Technical Note 118

Sealing of Unsealed Roads with Low Traffic

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Queensland Government

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

1 Introduction

This Technical Note identifies key technical issues to be considered when sealing an unsealed pavement or formation that carries low traffic, noting:

a) For the purposes of this Technical Note, low traffic is defined as an annual average daily traffic (AADT) maximum of 300 vehicles per day and with up to 50 of these vehicles being Austroads Classes 3 – 12 vehicles. Where the majority of these vehicles are Austroads Class 10 – 12 vehicles ("very heavy vehicles[1]"), additional considerations/expert design advice may be required.

b) The note best applies to roads where the composition and volume of traffic using the road after sealing will remain largely unchanged, and where the road will not be overloaded.

c) As drivers' expectations usually increase when an unsealed road is sealed, so too may operating speeds, which may alter the operational safety of the road. Transport and Main Roads (TMRs) *Road Planning and Design Manual* (2013) and *Guidelines for Road Design on Brownfields Sites* (2013) detail the requirements for geometric design and assessments.

d) The economic benefits of upgrading an unsealed road should be measured by undertaking a thorough cost benefit analysis. Benefits are greatest when the capital costs, ongoing maintenance and rehabilitation for the proposed works are minimised relative to the base case (i.e. the "do nothing" option). Assuring appropriate design and quality in construction is critical to achieving this.

e) A bituminous seal is not normally placed over an unformed road, which is a road that typically follows the natural alignment of the terrain without engineering inputs of drainage, cross fall and/ or gravelled pavement material.

f) A rational approach to deciding whether or not to seal is provided in this Technical Note. The rationale for the decision to seal an unsealed road must be documented in a report as a formal record.

g) Key technical documents are referenced rather than duplicated.

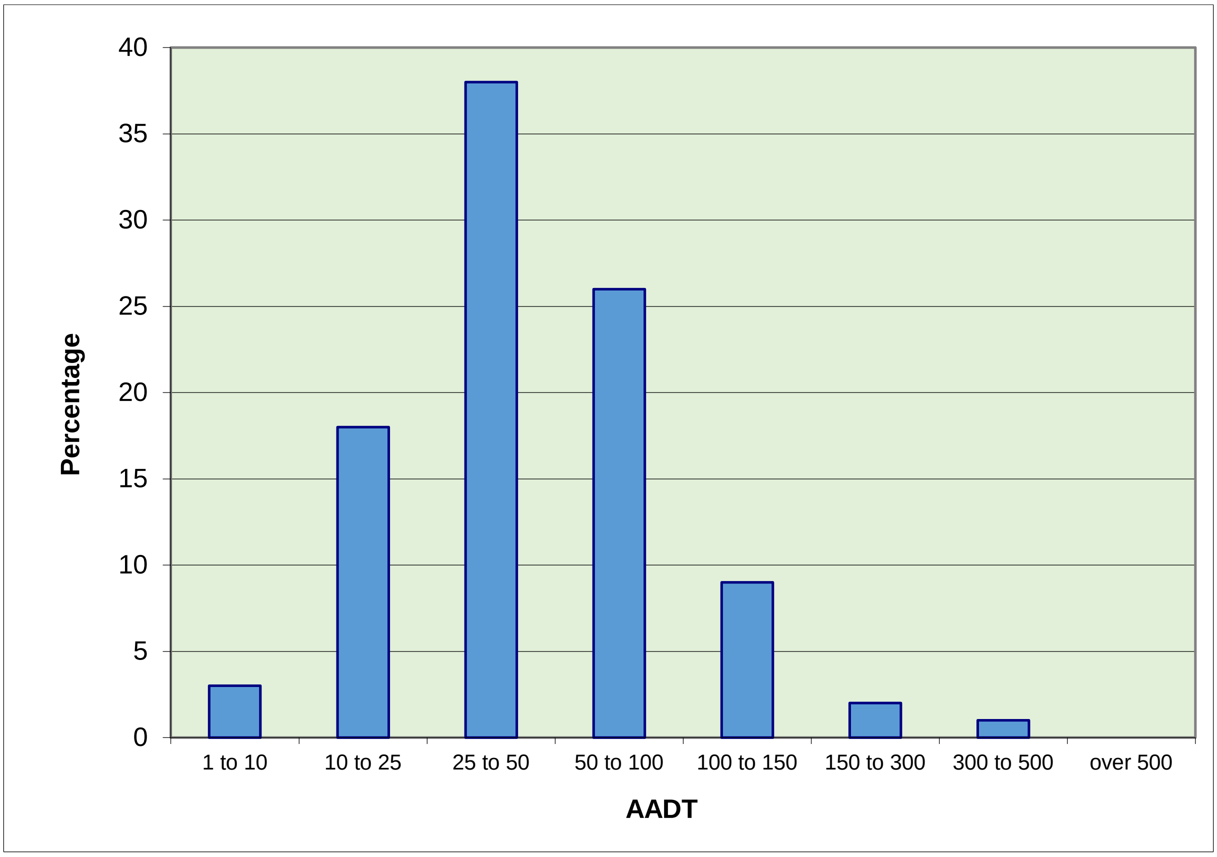
2 Context

The context of this technical note includes the following key items:

