# Engineering Design Specification

# D06 Pavement Design

Print version is uncontrolled. Current version is maintained on Wingecarribee Shire Council Website in searchable PDF format.

This document is a modified version of AUS-SPEC 0042 Pavement Design

Working with you

WSC.NSW.GOV.AU

Wingecarribee SHIRE COUNCIL

# Table of Contents

# 1 General

## 1.1 Responsibilities

### 1.1.1 General

Requirement: Provide design and documentation for pavement and surfacing materials; including types, layer thicknesses and configurations; so that the pavement performs to its designed functions and requires minimal maintenance under the anticipated traffic loading for the required design life.

## 1.2 Cross references

### 1.2.1 General

Requirement: This is not a self-contained worksection, conform to the following worksection(s):

- *D02 Quality requirements for design.*
- *D07 Subsurface drainage (Design).*

## 1.3 Standards

### 1.3.1 General

Road design: To Austroads AGRD01 and Austroads AGRD02.
Design considerations: To Austroads AGRD02 Table 3.1.
Pavement structural design: To Austroads AGPT02.

## 1.4 Interpretation

### 1.4.1 Abbreviations

General: For the purposes of this worksection the following abbreviations apply:

- CBR: California bearing ratio.
- DCP: Dynamic Cone Penetrometer.
- ESA: Equivalent standard axle.
- HVAG: Heavy vehicle axle group.
- HV: Heavy vehicle.

### 1.4.2 Definitions

General: For the purposes of this worksection the following definitions apply:

- Asphalt: A mixture of bituminous binder and aggregate with or without mineral filler, produced hot in a mixing plant, which is delivered, spread and compacted while hot.
- Asphalt pavement: A pavement, the predominant structural strength of which is provided by asphalt layers.
- Bound granular materials: Granular or subgrade materials to which a binder has been added to improve structural stiffness.
- Flexible pavement: A pavement which obtains its load-spreading properties from intergranular pressure, mechanical interlock and cohesion between the particles of the pavement material.
- Granular materials: Granular materials with no significant capacity to resist tensile stresses.
- Initial seal: An application of a sprayed seal to a prepared basecourse which has not been primed. It is intended to adhere to the base, whilst providing a temporary wearing course for traffic.

- Modified granular material: Granular materials to which small amounts of stabilising agent have been added to improve their performance without causing a significant increase in structural stiffness.
- New pavement: A combination of a base and surface course placed on a subgrade to support the traffic load and distribute it to the road bed for flexible pavements or rigid pavements.
- Oxidation of bitumen: A binder which becomes hard and brittle as a result of chemical attack by oxygen in the presence of heat and sunlight.
- Reconstruction: Treatments requiring full removal and replacement and/or improvement of the existing pavement structure including subbase, base course, and surface course.
- Rehabilitation: Resurfacing, stabilisation, restoration and rehabilitation work undertaken to restore serviceability and to extend the service life of an existing road. This may include partial recycling of the existing pavement, placement of additional surface materials, or other work required to return an existing pavement, including shoulders, to a condition of improved structural or functional adequacy.
- Reliability: The reliability of the pavement design performance process is the probability that a pavement section designed using the process will perform satisfactorily over the traffic and environmental conditions for the design period (life), that it will outlast its design traffic before major rehabilitation is required.
- Rigid pavements: A pavement composed of concrete or having a concrete base course.
- Seals:
  - Double/double: Two applications of binder and two applications of aggregate.
  - Single/single: A single application of binder and a single application of aggregate.

# 2 Pre-design planning

## 2.1 General

### 2.1.1 Data collection

Requirement: Determine the scope and data collection methods required based on the following:

- Whether pavement design is for new or existing pavement(s) and whether rehabilitation, reconstruction or construction of new pavement is required.
- Whether design decisions are required at the network or project level.
  - Network level: Requires information to manage the road system and make long term decisions for the pavement.
  - Project level: Requires site specific information to determine materials and economic requirements, and develop construction plan and specification.

Field testing: Identify the field testing/materials sampling requirements for each road segment and the associated traffic management requirements.
Site investigation: Assess climate, topography, land use, drainage, hazards, road geometry and any future changes for the site environment.

## 2.2 Existing pavement condition evaluation

### 2.2.1 Data collection

Requirement: Collect the following information for pavements requiring rehabilitation, to assess the existing pavement condition and the rehabilitation actions required:

- Traffic lane pavement condition (e.g. distress, smoothness, surface friction, and deflections).
- Shoulder pavement condition.
- Past maintenance activities.
- Pavement design features (e.g. layer thicknesses, shoulder type, joint spacing, and lane width).
- Geometric design features.
- Layer material and subgrade soil properties.
- Traffic volumes and loadings.
- Climatic conditions.
- Other miscellaneous factors (e.g. utilities and clearances).

