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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 requirement 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	IPWEA Mid North Coast Working Party Review of D2 15/9/2000	D2	AMO	HC	16/1/01
2	Table 13.6.1 Change of P1 (Class 1) to 6		A	AS	January 2005
2	Changed Footers and Headers from IPWEA to GTCC	All	M	NB	January 06
3	Amendment of subbase extension	D2.10 (1)	A	AS	June 06
	Face changed to "lip"	D2.10 (2)	A	AS	June 06

CONTENTS

PAVEMENT DESIGN

GENERAL

D2.01   SCOPE

1.   The work to be executed under this Specification consists of the design of the road   ***Design Criteria***
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.

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

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

D2.02   OBJECTIVES

1.   The objective in the design of the road pavement is to select appropriate pavement   ***Pavement***
and surfacing materials, types, layer thicknesses and configurations to ensure that   ***Performance***
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 Traffic Authority, NSW - Sprayed Sealing Guide, 1992.

EPA – NSW Traffic Noise Policy 1999

(c)   Other

AUSTROADS	-	Pavement Design, A Guide to the Structural Design of Road Pavements, 1992.
AUSTROADS	-	Guide to Control of Moisture in Roads.
APRG21	-	A Guide to the Design of New Pavements for Light Traffic
CCA – T33	-	Cement and Concrete Association, T33 - Concrete Street and Parking Area Pavement Design, 1984.
CCA – T51	-	1997 Concrete Pavement Design for Residential Streets
CCA – TN52	-	Cement and Concrete Association, TN52 - Single-Lane Concrete Bus Bays, 1984.
RTA	-	Standard Test Methods.
AS 1141		Methods for Sampling and Testing Aggregates
AS 1289		Methods of Testing Soils for Engineering Purposes
AS 1726		Geotechnical Site Investigations

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: ***Design 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 a minimum pavement design life of 50 years.   ***Minimum Pavement Design Life***

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   ***Traffic Data***

calculation of the design traffic. Not with standing, the minimum traffic for pavement design shall be as per Table D1.5 (Geometric Road Design).

4.   In general, reference should be made to APRG21 for the calculation of design traffic volumes up to 5×10^5 ESAs for flexible pavements and 5×10^6 CVAG's for rigid pavements and AUSTROADS Pavement Design elsewhere.   ***Design Traffic Volumes***

D2.06   SUBGRADE EVALUATION

1.   Evaluation of subgrade conditions shall be in accordance with APRG21 Section 13.5 or Austroads Pavement Design Section 5.

2.   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***

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 "subgrade areas" of similar traffic loading, subgrade material, moisture conditions and subgrade support. Pavement design shall be carried out for each subgrade area.   ***Subgrade Areas***

Design CBR may be determined using laboratory soaked CBRs <AS 1289 F1.1> in situ testing; Dynamic Cone Penetrometer for cohesive materials <AS 1289.6.3.2> or Perth Sand Penetrometer for noncohesive materials <AS 1289.6.3.3> Laboratory CBR's shall be calibrated with insitu testing with reference to insitu subgrade densities. Design CBR's from insitu tests may be used directly or adjusted to allow for subgrade compaction during construction. Where the design allows for adjustment of insitu CBR tests, insitu density shall be determined.   ***Design 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

        OR

       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.

*Field
Confirmation*

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.

5.   Where soft and/or wet subgrades occur and the insitu density is less than minimum subgrade compaction requirements specified in construction standards, the subgrade support adopted for pavement design shall be determined at the insitu density or a higher density, not exceeding minimum compaction requirements in C213 that may reasonably be achieved in construction.

Soft Subgrade

7.   Subgrade Separation

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

*Subgrade
Separation*

-        Soft subgrade – CBR 3 or less

-        Water table – less than 300mm below subgrade level

-        Dispersible clay subgrade

A separation membrane shall consist of a non woven geotextile, 140 g/m^2 or approved alternative permeable membrane.

8.   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 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 Austroads Pavement Design Guide, APRG21- Guide to Design of New Pavements for Light Traffic & Austroads – Guide to Control of Moisture in Roads.