a) Figure 1 has been developed from data extracted from Queensland Government Map 44 – AADT of Unsealed Roads (based on 1 km ARMIS data extracted on 30th June 2012). It illustrates the relationship between AADT and the percentage of the total length of Queensland's unsealed state controlled roads.

[1] As defined in *Update to the Austroads Sprayed Seal Design Method, Austroads Technical Report* AP-T68/06, (Austroads 2006)

Figure 1 – Percentage of Length of Queensland's unsealed state controlled roads by AADT



b) The benefits associated with sealing unsealed roads can include:
   i. Improved access, amenity and safety for all road users.
   ii. A reduction in road user costs including both outlay when purchasing vehicles and maintenance costs.
   iii. A reduction in agency costs relating to maintenance and rehabilitation items.
   iv. Improved environmental outcomes from dust reduction and preservation of scarce unbound granular pavement materials and water, resulting in better environmental outcomes (externalities).
   v. Improved conditions for vehicles carrying livestock, with better outcomes for livestock (for example, reduced damage to livestock through bruising and/or suffocation from dust) resulting in stock losses and the associated productivity losses.
   vi. Reduced delays during wet weather conditions.
   vii. Increased tourism uptake (particularly for tourists without four wheel drive vehicles).
   viii. Enabling increased freight competition/ efficiency resulting from reduced risk of damage and wear for freight, vehicles and trailers.
   ix. Improved social connectivity as road users are more willing to travel for social functions when the route is sealed.
   x. Reduced risk of damage to general freight.
   xi. Reduced travel times.
   xii. Reduced driver fatigue.
   xiii. Improved network flood resilience and associated reduced flood damage.
   xiv. Reduced freight costs.

c) Maintenance costs are a significant input in the decision to seal an unsealed road, as:
   i. Optimum maintenance regimes assure that moisture is kept out of the pavement.
   ii. As much as 60% of the total maintenance costs of unsealed roads can be the ongoing replacement of pavement gravel (ARRB, 2000).
   iii. After sealing, maintenance also remains critical to performance as low volume roads (which are often constructed from marginal or non-standard pavement materials, making them more water-sensitive) require timely resealing and maintenance of drainage provisions. Failure or inability to appropriately maintain these roads will result in accelerated pavement deterioration.

d) To achieve value, it is critical to ensure quality during design and construction to avoid rework with escalated transport costs and negative impact on routing. For example, in "getting it right the first time", material variability and water sensitivity risks of many non-standard pavement materials are best managed through project oversight by personnel technically experienced in assessing unsealed roads, locating and winning pavement materials, and their design and construction.

e) In minimising costs of sealing roads with low traffic, there should be consideration of adoption of local practices that have performed successfully over time in relation to materials selection and construction techniques.

f) This Technical Note should be referenced against the (governing) requirements of:
   i. Where TMR standards, manuals and technical notes apply, the TMR standards and manuals take precedence.
      - *Road Planning and Design Manual* (TMR, 2013)
      - *Guidelines for Road Design on Brownfields Sites* (TMR, 2013)
      - *Road Drainage Manual* (TMR, 2010)
      - *Pavement Rehabilitation Manual* (TMR, 2012)
      - *Pavement Design Supplement* (TMR, 2013)
      - *Cost Benefit Analysis Manual* (TMR, 2011)
      - *WQ35 - Paving Materials and Type Cross Sections for Roads on Expansive Soils in Western Queensland*, (TMR, 2014)
      - *Sprayed Seal Design Method, Austroads Technical Report* AP-T68/06, (Austroads 2006)
      - *Update of Double/Double Design for Austroads Sprayed Seal Design Methods* Austroads Technical Report AP-T236-13 (Austroads, 2013).
   ii. Additional useful references include:
      - the *Austroads Guide to Pavement Technology* series (for example Part 2: *Pavement Materials*, Part 3: *Surfacings* and Part 6: *Unsealed Pavements*) and
      - the *Unsealed Roads Manual - Guidelines to Good Practice* (ARRB, 2009) are useful references.

