Performance-based contracts for asphalt surfacings – a contractors experience v7

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Summary

- Queensland Metropolitan Region investigating innovative asphalt surfacings
- Performance based specification and project documents developed
- Two projects for thin asphalt overlays undertaken – one project detailed
- Boral thin asphalt surfacing project using SMA-type mix on Stafford Road, Brisbane
- Learnings on risks, treatment selection, proprietary products and performance assessment

1. Introduction

Increasing demands are being placed on asphalt surfacings to meet higher levels of performance with regard to their functional properties. These properties can range from providing skid resistance to noise attenuation to waterproofing the existing substrate. Often the desired surfacing characteristics required to achieve these properties can result in conflicting performance objectives. As an example the surfacing design needs to optimise balancing texture depth with permeability to ensure satisfactory performance during its expected service life. However under existing contractual arrangements the contractor does not carry any responsibility beyond the completion of the contract maintenance period for the performance of the surfacing with all the responsibility for the performance reverting to the client.

A new form of contracting is required which would necessitate a change from the existing specification system to allow the Road Asset owner an opportunity to pass more responsibility onto the contractor to design and construct functional asphalt surfacings with an extended performance warrantee period. Under such a performance based contracting system quality would need to be built into the system as the contractor carried more technical and financial risk. This system also encourages innovation and ensures best value engineering as the contract is not awarded on the lowest cost basis. It is important that the Road Asset owner identifies the key functional properties and specifies realistic performance properties that are achievable over time. In the case of thin asphalt surfacings five years would be considered as a reasonable time period to expect function performance to be maintained. Consideration also needs to be given as how to manage changes to the environmental conditions over time and the effect that variables such as traffic and climate will have on the performance of the surfacing.

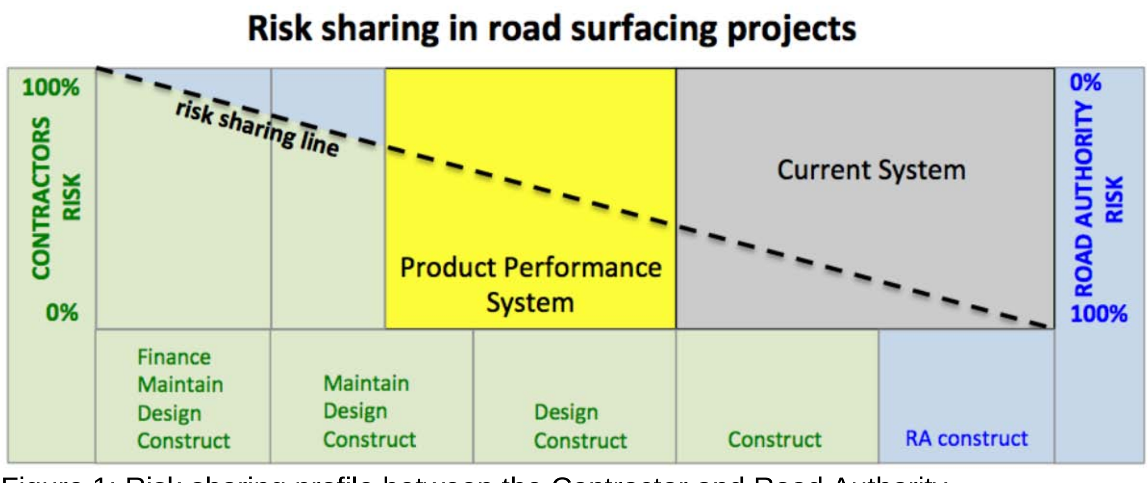

Figure 1: Risk sharing profile between the Contractor and Road Authority

In October 2009 Queensland Department of Transport and Main Roads (QDTMR) introduced a new form of procurement with the issuing of a new specification MRSS10D for the provision of thin asphalt surfacing for executing programmed road maintenance on their network. To this end the Metropolitan Region of QDTMR awarded two contracts in 2010 for the overlaying of Stafford and Stamford roads in the Brisbane area. This paper will report on the execution by Boral Asphalt of the Stafford Road contract.