### 2.2.2 Condition assessment

Data collection and assessment methods: Assess pavement condition as appropriate for the development, including through the following methods:

- Information from records: Gather information from records and as-constructed documents to provide information on the pavement history (including maintenance history and original design input data such as soil properties, climatic conditions, and traffic input) and features.
- Pavement condition/distress survey: Identify the following through detailed visual inspection(s):
    - Distress type: e.g. ravelling, bleeding, rutting, roughness and skid resistance.
    - Distress/condition grading: The level of distress severity, the degree of deterioration for each distress type.
    - Distress amount: The relative area (percentage of the project) affected by each combination of distress type and severity.
- In depth field investigation: If required, after gathering information from records and carrying out a distress survey on pavements affected, carry out in depth field investigations to determine the cause of distress for determining rehabilitation strategies. This may include detailed measuring and testing, such as coring and sampling, smoothness measurement, deflection testing, skid resistance measurement, drainage tests, and measuring vertical clearances on the project under evaluation. Pavement properties to measure include the following:
    - Structural adequacy, pavement strength evaluation.
    - Functional adequacy including foundation movement.
    - Surface and subsurface drainage adequacy.
    - Material durability.
    - Shoulder condition.
    - Variation of pavement condition.
    - Surface, base and subgrade condition.
    - Surface and subsurface drainage review.

## 2.3 Road assessment for the design of new pavements

### 2.3.1 Data collection

Requirement: Collect information for determining design requirements for new pavements as follows:

- Soil investigation to establish soil properties and characteristics to be used in the pavement design such as soil strength, applicable modulus (stiffness) and matrix stability.
- Site factors that affect the pavement structure or adjacent works.

### 2.3.2 Soil survey investigation

Requirement: Obtain clearances from land owners and authorities (including utility authorities) to access site locations for sampling and testing to determine the following:

- Soil type/classification across the road bed alignment.
- Estimation of characteristics and properties of soils.
- Estimated soil characteristics and properties, and potential geometric road layout to predict problematic areas, materials and conditions.
- Identification of possible soil contamination / presence of hazardous waste such as benzo(a)pyrenes, coal tar, asbestos
- Establish a testing plan for the road bed soils.
- Establish geotechnical lab testing of existing licensed Council or private quarries including basalt quarries.

### 2.3.3 Site factors

Requirement: Carry out reconnaissance of areas that affect the proposed pavement structure or adjacent works to determine the following:

- Physical layout and alignment: Assess geometrics and terrain features to determine drainage characteristics, side slope stability and cut/fill requirements, and terrain steepness that may contribute to shrinkage cracking.
- Hydrology: Identify water sources to determine drainage conditions and patterns.
- Topography: Assess development site topography to determine cut/fill, stability and drainage requirements.
- Vegetation: Identify vegetation close to the roadway edge where mitigation measures for shrinkage cracking may be required.
- Geology: Identify soil minerology, presence of rock, potential for sulfur acid soils and evaluate general support potential from surface survey(s).

### 2.3.4 Other factors

Requirement: Collect the following design input data:

- Traffic volume.
- Traffic operating speed.
- Historical performance of previous designs and construction.
- Road functional classification.
- Project budget.

## 2.4 Consultation

### 2.4.1 Council and other authorities

Council consultation: Before starting design, liaise with the Council's officer(s) for the following:

- Roadway layout and traffic management.
- Stormwater and subsurface drainage.
- Landscaping.

Other authorities: Consult with and seek approval for the development from the following government authorities:

- State roads authority.
- State and local planning authorities.
- State and federal environmental agencies.
- Rail authorities if the proposed project crosses the rail network.
- Regional catchment management authority.
- Other utility authorities.

### 2.4.2 Public consultation

Requirements: Consider consultation with the community and the following stakeholders:

- Affected and adjoining land owners.
- Road users.

### 2.4.3 Utilities services plans

Utility services location: To AS 5488.1 and AS 5488.2. Contact DIAL BEFORE YOU DIG to identify the locations of underground utility services pipes and cables. Site constraints may require positively locating services during the design phase

### 2.4.4 Development design team

Integrated development planning: Liaise with members of the development design team preparing the design of the following:

- Layouts of lots, roads, cycleways and pedestrian pathways.
- Stormwater and subsurface drainage systems.
- Services installations.

Rehabilitation pavement design: Coordinate between the design, construction and maintenance engineers to reinforce the design intent and provide feedback on project constructability, maintainability and performance.

# 3 General Design Criteria

## 3.1 General

### 3.1.1 Design objective

Requirement: Design pavement structure to meet the following:

- Required design life and traffic loading.
- Maximum economic value, safety and serviceability requirements over the pavement design life.
- Adequate for its load carrying capacity.

- Appropriate to subgrade strength, climatic conditions and environmental factors.
- Materials for the subgrade, subbase, base and wearing surface.
- Have minimal deterioration over pavement design life.
- Have minimal disruption to the adjoining land use.
- Fit into the built environment visually.

