Asphalt surfacing treatment selection guidelines

Version 2.1
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Acknowledgements

Thanks for the work of the contributing members from the roading industry, especially from Roading New Zealand, consultants and New Zealand Transport Agency.

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Record of amendments

Amendment no.	Detail of amendment/s	Effective date	Updated by
1	Rebrand and format, after industry development, and publish as NZ Transport Agency document	7/9/12	Joanna Towler
2 2.1	Clarify flowchart and text Step 1. Edit Acknowledgements section	20/2/13 25/3/13	Joanna Towler Joanna Towler
3			

Table of contents

Guidelines for surfacing treatment selection

In this section This section contains the following topics:

Manual management plan

Purpose

This manual management plan outlines the updating and contact points for the NZ Transport Agency *Asphalt Surfacing Treatment Selection Guidelines*.

Document information

Manual name	*Asphalt Surfacing Treatment Selection Guidelines*
Manual no.	SP/M/035
Availability	This manual is located in electronic, PDF format on the NZTA website at: http://www.nzta.govt.nz/resources/results.html?catid=43
Manual sponsor	National Manager Professional Services, NZTA National Office
Manual owner	Operations Manager, NZTA National Office
Manual contact person	Operations Engineer, NZTA National Office nzta.specifications@nzta.govt.nz
Manual Steering Group	Roading New Zealand's Pavement & Asphalt Committee: Asphalt Working Group

Amendment and review strategy

- All suggested changes to this manual should be sent to the manual contact person, and will be acknowledged by him/her.
- Amendments to the manual will comply with this management plan and will be detailed in the Record of amendments section of this document.

	Comments	**Frequency**
Amendments (of a minor nature)	Minor updates to information in this manual will be incorporated after they have been approved by the manual sponsor and ratified.	As required.
Review (major changes)	Amendments fundamentally changing the content or structure of this manual will be incorporated after appropriate consultation by the manual sponsor and approval by the ratification group.	12 months after issue then every 5 years.
Notification	All users that have registered their interest by email to nzta.specifications@nzta.govt.nz will be advised by email of amendments and reviews.	Immediately.

Other information

There will be occasions, depending on the subject matter, when proposed amendments to this manual will need to be considered by the NZTA and the industry, before an amendment is approved. This may cause some variation to the above noted timeframes.

Distribution

The Manual Management Plan is included in the manual and sent to Information Management.

Introduction

Purpose

These Guidelines for Surfacing Treatment Selection have been written for Asset Managers, Surfacing Engineers and Pavement Designers. They aim to guide the reader in the engineering decision making and processes that need to occur in selecting a treatment.

Status of manual

This manual is a guideline as it is impossible to define surfacing solutions suitable for all the different pavement types, traffic levels and environments found in New Zealand.

Flow charts

The Guidelines are in the form of four flow charts with accompanying notes. The flow charts guide the practitioner through:

Step 1. Existing pavement forensics, for new surfacing on existing pavements

Step 2. Selection of preferred surfacing type for new or existing pavements

Step 3. Asphalt considerations that influence preferred surfacing type

Step 4. Bonding of surfacing to substrate, sealing the surface

The flow charts and explanatory notes will guide pavement and surfacing designers through analysis of existing pavement performance and other factors to be considered that will potentially lead to a surfacing performing as expected for all relevant criteria.

Asset management

Guidance in the area of asset management techniques for pavement management is also included in the flow charts. This includes first questioning whether asphalt is required and consideration of alternatives to asphalt, as well as considerations, other than pavement engineering, in the decision process.

Communication

Emphasis is placed on communicating asphalt performance objectives with the local asphalt producer and supplier during the treatment selection phase, to ensure that locally available mixes are selected. Discussion with Clients and suppliers to manage expectations and work with available products is emphasised.

Any concerns the Client has with material properties, whether bitumen or aggregate, should be communicated to the Contractor. The Contractor may demonstrate to the Client their quality systems that are designed to detect and address any quality issues prior to asphalt being laid.

Specification principles

In an ideal world, the client would specify the desired asphaltic concrete performance and the contractor would design and construct the asphaltic mix to suit.

However, asphaltic concrete is usually specified in a method-based contract environment. Therefore the pavement designer selects from currently available mixes using available aggregates and chooses the binder in negotiation with the client and advice from the contractor.