3 Assessing suitability for sealing

There is no nominated traffic threshold that is the catalyst for sealing a low traffic unsealed road. Rather, a case-by-case analysis to assess the relative costs and benefits should consider:

a) functional prioritisation for sealing should be assessed using the TMR Portfolio Investment and Programming document '*State-Controlled Priority Road Network - Investment Guidelines*' and through addressing the following questions:

i. How does sealing the road align with the Queensland Government's priorities?

ii. What priority is implied by the road's hierarchy? For example, is it part of a national/freight route?

iii. What is the road's importance toward achieving community value? For example, if after flooding a sealed road can be reopened significantly earlier than if unsealed, significant value may be added through the potential to decrease user access down-time.

iv. What are the projections for the future level of service demands of the road including future use and traffic?

v. Is the current functionality of the road viable? For example, for heavy vehicles the rolling resistance impact implications (ARRB, 2009: 3.3) should be evaluated.

vi. What are the equity/access issues including emergency and essential services and school access?

vii. What are the key considerations in the investment analysis (Section b following) and engineering inputs (Section c following)?

b) Any investment intended to seal a currently unsealed road should represent value for money for the State. The proposed project needs to be justified through analysing the results of a thorough cost benefit analysis which is undertaken to advise on the merit of the work. The following may be considered:

i. Maintenance cost of the unsealed option, addressing:

- The deterioration of the unsealed road as a function of variables such as maintenance practices, site geometry, climate and rainfall, traffic volumes and types, and material local availability and properties.
- The long-term performance of the unsealed road measured against condition survey data such as gravel loss, roughness, rut depth, corrugation, other visual and insitu assessments.

ii. Capital cost for the construction of the sealed option including the cost of any rectification or improvements required prior to sealing, such as:

- drainage improvements
- adequate pavement thickness and material quality and
- changes to geometrics and pavement shape

iii. Routine and periodic maintenance cost and rehabilitation for both the base case and project options noting that:

- Future maintenance budget estimates (for example enrichment/ reseal treatment frequency) **must** be based on realistic (for example, current/previously enacted) estimates rather than idealised estimates.
- Binder brittleness is accelerated under conditions of very low traffic such as on the shoulders of low traffic roads or on sealed floodway surfacings that are wider than the road pavement. This will likely require careful attention to ongoing maintenance.

iv. Traffic data is required including:

- growth percentage and
- traffic breakdown for the route including the percentage of heavy vehicles and vehicle class (e.g. B doubles, type 1 road trains)

v. Delays to road users due to wet weather and flooding

vi. The evaluation period (based on the asset life) and discount rate

vii. Wider economic benefits (if relevant) should be considered

viii. Information on risks and the cost of their management is also required

ix. A strategic link strategy may be developed to address, for example:

- the feasibility of staged sealing and construction including linking several projects for the purposes of a cost benefit analysis
- prioritising critical short sections such as widening and sealing tight crests
- widening floodway crossings and other flood mitigation work
- eliminating tight horizontal curves and steep grades and
- issues that arise from engagement with user stakeholders.

The *Cost Benefit Analysis Manual* (TMR, 2011) provides an assessment methodology. Furthermore, Austroads *Guide to Pavement Technology Part 6: Unsealed Pavements* Section 9.2 provides specific guidance for life cycle analyses of selection of wearing course for unsealed roads. (The TMR Economic Evaluation Team may also provide additional information on cost benefit analysis and project evaluation.)

c) An engineering assessment will provide inputs to determine costs (both capital and maintenance) for the various options in the investment analysis:

i. Items to be considered are summarised in Clauses 4 to 8 following, noting that comprehensive methodologies are detailed in the references listed in Clause 2.

ii. Traffic incident history including risk of vehicle damage from unsealed surfacings should be considered.

iii. Traffic changes after sealing are a significant consideration. Changes could include, for example, increased drivers unfamiliar with the road such as tourists, increased heavy vehicles, or the road being used as a new short cut or bypass route.

