CAPRICORN MUNICIPAL DEVELOPMENT GUIDELINES

PAVEMENT DESIGN

D2

DESIGN GUIDELINES

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Keeping the Capricorn Municipal Development Guidelines up-to-date

The Capricorn Municipal Development Guidelines are living documents which reflect progress of municipal works in the Capricorn Region. To maintain a high level of currency that reflects the current municipal environment, all guidelines are periodically reviewed with new editions published and the possibility of some editions to be removed. Between the publishing of these editions, amendments may be issued. It is important that readers assure themselves they are using the current guideline, which should include any amendments which may have been published since the guideline was printed. A guideline will be deemed current at the date of development approval for construction works.

GENERAL

D2.01 SCOPE

1. This section sets out the Guidelines for 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

(b) rigid pavements (i.e. cement concrete 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
C248	-	Plain or Reinforced Concrete Base

(b) QLD State Authorities

Department of Transport and Main Roads
- Pavement Design Manual.

MRS11.11 - Specification for Sprayed Bituminous Surfacing.

(c) Other

AUSTROADS - Design of Sprayed Seals, 1990.

AUSTROADS - Pavement Design, A Guide to the Structural Design of Road Pavements, 2004

AUSTROADS - Guide to Control of Moisture in Roads.

APRG Report 21 - A Guide to the design of New Pavements for light traffic.

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 the following minimum design lives of pavement:- ***Minimum Pavement Design Life***

(a) Flexible - 20 years

(b) Rigid (Concrete) - 20 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 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 1×10^6. Beyond this, ESAs should be calculated. ***Design Traffic***

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

4. Any carriageway less than 7.0m wide shall be considered as one (1) lane when calculating design ESA’s. ***Narrow Streets***

Design Traffic Volumes

5. The calculation of the Design Traffic Volume will include traffic generated by construction vehicles, in-service vehicles, buses (where applicable) and garbage collection vehicles as given below (Ref: ARRB Transport Research Sealed Local Roads Manual, Design Traffic Loading).

Construction Traffic:

Construction traffic ESA's = (Number of houses serviced by the street) x (Number of ESA's generated by the average house)

Where the number of ESA'a generated by the average house during construction is 20.

In-service Traffic:

In-service traffic ESA's = N_s x 365 x Y

where N_s = ESA's per day per lane for commercial vehicles other than buses and garbage collection vehicles

$$N_s = \frac{AADT}{2} \times \frac{\%CV}{100} \times \frac{ESA's}{CV}$$ (refer Table D2.05.1 for %CV and ESA's/CV)

Design Traffic Volumes

Y = Growth factor

= P for r = 0

$$= \frac{(1 + r)^P - 1}{\ln (1 + r)}$$ for r > 0 and Q = P (refer Table D2.05.2for values of Y as a function of P and r)

$$= \frac{(1 + r)^Q - 1}{\ln (1 + r)} + (P - Q)(1 + r)^{Q-1}$$ for r > 0 and Q < P

r = Traffic growth rate

P = Design life in years

Q = Time in years for traffic to reach saturation level (however saturation is not likely on local roads)

Table D2.05.1 Traffic Statistics for Residential Streets

AADT Limits	%CV	ESA's/CV	ESA/day/lane	r
<150	1.0 – 15.0 (3.6)	0.01 – 0.70 (0.20)	0.03 – 5.0 (0.40)	0.00
150 - 700	1.0 – 25.0 (5.0)	0.10 – 1.00 (0.50)	0.2 – 15.0 (4.0)	0.01
700 – 2000	2.0 – 20.0 (7.0)	0.10 – 1.20 (0.50)	5.0 – 90.0 (30.0)	0.015
>2000	2.0 – 8.0 (3.7)	0.20 – 0.90 (0.50)	20.0 – 190.0 (60.0)	0.025

Figures in brackets are mean values and shall be used in the absence of actual traffic count data.

Table D2.05.2 Values of the Growth Factor Y as a function of P and r

P(yrs) / r	5	10	15	20	25	30	35	40
0.000	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00
0.005	5.06	10.24	15.57	21.02	26.61	32.36	38.22	44.25
0.010	5.13	10.51	16.18	22.13	28.38	34.95	41.87	49.14
0.015	5.19	10.78	16.80	23.29	30.28	37.82	45.93	54.65
0.020	5.26	11.06	17.47	24.55	32.35	40.98	50.50	61.03
0.025	5.32	11.34	18.15	25.85	34.57	44.48	55.60	68.21
0.030	5.39	11.63	18.88	27.28	37.00	48.28	61.36	76.54

Bus Traffic:

Bus traffic ESA's = N_b x 365 x Y

where N_b = bus types Σ (number of services per day per lane x ESA's per bus)

Garbage Traffic:

Garbage traffic ESA's = N_g x 52 x P

where N_g = ESA's per garbage collection vehicle x number of passes per week x f

f = Proportion of time the garbage collection vehicle traffic the outer wheel path
= 0.5 for minor and local access streets
= 1.0 for collectors and distributors

where ESA's per garbage collection vehicle is taken as 2.6 ESA's.

Design ESAs

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.

