WESTERN AUSTRALIA

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	*Minimum pavement design life*	*D2.05.1(a)*	*M*	*AW*	*November 2000*
2	*Minimum pavement design life*	*D2.05.1(b)*	*M*	*AW*	*November 2000*
3	*Minimum pavement design life*	*D2.05.1(c)*	*O*	*AW*	*November 2000*
4	*Minimum pavement design life*	*D2.05.1(d)*	*M*	*AW*	*November 2000*
5	*Design ESAs*	*D2.05.5*	*M*	*AW*	*November 2000*
6	*Minimum Pavement Thickness*	*D2.10.2(a)*	*M*	*AW*	*November 2000*
7	*Bitumen Wearing Surface*	*D2.16.1(a)*	*A,O,M*	*AW*	*November 2000*
8	*Bitumen Wearing Surface*	*D2.16.1(b)*	*A,O,M*	*AW*	*November 2000*
9	*Two Coat Flush seal*	*D2.17.3*	*O*	*AW*	*November 2000*
10	*Single Flush Seal*	*D2.17.4*	*A*	*AW*	*November 200*
11	*Asphaltic Concrete - Minimum Thickness*	*D2.19.3*	*M*	*AW*	*November 2000*
12	*Surfacing Classification*	*D2.08.06*	*A*	*AW*	*July 2002*
13	*Minimum Pavement Thickness*	*D2.10.1 D 2.10.2*	*A*	*YKW*	*January 2008*
14	*Clay segmental pavers*	*D2.20.2*	*M*	*YKW*	*July 2009*
15	*Seal Design*	*D2.17.1*	*M*	*YKW*	*July 2009*

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PAVEMENT DESIGN

GENERAL

D2.01 SCOPE

1. 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.

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.

Unsealed 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

D1	-	Geometric Road Design
D4	-	Subsurface Drainage Design
C242	-	Flexible Pavements
C244	-	Sprayed Bituminous Surfacing
C245	-	Asphaltic Concrete
C247	-	Mass Concrete Subbase
C248	-	Plain or Reinforced Concrete Base
C254	-	Segmental Paving
C255	-	Bituminous Microsurfacing

(b) Other

AUSTROADS - Pavement Design, A Guide to the Structural Design of Road Pavements, 1992.

AUSTROADS - Guide to Control of Moisture in Roads.

AAPA - Australian Asphalt Pavement Association's National Sprayed Sealing Specification(current edition).

AAPA - National Asphalt Specification(current edition).

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.

PAVEMENT DESIGN CRITERIA

D2.04 DESIGN VARIABLES

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

Minimum Pavement Design Life

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

(a) Flexible, Unbound Granular - 25 years

(b) Flexible, Containing one or more bound layers - 25 years

(c) Rigid (Concrete) - 40 years

(d) Segmental - 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 new subdivisions, the design traffic shall take account of both the construction traffic associated with the subdivision development and the in-service traffic for the subdivision and for any future developments linked to that subdivision. 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 development.

Design ESAs

Street Type:		**Design ESA's - 25 year design life**
Urban Residential	- Access Place	6×10^4
	- Access Way	3×10^5
	- Local Distributor	1×10^6
	- District Disrtibutor (B)	2×10^6
Rural Residential	-	3×10^5
Commercial and Industrial		5.0×10^6

D2.06 SUBGRADE EVALUATION

1. Except where a mechanistic design approach is employed using AUSTROADS Pavement Design, 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.

Design CBR

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.

Calculation of Design CBR

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:

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.

Field Confirmation

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.

Summary of Results

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.

D2.07 ENVIRONMENT

Reference

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.

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:

(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)

Evaluate Design CBR

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.

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 MASS CONCRETE SUBBASE or PLAIN OR REINFORCED CONCRETE BASE, as appropriate. (Clause not applicable within City of Swan)

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 265mm for roads in which kerb is to be constructed, and 200mm for unkerbed roads and 150mm for carparks, based on sand subgrade. ***Minimum Pavement Thickness***

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

(a)	Flexible pavement:	Subbase 150mm, Base 75mm local streets (valid prior to 31-1-2008)
(b)	Rigid pavement:	Subbase 100mm, Base 150mm
(c)	Flexible pavement:	Subbase 200mm, + High Fatigue Resistant Asphalt 40mm, + Wearing Course 25mm

3. The subbase layer shall extend a minimum of 150mm behind the rear face of any kerbing. ***Subbase Extent***

4. The base and surfacing shall extend to the face of any kerbing. Where the top surface of the subbase layer is below the level of the underside of the kerbing, the base layer shall also extend a minimum of 150mm behind the rear face of the kerbing. ***Base Extent***

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

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.

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.

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. ***Rigid (Concrete)***

2. Rigid (concrete) pavements for design traffic above 10^6 ESAs, the design shall be in accordance with AUSTROADS Pavement Design.

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. ***Concrete Segmental***

2. For design traffic above 10^6 estimated commercial vehicles exceeding 3T gross the design shall be in accordance with AUSTROADS Pavement Design, 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. ***Clay Segmental***

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.

SURFACING DESIGN

D2.16 CHOICE OF SURFACE TYPE

Bitumen Wearing Surface

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

(a) Urban Residential streets - Access Places and Ways, and Rural Residential streets:

- primer seal plus one coat flush seal (rural roads only)

  or

- primer seal, plus asphalt.

(b) Urban Residential streets - Local Distributor and District Distributor (B):

- primer seal plus one coat flush seal (rural roads only)

  or

- primer seal, plus asphalt

(c) Commercial and Industrial streets:

- primer seal, plus asphalt

Braking and Turning Zones

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.

Approval

3. Variations to these requirements may be approved by Council in special circumstances.

D2.17 SPRAYED BITUMINOUS SEALS (FLUSH SEALS)

Seal Design

1. The design of sprayed bituminous (flush) seals, including primer seals, shall be in accordance with the AAPA's National Sprayed Sealing Specification(current edition).

Primer Seal

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.

3. DELETED

Two- Coat Flush Seals

Single Coat Flush Seal

4. Single coat flush seal shall be one coat of binder and one coat of aggregates (14mm diorite).

D2.18 BITUMINOUS MICROSURFACING (COLD OVERLAY)

Minimum Thickness

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

Primer Seal and Single Coat Seal

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

D2.19 ASPHALTIC CONCRETE

1. In urban residential access and ways, rural or light trafficked commercial streets (design traffic up to approximately 3 x 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 local distributor and district distributor(B) 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 30mm 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 76mm 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 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. ***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 RESERVED

D2.23 RESERVED

D2.24 RESERVED

D2.25 RESERVED