4 Geometric considerations

Geometric design must be assessed according to the TMR *Road Planning and Design Manual* (2013) and the TMR *Guidelines for Road Design on Brownfields Sites* (2013) noting that:

a) Increased traffic speed is likely after sealing due to driver perception of an increase in the standard of the road, irrespective of whether the geometric standard of the road has actually been improved or not. Analysis is required of the risk of the likely increased traffic speed, and the proposed road geometry and line marking. Daily/seasonal peak volumes and distribution of traffic, in addition to AADT, may need to be considered as part of this.

b) Sealing of an Unsealed Road is a Road Design Class B project and the geometric requirements are given in Table 1.1 of the *Guidelines for Road Design on Brownfield Sites* (or alternatively in Table 2.1 of the Volume 1 of the TMR *Road Planning and Design Manual* (2013).

c) Check that the existing formation/pavement lies within the road reserve.

d) Designing within the limits of normal design domain is preferred, with the limits of the extended design domain applied to constrained situations. Design exceptions are only to be considered where values from the Design Domain are prohibitively expensive to justify.

e) The project may be sectioned for staged sealing considering the benefits of prioritising some sections and postponing others.

f) Evaluating the cross fall and superelevation before sealing an unsealed road is particularly important due to, for example:

   i. Shape and alignment correction may be more challenging to achieve after sealing

   ii. Unsealed, thin and weak (e.g. non-standard materials) pavements tend to ''flatten out' over time

   iii. Shape and crossfall of unsealed roads will be more variable

   iv. Adequate crossfall for drainage is critical noting that a 4% pavement minimum crossfall is desirable for low traffic roads to ensure good pavement drainage. This is particularly so for expansive subgrades in the event of subgrade movement due to environmental moisture change.

   v. In hilly country on unsealed roads, water will run down and scour the wheel paths if crossfall is not installed.

g) For low volume single lane roads, the omission of the centreline encourages vehicles to drive in the centre of the seal/road and so assist in mitigating the problems associated with the outer wheel track being too close to the sealed edge. This is advantageous where there is a significant influence of moisture variation on pavement materials as moisture moves across under the pavement. However, the associated geometric implications should be assessed in accordance with the TMR *Road Planning and Design Manual* (2013).

h) Well-constructed and maintained shoulders impact geometric considerations as they provide:

   - extra width for traffic if required in emergency
   - positive assistance to return errant vehicles when superelevated on the outer edge of the curve
   - additional space for cyclists
   - improved sight distance for avoiding animals and across the inside of curves, and
   - improved space for passing and overtaking movements.

   Furthermore, sealing the shoulders may change the perception, and associated driving behaviour, of road users.

i) Gradient changes and crown height may impact drainage.

j) Alignment options that include existing formation may have the advantage of existing material being consolidated under historic traffic. However, in addition to existing geometry, the existing formation's drainage and formation condition needs to be evaluated.

5 Moisture considerations

Excessive moisture in pavement materials is one of the most important influences on performance as the stiffness/strength of unbound materials, and subgrade performance, typically inversely correlates with the moisture content. Because of the moisture sensitivity of nonstandard and marginal materials, moisture entry often has a greater impact on the performance of low volume roads than vehicle load-associated stresses.

The following should be considered in designing to seal an unsealed pavement:

a) Drainage assessment should be in accordance with the *Road Planning and Design Manual* (TMR 2013) and the *Road Drainage Manual* (TMR 2010).

b) Drainage impacts for both small and large scale flows should be considered including:

   i. Optimise gathering data about water flow through using all feasible tools including for example: Lidar survey, gathering anecdotal data, local authority records and history.

   ii. The flow across floodplains may be impacted by the raised height of a pavement as part of preparation for sealing. Alignments that are diagonal across long flood plains may result in severe scouring and washaways. Block (e.g. soft rock bags or gabions) and floodway pairing positioned every 200 to 500 m may manage this risk.

   iii. The increased intensity of rain on small catchments can impact on channel size, location, volume and flow over time; and these changes will likely accelerate during peak flood periods.

   iv. The type and condition of existing and required drainage including surface drainage, drainage channels, table drains, side drains, mitre or turn out drains, relief drains, and cut-off/interceptor drains.

   v. The identification of culverts and other structures including adequacy of outlet, width, condition, structural strength, erosion, response to flooding, settlement, scouring, capacity/level of immunity.

   vi. Risk of erosion in embankments, cuttings, road reserves, soil types, climate and vegetation.

   vii. Consider in design the range of possible flows - from minimal inundation to flooding of the pavement.

c) Where they cross the pavement, a series of closely spaced natural water channels could be smoothed out into one large floodway in order to facilitate wide smooth flow of water.

d) Sealing approaches to floodways can reduce the pavement deterioration that results from the braking of vehicles.

e) Avoid placement and compaction of unbound pavement materials when heavy rain is expected during or immediately after placement.

f) Assess insitu moisture conditions (of pavement layers and subgrade), including inundation scenarios if applicable, and their influence on pavement performance and accessibility. For example, CBR assessment of subgrades subjected to high water tables or on floodways should be in a soaked condition. (This may not apply in dry and arid environments.)

g) Adequate crossfall for drainage is critical (see Section 4 above).