Table D2.05.3 Minimum Traffic Loadings

Street Type	%CV	%ESA/CV	Minimum ESA's
Urban			
Access Place	3.6	1.0	5×10^4
Access Street	5	1.0	1×10^5
Minor Urban Collector	7	1.0	5×10^5
Major Urban Collector	10	1.0	1×10^6
Rural			
<250vpd	5	1.0	5×10^5
>250vpd	9	1.0	1×10^6
Industrial	To be determined by specific design data		
Business/ Commercial	To be determined by specific design data		

D2.06 SUBGRADE EVALUATION

California Bearing Ratio

1. Subgrade evaluation shall be carried out by a NATA registered materials test authority and shall be by the conduct of insitu and soaked 4 day CBR laboratory testing. Design CBR for each subgrade area shall be determined in accordance with the method outlined in AUSTROADS – Pavement Design, A Guide to the structural design of Road Pavements, 2004.

Design Considerations

2. The following factors must be considered in determining the design strength/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. Where required by Table D2.06.1 excavate a minimum test pit depth of at least 1.0m below proposed subgrade level (calculated based on assumed CBR) fully logged.

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

Table D2.06.1 Subgrade Variability Test Pit Requirements

Council	Requirement for Test Pit Depth 1.0m Below Subgrade
Banana Shire	No
Central Highlands Regional	No
Gladstone Regional	No
Isaac Regional	Yes
Livingstone Shire	No
Maranoa Regional	No
Rockhampton Regional	No

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.

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, APRG Report 21, 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/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)

(g) Subject to flooding (eg. Causeways and Floodways).

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.

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, 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.

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.

PAVEMENT THICKNESS DESIGN

D2.08 PAVEMENT STRUCTURE – GENERAL

Minimum Pavement

1. The minimum pavement requirements excluding asphalt shall be as detailed in Table D2.08.1.

Table D2.08.1 Pavement Design Criteria

Street Type	Minimum Pavement (mm)	Minimum Surface Treatment	Minimum Base Course CBR (1)	Minimum Subbase Course CBR
Access Place/Access Street	200	25mm (DG10) or 40mm (DG14)	80	35
Urban Collectors (Major and Minor)	200	40mm (DG14)	80	45
Sub-Arterial	250	40mm (DG14)	80	45
Arterial	In accordance with DTMR Pavement Design Manual		80	45
Park Residential	200	25mm (DG10) or 40mm (DG14)	80	35
Rural & Rural Residential				
• <150 vpd	150(2)	Gravel (3)	80	35
• >150 vpd	200	2 coat seal	80	35
Industrial	300	50mm (DG14)	80	45
Roundabouts	250	50mm (DG14 Polymer modified)	80	45

Note:

1. Should supply of CBR 80 material be unavailable then CBR 60 material may be used subject to satisfactory pavement design.
2. depth of base course only (subbase course not required)
3. Seal may be required in some instances – refer to Rural Road Element Tables for the relevant Local Government in D1 Geometric Road Design

2. Not withstanding 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

3. The subbase layer shall extend a minimum of 150mm behind the rear face 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.

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

D2.09 FLEXIBLE PAVEMENTS

1. Flexible pavements with a design traffic up to 5 x 10^5 ESA's shall be designed in accordance with APRG Report 21.

- Urban Residential/Park Residential - Figure 13.8.2 (A) 95% Confidence limit
- Rural/Rural Residential - Figure 13.8.2 (B) 90% Confidence limit

2. Flexible pavement with a design traffic above 5 x 10^5 ESA's shall be designed in accordance with AUSTROADS – Pavement Design, A Guide to the structural design of Road Pavements, 2004.

D2.10 RIGID PAVEMENTS

Rigid (Concrete)

1. Rigid (concrete) pavements, with design traffic up to 1 x 10^6 ESAs shall be designed in accordance with APRG Report 21.

2. Rigid (concrete) pavements for design traffic above 1 x 10^6 ESAs, the design shall be in accordance with AUSTROADS Pavement Design, A Guide to the structural design of Road Pavements, 2004.

D2.11 SEGMENTAL PAVERS

1. Segmental pavers generally are not accepted in any Local Government.

SURFACING DESIGN

D2.12 BITUMEN WEARING SURFACE

Bitumen Wearing Surface

1. Except where the pavement is designed for concrete or where a gravel pavement is permitted in a rural situation, the wearing surface shall be a bituminous wearing surface of primer seal, plus asphalt

2. Where a 2 coat spray seal is permitted by the Council in a rural situation the design of the seal must comply with Austroads Design of Sprayed Seals 1990.

D2.13 ASPHALTIC CONCRETE

1. In Urban residential, Access Places and Streets, the asphalt mix design shall be either a 'high-bitumen content' mix or the ARRB Gap-graded mix in accordance with ARRB-SR41.

Access Places and Streets

Table D2.13.1 Preferred Asphaltic Concrete applications

Road Type	DG10 (Depth)	DG14 (Depth)
Access Place	25mm	40mm
Access Street	25mm	40mm
Minor Urban Collector		40mm
Major Urban Collector		40mm
Trunk Collector Street		40mm
Sub Arterial		40mm
Park Residential	25mm	40mm
Industrial Access		50mm
Industrial Collector		50mm

2. In Urban residential collector streets, commercial roads and in all industrial and classified roads, the asphalt mix design shall be a dense graded mix.

Collector, Commercial & Industrial

3. As a minimum, a 7mm or 10mm primer seal shall be indicated on the Drawings below the asphalt surfacing (required for all new surfaces which will have a new asphalt surfacing applied).

Primer Seal