Specification

Specifications continue to evolve to give choice in asphalt selection and achieving performance. Both prescriptive type specifications and performance based specifications exist. It is recommended that:

- Performance type specifications be adopted if innovation and product development to achieve an end performance requirement is desired
- Using both performance based specifications and prescriptive specifications on a project is avoided, if possible, because misunderstanding and confusion in demonstrating compliance of the asphalt can occur.

Inventory

It is extremely important to have good inventory data in order to answer all the flowchart questions satisfactorily and get maximum benefit from these guidelines.

Other related documents

This is a high level document and links to various other documents such as Austroads guides and *Chipsealing in New Zealand* to provide further detail.

Notes to the flow charts

Step 1 Existing pavement forensics

Aims	The aim of this section is to discover why an existing surfacing has reached the end of its useful life.
Pavement forensics	In this step pavement forensics is introduced to aid designers in understanding the reasons for premature failure and to enable any required corrective actions to be undertaken prior to resurfacing, to avoid a repeat of poor performance.
Failure mechanisms and reasons	A range of failure mechanisms are listed; two or more of these may occur simultaneously: - Cracking - Ravelling - Rutting - Shoving - Flushing - Macrotexture Loss - Microtexture Loss - Delamination Step 1 then introduces potential reasons for the failure mechanism(s): - Issues below the surfacing such as layer weakness, inadequate pavement thickness, utility services trenches, tree roots, cracked pavements, ground movement - Drainage issues, causing water to pond in the pavement, reducing layer shear strength - Changes in road use, which could be type, magnitude, frequency or duration of load - Deficient construction quality such as mix production issues, layer bonding, jointing, voids or compaction issues - Inappropriate specification of asphalt type or pavement material components - Other issues such as chemical spills, accident damage, flood inundation during loading - Other issues identified during the forensic investigation Pavement surfacing premature failure may be a result of a combination of reasons for failure and number of failure mechanisms. For guidance on pavement layer weakness, refer Step 3.
Analysis	It is important that pavement forensic investigations consider multiple failure mechanisms, as addressing only one, and not considering other failure mechanisms that may exist, could result in repeated early failure.

Step 2 Surfacing selection

Aims

The aim of this section is to choose the most appropriate surfacing treatment that delivers the optimal whole of life solution in terms of value for money.

Treatment selection

For surfacing treatment selection, it is important to consider a full range of options and associated conditions or issues. The New Zealand Supplement to Austroads pavement design guideline (Transit New Zealand, 2007) requires whole of life analysis, with and without risk, to be considered as one of the inputs to pavement type considerations. As this document is primarily about surfacing treatment selection, the whole of life analysis of pavement types is not covered, and is assumed to be a separate exercise.

In New Zealand, the first surfacing engineering criteria to consider is whether a chipseal, asphalt or other surfacing type should be used. The Treatment Selection Chart from *Chipsealing in New Zealand* (Transit New Zealand, 2005), Figure 6.3, should be followed for guidance on this, unless chipseal has been precluded for technical or Client Road Controlling Authority (RCA) specified reasons.

If *Chipsealing in New Zealand*, Figure 6.3, suggests asphalt is required, a recommended guide for designers is the Austroads surfacing selection guideline *Guide to the Selection of Road Surfacings* (Austroads, 2003). Surfacing types and their relevant ranking for differing properties are well covered by this document.

A last check for chipsealing suitability is to ask 'Will chipsealing give an acceptable surfacing life?' In some specific low traffic sites, a combination of factors (e.g. temperature, longitudinal gradient, turning vehicles, infrequent loading) may change a surfacing selection recommendation to asphalt, or an alternative such as slurry seal, Cape Seal, or other proprietary surfacing. For alternative surfacing types, seek local Contractor or other specialist advice for availability and any potential risk or quality issues that may be identified.

Selection of Asphalt

If asphalt is selected as the preferred treatment, Step 2 guides the designer through a process of selecting asphalt types to satisfy other engineering criteria:

- low texture for certain users (cyclists or pedestrians): fine gap graded asphalt (FGGA)
- low noise: open graded porous asphalt (OGPA) or stone mastic asphalt (SMA)
- macrotexture (refer NZTA T/10): OGPA or SMA
- water spray suppression: OGPA or SMA

Pedestrian considerations

Some low volume, low speed, roads in city or town centres may have a high demand for midblock pedestrian crossing. A fine asphalt or slurry seal surface may be used for this.

Pavement considerations

A key issue for all asphalt surfacings is whether the underlying pavement can adequately support the asphalt to allow the intended life to be achieved. This issue is addressed in Step 3, Asphalt Considerations, ensuring that this issue is addressed by the designer.