h) Unbound granular pavement materials should only be used in applications where the degree of saturation can be maintained below about 70% when trafficked. Moisture contents above this level may result in significant loss of strength, and accelerated pavement deterioration.

i) Additional drainage for sheet flow and/or acceptance of the afflux effects may be required for an increase in the height of the road's surface.

j) Sealing of an unsealed road may influence the existing drainage requirements due to increased runoff.

k) Well-constructed and maintained shoulders impact a pavement's moisture content as:

   i. They protect the pavement edges as they provide lateral structural support to the pavement.

   ii. They restrict water movements under the road. For example, where there are unsealed shoulders the pavement in the outer wheel path is more affected by the seasonal moisture variations. With the reduction in stiffness of the pavement layers that occurs as moisture contents increase, accelerated deformation leading to loss of shape can occur in the outer wheel path requiring ongoing and more frequent maintenance.

   iii. They carry water away from the pavement.

   iv. Sealed shoulders are highly beneficial in moving the zone of moisture influence away from the effective outer wheel path of the pavement, which can be achieved with a minimum sealed shoulder width of 1 m.

   v. Less erodible shoulders can be achieved through appropriate shoulder material selection.

   vi. For AADT's of less than 30 vpd, it has been reported that <u>not</u> sealing the shoulder is desirable, except in floodways. Lack of traffic on the shoulder has been observed to become a maintenance problem, as small cracks may develop in the brittle, unworked bitumen - through which grass grows, moisture enters and ravelling occurs.

l) Maintenance or rectification of seals that are cracked and/or ravelled should be prioritised in order to avoid severe and rapid pavement deterioration that will result from water ingress.

m) Avoid standing water and/or pondage within 5 m of road formation.

n) Design, construction and maintenance of diversion banks, drains, outlets and inlets to floodways and culverts impact pavement performance.

o) Provide protection from moisture absorbed through soil suction through installing, for example, a full width drainage/capillary break layer.

p) The following applies to table drains:

   i. adopt open table drains in cuttings

   ii. in other than cuttings, if possible replace table drains with batters

iii. Where table drains are required:

- minimise their required lengths where possible.
- a wide and flat bottom shape is preferred to enable the flow of water to spread over a broader invert with a shallower depth of flow, making them less prone to erosion and maintenance.
- aim to position the table drain as far away from the road as possible.
- maintain positive drainage.
- they should be a minimum of 300 mm deep.
- aim for regular diversion drains to reduce need for table drains.

q) Prior to placement of pavement material and - if applicable - the seal, treatment of cross drainage to prevent scour after rain is a cost effective early intervention in upgrading an unsealed road.

r) In flat terrain where positive drainage is difficult to provide or maintain, provided the formation is elevated above the surrounding terrain, wide flat batters can be used to shed and keep surface water away from the pavement.

s) On flat formations, grass on the edge of shoulders may inhibit edge drying and attract long-term wetter moisture conditions.

t) For embankments up to 2 m high, keep batters 1 on 4 or flatter.

u) WQ35 Appendix A provides guidance for controlling moisture in pavements on expansive soils in Western Queensland.

6 Subgrade and geotechnical considerations

a) Large parts of Queensland have challenging subgrades including: expansive soils, dispersive soils, compressible soils, salt-affected areas, and high water tables. Problematic soils and environments should be identified at an early stage of the investigations by referencing local performance, local experience where possible, and testing. *The Environmental Practices Manual for Rural Sealed and Unsealed Roads* (McRobert et al. 2002) provides guidance on design practices for such areas.

b) The *Austroads Guide to Road Design Part 7: Geotechnical Investigation and Design* (2008) addresses geotechnical issues associated with cuttings, embankments and alignment. Geotechnical issues are generally more costly to remediate after sealing.

c) For highly expansive clay subgrades, moisture movement causes longitudinal cracking of pavements, which can be managed by the use of wide impermeable shoulders and prompt sealing of any cracks which occur. Loss of pavement shape due to subgrade moisture change can also be a problem in these areas.

d) As a general rule, it is not recommended to use permeable embankment materials over expansive soils.

e) Very expansive blacksoil materials are likely to undergo significant volumetric change (i.e. shrink and swell) during the life of the pavement, which may lead to heaving of the shoulder edges. These materials may benefit from being retained close to Optimum Moisture Content (OMC), or just above, during and after compaction.