Pavement rehabilitation and reconstruction: Develop design options to repair existing pavement distress and prevent future problems.
Noise control: Integrate control measures in the development design.
Light traffic roads or minor roads: Consider that in comparison to roads with other traffic loadings, light traffic roads:

- Are more susceptible to the effects of the environment.
- Have higher variation in subgrade and moisture conditions.
- Have lower traffic speeds in urban locations.
- Are more susceptible to significant pavement damage resulting from a small number of passages of heavily overloaded vehicles.

## 3.2 Rehabilitation pavement design

### 3.2.1 Project evaluation

Pavement condition assessment: After carry out data collection to PLANNING, Existing Pavement condition evaluation to establish the condition of the in-place pavement, evaluate feasible options for repairing the existing distress to maintain pavement service life and prevent the premature reoccurrence of the distress.
Pavement evaluation and treatment design: Conform to Austroads AGPT05 for investigation of existing road pavements and design of pavement treatment.

### 3.2.2 Project analysis

Engineering and economic analysis of strategies: Conduct analysis of the feasible options as follows:

- Engineering analysis: Consider present and future traffic loads, climate, testing of local pit gravels blended with basalt gravels to achieve required strength and plasticity for pavement materials. Check a range of geotechnical test criteria required for bitumen surface sealing.
- Examine local gravel with opposite characteristics with a view to getting blended gravel with a high MDD density and high CBR%. With these blend test with the adding of small amounts of stabilents such as lime to see if high CBR% and low plasticity Index can be manufactured with cheap local materials.
- Examine as another option a local gravel blended with a small % say 20 to 30% of commercial basalt quarry by product such as DG20 or DGS30. Use the same testing as the two local gravels abovementioned with the same objectives.
- Economic analysis: Based on life cycle costs, consider service life, initial capital cost, maintenance costs, user costs, and future rehabilitation requirements, including traffic management.

Option selection for design implementation: Select the rehabilitation option that best meets the project based on economics, budget constraints, traffic service, climate, and engineering requirements.

## 3.3 Design of new pavements

### 3.3.1 Pavement design procedure

Design variables: After carry out data collection to **pre-design planning**, **Road assessment for the design of new pavements** to define design criteria for acceptable pavement performance, design pavement as follows:

- Determine the design input variables and carry out subgrade evaluation.
- Pavement type: Select pavement type based on the design variables and subgrade evaluation for the pavement performance required. Determine material properties and properties for the structural design.
- Surfacing (wearing course) treatment: Select treatment based on required skid resistance, traffic abrasion, and site climatic conditions (and its effect on surface disintegration).
- Pavement thickness: Determine the thicknesses of subbase, base and surface course for the performance required.
- Shoulder design: To *D05 Geometric road design*.
- Drainage design: To *D09 Stormwater drainage (Design)* and *D07 Subsurface drainage (Design)*.

## 3.4 Design inputs

### 3.4.1 Project scope and project base design factors

Scope: Determine the extent of pavement design required for the development for the project, budget and project delivery timeline.
Project design factors: Determine the following base criteria of pavement design for the development:

- Project objectives: Level of service, project reliability, pavement design life, structural capacity, and level of maintenance and rehabilitation.
- Usage: Required levels of usage, including traffic volume, traffic loading, future trends and functional road classification to Austroads AGRD02 Table 2.2 and Table 2.3.
- Environment constraints: Planning regulations, use of recycled materials, air, noise, water pollution, erosion and sediment control.
- Safety: Levels of service required including skid resistance, ride quality, road geometry and visibility in wet and dry conditions.
- Pavement properties required: Required functional and structural performance, pavement type, composition and future maintenance practices.

Development/precinct design factors: Consider the following development related issues when designing the road pavement:

- Land use and zoning areas.
- Transport and community needs.
- Re-use of heritage infrastructure items.
- Protection of sites with aboriginal heritage significance.
- Road hierarchies based on different speed and functional requirements.

### 3.4.2 Design input variables

Pavement design influencing factors: Consider the following input variables for urban and rural roads:

- Design traffic to AGPT02 Section 7

- Project reliability as per Section 3.6
- Subgrade and pavement material.
- Construction and maintenance considerations: To Austroads AGPT02 Section 3.
- Environment: To Austroads AGPT02 Section 4 including climatic conditions.

## 3.5 Design traffic

### 3.5.1 Traffic loading

Standards: To Austroads AGPT02 Sections 7 and 12.
Requirement: Design road pavement so that the pavement width and geometry allows vehicles to operate safely at an acceptable speed. Make sure the pavement strength is suitable for the heaviest of the design vehicles and is able to withstand the cumulative effects of the passage of all vehicles.