2. Performance specification criteria and tender requirements

The introduction of performance based contracting meant a departure from the existing procurement system used by QDTMR. The RTA had previously introduced the first formal performance tender specification in Australia when they published a draft QA Maintenance Specification RPB125: Thin High Textured Asphalt Surfacing (draft) in 2007.

The MRSS10D specification provided for the provision of four types of thin asphalt surfacings which are shown in table 1.

Classification	Description	Layer thickness
Type A	Ultra Thin Open Graded	< 20 mm
Type B1	Free draining SMA	20 – 30 mm
Type B2	Low permeability SMA	30 – 40 mm
Type C	Open graded asphalt	------

Table 1: Classification of thin asphalt surfacings types for MRSS10D performance specifications

The specification contained minimum requirements which had to be met through the asphalt mix design testing. These where durability, rut resistance, fatigue life and permeability. A summary of the surfacing mix design requirements are shown in table 2. No criteria or limits were specified for air voids and particle size distribution of the mix.

Property	Type A	Type B1	Type B2	Type C
Bond coat (l/m², min)	nominated	1.8 including SAMI	0.2	1.8 including SAMI
Compaction standard (CS)	Process controlled	< 5% below contractor's max CS as nominated by the contractor	As nominated by the contractor	Process controlled
Permeability (µm/s)	100 min	100 min	15 max	100 min
Binder volume (%, min)	10	13	14	9
Fatigue life @ 600 µ strain, min	NA	>1 million cycles	>1 million cycles	NA
Rut depth (mm, max)	NA	2.0	2.0	NA
Abrasion loss (%, max)	15			
Binder drainage (%, max)	0.3			

Table 2: Performance mix design requirements

In developing suitable criteria consideration needed to be given to what performance measures should be used and at what periods should these measurements be made. Under current standard contract arrangements the contractor is only responsible for defects for the first three months after completion of the construction. The new contract required ongoing assessments be made during the two year maintenance period being; at completion, after three months and again after an extended two years defects liability period. The assessments would focus on the following performance characteristics:

- Visual defects
- Deviation from straight edge
- Surface evenness (at completion only)
- Surface texture depth

The tender also required the contractor to make an assessment of the pavement conditions and to carry out necessary remedial work to ensure a surfacing with a performance design life greater than 15 years under heavy traffic. According to AUSTROADS Guide to Selection & Design of Asphalt Mixes, heavy traffic is defined as:

• 5×10^6 to 2×10^7 or 500 commercial vehicles/lane/day generally travelling at >25km/h; or

• 5×10^5 to 5×10^6 or 100 to 500 commercial vehicles/lane/day involving stop/start, in climbing lanes or generally travelling at ≤25km/ h.

This required the contractor to either engage the services of or acquire in-house engineering skills to conduct such assessments which are not necessary part of his existing human resources capabilities.

The contractor may be required to quantify his offer on a square meter rate basis as opposed to a tonnage rate. This way the contractor has to take the risk on the actual quantity of materials required to execute the works and the scope of pre-treatment works required to ensure the long term performance of the surfacing.

The specification was issued with the tenderer having to provide further details on the following requirements:

- Performance history of the asphalt surfacing product
- Quality assurance plan
    - Quarry Assessment Certificate
    - PAFV test report
    - Surface texture report
    - Wheel tracking report
    - Fatigue life report
    - Permeability test report
    - Scrim test report
    - Case Study SM10

3. Project details

The Metropolitan Region of QDTMR advertised two tenders, one for the overlay of 3.6 km of Stamford Road and the other 1km of Stafford Road using a type B2 asphalt surfacing. Boral tendered for both the performance contracts but was only awarded the Stafford Road contract.

The works area in Stafford Road was a dual carriageway with two lanes in each direction with no median. Stafford Road carries 10,000 vehicles per day in each direction with an estimated 10% being heavy vehicles. The slow lanes are used for parking vehicles during off peak hours and as bus stops. This section of the road works has two intersections which showed signs of localised failures including rutting, crocodile cracking and shoving.

