, medium to heavily trafficked commercial streets and in all industrial roads, the asphalt mix design shall be a dense graded mix in accordance with the Construction Specification for ASPHALTIC CONCRETE.

Medium to Heavy Traffic

3. Asphaltic concrete surfacings shall be designed to provide a nominal compacted layer thickness of not less than 25mm on light to medium trafficked residential, rural and commercial streets, and 40mm on medium to heavily trafficked residential, rural or commercial roads and on all industrial and classified roads.

Minimum Thickness

4. As a minimum, a 7mm or 10mm primer seal shall be indicated on the Drawings below the asphalt surfacing.

Primer Seal

D2.20 SEGMENTAL PAVERS

1. Concrete segmental pavers shall be 80mm thick, shape Type A, and designed to be paved in a herringbone pattern.

Size and Shape

2. Clay segmental pavers shall be 65mm thick, Class 4, and designed to be paved in a herringbone pattern.

3. The edges of all paving shall be designed to be constrained by either kerbing and/or guttering, or by concrete edge strips.

Edge Constraint

DOCUMENTATION**D2.21 DESIGN CRITERIA AND CALCULATIONS**

1. All considerations, assumptions, subgrade test results, and calculations shall be submitted with the pavement design for approval by Council's Design Manager.

Submission Details

2. The Drawings shall clearly indicate the structure, material types and layer thicknesses of the proposed pavement and surfacing.

Drawings

SPECIAL REQUIREMENTS

D2.22 SURFACE TYPE – RURAL ROADS

Add the following to Clause D2.16

(d) Rural Roads

- primer seal plus two coat flush seal



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