### 3.5.2 Traffic data

Pavement design: Include all traffic data and assumptions for calculating design traffic. Consider traffic loading beyond the width of the trafficked lanes.

| Road Classification | Street type | | Indicative Design ESA's |
|---|---|---|---|
| Access | Urban residential | Cul De Sac | $5x10^4$ |
| Access | | Access Type 1,2 &3 | $3x\ 10^5$ |
| Collector | | Collector | $1x10^6$ |
| Collector | | Local Distributer | $2x10^6$ |
| Access | Rural residential | Cul de sac up to 10 lots | $5x10^4$ |
| Access | | Other | $3x10^5$ |
| Local | Rural | Up to 1000AADT | $1x10^6$ |
| | | Over 1000 AADT | $2x10^6$ |
| Industrial | Access to rural industries on private property | | $1x10^6$ |
| Industrial | Commercial and industrial | | $5x10^6$ |
| | Carparks | Cars Only | $5x10^4$ |
| | | Subject to commercial vehicles | $5x10^5$ |

### 3.5.3 Minimum pavement design life (period)

General method: Determine the design life to suit the design traffic conditions, as appropriate for the road pavement, to function without major rehabilitation or reconstruction, based on the following minimum design life for the pavement type:

- Flexible, unbound granular: 40 years.
- Flexible, containing one or more bound layers: 40 years.
- Rigid (concrete): 40 - 50 years.
- Segmental paving: 40 years.

Factors to consider: Consider the following when determining pavement design life:

- Importance of the road.
- Likelihood of a future realignment.

- Likelihood that major future upgrading will be required to improve the road capacity.
- Likelihood that factors other than traffic such as reactive subgrades, consolidation of imported fills or compressible soil strata will cause distress requiring major rehabilitation or reconstruction.
- Likelihood of existing fixed levels of kerb and gutter, clearance under overhead structures constraining the selection of rehabilitation treatments.

### 3.5.4 Equivalent Standard Axles (ESA)

Requirement: Calculate design traffic in equivalent standard axles (ESAs) for the design life of the pavement. Take into account the present and predicted commercial traffic volumes, axle loadings and configurations, commercial traffic growth and street capacity.
Predicted volume: Use the cumulative growth factor (CGF) from Austroads AGPT02 Table 7.4, based on the annual growth rate and design period for future traffic growth provisions.
Interlocking concrete segmental paving: For design traffic up to $10^6$ ESA, replace ESA's with the number of commercial vehicles exceeding 3 tonne gross to CMAA PA02. For higher traffic volume, calculate ESAs for the development.

### 3.5.5 Design traffic volumes

To be calculated in accordance with Austroads

### 3.5.6 Additional requirements

Additional traffic allowance: Calculate and assess the following:

- Proportion of heavy vehicle traffic generated by waste collection and subdivision development construction.
- Heavy vehicle load factors incorporating average number of HVAG per HV and average number of ESA per HVAG for flexible pavements.

## 3.6 Project reliability

### 3.6.1 Desired project reliability levels table

| Road type | Project reliability |
|---|---|
| Access street | 90% |
| Local Street | 90% |
| Collector Street | 90% |
| Local Sub-Arterial Road | 90% |
| Industrial Road | 90% |
| Arterial road | 95% |

## 3.7 Construction and maintenance

### 3.7.1 Considerations

- Construction and maintenance factors: Consider the following for the pavement type, base and subbase materials, and the wearing surfacing required:
- Extent and type of drainage: To the *D09 Stormwater drainage (Design)* and *D07 Subsurface drainage (Design)* worksections. Also consider pavement base and subgrade material selection for permeability.
- Surfacing type.

- Use of boxed or full width construction: Where pavement materials are expensive or wide verges and flat batters are used, it may be more economical to adopt boxed instead of full width construction. If boxed construction is required, provide measures to prevent excessive moisture collecting in the pavement during its service life.
- Equipment available to the contractor: Make sure the pavement type selected is compatible with the available equipment.
- Use of staged construction: If required, consider fatigue cracking which may occur with bound layers and whole of life costs.
- Use of stabilisation: If required (e.g. to provide a working platform), allow for subgrade material with CBR value of 15% minimum.
- Use of geotextiles and soil reinforcement to strengthen subgrade or pavement layers.
- Pavement layering considerations: To reduce the chances of rutting in heavily-trafficked asphalt surfaced pavements.
- Transverse variations in pavement design.
- Use of Strain Alleviating Membrane Interlayers (SAMIs): To reduce reflective cracking.
- Aesthetic, environmental and safety requirements: Consider issues such as skid resistance, noise, wheel spray and night time visibility when selecting surfacing type.
- Social considerations: In heavily trafficked areas or for roads adjacent to commercial developments, rapid forms of construction may be required. This may affect pavement type and wearing surface selection, especially if pavements are used by pedestrians and cyclists, e.g. in terms of texture and colour.
- Construction under traffic: If required, select pavement types requiring deep excavations or long curing periods.
- Maintenance strategy: Consider traffic loading, future hazards and costs associated with future maintenance, e.g. to minimise disruption. For urban pavements, consider constraints on future overlays, e.g. due to kerbing levels.
- Waste minimisation by using stiffer pavement materials or stabilising subgrade
- Whole of life cycle costing
- Acceptable risk: Consider design parameters appropriate for the road function and issues which may be encountered during construction.

