DEVELOPMENT DESIGN SPECIFICATION

D2

PAVEMENT DESIGN

PAVEMENT DESIGN

GENERAL

D2.01 SCOPE

Design Criteria

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.

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;

(c) rigid pavements (i.e. cement concrete pavements);

(d) concrete segmental block pavements.

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
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) State Authorities

Roads and Maritime Services Sprayed Sealing Guide

(c) Other

AUSTROADS - Pavement Design, Technical Basis of Austroads Guide to Pavement Technology Part 2: Pavement Structural Design.

AUSTROADS - Guide to Control of Moisture in Roads.

AUSTROADS - Pavement Design for Light Traffic - A supplement to AUSTROADS Pavement Design Guide

C&CAA – T51 - Cement and Concrete Aggregates Australia, T51 – Guide to Residential Streets and Paths, 2004.

CMAA – T45 - Concrete Segmental Pavements – Design Guide for Residential Accessways and Roads 1997.

CACA - TN52 - Cement and Concrete Association, TN52 - Single-Lane Concrete Bus Bays, 1984.

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 - 50 years

(b) Flexible, Containing one or more bound layers - 50 years

(c) Rigid (Concrete) - 50 years

(d) Segmental Block - 50 years

Design Traffic

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.

3. 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 interlocking concrete segmental pavements, the simplification of replacing ESA's with the number of commercial vehicles exceeding 3 tonne gross contained in CMAA -

Concrete Segmental Pavements – Design Guide for Residential Accessways and Roads is acceptable up to a design traffic of 10^6. Beyond this, ESAs should be calculated.

4. The pavement design shall include all traffic data and/or assumptions made in the calculation of the design traffic. ***Traffic Data***

5. In general, reference should be made to APRG - No21 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***

6. 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 - 50 year design life**
Urban Residential	- Cul-de-sac	2×10^4
	- Minor	6×10^4
	- Local Access	3×10^5
	- Collector	1×10^6
	- Distributor	2×10^6
Rural Residential	- Cul-de-sac	2×10^4
	- Other	3×10^5
	- Private Road	3×10^4
Commercial and Industrial		5×10^6

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.

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. 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***

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 ***Calculation of Design CBR***

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 Pavement Design for Light Traffic - A supplement to AUSTROADS Pavement Design Guide) 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 equilibrium CBRs, for less than five results

Design CBR = 10th percentile of all estimated equilibrium CBRS, for five or more results

= C - 1.3S

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

5. 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 for Light Traffic – A Supplement to Austroads Pavement Design Guide, and to AUSTROADS - Guide to Control of Moisture in Roads.

Reference

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
(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 sub-grade strength parameters (i.e. CBR or modulus) at the highest moisture content likely to occur during the design life, i.e. 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 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 four categories or types:- ***Surfacing Classification***

(a) Sprayed bituminous seals (rural roads only)

(b) Asphaltic concrete (residential, industrial and commercial),

(c) Cement Concrete (in public roads only where approved by Council in the Development Consent),

(d) Concrete Segmental Pavers (in public roads only where approved by Council in the Development Consent)

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, PLAIN OR REINFORCED CONCRETE BASE, or FIBRE REINFORCED CONCRETE, as appropriate.

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

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

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

Minimum Pavement Thickness

1. 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

Subbase Extent

2. The subbase 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 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.

4. For un-kerbed roads, the subbase and base layers shall extend at least to the outer edge of the nominated width of shoulder.

D2.11 UNBOUND GRANULAR FLEXIBLE PAVEMENTS (BITUMINOUS SURFACED)

1. Unbound granular flexible pavements with thin bituminous surfacing, including those with cement or lime modified granular materials, with design traffic up to 10^6 ESAs shall be designed in accordance with Pavement Design for Light Traffic – A Supplement to Austroads Pavement Design Guide.

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 surfacing, shall be designed in accordance with AUSTROADS Pavement Design Guide.

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 Pavement Design for Light Traffic – A Supplement to Austroads Pavement Design Guide.

D2.13 RIGID PAVEMENTS

Rigid (Concrete)

1. Rigid (concrete) pavements, with design traffic up to 10^6 ESAs shall be designed in accordance with either CACA -T33 or AUSTROADS Pavement Design.

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

3. Single lane concrete bus bays adjacent to a flexible pavement shall be designed in accordance with CACA -TN52.

D2.14 CONCRETE SEGMENTAL BLOCK PAVEMENTS

Concrete Segmental Block

1. Concrete segmental block pavements with design traffic up to 10^6 estimated commercial vehicles exceeding 3T gross shall be designed in accordance with CACA - T35.

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.

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 :

A final layer of 25mm ARRB gap graded AC 10 over either

i. an initial layer of 15 mm AC 5, or

ii. a primer seal (7mm).

(b) Rural and Rural Residential Roads :

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:

1st coat 14mm
2nd coat 7mm.

(c) Commercial and Industrial streets:

40 mm AC 14 over primer seal (7mm)

(d) Sub-arterial, Arterial roads and Roundabouts:

50 mm AC 14 with stabilised binder over primer seal

Size and Shape

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

Edge Constraint

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

DOCUMENTATION

D2.21 DESIGN CRITERIA AND CALCULATIONS

Submission Details

1. All considerations, assumptions, subgrade test results, and calculations shall be submitted with the pavement design.

Drawings

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

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