Specification

After selection of asphalt type it is necessary to determine which specification should be used. In New Zealand there is a choice of method based (prescriptive) or performance based (outcome) specifications for asphalt production.

Specifications are continually evolving in response to industry initiatives with new products, changes in physical properties of material supply or material types, to encourage innovation and maintain intellectual property in supplier products that may offer performance advantages. Due to specification evolution a list is not included here.

Client requirements may define the specifications to be used for a particular project. Where this decision is the responsibility of designers the project context needs consideration. If particular surfacing performance requirements are required and traditional method based specifications do not require the performance as an outcome, it may be better to give the asphalt supplier the responsibility for providing a mix that will achieve these outcomes. An example of this is very heavy duty asphalt surfacing, where polymer addition to the asphalt binder is required to provide high rut resistance or tensile fatigue resistance. Another example might be where an ultra thin surface is required, with a surface texture, on a relatively flexible pavement.

Step 3 Asphalt considerations

Aims

The aim of this section is to ensure practitioners have considered issues for asphalt surfacings that may or may not be referenced in standard specifications or Client project specifications.

Pavement considerations

The designer should first ask 'Is the pavement structure suitable for asphalt support?' Step 3 guides the designer in investigation and potential remedies to structural deficiency. An option of accepting reduced surfacing life is shown should funding preclude improving the pavement structure. This may be acceptable provided the Client accepts such a reduced life for the surfacing. A temporary solution could be adopted until funding is available, or default to chipseal might occur. Preparing a whole of life cost analysis for options can assist Clients with decision making around capital investment today to incur lower maintenance costs during the life of the pavement.

Pavement curvature, measured by Falling Weight Deflectometer (FWD) or Benkelman Beam (expressed as FWD curvature D_0-D_{200}) is a good measure of a pavement structure's ability to support thin asphalt surfacing and resist fatigue cracking.

Austroads Guide to Pavement Technology Part 5 – Pavement Evaluation and Treatment Design (Austroads, 2009), Appendix E, has guidance on deflection curvature for dense graded asphalt overlay thicknesses (40 to 150 mm) and traffic level.

Auckland experience

NZTA Auckland Region has good correlation of motorway open graded porous asphalt life with deflection curvature. For traffic levels greater than 10 million Equivalent Standard Axles (ESAs) a pavement curvature of less than 0.15 mm FWD curvature, D_0-D_{200} is sought to achieve 8 to 10 years OGPA life before ravelling occurs.

FWD surveys

For existing pavements where asphalt overlay or new asphalt surfacing is proposed, the designer can carry out FWD surveys and model the pavement to determine whether the deflection curvature is suitable or not. For new pavements, the pavement can also be modelled to predict the deflection curvature and determine whether it is suitable or not.

Crack mitigation

Step 3 reminds designers to consider the potential negative effects of a bound (cemented) layer underneath the surfacing and offers crack/warping risk mitigation options.

Loading and binder considerations

Magnitude of loading is considered along with pavement support in selection of binder type and additives. For stiffer pavements where tensile fatigue at the top or bottom of the surfacing is not a primary failure mechanism relatively stiffer bitumen binders are recommended (to resist asphalt shoving). For more flexible pavements, a polymer addition to the bitumen binder is recommended.

For guidance on polymers and their use, refer to Austroads document AP-T42/06: Guide to the Selection and Use of Polymer Modified Binders and Multigrade Bitumens (Austroads 2006), and seek local asphalt producer and constructor advice.

Stability in high stress situations

The designer should consider structural asphalt or other very stiff pavement for supporting asphalt surfacings in very high stress areas, for example areas with heavy traffic turning and braking.