## 3.8 Environment

### 3.8.1 Environmental considerations

Requirement: Consider environmental factors that affect the pavement performance (subgrade strength, pavement type and surfacing material selection) the effect of pavement design on the environment (water quality, air quality, flora, fauna, soil contamination, noise attenuation).

### 3.8.2 Moisture and temperature considerations

General: Consider moisture and temperature related factors that affect pavement performance, including freeze/thaw conditions.
Moisture related factors: To Austroads AGPT02 clause 4.2. Coordinate pavement design with the stormwater and subsurface drainage design for the development.
Temperature related factors: To Austroads AGPT02 clause 4.2.

- Oxidation of bitumen seals: Consider the oxidation effect of bitumen binder when exposed to air, heat and sunlight, that is it becomes hard and brittle. This process is accelerated by high temperatures and sunlight which leads to cracking of surface seals and asphalt surfaces.

### 3.8.3 Specific location effects considerations

Pavement selection: Consider the environmental effects on pavement performance in the following areas:

- Mine subsidence.
- Bushfire heat in bushfire prone areas.

# 4 Subgrade and pavement material design criteria

## 4.1 Subgrade evaluation

### 4.1.1 Design considerations

Subgrade support design: Consider the following factors:

- Sequence of earthworks construction.
- The compaction moisture content and field density required for construction.
- Moisture changes during service life.
- Susceptibility to flooding.
- Subgrade variability.
- Do more DCP testing at closer intervals where variability occurs.
- The presence of weak layers below the subgrade design level.
- Stabilisation requirements.
- Dispersive soils.
- Plasticity parameters.
- Swell characteristics.
- Salinity.

### 4.1.2 Management of exposed dispersive soils

Dispersive soils: Consider the following:

- These soils are very susceptible to most forms of erosion, including raindrop impact, gully, and stream bank erosion.
- They are responsible for most of the turbidity in our local waterways.
- They can have low fertility and poor soil structure which reduces the ability to re-establish vegetation following disturbances.
- Wherever possible, avoid disturbance of dispersive soils. If this is not possible, consider the following management options:
    - Keep topsoil separate from subsoil when excavating.
    - Consider lime stabilisation.
    - Runoff management.
    - Revegetation.

### 4.1.3 Design approach

General approach: Except where a mechanistic design approach is employed using Austroads AGPT02 (or software designed for this purpose) as the measure of subgrade support, use the California bearing ratio (CBR).

Mechanistic design approach: If adopted using the linear elastic theory for flexible pavements, the subgrade support measurement is based on the elastic parameters (modulus, Poisson's ratio).

### 4.1.4 Design CBR

Design CBR value: For the design, determine a subgrade CBR value at the density and moisture conditions which are expected to prevail in-service for each identifiable unit, defined by topography, drainage and soil type. CBR values can be gained from either field testing or laboratory testing. It is important that clay subgrades are compacted to the required density at moisture contents consistent with the moisture levels likely in the finished road. It is desirable that the selected subbase cover gravel is an impervious material to protect the clay subgrade from undesirable moisture incursions and variations causing strength loss and subgrade pavement failure causing potholes. See Austroads AGPT02 Figure 5.1 for an example of variation of CBR with dry density($t/m^3$) for a clayey sand comparing moulding moisture content (%).
Subsurface drainage: If subsurface drainage is not proposed, allow for a CBR value with greater variability in subgrade moisture content during the pavement service life, that is a design moisture content above the optimum moisture content.

### 4.1.5 Calculation of design CBR

Methods of calculating CBR: Determine the CBR value based on either of the following methods:

- Field testing: To Austroads AGPT02 clause 5.5 where the support values from the in situ subgrade soil conditions are expected to be similar to those of the proposed pavement.
- Laboratory testing: To Austroads AGPT02 clause 5.6 when subgrade support is to be determined from first principles.

### 4.1.6 Summary of results

Pavement design: Include a summary of all laboratory and field test results and assumptions and/or calculations made in the assessment of design CBR.

## 4.2 Pavement types

### 4.2.1 Pavement selection

Requirement: Select the most appropriate pavement type based on the road functional classification, estimated traffic volume, availability of materials and the site environmental properties.

### 4.2.2 Types of pavements

Pavement types: To Austroads AGPT01.

- Flexible pavements: Select from the following:
  - Granular pavements with sprayed seal surfacings.
  - Cemented granular bases with sprayed seal surfacings.
  - Granular pavements with thin asphalt surfacings.
  - Asphalt over granular pavements.
  - Unsealed pavements
- Rigid pavement types: Select from the following:
  - Plain (jointed unreinforced) concrete pavements.
  - Jointed reinforced concrete pavements.
  - Continuously reinforced concrete pavements (CRCP).

