Armidale
Regional Council

ENGINEERING DESIGN CODE
SPECIFICATION D2

PAVEMENT DESIGN

Amendment Record for this Specification Part

This Specification is the Armidale Regional Council version of the AUS-SPEC generic specification D2 and includes Council's primary amendments to the specification.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part D2. 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	Major Revision of specifications for adoption by Armidale Regional Council	All	AMO	SPM	13/07/16

CLAUSE CONTENTS PAGE

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. concrete pavements);

(d) concrete or clay segmental pavements.

Unsealed Pavements

3. The design of unsealed (gravel) pavements will only be supported for minor rural subdivisions/developments in isolated rural areas where the access to the subdivision is via an existing unsealed road. Existing unsealed Council roads, which may require upgrading and realignment from time to time, shall remain as gravel pavements and shall generally be roads with an AADT of less than 250vpd.

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.

Subgrade at OMC

2. To logically assess the strength of the supporting subgrade to enable the variations in properties of the subgrade be accurately predicted. The long term performance of a new pavement will depend partly on the strength of the subgrade achieved at construction, but more critically on the strength of the subgrade at equilibrium moisture conditions that can be maintained after pavement construction.

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 Micro surfacing

(b) State Authorities

Roads and Maritime Services, NSW - Sprayed Sealing Guide, 1992.

(c) Other

AUSTROADS - Guide to Pavement Technology.
- Guide to the Design of Lightly Trafficked Pavements.

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.

Concrete Masonry Association of Australia

CMAA - T44 - Concrete Segmental Pavements - Guide to Specifying
CMAA - T45 - Concrete Segmental Pavements - Design Guide for Residential Access Ways and Roads
CMAA - T46 - Concrete Segmental Pavements - Detailing Guide.

Clay Brick and Paver Institute

- Design Manual 1 - Clay Segmental Pavements, A Design and Construction Guide for Sites Subjected to Vehicular and Pedestrian Traffic

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 - 20 years
(b) Flexible, Containing one or more bound layers - 20 years
(c) Rigid (Concrete) - 40 years
(d) Segmental - 25 years

Design Traffic ESAs

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

the case where interlocking concrete segmental pavements are to be used, the simplification of replacing ESAs with the number of commercial vehicles exceeding 3 tonne gross contained in CMAA – T45 is acceptable up to a design traffic loading of 10^6. Beyond this, ESAs should be calculated.

Traffic Data

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

Equivalent Standard axles

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 ESAs

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.

Street Type:		**Design ESA's - 20 year design life**
Urban Residential	- Access Place	3×10^5
	- Local Street	3×10^5
	- Access Street	1×10^6
	- Local Collector	1×10^6
	- Major Distributor	2×10^6
Rural Residential	- Cul-de-sac (up to 10 lots)	3×10^5
	- Other	3×10^5
Rural	- Up to 1000 AADT	1×10^6
	- Over 1000 AADT	2×10^6
Commercial and Industrial		5×10^6

D2.06 SUBGRADE EVALUATION

California Bearing Ratio

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). Council currently uses the computer software package CIRCLY for the mechanistic design of pavements.

CIRCLY

Design Considerations

2. The following factors must be considered in determining the design strength and stiffness of the subgrade:

(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 and localised soft spots;

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

(f) Topography and geology along the pavement route;

(g) Variation in depths of excavation along the pavement route;

(h) Anticipated variation in subgrade materials; and

(i) Gullies, water courses and overland flow paths and the potential to impact on the subgrade during test pitting and DCP testing.

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, so consideration must be given to the provision of subsurface drainage in the estimation of equilibrium in-situ CBRs and in the design of the pavement structure. Warrants for the provision of subsurface drainage are given in Specification **D4** 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 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 (3) four (4) day soaked CBR laboratory samples for each subgrade area. These must be 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 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 calculations made in the assessment of Design CBR.

Testing Frequency

7. The frequency of test locations for any specific site shall be to the satisfaction of the nominated Council Engineer. And shall generally be in accordance with Table D02-1

Pavement length	Minimum testing frequency
Less than 100m	1 per change in material with a minimum of 1 test location
101m to 200m	1 per change in material with a minimum of 2 test locations
201m to 500m	1 per change in material with a minimum of 3 test locations
Over 500m	1 per change in material or 1 per 250m or part thereof with a minimum of 3 test locations

Table D02-1 Minimum subgrade testing frequency

Additional testing may be required if the Engineer considers that the variation in in-situ subgrade material properties is such that an indicative test result for pavement design is not achievable with the minimum testing frequency.

DCP Tests

8. Static or Dynamic Cone Penetrometer (DCP) tests may also be undertaken if the subgrade moisture conditions are considered to be representative of optimum moisture conditions or if a preliminary assessment is required of the approximate in-situ CBR of the subgrade for preliminary pavement thickness designs.

Sample Size

9. Test bores shall be extended to depth 500mm below the estimated subgrade level and sufficient quantity of soil samples shall be collected to allow the classification of the samples through laboratory testing for field moisture content, plasticity index and 4 day soaked CBR.

10. Testing of subgrade and pavement materials shall be undertaken by a NATA accredited testing laboratory or by the Armidale Regional Council testing laboratory.

11. Test results shall be reported in written format and test sites shall be accurately located on a plan of the job site. Reporting shall be in accordance with current best practice and shall clearly and concisely present the findings of the test results in plain English.