3.1 Existing pavement condition

The client provided falling weight deflectomer data and NAASRA ride counts on the existing pavement. Figure 2 shows that the NASSRA ride counts are acceptable when compared against Austroads Table B.1 and rutting is also acceptable compared to Table B.2 given the pavements age.

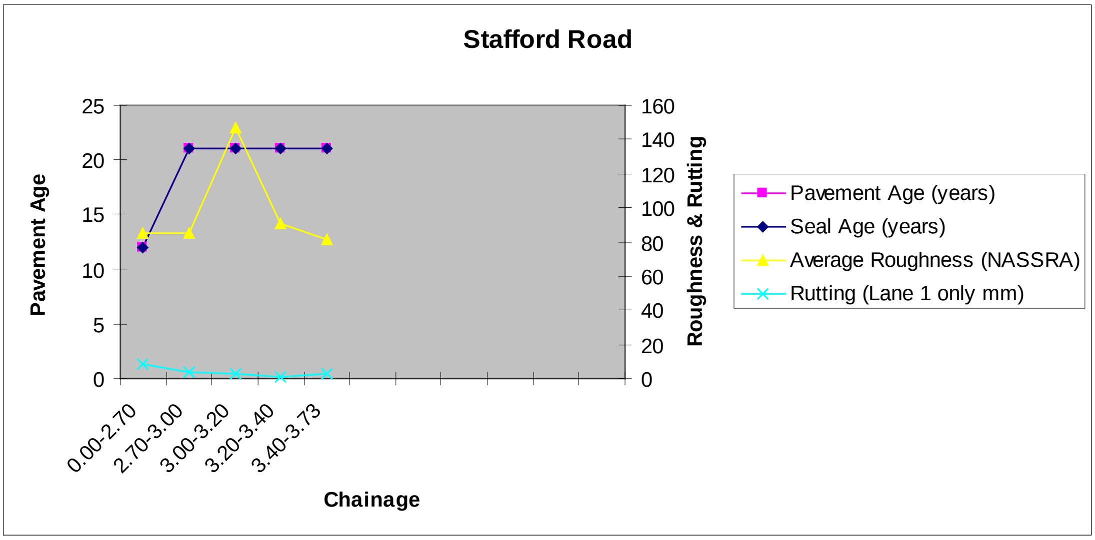

Figure 2: Comparison of roughness and rutting

The deflections provided by QDTMR where less than the 0.85mm value which is provided in Table E.5 of Austroads Part 5 for an assumed design traffic loading of 12 million DESA.

No prior information was supplied relating to the previous pavement design and nor was any information supplied on the construction or previous maintenance methods or materials used.

The existing pavement was generally in a poor condition and exhibited a variety of failure modes including surface cracks. The cross section gradient ranged from 3 to 8% with the steeper gradient being in the slow lane adjacent to the kerb and channel. The fast lane showed evidence of rutting up to 20 mm in both directions for the majority of the works. These defects would all require repair prior to overlaying.

Figure 3: Photographs of existing pavement conditions

Potential problems were also identified at the eastern end of the works which were caused by leaking underground water mains and have thus been excluded from the warranty.

4. Risk assessment

4.1 Extent and scope of pre-treatment requirements

As no ‘as built’ data or pavement design information was supplied it was difficult to assess the possible causes for the existing distress observed in the pavement. Given the existing pavement condition Boral proposed extensive pretreatments be carried out prior to overlaying. The services of an engineering consultant was engaged to review the proposed pavement pretreatment.

4.2 Surfacing selection and mix design

The decision was made to use a proprietary product called DuraPave based on the experience gained in New South Wales with the development of a high performance surfacing to meet the requirements of the RTA Specification RPB125 for thin high textured asphalt surfacings. This required a new mix design utilising local aggregates and new polymer modified binder not used by Boral in Queensland. Laboratory mix designs were done to ensure the mix performance properties were achieved and a plant trial was carried out to measure compliance with the field requirements.