- Steel fibre reinforced concrete pavements.
- Concrete or clay segmental pavements

## 4.3 Rehabilitation pavement design

### 4.3.1 Pavement evaluation and treatment design

Existing pavement: Conform to Austroads AGPT05 for existing sealed road pavements investigation and pavement treatment design requirements.

## 4.4 Pavement materials

### 4.4.1 Pavement material types

Pavement materials: Select the pavement material to meet pavement performance required under the applied loadings.
Flexible pavement materials: Select from the following:

- Unbound granular materials, including modified granular materials.
- Bound (cemented) granular materials.
- Asphalt.

Rigid pavement materials: To Austroads AGPT04C.
Unsealed roads: To Austroads AGPT06.

### 4.4.2 Materials

Pavement materials characteristics: To Austroads AGPT02 Table 6.1.
Material types: Select from the following:

- Unbound granular: Crushed rock, natural gravel, soil aggregate and granular stabilised materials.
- Modified granular: Bitumen stabilised, chemically modified, Cement, lime, lime/fly ash or slag-modified materials.
- Cemented: Lime stabilised, Cement stabilised, Lime/fly ash stabilised, Slag-stabilised, Slag/lime stabilised.
- Asphalt.
- Concrete.

Blending of locally available materials: As approved by Council's Engineer.
Local pit gravels are no longer fit for purpose: Due to a lack of funds Councils are persevering with gravels that are no longer fit for purpose. The materials used are redundant without a range of stabilisation options, including better geotechnical testing and optimum density and CBR matching research with mechanical gravel blending and quality construction control.
Ideal objective: The aim is to build and maintain the roads for lower whole of life costs rather than focus on initial gravel costs. This has to be achieved with blending of local pit gravels with different grading characteristics with a view to achieving a higher optimum density, higher CBR and complying Plasticity Index (PI). Ideally creation of an impermeable gravel is better for increased whole of life costs and lower maintenance costs.

## 4.5 Pavement thickness

### 4.5.1 Minimum pavement thickness

The minimum thickness of flexible pavements, excluding the thickness of surfacing, shall be not less than 300mm. The only exception is for lightly trafficked sealed private access roads (excluding access to rural industries), where the pavement thickness may be reduced to 250mm. 250mm thick pavements shall only be approved where it can be demonstrated that:

- There is a very low probability of regular or frequent heavy vehicle use, and
- The pavement design is rigorous, in accordance with accepted design standards, and demonstrates that the pavement should fulfil its design service live. All design criteria are to be clearly stated in the design submission

Notwithstanding subgrade testing and subsequent pavement thickness design, the thickness of subbase and base layers for all sealed pavements other than private access roads shall not be less than the following: -

(a) Flexible pavement: Subbase 200mm, Base 100mm
b) Rigid pavement: Subbase 100mm, Base 150mm

### 4.5.2 Subbase extent

Subbase layer: Minimum 150 mm thick behind the rear face of any kerb and/or channel (gutter).

### 4.5.3 Base extent

Base and surfacing: To the face of kerbing and/or channel (gutter).
Kerb conditions: If the top surface of the subbase layer is below the level of the underside of the kerb channel (gutter), extend the base layer minimum 150 mm behind the rear face of the kerb and/or channel (gutter).
Unkerbed roads: Extend the subbase and base layers at least to the required shoulder width.

### 4.5.4 Carparks

Load concentrations: Make provisions for areas likely to have traffic concentrations (and consequently load concentrations) within the carpark area (e.g. entrances/exits and at ramps).

### 4.5.5 Drainage

Precautions: Make provision for pavement layer drainage based on the assumption that during the service life of the pavement, ingress of water will occur.

## 4.6 Design traffic and pavement thickness

### 4.6.1 Unbound granular flexible pavements – bituminous surfaced

Pavement material: Unbound granular flexible pavements with thin bituminous surfacings, including those with cement or lime modified granular materials.
Pavement thickness: Allow for the pavement thicknesses as follows:

- Design traffic up to $10^6$ ESAs: To Austroads AGPT02 Figure 12.2. Chart for low order traffic with Design traffic ESA against selected subgrade CBR giving output of total pavement thickness in mm.
- Design traffic above $10^6$ ESAs: To Austroads AGPT02 Figure 8.4 Chart with high order traffic Design traffic ESA against selected subgrade CBR giving output of total pavement thickness in mm.

### 4.6.2 Flexible pavements containing bound layers – bituminous surfaced

Pavement material: Flexible pavements containing one or more bound layers, including cement stabilised layers or asphalt layers other than thin asphalt surfacings.
Pavement thickness: Use software designed for this purpose.

### 4.6.3 Rigid pavements

Pavement material: Rigid concrete pavements.
Pavement thickness: Allow for the pavement thicknesses as follows:

- Design traffic up to $10^6$ ESAs: To CCAA T51, Austroads AGPT02 clauses 12.9.3 and 12.9.4, or use software designed for this purpose.
- Design traffic above $10^6$ ESAs: To Austroads AGPT02 clause 9.4 or use software designed for this purpose.