Subgrade Stabilisation

12. Where testing of subgrade reveals in-situ CBRs of 3% or less, consideration shall be given to subgrade improvement through mechanical or chemical stabilisation. This may take the form of:

- Geotextile fabric stabilisation;
- Geogrid fabric stabilisation
- Rip-rap rock blanket stabilisation for isolated soft spots;
- Cement stabilisation
- Lime stabilisation
- Slag/lime stabilisation

Regardless of the form of subgrade stabilisation proposed, any proposal shall be supported by scientific analysis of the design treatment adopted.

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.

Moisture Environment

2. The following factors relating to moisture environment must be considered in determining the design subgrade strength and 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 and stiffness of the subgrade shall be taken into account by evaluating the design subgrade 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 generally higher Design CBR.

Temperature Change

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. This can cause 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.

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 granular materials stabilised with lime, blast furnace slab or cement

(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 micro surfacing (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 **C242** FLEXIBLE PAVEMENTS. *C242*

4. Bound (stabilised) granular materials shall satisfy the requirements of the Construction Specification **C242** FLEXIBLE PAVEMENTS. *C242*

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

6. Cement concrete shall satisfy the requirements of the Construction Specifications **C247** MASS CONCRETE SUBBASE, **C248** PLAIN OR REINFORCED CONCRETE BASE, or fibre reinforced concrete (FRC), as appropriate. *C247, C248, FRC*

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

8. Concrete and clay segmental pavers shall satisfy the requirements of the Construction Specification **C254** SEGMENTAL PAVING. *C254*

9. Bituminous micro surfacing (cold overlay) shall satisfy the requirements of the Construction Specification **C255** BITUMINOUS MICROSURFACING. *C255*

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

(j) Consideration of the allowable use of vibratory equipment in roadworks with limitations on the use of heavy vibratory equipment in built areas.

These factors are further discussed in AUSTROADS Pavement Design.

PAVEMENT THICKNESS DESIGN

D2.10 PAVEMENT STRUCTURE - GENERAL

Minimum Pavement Thickness

1. The minimum pavement thickness, excluding the thickness of surfacings, for sealed roads shall be 300mm for urban roads 250mm for rural roads.

2. Notwithstanding subgrade testing and subsequent pavement thickness design, the thickness of sub-base and base layers for sealed roads shall not be less than the following:-

Min 300mm Pavement

(a) Flexible pavement - Base 150mm. Subbase varies with minimum pavement thickness but shall result in an overall pavement thickness of not less than 300mm;

(b) Rigid pavement - Base 150mm, Subbase 100mm.

Subbase Extent

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

Base 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.

Shoulder

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

Car Parks

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

Drainage

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.

D2.11 UNBOUND GRANULAR FLEXIBLE PAVEMENTS (BITUMINOUS SURFACED)

1. Unbound granular flexible pavements with thin bituminous surfacings, including those with cement, lime or slag-lime modified granular materials, shall be designed 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).

Alternative Design

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.

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

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 BLOCK 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

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

Wearing Surface

Urban residential - Access & Local Streets	Urban - Collector & Local Sub-Arterial	Rural Residential	Rural
Primer + asphalt	primer + asphalt	Prime & 2 coat flush seal	Prime & 2 coat flush seal

2. At intersection approaches with flush seals, on residential streets and within industrial/commercial zones, either bituminous micro surfacing 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 in special circumstances. In some cases the design of the seal and/or the characteristics of the unbound pavement may be such that a prime may not be considered necessary and could be dispensed with.

Approval of Variations

4. Roundabouts are to be designed with deep lift AC pavements design in accordance with AUSTROADS Pavement Design guide. All layers shall be dense graded mix with the surface layer SBS modified. Alternate pavement designs may be considered – e.g. concrete subbase, DGB base and double interlocked pavers. Construction of roundabouts on main roads under the control of the RMS will be subject to RMS requirements.

Roundabouts

D2.17 SPRAYED BITUMINOUS SEALS (FLUSH SEALS)

1. The design of sprayed bituminous (flush) seals, including primer seals, shall be in accordance with the RMS Sprayed Sealing Guide. Alternatively the Austroads design guide for seal design, "*AP-2/90 Design of Sprayed Seals"*, can be used

Seal Design

2. Primer seals shall be 7mm and shall be indicated on the Drawings below all flush seals, bituminous micro surfacing, and asphalt surfacings. Where a 7mm primer seal is impractical, a 10mm primer seal shall be permitted. Where traffic is to be restricted from the road surface until final sealing, a prime may be substituted for the primer seal.

Primer Seal

Prime

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	10mm	or	7mm

4. Single coat flush seals shall be allowable if bituminous micro surfacing (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 micro surfacing, also referred to as 'cold overlay', shall be designed to provide a nominal compacted thickness of not less than 8mm.

Minimum Thickness 8mm

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

Requirement for 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 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 **C245** ASPHALTIC CONCRETE.

Light to Medium Traffic C245

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 **C245** ASPHALTIC CONCRETE.

Medium to Heavy Traffic C245

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. The minimum compacted layer thickness of asphalt shall be in accordance with Table C245.9 of Construction Specification C245 ASPHALTIC CONCRETE.

Minimum Thickness

C245

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 not be used. *Clay not used*

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. *Submission Details*

2. Drawings shall clearly indicate the structure, material types and layer thicknesses of the proposed pavement and surfacing and shall also include pavement test pit logs and CBR calculations. *Drawings*

SPECIAL REQUIREMENTS

D2.22 RESERVED

D2.23 RESERVED

D2.24 RESERVED

D2.25 RESERVED

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