7 Pavement considerations

7.1 Pavement assessment

a) There are benefits in the pavement designer/assessor walking the length of the alignment to make careful/relevant observations during the inspection process.

b) Assessment using dynamic cone penetrometer (DCP) testing will provide useful data for sectioning fine-grained pavement materials and subgrade.

c) In assessing the suitability of an unsealed road to remain unsealed, desirable characteristics of the wearing course are skid resistance, smooth riding characteristics, wet and dry stability, low permeability, load spreading capacity, and material workability to regrade and compact. The unsealed road's wearing course should also have resistance to the following defects:

   i. Corrugations are regular ridges formed by material displacement resulting from loose fine aggregate material and vehicle dynamics. They affect ride safety, comfort and speed. After dragging or grading out the corrugations, a tightly bound surface (similar to a seal) may prevent future corrugations.

   ii. Potholes develop most frequently where drainage/crossfall is inadequate. Long term solutions include redressing drainage deficiencies such as restoration of crossfall.

   iii. Rutting is a longitudinal deformation in the wheelpaths, which may also be caused by a structural failure (in subgrade or base layers). Rutting can be delayed by ensuring appropriate drainage, using appropriate pavement materials with appropriate grading, and applying a tightly bound wearing course (similar to a seal). Unbound pavement treatment of rutting typically includes scarifying and recompacting to correct shape and crossfall, and adding additional pavement material if required.

   iv. Scouring or erosion of surface material due to free flowing water, which can be reduced by increasing the shear strength of the surface material, reducing the rate of water flow and avoiding unsealed surfaces on steep grades.

   v. Ravelling or loss of surface material, which may result in:

      - reduced surface friction due to loose aggregates
      - increased maintenance costs in replacing gravel and
      - increased dustiness and (after rain) wet, fine, plastic material on the surface.

   vi. Large hard rock "floaters" buried into the pavement may have sharp edges at the surface that can cause additional damage to vehicles (including tyres).

   vii. Oversize surface material (greater than 50 mm) can create challenges for adhesion of the bituminous material in bituminous seal, if applied.

   viii. Unsealed roads that are very hard in the wheelpaths but soft between the wheelpaths will likely require complete reconstruction of the pavement prior to sealing.

ix. Very fine-grained pavement materials (e.g. 'bulldust') typically have very low shear strength and will fail quickly under heavy traffic such as road trains. These pavements and subgrades will likely require complete reconstruction prior to being sealed.

x. Hazards such as the impact of dust on visibility.

d) As an indicator of pavement structural condition and surface defects, road roughness is also an important indicator of user satisfaction, and is often used in determining maintenance regimes.

e) Pavement structural assessment of an unsealed road including review of pavement layer thicknesses, and material properties and quality should address the following:

i. Prior to sealing, the residual life of the pavement should be assessed to determine if structural strengthening is required (e.g. whether the residual pavement life is less than the seal life). The *Pavement Rehabilitation Manual* (TMR, 2012) provides a methodology toward determining the residual life in the pavement/formation structure.

ii. Structural defects often appear as rutting, shear deformation, soft or wet patches, loss of pavement material or large depressions. Analysis of pavement/formation structural defects would examine whether a failure is located within the pavement layers or subgrade, and/or relates to the material, pavement thickness, geometry and/or drainage deficiencies.

iii. The condition of the shoulders should also be assessed.

iv. Assessment should be completed and rationalised in uniform/representative sections.

7.2 Pavement design

a) The *Pavement Design Supplement* (TMR, 2013) and the *Pavement Rehabilitation Manual* (TMR, 2012) address the structural design of pavements.

b) The pavement design period is selected on a project specific basis considering the residual life of the pavement, the typical life of a seal (8 to 10 years), and the cost of treatment, where:

i. Comparing options using a whole-of-life costing approach may be useful in selecting the most cost-effective design period.

ii. Before deciding to seal an unsealed road consider that, for lightly trafficked unsealed roads, the treatment at the end of the design period commonly only necessitates re-shaping the unsealed road.

c) In floodplains/floodways, cementitiously stabilised/treated base with a 28 day unconfined compressive strength of at least 1.5 to 2.5 MPa should be considered.

d) TMR uses a variety of 'non-standard' pavement materials throughout the state, which are typically specified through local supplementary specifications. Examples of non-standard materials and a methodology for their specification are detailed in WQ35 *Paving Materials and Type Cross Sections for Roads on Expansive Soils in Western Queensland* (2014). Where possible, select a pavement gravel that is impermeable, which may require mixing two materials together.

e) For low volume roads, the extent of the "wet zone" under the outer wheel path appears to be dependent on the thickness of the pavement and it has been observed that:

i. 150 mm to 250 mm pavement thickness generally provides satisfactory performance, and

ii. >300 mm pavement thickness has shown no performance advantage.

f) The permeability of pavement materials used in low volume roads impacts on performance in the following manner:

i. Where a permeable pavement layer is placed on a significantly less permeable material, resulting in a 'permeability reversal', build-up of water in the permeable layer may increase the risk of pore pressure development and associated failure of the overlying layer/s. Historically this has presented a significant risk for low and medium volume roads. This risk can be mitigated through:

- specifying material permeability requirements for the different pavement layers and
- appropriate subsurface and pavement drainage.

ii. High permeability pavement materials allow more moisture entry and create edge effects up to 2.5 m under the seal, which should be avoided.

iii. Low permeability paving materials typically produce better performance.