### 4.6.4 Concrete segmental paving

Pavement material: Concrete segmental paving with various base courses including bound and unbound granular material.
Pavement thickness: To CMAA PA02 for design traffic up to $10^6$ estimated commercial vehicles exceeding 3 T gross.

### 4.6.5 Clay segmental paving

Pavement material: Clay segmental paving with various base courses including bound and unbound granular material.
Pavement thickness: To *Think Brick Manual 01* for design traffic up to $10^6$ ESAs.

# 5 Surfacing design

## 5.1 Surfacing types and properties

### 5.1.1 Surfacing classification

Surfacing materials: Select from the following wearing surface material to meet surface characteristics and performance required for the road:

- Sprayed seal surfacing treatments.
- Bituminous slurry surfacing.
- Asphalt.
- Cement concrete.
- Concrete segmental pavers.
- Clay segmental pavers.

### 5.1.2 Sprayed treatments

Materials: Sprayed seal surfacing (a layer of binder sprayed onto the pavement surface with a layer of aggregate incorporated), including initial seals to Austroads AP-T310 or to the relevant state road authority's requirements.
Initial seal aggregate size: Allow for initial seals below all final sprayed surfacing treatment, bituminous slurry surfacing, and asphalt surfacing with aggregate sizes to suit traffic and climatic conditions and as follows:

- < 1200 vehicle/lane/day: 5 to 7 mm.
- > 1200 vehicle/lane/day: 7 to 10 mm.

- > 600 v/l/d and hot or wet conditions: 10 mm.

Double/double seals: Allow in locations with the following properties:

- When additional waterproofing is required.
- When the traffic noise from a single/single application is unacceptable.
- When a fine texture is required, such as in parking areas, residential streets or footpaths.
- In areas subject to high shear loading compared to single/single seals.

Double/double seal aggregates: Allow for the following aggregate sizes:

- 1st coat: 14 mm.
- 2nd coat: 7 mm.

Single/single seal: If bituminous slurry surfacing or asphalt surfacing is required as the finished surface, provide 14 mm or 10 mm thick single/single seals.

### 5.1.3 Bituminous slurry surfacing

Materials: A mixture of graded aggregates and bitumen emulsion produced as a slurry. Select from the following types:

- Slurry seal: Basic mixture, usually without a polymer modifier.
- Microsurfacing: Enhanced mixture, usually containing polymer.

Minimum thickness: 8 mm nominal compacted thickness.

Application locations: Allow as a thin wearing course to existing sound pavement as follows:

- Preventative maintenance.
- Corrective maintenance to restore surface texture.
- To correct ravelling and loss of fines.
- To fill minor surface cracks

### 5.1.4 Asphalt

Asphalt mix types: Select from the following mix types:

- Dense graded asphalt.
- Open graded asphalt.
- Stone mastic asphalt.
- Fine gap graded asphalt.

Application locations: Allow for mix as follows:

- Generally: Dense graded asphalt to Austroads AGPT04B.
- Open graded asphalt:
    - Light or medium traffic: With bitumen (binder) class 320.
    - Heavy or very heavy traffic: With polymer modified binders (PMB).
- Stone mastic asphalt:
    - Light or medium traffic: With bitumen (binder) class 320.
    - Heavy or very heavy traffic: With bitumen (binder) class 320 or multigrade.
    - Very heavy special application: With PMB.
- Fine gap graded asphalt:
    - Light or medium traffic: With bitumen (binder) class 320.

Minimum thickness: Design asphalt surfacings to provide the following nominal compacted layer thickness:

- On light to medium trafficked residential rural and industrial streets: > 30 mm.
- On medium to heavily trafficked residential, rural or industrial roads: 50 mm.

### 5.1.5 Concrete surface finishes

Finishes types: To Austroads AGPT03 Table 7.1.

### 5.1.6 Segmental pavers

Surfacing finish: Determined by the paver shape, colour and type.
Concrete segmental pavers: Design paving as follows:

- Type: Type A to CMAA PA05 clause 4.4.1.
- Thickness: To CMAA PA05 Table 3.
- Base course: To CMAA PA05 Design charts A, B or C and clause 6.3.

Clay segmental pavers: Design paving as follows:

- Thickness: To Think Brick Manual *01* Table 3.
- Bedding and base course: To *Think Brick Manual 01* clause 4.2.3 and clause 4.2.4.

Paving pattern: Herringbone.
Edge restraint: Design paving so that all edges are constrained by kerbing, guttering or concrete edge strips.

### 5.1.7 Surfacing Design

Choice of surface type:
Except where the pavement is designed for concrete, segmental block surfacing or unsealed pavements, the wearing surface shall be a bituminous wearing surface is as follows or as advised by the client:

- An Urban Residential Roads: prime, plus asphalt
- Rural Roads: prime, plus two coat flush seal
- Commercial and industrial roads: primer seal or single coat seal, plus asphalt.