4.3 Quantifying risk

Given that this was the first time that Boral was pricing a tender in Queensland which had an extended defects liability period longer than the current three months, careful consideration had to be given to how to qualify and price the risk against the surfacing not performing in the longer term. The main concern was the uncertainty of the existing pavement foundation conditions and how this would impact on the longer term performance of the surfacing. Whilst it was critical to ensure adequate measures were taken it was necessary to do so without over pricing the extent of the remedial works which could jeopardise Boral’s tender bid.

4.4 Additional controls

With this type of contract it was important that the Contractor review his controls for the manufacture and paving of the asphalt to ensure the long term performance would not be compromised in any way. To this end additional controls were identified and resources were allocated to ensure proper execution took place. A philosophy of building in quality to the process was considered essential to ensure successful execution.

5. Contract execution

5.1 Pretreatment

50mm and 100mm deep patches were carried out to repair the existing pavement as identified from the preconstruction walk over that was carried out in the presence of the client’s representative. Bitak stress absorbing fabric strips were placed over:

- minor cracks which were not removed and patched
- cracks at the bottom of excavated areas.

Full width profiling was undertaken to remove the rutted asphalt and improve the cross fall shape.

The entire pavement was sealed with a SAMI seal to help waterproof and prevent reflection cracking. The binder was S4.5S applied at 1.7 l/m^2 and the 10mm aggregate was applied at a spread rate of 145 m^2/m^3. Boral proposed to overlay the pavement with a 35mm thick 10mm nominal maximum aggregate size proprietary asphalt product called DuraPave.

5.2 Construction of the DuraPave

The preparation of the pavement commenced in November and the construction was completed in December. All the work was carried out at night to accommodate and avoid traffic disruptions. The SAMI seal was placed prior to the paving of the DuraPave in the same shift.

The DuraPave surfacing was gritted on completion of the works using a minus 2mm aggregate to improve the skid resistance of the surfacing by removing the excess binder under traffic.

Figure 4 : Photograph of the Durapave 10 mix with grit

6 Performance assessment and outcomes

6.1 Mix performance

A laboratory assessment was carried out on the mix and tested against the specifications requirements. The results are shown in table 3.

Property	Specification	Actual
Compaction standard	> 93% CV	92.6 – 94.4%CV
Permeability (µm/s)	15 max	10 – 29
Binder volume (%, min)	14	12.9 - 14
Fatigue life @ 600 µ strain, min	>1 million cycles	2.1 million cycles
Rut depth (mm, max)	2.0	1.7
Abrasion loss (%, max)	15	passed
Binder drainage (%, max)	0.3	passed

