Topic: Developing a proprietary product under a quasi-performance based specification.

Background: In 2009, the NSW Roads and Traffic Authority (RTA) issued a draft specification, RPB125 "Thin High Textured Asphalt Surfacing", to address the need to purchase proprietary thin surfacings under a performance based criteria. The specification emphasised that it should be used in conjunction with an effective Contractor accreditation scheme – addressing both the performance of the Contractor and the proprietary product supplied.

Downer Australia developed a thin surfacing product based on a gap graded mastic asphalt that would meet the performance criteria specified under RPB125, but not necessarily to the design requirements. The departure from the design requirements included in the specification was as a result of international practices that were being used at the time (and still are being used) to design stone mastic asphalts.

This paper reviews the requirements of the specification, the approach used to design a mix that would achieve the desired performance properties of the specification, production and placement trails which lead to the development of the proprietary thin high textured asphalt surfacing - GripPhalt.

RTA Specification RPB125: The specification scope stated that the work included the design, supply, placement and performance warranty of a stone mastic asphalt-like product of nominal aggregate size 7mm or 10mm, containing a modified binder. Table RPB125.1 in the specification listed various design and performance criteria to be complied with at the time of placement of the surfacing and is reproduced in Appendix 1.

It is unusual for a performance-based specification to contain design requirements as this creates the need to design the product to meet criteria which the "purchaser" believes will provide the desired level of performance. If the product was to fail performance but meet the design requirements and no material or workmanship non-conformances occurred, then who is responsible for the failure and any ensuing rectification costs? A performance-based specification should only contain performance criteria and not specify the "how" to achieve them.

If specification RPB125 is accepted as a quasi-performance based specification (as it contains both performance criteria and input requirements such as the compaction method, voids, layer thickness limits, limits for wheel tracking, fatigue and permeability results), then it is a reasonable move towards the development of a performance based specification. It is not the intent to focus on what are believed to be some inadequacies with the concept or the current specification. Downer Australia and the other AAPA producer members have worked diligently to develop products that meet the requirements and/or the intent of RPB125.

The Development of GripPhalt: The development of GripPhalt was based on learnings acquired during a scanning tour of Europe during 2007, where thin surfacings loosely based on stone mastic asphalt concepts were gaining more prominence in some countries, and, the release of the RTA specification RPB125. Development work commenced in February 2008, in the Downer Australia National R&D Laboratory, based in Somerton, Victoria, using an aggregate

source readily available to the Sydney market. Initially, a 7mm nominal maximum aggregate size (NMAS) was evaluated and a 10mm NMAS later developed (August 2009).

Several different grading concepts were evaluated with a conventional bitumen (C320), mainly from an ease of mixing perspective. Compactions were undertaken at 50 blow Marshall, even though the requirements of RPB125 is for 75 blow Marshall, due to the German practice of designing their SMA's using 50 blow. The binder content was varied to achieve a desired air voids target that would provide a relatively impervious asphalt surfacings, nominally less than 6% in situ voids.

Laboratory mixes were repeated substituting different grades of readily available polymer modified binders (PMB's), such as A20E, A15E and A10E, and some proprietary trial polymer modified binders. The various asphalts were then subjected to compaction testing using both Marshall (50 blow) and gyratory compaction. Slabs and briquettes were prepared to evaluate performance test properties such as deformation resistance (wheel tracking), resilient modulus, permeability and fatigue properties.

An optimum grading and binder content were selected as a result of the laboratory evaluation and these were used to determine target parameters for future designs undertaken with alternative raw materials.

An initial production trail was scheduled to be undertaken at Downer Australia's Mogo NSW asphalt plant, located approximately 300km south of Sydney. The trial was undertaken in July 2009 and involved producing and laying a nominal 30t of GripPhalt. The raw material proportions were adjusted to address the specifics with this plant as it is a parallel flow plant with a wet scrubber. The GripPhalt was laid by the Mogo crew in the yard on the access road around the asphalt plant using a local paver and rollers i.e. the equipment that will be used when undertaking future placement of this product. This trial surfacing would be trafficked by the majority of truck traffic that enters the depot. The GripPhalt was placed at a nominal 30mm.

As with most initial trials, the actual properties obtained differed from the desired or targeted properties, most noticeably the grading, air voids, permeability and paved thickness (due to some surface irregularities). It may be more appropriate to suggest that the trial was a good means of making the mistake in our own backyard prior to supplying this product to our clients. One of the key outcomes of the early trial was to familiarise the local personnel with an asphalt mix type that they had no previous experience with. Nevertheless, the trial continues to perform well and has been monitored for deformation and changes in surface texture, with little change in either of these monitored properties.

As a result of the trial, the plant feed rates were adjusted so that the desired properties were achieved on the next production run of the GripPhalt. GripPhalt has now been placed on two sections of the Kings Highway and three sections of the Princes Highway around Batemans Bay, NSW, with the longest section being slightly over 1,200m in length.

A production trial of a 10mm GripPhalt for use in and around Sydney was undertaken in September 2009 (using locally available materials). Learnings from the Mogo trial and the

laboratory development of this product were built on in an attempt to replicate the good results achieved from the Mogo work. Visually, the asphalts appeared similar but some differences in mix properties were apparent – most noticeably the air voids. The Sydney product was more prone to higher air voids with little variation in binder content or aggregate grading, believed to be due to an aggregate shape and surface effect (or rugosity). This issue has not been resolved and the corrective measure implemented is a greater focus on process control when this product is made.