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 three categories or types:-

*Surfacing
Classification*

(a)   Sprayed bituminous seals (flush seals)

(b)   Asphaltic concrete and bituminous microsurfacing (cold overlay)

(c)   Cement Concrete

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

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

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

6.   Cement concrete shall satisfy the requirements of the Construction Specifications for C248 CONCRETE BASE.

7.   Sprayed bituminous seals shall satisfy the requirements of the Construction Specification for 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 microsurfacing (cold overlay) shall not be used for new road construction and other applications where approved by Council shall satisfy the requirements of the Construction Specification for C255 BITUMINOUS MICROSURFACING.

10.   The properties of crushed rock pavement material shall be in accordance with APRG21 Table 13.6.1 as amended (see amended table with this specification).

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, 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 AUSTROADS Pavement Design.

PAVEMENT THICKNESS DESIGN

D2.10   PAVEMENT STRUCTURE – GENERAL

1.   The minimum overall pavement thickness for flexible pavements of new roads shall be 250 mm. Asphaltic Concrete surfacing less than 30mm shall not be included in the overall pavement thickness.

Minimum Pavement Thickness

2.   The subbase layer shall extend a minimum of 300mm behind the back of any kerbing and/or guttering.

Subbase Extent

3.   The base and surfacing shall extend to the lip 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

4.   For unkerbed roads, the subbase and base layers shall extend at least to the nominated width of shoulder. Where subsoil drainage is not provided, the subbase 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.

D2.11   UNBOUND GRANULAR FLEXIBLE PAVEMENTS (BITUMINOUS SURFACED)

1.   Unbound and modified granular flexible pavements with thin bituminous surfacing with design traffic up to 5×10^5 ESAs shall be designed in accordance with APRG21, using Figure 13.8.2(A) (95% confidence limit curves).

2.   For design traffic above 5×10^5 ESAs, the design shall be in accordance with AUSTROADS Pavement Design.

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

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.   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

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.

Deep Lift Compaction

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 minimum thickness of bound layers shall be 150mm.

The thickness of bound layers is critical to achieving design life and small reductions in thickness can result in significant reductions in pavement life. A tolerance of 20mm shall be added to the design pavement thickness of bound

Bound Layer Thickness

pavement layers to allow for construction tolerances.

D2.13   RIGID PAVEMENTS

1.   Rigid (concrete) pavements, with design traffic up to 10^6 ESAs shall be designed in accordance with either CACA -T33, APRG21 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 CCA -TN52.

D2.14   RESERVED

D2.15   RESERVED

SURFACING DESIGN

D2.16   CHOICE OF SURFACE TYPE

1.   Shall be as follows:-

Bitumen
Wearing
Surface

    (a)   All Urban Residential streets

-     asphaltic concrete
    or
-     concrete

    (b)   Rural Residential streets

-     two coat flush seal or asphaltic concrete

    (c)   Rural streets (for new and existing roads which will be an extension of existing sealed roads)

-     2 coat flush seal

    (d)   Commercial and Industrial streets:

-     asphaltic concrete

    or

-        concrete

(e)   Sub-arterial and Arterial roads:

-   -   asphaltic concrete

or

-                concrete

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

(f)   Roundabouts, traffic lights:

-                minimum 100mm thick Asphaltic Concrete, consisting of 50mm AC10 base layer and 50mm AC10 Polymer Modified Bitumen (PMB) Surface Layer.

or

-                concrete

3.   Variations to these requirements may be approved by Council 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 RTA Sprayed Sealing Guide.   ***Seal Design***

2.   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***

	Rural Residential	Rural Roads and Arterial/Sub-Arterial Roads
1st coat	14mm	20mm
2nd coat	10mm	10mm (check compliance for noise)

D2.18   BITUMINOUS MICROSURFACING (COLD OVERLAY)

1.   Bituminous microsurfacing, also referred to as "cold overlay", where approved 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 (14 or 10mm) shall be indicated on the Drawings below the bituminous microsurfacing.   ***Primer Seal and Single Coat Seal***

D2.19   ASPHALTIC CONCRETE

1.   In light to medium trafficked residential, rural or commercial streets (design traffic   ***Light to***

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 APRG21 and the Construction Specification C245 ASPHALTIC CONCRETE.   *Medium Traffic*

2.   In medium to heavily trafficked residential, rural or commercial roads and in all industrial and classified roads, the asphalt mix design shall be a dense graded mix in accordance with the Construction Specification for C245 ASPHALTIC CONCRETE.   *Medium to Heavy Traffic*