Table 3: Mix performance measurements

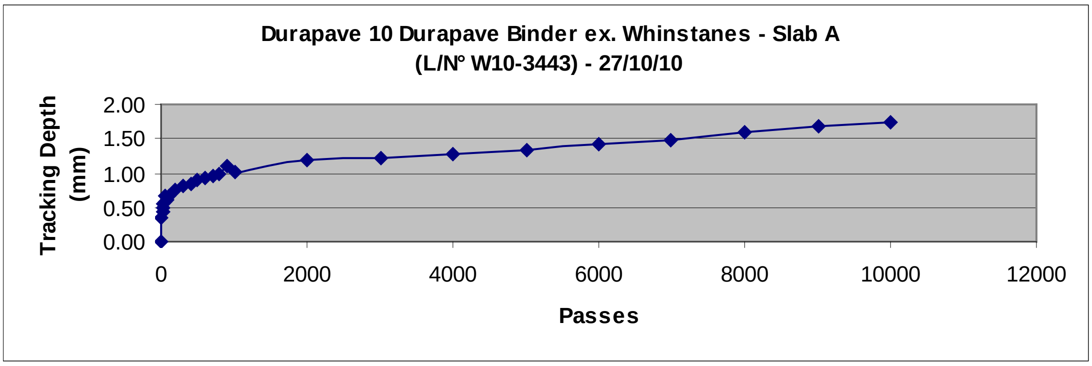

Figure 5: Wheel tracking performance of DuraPave 10 mm

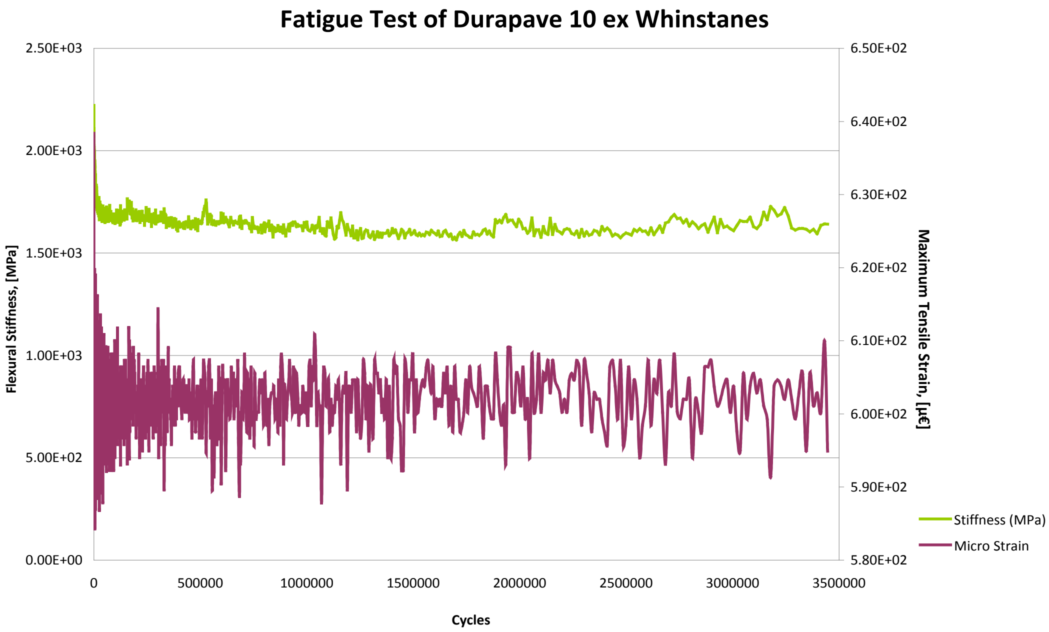

Figure 6: Fatigue life testing at 600 microstrain

6.2 In-situ performance

A performance assessment was made upon the completion to measure the functional properties of DuraPave surfacing against the required criteria as listed in Table 4.

Criteria	On completion	+ 3 months	+ 2 years
Visual assessment	No signs of flushing, shoving or cracking of the asphalt surface		
Deviation from a straight edge			
Surface evenness	< 60% + 5 units improvement	N/A	N/A
Layer thickness limits	30 – 40 mm	N/A	N/A
Surface texture depth	0.7 mm	0.6	0.6

Table 4: In-situ performance criteria

6.2.1 Visual assessment

Based on a walkover (at the +3 months inspection) minor localised flushing had occurred at areas of heavy braking and intersections which do not represent the general mix characteristics.

6.2.2 Straight edge results

The cross fall of the surfacing was measured at 20 m intervals along the length of the entire works meeting specification requirements.

6.2.3 Road roughness results

The specification requirement was Rs = Rp x 0.6 + 5 for lot sizes with a minimum length of 100m and a maximum length of 500 m.

Lot #	Rp	Rs	Actual
Eastbound inner lane			
1	112	72	69
2	79	53	42
Eastbound outer lane			
1	147	93	72
2	106	68	57
Westbound inner lane			
1	101	66	52
2	104	67	53
Westbound outer lane			
1	127	81	66
2	119	76	69

Table 5: Roughness measurements after completion

All the measurements obtained exceeded the specification requirements for surface evenness.

6.2.4 Surface texture

Number of measurements	Lowest value	Highest vale	Mean value	Standard deviation
After construction				
177	0.7 mm	1.3 mm	0.9 mm	--

Table 6: Surface texture depth measurements after construction

All the surface measurements were above the minimum texture depth requirement of 0.7 mm after completion and before gritting.

