

***COFFS HARBOUR CITY COUNCIL***



**DEVELOPMENT SPECIFICATION  
DESIGN**

***0042 Pavement***

***Version 1      01 January 2009***

<b>0042 PAVEMENT</b>
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## 1 SCOPE AND GENERAL

### Scope

This worksection covers the design of road pavement to meet the required design life, based on the subgrade strength, traffic loading, environmental factors, and includes the selection of appropriate materials for select subgrade, subbase, base and wearing surface.

### 1.1 APPLICATION

The worksection contains procedures for the design of the following forms of pavement construction:

- flexible pavements consisting of unbound granular materials;
- flexible pavements that contain one or more bound layers, including pavements containing asphalt layers other than thin asphalt wearing surfaces;
- rigid pavements (i.e. cement concrete pavements);
- concrete or clay segmental pavements. NOTE – Concrete and Clay segmental pavers are NOT permitted unless specifically approved for a particular application.

### 1.2 OBJECTIVES

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.

### 1.3 REFERENCED DOCUMENTS

The following documents are referred to in this worksection:

#### Worksections

- 0041 *Geometric road layout*
- 0043 *Subsurface drainage*
- 1131 *Rolled concrete subbase*
- 1132 *Mass concrete subbase*
- 1133 *Plain or reinforced concrete base*
- 1134 *Steel fibre reinforced concrete base*
- 1135 *Continuously reinforced concrete base*
- 1141 *Flexible pavements*
- 1143 *Sprayed bituminous surfacing*
- 1144 *Asphaltic concrete (Roadways)*
- 1145 *Segmental paving*
- 1146 *Bituminous microsurfacing*

#### Other publications

##### AUSTROADS

AP – R258/04 *Sprayed Seal Design*

*Pavement design, a guide to the structural design of road pavements, 2007*

APT36/06 *Pavement design for light traffic: A supplement to Austroads Pavement Design guide.*

*Cement and Concrete Association of Australia*

C&CAA—T51      *Guide to Residential Streets and Paths.*

*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 paving, 1989.

*Resource NSW*

Specification for supply of recycled materials for pavements, earthworks and drainage, 2003

## 2 PAVEMENT DESIGN CRITERIA

### 2.1 DESIGN VARIABLES

Regardless of the type of road pavement proposed, the design of the pavement shall involve consideration of the following input variables:

- Design traffic
- Subgrade evaluation
- Environment
- Pavement and surfacing materials
- Construction and maintenance considerations

### 2.2 DESIGN TRAFFIC

#### Minimum pavement design life

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

- Flexible, Unbound Granular—25 years
- Flexible, Containing one or more bound layers—25 years
- Rigid (Concrete)—40 years
- Segmental Block—25 years

#### Equivalent standard axles (ESA)

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.

#### Traffic data

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

#### Design traffic volumes

In general, reference should be made to APT36/06 calculation of design traffic volumes up to  $10^6$  ESAs and AUSTROADS *Pavement Design* for design traffic volumes approaching or exceeding  $10^6$  ESAs.

#### Guide to design ESAs

In the absence of other traffic data, Table 2.1 gives traffic values (in ESAs) that may be taken as a guide to the design traffic, but shall be subject to variation depending on the circumstances for the particular project.

**Table 2.1 Design ESA's 25 year design life**

Street type	Design ESA's—25 year design life
Urban Residential	
- Access Street	$7 \times 10^4$
- Local Street	$5 \times 10^5$
- Collector Street	$1 \times 10^6$
Local Sub-Arterial	$1 \times 10^7$
Rural Residential	$3 \times 10^5$
Commercial and Industrial	$1 \times 10^7$

## 2.3 SUBGRADE EVALUATION

### Design considerations

The following factors shall be considered in determining the design strength/stiffness of the subgrade:

- Sequence of earthworks construction
- The compaction moisture content and field density specified for construction
- Moisture changes during service life
- Subgrade variability
- The presence or otherwise of weak layers below the design subgrade level.

### California Bearing Ratio (CBR)

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).

### Design CBR considerations

The subgrade Design CBR adopted for the pavement design shall consider the effect of moisture changes in the pavement and subgrade during the service life, and hence consideration shall 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 0043 *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

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 APT 36/06) to give an estimated equilibrium in-situ CBR.

The Design CBR for each subgrade area shall be 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

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

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.

## 2.4 ENVIRONMENT

### Environmental factors

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.

**Moisture and temperature**

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 AUSTRROADS *Pavement design*, APT 36/06, and to AUSTRROADS *Guide to control of moisture in roads*.

**Moisture considerations**

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

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

**Evaluate CBR or modulus using highest moisture content**

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 (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.

**Temperature changes**

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.

**2.5 PAVEMENT AND SURFACING MATERIALS****Pavement classification**

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

- Unbound granular materials, including modified granular materials
- Bound (cemented) granular materials
- Asphaltic Concrete
- Cement Concrete

**Surfacing classification**

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

- Sprayed bituminous seals (flush seals)
- Asphaltic concrete and bituminous microsurfacing (cold overlay)
- Cement concrete
- Concrete segmental pavers
- Clay segmental pavers

Unbound granular materials, including modified granular materials, shall satisfy the requirements of 1141 *Flexible pavements*.