7.3 Pavement consideration

a) Selection of non-standard pavement materials, usually occurs at the job planning stage.

b) As a general principal, winning and overworking of non-standard materials should be avoided to prevent excessive break down of the material.

c) Variability inherent in non-standard pavement material demands close attention. For example, where used, nuclear gauges require calibration on an ongoing basis.

d) Ensure pavement material is not segregated and is consistently compacted. Homogenous well-compacted pavements are less likely to wet up during long periods of steady rain. Furthermore, segregated pavement edges can act as a moisture trap – similar to a soakage pit.

e) Moisture content during construction of unbound pavement layers must be appropriate for both the pavement materials and construction method. For example, fine grained and/or more absorptive materials seem to require excessive moisture to achieve density, and in these cases:

i. Particular care is needed not to wet up and thereby weaken the subgrade.

ii. Using a pugmill to incorporate moisture into the pavement material may be advantageous.

f) 'Drying back' or 'baking out' of pavements during construction before sealing may be necessary and is often more important for fine grained pavement materials. The main purpose of dryback is to ensure that moisture is not trapped in the pavement under the seal. Dryback is typically assessed by Degree of Saturation (DoS) testing. Local specifications may specify a moisture content as a percentage of Optimum Moisture Content (OMC).

g) The performance of unsealed non-standard pavement materials with higher plasticity index is enhanced through their capacity to constantly dry out. However for these materials to perform adequately when sealed, additional precautions are required to ensure that they have sufficiently dried back prior to sealing, and that they are sufficiently protected from groundwater entry (such as effective longitudinal drainage in rolling country.) Water trapped in the pavement may significantly reduce performance.

7.4 Pavement surface preparation

a) Prior to sealing the pavement surface must adequately prepared.

b) Prior to sealing unbound pavement materials, the final layer must have a uniform surface free from loose, segregated and contaminated areas and the coarse particles should be slightly exposed.

c) Aggregates on the surface should be no greater than 50 mm in size to facilitate adherence of the bituminous binder.

d) Any surface irregularities whose size is greater than the thickness of the seal may result in very thin or no surfacing in the high spots which through rapid wear, and acceleration of formation of potholes.

e) During pavement reshaping, avoid lensing (e.g. a “crusty top”) whereby:

  i. If lensing occurs, tyning and reworking (or possible replacement) of the pavement material will be required.

  ii. Pavement layers less than 75 mm thick can result in delamination and/or cover aggregate embedment when sealed.

  iii. Pavement final trimming should always be trimmed to waste to avoid lensing.

f) When trimming to waste, loose rills should not be left along the side of the road and loose material that is removed/ swept from the surface should be removed well away from the pavement and its shoulders. This will prevent rills and loose material becoming a water capture/ absorption risk to the pavement material.

g) Ball embedment test results are part of the seal design process. When sealing over existing unsealed formations, the Ball Penetration Test (Q706 or AGPT/T251) should be performed prior to sealing where:

  i. More frequent testing than those nominated in MRTS11 *Sprayed Bituminous Surfacing (Excluding Emulsion)* may be required when the pavement material is variable.

  ii. Local specifications may in addition be used, for example a pick handle “thud” test where the resonance of the sound of a pick handle dropped onto the compacted surface is an indicator of surface hardness and readiness to seal.

h) Engineering judgement is required to prepare the surface of fine-grained non-standard pavement materials for sealing. For example:

  i. All brooming should be completed with caution to ensure that the surface is not damaged prior to application of the bituminous surfacing/s.

  ii. A drag broom may be used to fill in very small indentations in the pavement surface. However avoid slurrying the surface as this may form a thin layer of “biscuit” fines, which may result in excessive embedment of the cover aggregate and result in a fatty seal.

i) If screenings are rotary broomed off, do not leave a rill. Broom them into the table drain, or cut them off with the grader, and finalise removal during the tidy up.

j) Where the insitu material is low standard, soft and/or not uniform (such as is indicated by high Ball Penetration test results exceeding 4 mm), “armour coating” will likely improve the performance of the seal. (This is typically less of a risk for ironstone and other “cementitious” non-standard pavement materials.)

k) Sprayed seals do not alter or correct pavement shape. Therefore a pavement that is rough after trimming will remain rough when sealed.

l) It may be appropriate to seal the existing formation where its structure, surfacing, drainage and geometry are satisfactory.