Binder considerations – performance based	When performance based specifications are used, or where the Contractor designs the pavement, it is recommended that project specifications do not specify the binder. In order to aid asphalt performance, it is preferable that the choice of appropriate binder and additives is left with asphalt producers and suppliers who best understand their binder products. Provision of design traffic information and site geometric characteristics in lieu of binder type will greatly assist the asphalt producer to develop the optimum binder properties. The selection of an appropriate binder should then be discussed between the Contractor and the Engineer (pavement designer).
Binder considerations – method based	For prescriptive type specifications the Engineer (pavement designer) will usually specify the binder type. However, the Engineer should be open to the contractor suggesting a different binder for a given set of reasons, and this should be discussed with the pavement designer. Therefore it is appropriate to provide design traffic information and site geometric characteristics, for the asphalt producer to take into consideration, even when specifying a binder in a method-based contract.
OGPA considerations	OGPA may be required for spray or noise suppression. Where traffic volumes of 500 or more heavy commercial vehicles per lane per day and pavement FWD curvature, D_0-D_{200}, (modelled or measured) is greater than the limits shown in Figure E-A3.4 (Austroads, 2009), polymer modified binder is recommended. High void (30%) OGPA (e.g. PA HV as specified in *TNZ P/11:2007*) may be used for high spray suppression or surface drainage purposes. This mix should not be used in high stress areas.
Skid resistance considerations	Skid resistance is an important safety consideration for all surfacings including asphaltic surfacings. The basic requirements are that the specified levels of microtexture and macrotexture are retained throughout the life of the surfacing. Further details are contained in *NZTA T10* specification.
RAP considerations	If local asphalt producers are utilising millings (reclaimed asphalt pavement, or RAP) in new asphalt surfacing on relatively flexible pavements, it is worthwhile to consider the effects this may have on the performance of the surfacing. RAP typically increases mix stiffness modulus due to the stiffness of the existing binder in the RAP material. For thin surfacings tolerant to deflection, the effects are likely to be minor. For asphalt surfacing types with lower binder contents, that are less tolerant to pavement curvature (FWD curvature D_0-D_{200}), the addition of RAP may shorten surfacing life when constructed on a more flexible pavement.
Other issues	Other issues referenced in Step 3: - Local asphalt producer asphalt type options - Local quarry aggregate characteristics - Using the right asphalt type for the project location - Better performance where minimum asphalt thickness is 3 times nominal stone size for dense graded and open graded porous asphalt and 4 times for stone mastic asphalt - Provision of adequate water resistance under the asphalt layers, introduction to Step 4

Step 4 Bonding the surface to the substrate and sealing the surface

Aims

The aim of this section is to effectively bond the asphalt surfacing to the pavement below whilst accounting for water resistance requirements.

Inputs

Inputs to decision making are:

- the thickness of the surfacing
- the upper pavement layer types
- the various surfacing types
- traffic demands and suggested response

Pre- leveling before applying OGPA

Prior to applying bonding layers, pre-levelling with a scrub coat of fine asphalt mix may be required on existing surfaces (rut fill) to prevent water ponding under OGPA overlay, and to give surfacing layer thickness consistency to avoid differences in compaction density.

Bonding methodology

Suggested bonding methodology is provided and, where required, degree of water resistance, reported as suggested layer configurations with minimum residual binder applications.

Membrane seals

For membrane seals, primer seal with emulsion will penetrate a damp surface but not a dry, dusty, surface, and not a cemented aggregate with cement laitance remaining on the surface. Cemented stabilised aggregate surfaces need to be well broomed, before cement setting, to provide a textured interface for membrane seals and asphalt bonding.

The flow chart indicates relatively high residual binder contents for membrane seals under asphalt surfacings on unbound granular pavements:

- In heavy traffic areas 2 l/m^2 residual binder under dense grade or stone mastic asphalt
- In all traffic areas 3 l/m^2 residual binder under OGPA is recommended

These residual binder rates have been derived from successful applications aimed to provide as much water resistance as possible under asphalt on new unbound granular basecourse, where it has not been possible to traffic with a chip seal for 2 years before asphalt laying.

Generally, for membrane seals, there should be just enough binder to provide water resistance to the pavement and just enough chip spread to stop it being carried off by traffic.

Is the underlying pavement foamed bitumen stabilised?

In accordance with Roading New Zealand's *Technical Note No 002: First Coat Sealing on a Stabilised Basecourse*, when first coat sealing foamed bitumen stabilised basecourse, first calculate the binder application rate as per normal, then reduce by 15%.

References

Austroads (2003). Guide to the Selection of Road Surfacings (2nd ed). *Austroads Publication AP-G63/03* (now replaced with *Guide to Pavement Technology PT3* and *PT4B*). Sydney, NSW: Austroads.

Austroads (2006). Austroads Technical Report: Asphalt Characterisation for Pavement Design. *Austroads Publication AP-T63/06*. Sydney, NSW: Austroads.

Austroads (2006). Austroads Technical Report: Guide to the Selection and Use of Polymer Modified Binders and Multigrade Bitumens. *Austroads Publication AP–T42/06*. Sydney, NSW: Austroads.

Austroads (2009). Guide to Pavement Technology: Part 5 – Pavement Evaluation and Treatment Design *Austroads Publication AGPT05/09*. Sydney, NSW: Austroads.