Due regard should be taken of the opportunity to use recycled materials for sub-base and base course of pavement (RESOURCE NSW—Specification for supply of recycled materials for pavements, earthworks and drainage. (See disclaimer in front cover of specification under 'Important' regarding liability)).

Bound (cemented) granular materials shall satisfy the requirements of the 1141 *Flexible pavements*.

Asphaltic concrete shall satisfy the requirements of the 1144 *Asphaltic concrete (Roadways)*.

Cement concrete shall satisfy the requirements of 1131 *Rolled concrete subbase*, 1132 *Mass concrete subbase*, 1133 *Plain or reinforced concrete base*, 1134 *Steel fibre reinforced concrete* or 1135 *Continuously reinforced concrete base*, as appropriate.

Sprayed bituminous seals shall satisfy the requirements of 1143 *Sprayed bituminous surfacing*.

Where permitted - Concrete and clay segmental pavers shall satisfy the requirements of 1145 *Segmental paving*.

Bituminous microsurfacing (cold overlay) shall satisfy the requirements of 1146 *Bituminous microsurfacing*.

## 2.6 CONSTRUCTION AND MAINTENANCE CONSIDERATIONS

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:

- Extent and type of drainage
- Use of boxed or full width construction
- Available equipment of the Contractor
- Use of stabilisation
- Aesthetic, environmental and safety requirements
- Social considerations
- Construction under traffic
- Use of staged construction
- Ongoing and long-term maintenance costs

For further information on how these factors are incorporated, refer to AUSTROADS *Pavement design*.

## 3 PAVEMENT THICKNESS DESIGN

### 3.1 PAVEMENT STRUCTURE

#### Minimum pavement thickness

The pavement thickness, including the thickness of surfacings, shall not be less than 250 mm for roads with kerb and guttering, 200 mm for unkerbed roads and 150 mm for carparks.

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

- Flexible pavement—subbase 100 mm, base 100 mm
- Rigid pavement—subbase 100 mm, base 150 mm

#### Subbase extent

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

#### Base extent

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 150 mm behind the rear face of the kerbing and/or guttering.

#### Unkerbed roads

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

#### Carparks

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

#### Drainage

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.

### 3.2 UNBOUND GRANULAR FLEXIBLE PAVEMENTS—BITUMINOUS SURFACED

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 APT36/06, using **95% confidence limit curves**.

For design traffic above  $10^6$  ESAs, the design shall be in accordance with AUSTROADS *Pavement design* (or software designed for this purpose).

### 3.3 FLEXIBLE PAVEMENTS CONTAINING BOUND LAYERS—BITUMINOUS SURFACED

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).

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 APT36/06, using Figure 7 *95% confidence limit curves*.

### 3.4 RIGID PAVEMENTS

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).

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).

### 3.5 CONCRETE SEGMENTAL PAVEMENTS – WHERE PERMITTED

Concrete segmental pavements with design traffic up to  $10^6$  estimated commercial vehicles exceeding 3T gross shall be designed in accordance with CMAA-T45.

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.

### 3.6 CLAY SEGMENTAL PAVEMENTS – WHERE PERMITTED

Clay segmental pavements with design traffic up to  $10^6$  ESAs shall be designed in accordance with *Design Manual 1—Clay segmental pavements*.

For design traffic above  $10^6$  ESAs and up to  $10^7$  ESAs the design shall involve consideration of both *Design Manual 1—Clay paving* and AUSTROADS *Pavement design*, with the thicker and more conservative design of each of the two methods adopted.

For design traffic above  $10^7$  ESAs, the pavement shall be designed in accordance with AUSTROADS *Pavement design* (or software designed for this purpose).

## 4 SURFACING DESIGN

### 4.1 SURFACE TYPE

#### Streets

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

- urban residential streets—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 (single coat 10mm seal), plus asphalt. (25 AC or 40mmAC without primer)
- urban residential streets—access street, collector and local sub-arterial:
  - . primer seal, plus one coat flush seal, plus bituminous microsurfacing; or
  - . primer seal, plus asphalt.
  - . Note Primer seal to be single coat 10mm. AC to be 25mm for access street, 40mm for collector and sub arterial.
- commercial and industrial streets:
  - . primer seal, plus asphalt.

**Braking and turning zones**

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**

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

**4.2 SPRAYED BITUMINOUS SEALS (FLUSH SEALS)****Seal design**

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.

**Primer seal**

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

**Two-coat flush seals**

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—14 mm
- 2nd coat—7 mm

**Single coat flush seal**

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 14 mm or 10 mm.

**4.3 BITUMINOUS MICROSURFACING (COLD OVERLAY)****Minimum thickness**

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

**Primer seal and single coat seal**

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

**4.4 ASPHALTIC CONCRETE****Light to medium traffic**

In urban residential access and local streets, rural or light trafficked commercial streets (design traffic up to approximately  $3 \times 10^5$  ESAs), the asphalt mix design shall be either a 'high-bitumen content' mix or APT36/06 and 1144 *Asphaltic concrete (Roadways)*.

**Medium to heavy traffic**

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 1144 *Asphaltic concrete (Roadways)*.

**Minimum thickness**

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

**Primer seal**

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

**4.5 SEGMENTAL PAVERS – WHERE PERMITTED****Size and shape**

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



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

**Edge constraint**

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

**5 DOCUMENTATION**

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**5.1 DESIGN CRITERIA AND CALCULATIONS**

**Submission details**

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

**Drawings**

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