8 Bituminous sealed surfacing – selection, design and construction

a) “*Pavement Work Tip No. 18 Sprayed Sealing – Selection of Initial Treatments*” (August, 2010, AAPA/ Austroads) details the advantages and disadvantages of prime and seal versus primerseals.

b) Seal selection guidance and the design methodology (including materials and their application rates) are detailed in:

   i. The Update to the *Austroads Sprayed Seal Design Method*, Austroads Technical Report AP-T68/06 (Austroads 2006), and

   ii. *Update of Double/Double Design for Austroads Sprayed Seal Design Methods* AP-T236-13 (Austroads, 2013).

c) Where the percentage of Equivalent Heavy Vehicles (EHV) exceeds 65 percent, the surfacing should be designed as an “access road to quarries, mining locations etc” as defined in Section 1.5.6 of the Update to the *Austroads Sprayed Seal Design Method*, Austroads Technical Report AP-T68/06 (Austroads 2006).

d) Adequate curing time must be allowed for the volatiles to escape before the next bituminous treatment is applied. Failure to allow for curing will likely result in bleeding and premature failure of the seal. MRTS11 *Sprayed Bituminous Surfacing (Excluding Emulsion)* details minimum curing periods for these treatments.

e) For fine-grained pavement materials, particularly more porous materials, a prime may be drawn into the pavement, requiring heavier/ multiple applications and/or a heavier grade of prime.

f) The risk of excessive embedment occurring may be assessed by trialling the seal design and construction methods prior to construction, noting that embedment is determined by aggregate size and shape, hardness of pavement surface, and subsequent traffic.

g) “Armour coating” is an initial seal using of a small size aggregate (for example 7 mm). Typically a follow-up seal using a larger aggregate (for example 14 mm or 16 mm) is subsequently applied. Where the construction/ trafficking staging permits adequate prime curing time, a prime and 7 mm seal may alternatively be used as an armour coat.

h) Fine cracking and small surface irregularities may contribute to roughness in an unsealed pavement. This has been successfully addressed (in parts of Western Queensland) with a two-stage construction process using:

   i. an initial prime and 16 mm C170 seal and

ii. a 10 mm PMB seal two to three years later

The traffic on the C170 seal serves to “work in” some surface irregularities, while the subsequent PMB seal provides a strong membrane to seal cracks, provide waterproofing and further correct small irregularities.

i) Geotextile seals have proven cost-effective in reducing reflective cracking and extending the life of pavements. For example they may be considered for:

  i. cracked, high deflection, non-standard or softer bases

  ii. pavements with broken edges, for example block-cracked mudstone pavements where a possible treatment is to apply an asphalt premix edge strip and cover all with a geotextile seal

  iii. pavements with longitudinal cracking on very reactive subgrades, for example “black soil” and

  iv. pavements constructed with local clay soils.

j) The Austroads Guide to Pavement Technology Part 4K Section 3 (2009) provides guidelines for treatment of salt affected pavements. Wetted-up salt can act as a series of "small eruptions" under the seal, and lead to delaminated lengths of seal. Typically two applications of prime, a heavier seal and additional rolling is required toward supressing the effect of the salt.

k) The required amount of rolling depends on the “working” and embedment provided by traffic after placement of the seal. For example:

  i. Low traffic seals on unsealed roads require additional rolling in order to sufficiently reorient the aggregate particles, and for the binder to migrate up. Insufficient rolling may result in serious stripping of cover aggregate soon after sealing. In very remote areas with very low traffic, extra rolling using a multi-tyred roller for a week after placement of the seal is recommended. (A rolling rate of 4 – 5 km per week per roller has reportedly mitigated this risk for new seals.) Aggregate orientation and the aggregate coating by the rising binder level should be regularly checked and assessed during rolling.

  ii. As the shoulders are generally subject to less traffic, it is essential that this additional rolling extend the full width of the seal to include shoulders. Assessment may indicate that even more rolling of the shoulders is required after several days.

l) Because of the uniqueness and variability of nonstandard pavement materials:

  i. A trial of sprayed sealed treatments should be conducted, particularly the surface preparation, priming and first coat seal practices.

  ii. It is essential that construction be closely monitored and supervised by experienced personnel.

  iii. All testing should be conducted during or directly after construction due to the cost impost of rework in remote locations. Test result assessment may require additional input from the Seal Designer/Seal Designer’s Delegate in determining whether the engineering intent is achieved.

9 References

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