NZ Transport Agency (2010). Specification for state highway skid resistance management. *NZTA T10: 2010*.

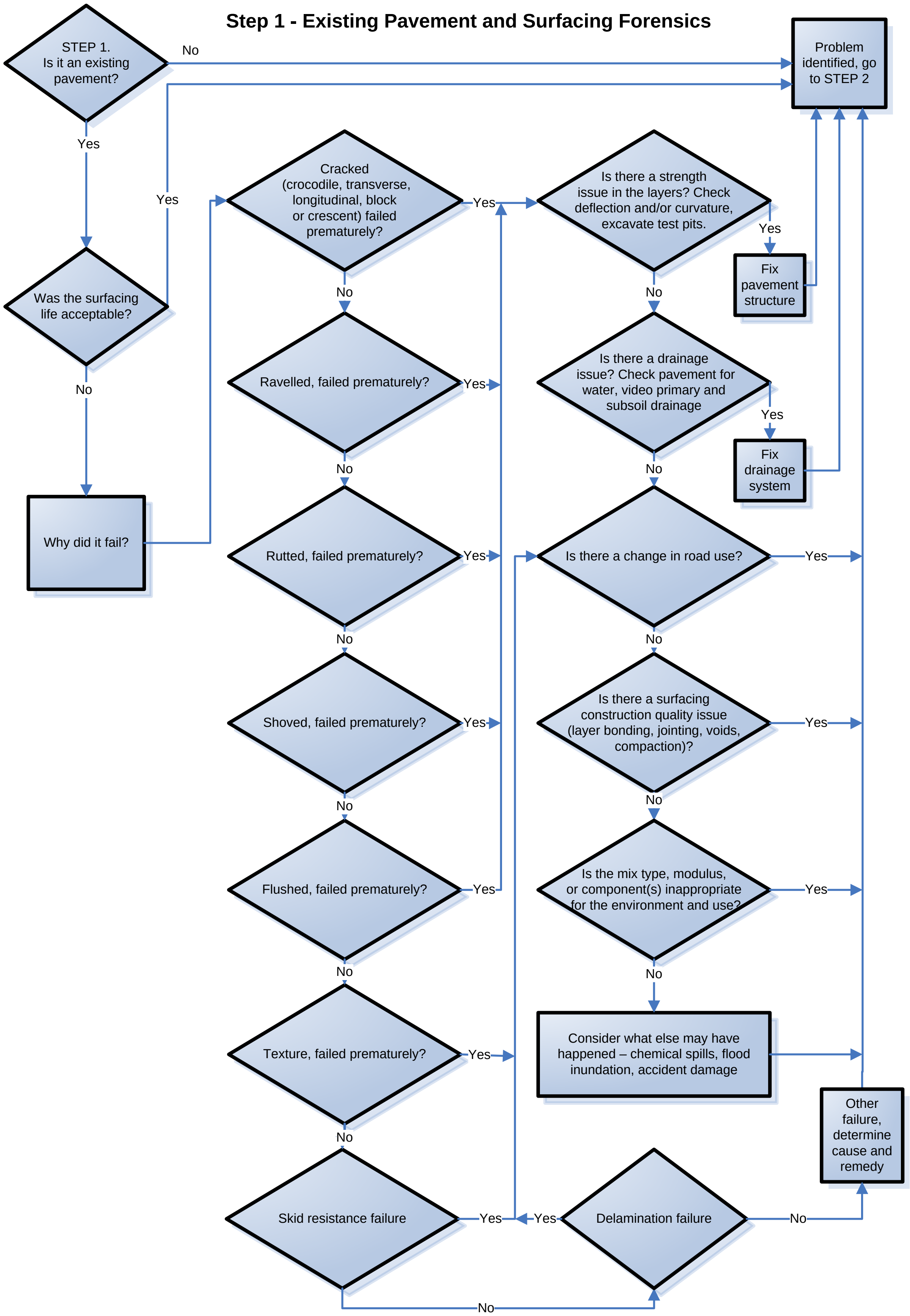
Roading NZ (2010). *Technical Note No 002: First Coat Sealing on a Stabilised Basecourse*. Wellington: Roading New Zealand.

Transit NZ, RCA, Roading NZ (2005). *Chipsealing in New Zealand*. Wellington: Transit New Zealand, Road Controlling Authorities, Roading New Zealand.