Figure 7: Photograph of DuraPave after construction

7. Key learnings

7.1 Asphalt production and quality control

Strict quality control is critical to ensure that the properties of the asphalt surfacing product are compliant. This requires regular and close monitoring of the incoming raw materials properties and mix proportions as minor variations have a noticeable impact on the functional properties of the final surfacing. The key components which require monitoring are:

- Aggregates - grading and moisture content. Variations in the moisture resulted in problems in controlling mix temperature.
- Binder content - a slight variation of 0.1% in binder resulted in some fatty areas
- Fibre – accurate input control
- Asphalt – mix output temperature

It is important to ensure that there is good communication between the laboratory testers and asphalt plant operators so that they check for variations in the key components and report back.

7.2 Transporting of mix

It is important to ensure that there are sufficient tippers available to maintain a continuous supply of asphalt to the paver to prevent multiple stop/starts. Unfortunately this was not always achieved on this project. Heavy tarpaulins are necessary to minimise temperature losses in the mix during transport.

7.3 Treatment and road preparation

Extensive preparation of the existing pavement was required prior to overlaying to provide a suitable surface. This included profiling up to 60mm of the existing pavement to improve the road shape and to ensure a minimum and consistent wearing course thickness.

7.4 Asphalt paving

A materials transfer device was used to ensure a uniform temperature across the matt after paving. It is also important to ensure a uniform thickness to achieve consistent compaction density in the matt. However varying thicknesses did result due to the varying profile of the road.

7.5 Asphalt compaction

Two steel wheeled vibratory rollers were used in tandem to compact the newly placed wearing course. Care had to be taken to not over compact the matt as this could lead to reducing the surface texture. Generally 12 passes were applied with a further 3 to 4 back passes. A third roller was used for back rolling and spreading the grit. A nuclear density gauge was used to measure density prior to gritting. The density results increased by 4% following the application of grit.

7.6 Field testing

A minimum of two field testers are required due to the extent of the measurements despite this being a relative small sized job. It is important that the field testing is completed at the end of each shift to allow adjustments to be made and potentially reduce the amount of testing required.

7.7 Balancing mix properties

The conflicting requirements of impermeability and texture depth required careful balancing of the volumetric properties and binder content. The variable road surface shape and limited correction impacted on the balance required during production of the mix.

7.8 Tender and Contract documentation

The road authority and contractors use of performance based contracts and the specification requirements has been strengthened through these projects. This will allow for improvements in specification interpretation, streamlining of future contract evaluation and improved performance reporting of locally applied asphalt surfacings.

8. Summary and conclusions

Performance contracts provide Road Authorities with an ideal opportunity to encourage innovation by allowing contractors to develop proprietary asphalt surfacing products. Contractors are required to invest more resources into finding ways to improve the performance of their products rather than seeking measures to reduce costs to win contract. Road Authorities have to specify achievable outcomes to encourage Contractors to participate in this form of contracting. Contractors need to develop and invest in resources to enable them to develop proprietary high performance surfacing products to ensure performance against the criteria.

Performance specifications presents a set of new risks to the contractor and the Road Authority must avoid passing unquantifiable risks onto the contractor for which he is unable to mitigate against. In the case of Stafford Road the existing pavement condition provided for more detailed assessment which is generally beyond the capability of the contractor. Ideally a sounder pavement should be sort which was requiring its first routine overlay. Similarly more information should be supplied on the pavement design, as built data and maintenance records. This would also reduce the time and resources required to investigate and quantify the remediation required for the tender submission.

All the requirements where met for both the mix and surface criteria. The texture depth values were lower than expected but it is anticipated that the skid resistance should improve as the binder wears off the surface aggregate over time or is re-established during maintenance prior to handover.

9. Acknowledgements

The authors of this paper would like to acknowledge the efforts of the staff at Whinstanes in executing this contract and the support of QDTMR in taking the initiative to introduce performance contract for constructing thin asphalt surfacings in Queensland.

10. References

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5. Boral Asphalt DuraPave brochure www.boral.com.au/asphalt