## 5.2 Surfacing selection

### 5.2.1 Parameters

Surface parameters: Design surfacing to meet the following wearing property requirements for the pavement:

- Longitudinal profile and roughness.
- Transverse profile and rutting.
- Skid resistance.
- Texture.
- Noise attenuation.
- Conspicuity of markings/reflectivity.
- Delineation.
- Water spray generation.
- Appearance.
- Pavement strength.

- Cracking.
- Resistance to shear forces.

Refer to Council's Standard Drawings

### 5.2.2 Braking and turning zones

Alternatives: Provide either bituminous slurry surfacing or asphalt surfacing with suitable binders (eg polymer Modified) at intersection approaches and cul-de-sac turning circles on residential streets with flush seals, within the vehicle braking and turning zones. Consider surfacing materials in braking zones to provide additional wear and roughness properties.

Consider asphalt wearing surfaces in braking and turning zones

# 6 Documentation

## 6.1 Statutory documentation requirements

### 6.1.1 Approvals

Requirement: Document the conditions, advised by the appropriate authority, required to obtain approval of the development for the following:
Authorities: Pavement Design Report shall be submitted to Council for approval prior to construction.

- Council for:
  - Road geometric layout and pavement design, including geotechnical reports .
  - Landscaping adjacent to the pavement.
  - Stormwater and subsurface drainage design affecting pavement design.
- The planning and water resources department for road and drainage layout.
- Utilities authority for any public or private utility affected by the development.

## 6.2 Drawings

### 6.2.1 Drawing content

Requirement: Provide the following drawings, describing the pavement design for the development:

- Site plan/maps: Showing the location and extent of pavement subject to improvement and design. If required to determine rainfall requirements, catchment area maps.
- Typical cross-sections for standard pavement types: Showing pavement and surface treatment design, including for any special or unusual pavement treatment, with the following details:
  - The number of lanes.
  - The pavement structure and reinforcement.
  - Material types and layer thicknesses, including thicknesses for subbase, base and wearing course.
  - Shoulders, kerbs, gutters and drainage.
- Joint layout plan and details.
- Shoulder design.
- Construction staging plan.

## 6.3 Supporting design documents

### 6.3.1 Design reports

Requirement: Identify and describe the design proposal and the basis for pavement selection. Include all data and assumptions used for designing the pavement, including geotechnical information, traffic information, rainfall data, hydrographs, and other environmental considerations.
Existing pavement condition: Provide report with distress details and rehabilitation or reconstruction proposals, include all analyses, data and other considerations used to design the pavement.
Rehabilitation pavement design: Document the design intent in the project plans and specifications to provide the contractor a clear and concise project proposal. To facilitate preventative maintenance in the pavement management process, include pavement performance information.
Economic analysis: Include all calculations and assumptions related to the economic analysis (e.g. capital cost analysis, life cycle (whole of life) cost analysis, total annual cost per kilometre, maintenance and rehabilitation activities, capital recovery and current worth factors). Illustrate how the economic analysis was performed.
Other information: Include details of any unusual factors affecting the design or have influenced the pavement selection process (e.g. construction staging, high stress locations, Council requests, unusual traffic volumes, traffic count summary sheets).

### 6.3.2 Calculations

Requirements: Submit all assumptions (e.g. traffic factor calculations, thickness calculations, thickness nomographs and related charts, temperature location map), subgrade test results, and design calculations with the pavement design. Illustrate how the pavement thickness was determined.
Subgrade stability chart: If the soil condition is found to be fair or granular, include the subgrade stability chart used in the analysis. Also include details of any unusual soil conditions that affect the pavement design (e.g. laboratory test results).

### 6.3.3 Specifications

**Requirement:** Refer to Council's Engineering Construction Specifications.

### 6.3.4 Design certification

Certificate: Provide a signed and dated design certificate as evidence that a Professional Engineer has reviewed all the design documents, verifying that the designed road pavement for the development site meet the Council and statutory requirements. Refer D02-Annexure A-Sect 3.1.1

### 6.3.5 Design reports & Calculations

Submit all considerations, assumptions, subgrade test results, and calculations with the pavement design in report form for approval by Council.

## 6.4 Work-as-executed

### 6.4.1 Work-as-executed documents

Work-as-executed drawings: Provide an additional set of final construction drawings for the purpose of recording the work completed by the Contractor.

Provide all required data and electronic files as outlined in WSC "Work as Executed plans specification and attribute requirements" located on Council's website.

### 6.4.2 Final certification of completed works

Requirement: Council requires the designer or its representative to carry out sufficient site inspections to validate the final certification of the proposed works.

Completed works: The designer to provide evidence that the site inspections were undertaken during construction works and provide final certification that the completed work is consistent with the approved design.