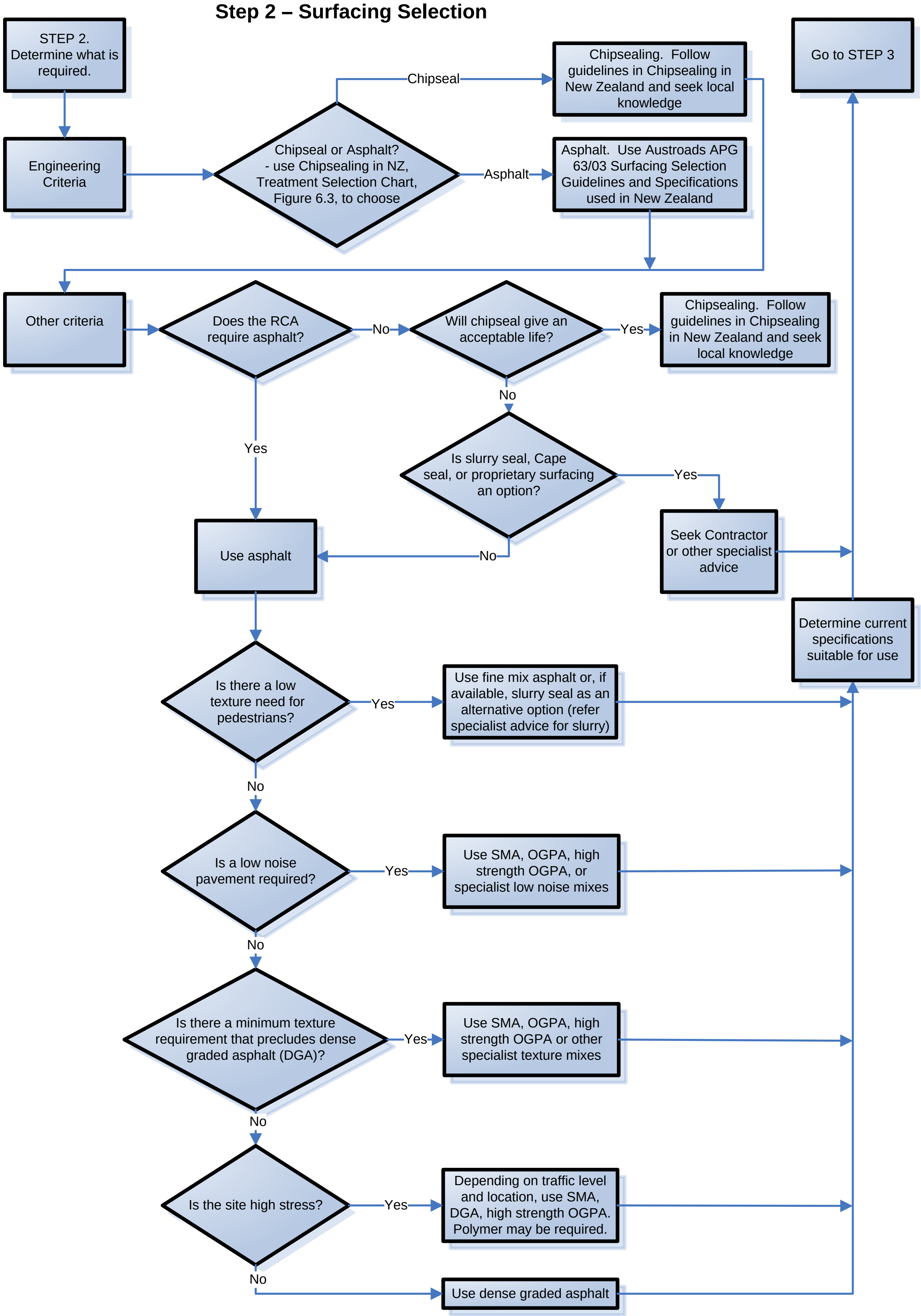
Transit New Zealand. 2007. *NEW ZEALAND SUPPLEMENT TO THE DOCUMENT, Pavement Design – A Guide to the Structural Design of Road Pavements (AUSTROADS, 2004)*. Wellington: Transit New Zealand.