The production (nominal 60t) and placement trial was undertaken at the Rosehill asphalt plant (in Sydney) and involved two runs of a nominal 120m in length and some shorter runs perpendicular to the main runs. This gave the benefit of gaining experience with transverse joints as well as some hand work (which should be kept to a minimum with this type of asphalt). Learnings from the trial were used to adjust the mix proportions and placement techniques during the first supply of this product to a client – which was a 4.2km two lane section of Wisemans Ferry – Pitt Town Rd at South Maroota in Sydney's northwest). The 10mm GripPhalt mix design was deemed to be an appropriate for the intended application.

A 7mm variation of the thin surfacing concept was trailed at Rosehill during January 2010, even though the laboratory development of this product was undertaken almost two years earlier. The logic behind the use of a smaller nominal maximum aggregate size was basically that it could be applied in a thinner layer thickness i.e. a nominal 15-20mm. Due to the limited aggregate fractions used (i.e. two aggregates and one filler), the ability to influence the grading was restricted.

The production and placement trial identified some issues with this product, especially regarding the minimum practical layer thickness. This was even more apparent when a night field placement of this asphalt was undertaken during February/March 2010, which involved a nominal one hour cartage from the asphalt plant and the ambient temperature was uncharacteristically cool. With this type of mix, placing it below a nominal 20mm (and this should really be increased to a minimum 25mm) resulted in some tearing of the mat, compaction issues and texture issues with hand work. The addition of a warm mix additive to increase the workability of this asphalt gave minimal benefit.

The limitations of this type of mix i.e. the 7mm mix design were quickly identified. The "GripPhalt" branding would not apply to this particular mix design as it does not meet the placement attributes as the 10mm mix design – it would be referred to as a "7mm thin highly textured asphalt surfacing" or "7mm THTAS". Further work is required to improve the 7mm mix design if it is to become a viable product that will meet the placement and performance characteristics demanded of such a product.

Photos from the various sites where 10mm GripPhalt and the 7mm THTAS have been placed are included in Appendix 2.

Successes, Pitfalls and Recommendations: The 10mm GripPhalt products placed to date continue to perform. Some minor reduction (<0.1mm) in surface texture in the wheel paths has occurred. No deformation has been observed but none would be expected in the pavements

where these works have been undertaken due to limited heavy vehicles movements and no stop-start traffic. Some minor ravelling was observed at one intersection on the South Maroota work – most likely due to the skidding nature of trailers around the acute bend. The 10mm GripPhalt has shown to perform to the intent of Specification RPB125.

These types of thin asphalts i.e. gap graded mastic asphalts, have limitations as to layer thicknesses and the amount of hand work they can tolerate. It is recommended that hand work be kept to a minimum and in fillets and fill in areas where considerable hand work is required, consideration should be given to using a dense graded asphalt (for both aesthetic and potential performance reasons).

Some of the pavement where the 7mm asphalt was placed is showing some fatigue cracking and other damage typical of a pavement lacking in strength. The cause of the failure is unknown i.e. whether an existing problem or the thin surfacing has allowed moisture to enter the pavement (as the same type of failure was observed in sections of the pavement where work was not undertaken).

It is evident that the mix design can not follow a recipe-type approach. The design must be undertaken taking into consideration the properties (grading, shape, etc) of the local materials. The key is to design the asphalt with low voids and ensure that the asphalt can be placed (and compacted) to achieve the desired properties.

The main recommendation with these types of thin surfacings is that the pavement must be sound as even an asphalt with good fatigue properties will not perform on a pavement with excessive deflection. The pavement should also have an asphalt intermediate or base layer as these types of mixes should not be placed directly on a granular base. Where such conditions exist, a more appropriate surface treatment rather than a thin highly textured asphalt surfacing should be considered.

GripPhalt and other types of thin highly textured asphalt surfacings are a viable solution to some pavement maintenance requirements but they are not a miracle fix.

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Appendix 1: Table RPB125.1

Property	Test Method	Limits
Air voids in laboratory compacted samples (% voids in total volume of mix) #	AS 2891.5 (refer Clause 4.3.1), AS 2891.7.3, AS 2891.8, AS 2891.9.2	≥ 3.0 and ≤ 5.0
Marshall Stability (kN)	AS 2891.5 (refer Clause 4.3.1)	≥ 8
Marshall Flow (mm)	AS 2891.5 (refer Clause 4.3.1)	≥ 2 and ≤ 4
Rut resistance by wheel tracking test (mm rut depth)	AG:PT/T231	≤ 2
Cracking resistance by beam fatigue test (cycles to failure condition at standard reference test conditions)	AG:PT/T233	≥ 8,000,000
Permeability of laboratory compacted plant sample (µm/s)	RTA T655	≤ 10
Note #: Specimens prepared for determination of air voids in laboratory compacted samples must be prepared in accordance with AS 2891.5 with 75 blows of Marshall compaction.		

Appendix 2: Photos of GripPhalt projects.

10mm GripPhalt – Wisemans Ferry Rd, South Maroota, NSW.

10mm GripPhalt – Wisemans Ferry Rd, South Maroota, NSW.

10mm GripPhalt – Kings Highway, Nelligen NSW.

10mm GripPhalt – Princes Highway, Lake Conjola, NSW.

10mm GripPhalt surface texture – Kings Highway, Nelligen, NSW.

7mm THTAS surface texture – Hawkesbury Rd, North Springwood, NSW.