3.   Asphaltic concrete surfacings shall be designed to provide a nominal compacted layer thickness of not less than specified in Table D1.5.   *Minimum Thickness*

4.   As a minimum, a 7mm primer seal shall be indicated on the Drawings below the asphaltic concrete surfacing.   *Primer Seal*

D2.20   RESERVED

DOCUMENTATION

D2.21   DESIGN CRITERIA AND CALCULATIONS

1.   As a minimum, a Geotechnical Report indicating considerations, assumptions, subgrade test locations & 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. The drawings shall also state the minimum subgrade CBR to be achieved and the corresponding DCP/PSPT requirement in blows/150mm.   *Drawings*

3.   Pavement design details required to be submitted to Council under this specification shall be certified by an approved Geotechnical or Civil Engineer.

SPECIAL REQUIREMENTS

D2.22   NOISE POLICY

Road surfacing choices shall give consideration to the requirements of the NSW Traffic Noise Policy 1999. Choice of road surfacing materials shall be made in conjunction with other design options for mitigation of traffic noise where required by the policy.

D2.23   GEOTEXTILES

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:

-      be in accordance with design and construction requirements provided by the manufactures

-      have sufficient overlaps shall be provided to development length for

stresses

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

D2.24   SUBSOIL DRAINAGE

Subsoil drainage shall be provided as per D04 – Subsoil Drainage..

D2.25   DEFINITIONS

Modified material – small addition of stabilising material (binder) to improve performance in properties such as wet strength. Typically modified gravels may contain up to 2% cement or lime by mass. Modified materials have an unconfined compressive strength (UCS) less than 1mpa. Modified pavements are designed as per flexible pavements.

Bound material – are produced by the addition of cement, lime or other binders sufficient to produce significant tensile strength. Lightly bound materials have UCS between 1-4mpa and bound materials have a UCS greater than 4mpa. Bound pavements are typically designed to limit strains in pavement layers to pre-determined criteria. Design procedures are included in Austroads Pavement Design.

DESIGN OF NEW PAVEMENTS FOR LIGHT TRAFFIC

AMENDMENT TO TABLE 13.6.1

GUIDE TO PROPERTIES OF CRUSHED ROCK MATERIAL

Material Description	Atterberg Limits	Soaked CBR (see Note *)	Grading and Plasticity Requirements	Durability/Hardness	Remarks
Class 1 or 2 (usually 20 mm max size) *High Quality*	LL ≤ 25 (Class 1) LL ≤ 25 (Class 2) PI ≤ 6 (Class 1) PI ≤ 6 (Class 2)	Typically * > 100% (Class 1) > 80% (Class 2)	Grading limits defined by a narrow band at close sieve size intervals. PI to be less than 6%	% fines passing 2.36mm sieve to be in the range of 35 to 60% after 3 compactions of test RTA T102a (ie little increase in fines)	Classes 1 and 2 are generally crushed rock (DGC 20) and some NGB 20
Class 3 (usually 20 or 40 mm max size) *Moderate Quality*	LL ≤ 35 PI ≤ 10	Typically > 30%	Grading limits defined by a broader band at close sieve size intervals. PI max 12	% fines passing 2.36 mm sieve not to increase by more than 10% after 2 compactions of test. RTA T102a	Includes natural gravels and meta sediments won by ripping
Class 4 (Specified over a wide size range; up to 75 mm) *Low Quality*	LL ≤ 40 PI ≤ 20	≥ 15%	Relatively open envelope may be defined at only a few sieve sizes. PI x % passing 0.425 mm AS sieve ≤ 600. PI not to exceed 15%	% fines passing 2.36 mm sieve to be at least 5% after 2 compactions of nom. 40 mm portion and not to increase by more than 15%	Allows the use of softer sedimentary rock won by ripping

REFERENCES

(a) RTA test method T102a
(b) "Evaluation of soft rock proposed for use in pavement construction in Australia (with special reference to NSW)" MINTY, E AND SMITH R - published in Bulletin of the International Association of Engineering Geology No 22 1980
(c) APRB Report No 21

NOTE:

Lime or cement modification may be used to obtain satisfactory subbase.