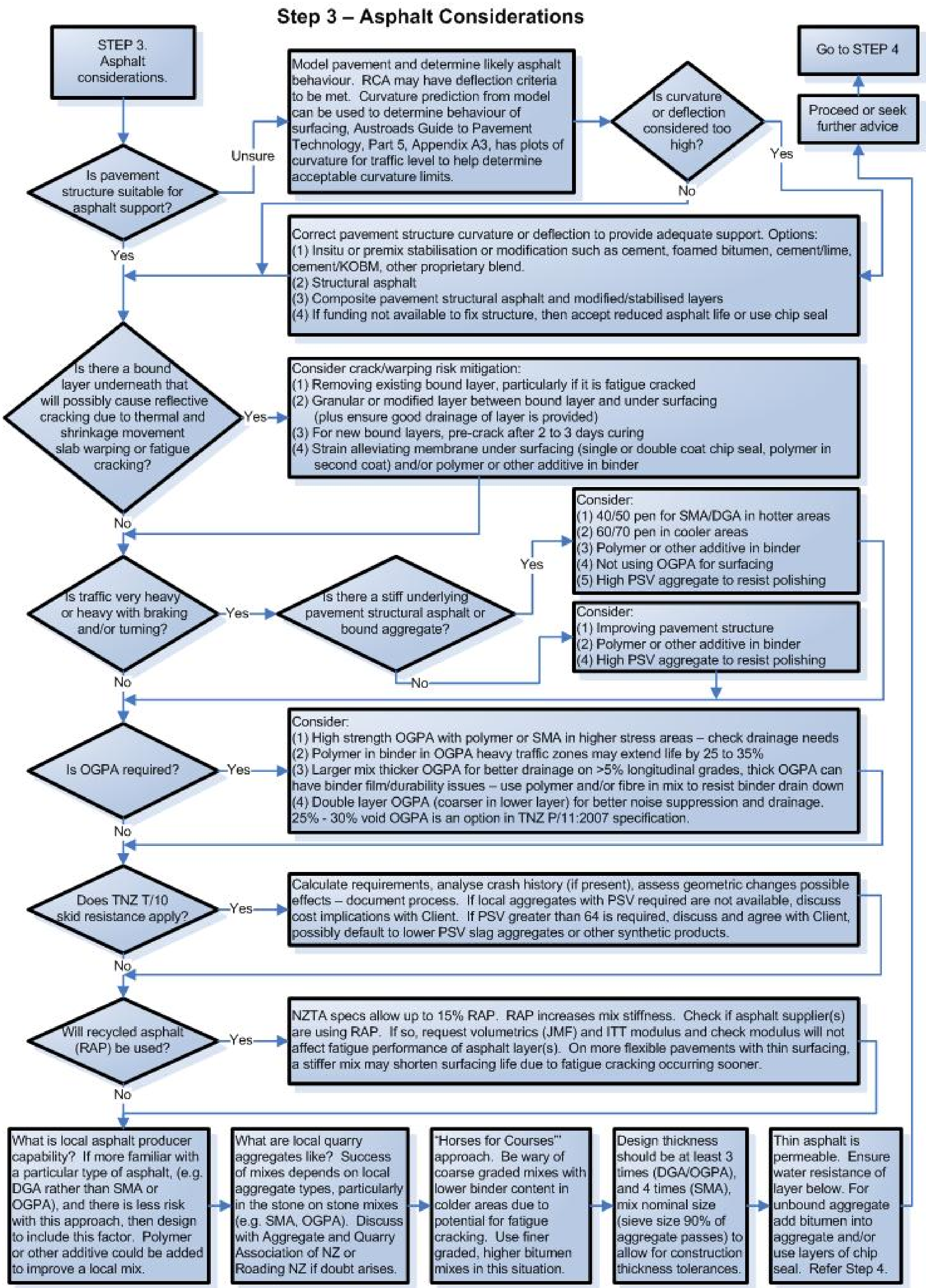
Transit New Zealand (2007). Specification for Open Graded Porous Asphalt. *TNZ P/11:2007*.

Flow charts


Step 1 - Existing Pavement and Surfacing Forensics
STEP 1.
Is it an existing pavement?
No
Yes
Problem identified, go to STEP 2
Was the surfacing life acceptable?
Yes
No
Why did it fail?
Cracked (crocodile, transverse, longitudinal, block or crescent) failed prematurely?
Ravelled, failed prematurely?
Rutted, failed prematurely?
Shoved, failed prematurely?
Flushed, failed prematurely?
Texture, failed prematurely?
Skid resistance failure
Is there a strength issue in the layers? Check deflection and/or curvature, excavate test pits.
Fix pavement structure
Is there a drainage issue? Check pavement for water, video primary and subsoil drainage
Fix drainage system
Is there a change in road use?
Is there a surfacing construction quality issue (layer bonding, jointing, voids, compaction)?
Is the mix type, modulus, or component(s) inappropriate for the environment and use?
Consider what else may have happened – chemical spills, flood inundation, accident damage
Other failure, determine cause and remedy
Delamination failure

Step 2 – Surfacing Selection




Step 3 – Asphalt Considerations
STEP 3. Asphalt considerations.
Is pavement structure suitable for asphalt support?
Unsure
Model pavement and determine likely asphalt behaviour. RCA may have deflection criteria to be met. Curvature prediction from model can be used to determine behaviour of surfacing, Austroads Guide to Pavement Technology, Part 5, Appendix A3, has plots of curvature for traffic level to help determine acceptable curvature limits.
Is curvature or deflection considered too high?
Yes
No
Go to STEP 4
Proceed or seek further advice
Yes
Correct pavement structure curvature or deflection to provide adequate support. Options:
(1) Insitu or premix stabilisation or modification such as cement, foamed bitumen, cement/lime, cement/KOBM, other proprietary blend.
(2) Structural asphalt
(3) Composite pavement structural asphalt and modified/stabilised layers
(4) If funding not available to fix structure, then accept reduced asphalt life or use chip seal
Is there a bound layer underneath that will possibly cause reflective cracking due to thermal and shrinkage movement slab warping or fatigue cracking?
Yes
Consider crack/warping risk mitigation:
(1) Removing existing bound layer, particularly if it is fatigue cracked
(2) Granular or modified layer between bound layer and under surfacing (plus ensure good drainage of layer is provided)
(3) For new bound layers, pre-crack after 2 to 3 days curing
(4) Strain alleviating membrane under surfacing (single or double coat chip seal, polymer in second coat) and/or polymer or other additive in binder
No
Consider:
(1) 40/50 pen for SMA/DGA in hotter areas
(2) 60/70 pen in cooler areas
(3) Polymer or other additive in binder
(4) Not using OGPA for surfacing
(5) High PSV aggregate to resist polishing
Yes
Is traffic very heavy or heavy with braking and/or turning?
Yes
Is there a stiff underlying pavement structural asphalt or bound aggregate?
Consider:
(1) Improving pavement structure
(2) Polymer or other additive in binder
(4) High PSV aggregate to resist polishing
No
No
Is OGPA required?
Yes
Consider:
(1) High strength OGPA with polymer or SMA in higher stress areas – check drainage needs
(2) Polymer in binder in OGPA heavy traffic zones may extend life by 25 to 35%
(3) Larger mix thicker OGPA for better drainage on >5% longitudinal grades, thick OGPA can have binder film/durability issues – use polymer and/or fibre in mix to resist binder drain down
(4) Double layer OGPA (coarser in lower layer) for better noise suppression and drainage. 25% - 30% void OGPA is an option in TNZ P/11:2007 specification.
No
Does TNZ T/10 skid resistance apply?
Yes
Calculate requirements, analyse crash history (if present), assess geometric changes possible effects – document process. If local aggregates with PSV required are not available, discuss cost implications with Client. If PSV greater than 64 is required, discuss and agree with Client, possibly default to lower PSV slag aggregates or other synthetic products.
No
Will recycled asphalt (RAP) be used?
Yes
NZTA specs allow up to 15% RAP. RAP increases mix stiffness. Check if asphalt supplier(s) are using RAP. If so, request volumetrics (JMF) and ITT modulus and check modulus will not affect fatigue performance of asphalt layer(s). On more flexible pavements with thin surfacing, a stiffer mix may shorten surfacing life due to fatigue cracking occurring sooner.
No
What is local asphalt producer capability? If more familiar with a particular type of asphalt, (e.g. DGA rather than SMA or OGPA), and there is less risk with this approach, then design to include this factor. Polymer or other additive could be added to improve a local mix.
What are local quarry aggregates like? Success of mixes depends on local aggregate types, particularly in the stone on stone mixes (e.g. SMA, OGPA). Discuss with Aggregate and Quarry Association of NZ or Roading NZ if doubt arises.
"Horses for Courses" approach. Be wary of coarse graded mixes with lower binder content in colder areas due to potential for fatigue cracking. Use finer graded, higher bitumen mixes in this situation.
Design thickness should be at least 3 times (DGA/OGPA), and 4 times (SMA), mix nominal size (sieve size 90% of aggregate passes) to allow for construction thickness tolerances.
Thin asphalt is permeable. Ensure water resistance of layer below. For unbound aggregate add bitumen into aggregate and/or use layers of chip seal. Refer Step 4.

Step 4 – Bond and Seal