Managing Surface Friction in Queensland – and Industry Response

Authors:
Robert Vos – Queensland Executive, AAPA
Justin Weligamage – Manager (Road Asset Strategy), Queensland Department of Transport and Main Roads

Summary

- Skid resistance management and provision subjected to public and media scrutiny
- Industry embarked on projects with national team including ARRB, SRA's
- Three key areas:
    1. Surface Friction measurement device & testing protocol for use in court
    2. Evaluation of Qld TMR skid resistance data to identify management & budget implications
    3. Site specific assessments of materials and surface friction over time
- Feedback on achievements and outcomes of products and management

Synopsis

Skid resistance requirements of road surfaces have long been met through the selection and specification of appropriate road surfacing products. Skid resistance of the road surface is expected to decrease with time due to wear and skid resistance is known to be affected by contamination of the road surface, wet weather and seasonal influences on the measurement. As traffic volumes and road user driving speed increases so does the skid demand changing the risk profile of the road.

AAPA Queensland members have been confronted with a rapidly escalating need for their products to meet previously not measured skid resistance values and have had limited access to long term skid resistance measurements from the road authority. Agreement on the standard skid test measurement device has taken some time as has the finalisation of the aggregate friction properties and final texture depth requirements.

The industry has collected limited skid resistance data generally during the contract defects liability period although the quantity of information has grown on the performance based projects using proprietary products.

On the longer term improved understanding of how skid resistance can be improved is necessary as is the sharing of information on longer term performance between the road authority and industry.

1. BACKGROUND

1.1 Queensland sprayed seals and asphalt industry skid resistance interests awoken

In 2005 the accidents on the Bruce Highway near Federal, and the Troutbeck, Kennedy report [(1)] that followed, highlighted skid resistance and road surfacing selection for skid resistance as responsibility for the roads authority and indirectly the supplier of road surfacing products. The recommendations were numerous and, from the road surfacing industry, required a system to provide products that would meet at skid resistance specification for a period of at least 24 months. The report also envisaged the creation of a HAPAS type system for the certification of performance products.

This raised numerous issues for commercial management in the road surfacing companies ranging from lack of knowledge about skid resistance of their products over time, Queensland government's co-joining companies in civil action involving road surfaces and the member's limited control over asphalt and sprayed seal product specifications and their component materials.

Recommendation 22.

It is recommended that the Department of Main Roads consider a 24-month warranty period for skid resistance performance and surface condition in addition to a 12-month warranty against adverse rutting and other characteristics.

Figure 1:Troutbeck & Kennedy Report – Review of SMA surfacings – Recommendation 22 (1)

1.2 General need for policy and information

It was clear that accidents had occurred and there was concern as to the potential lack of adequate surface friction. Expert third party investigations were held which highlighted a wide range of contributory factors. They included incorrect selection/usage of the products or geometric limitations, such as in Federal or through to contaminants on the surface, such as in Sippy Downs.

It was clear that a systemised approach was required to address the provision of skid resistance and a QTMR Skid Resistance Management Plan was published in 2006. This provided a framework for operation but also highlighted the need for improved management and measurement of skid resistance properties across the network and the identification of project level interventions.

Early management issues included the range of test equipment available and the lack of solid correlation. The test equipment used varied across road authorities in Australia with limited correlation in Queensland for the available skid resistance measurement devices SCRIM, ROAR Norsemeter, British Pendulum Tester and Grip Tester. Further, the Queensland Police Services (QPS) crash investigation equipment made use of the Vericom device (Accelerometer) which has no direct correlation to the road authority's network or project level test equipment.

Another complication in assessing skid resistance was the change in each of the surfacing types skid resistance over time, varying traffic impacts or the significance of high speeds, and the results were further distorted by seasonal and road surface temperature effects.

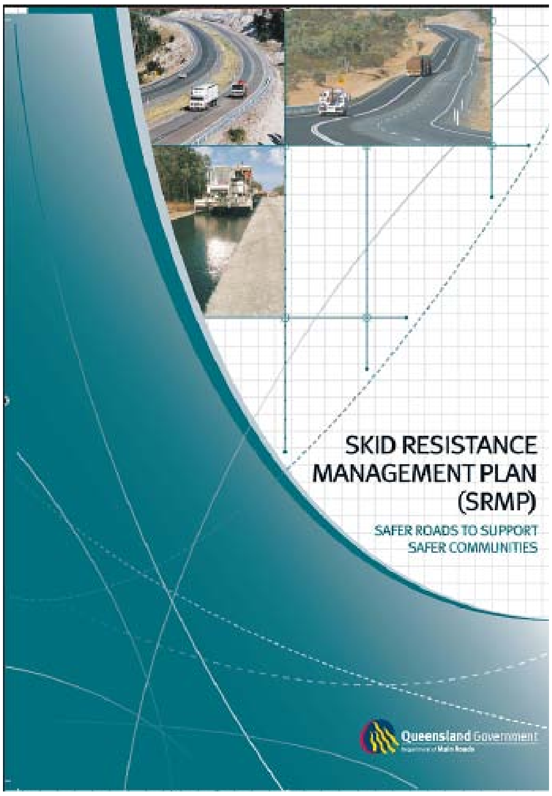


Figure 2 : QTMR Skid Resistance Management Plan

Whilst limited measurement or data was available the need for skid resistance reporting was elevated in the press and court actions presenting a commercial threat to industry which had not previously existed to the same extent.

1.3 Context of Queensland specification setting and purchase of road surfacing products

The Queensland Department of Transport and Main Roads (QTMR) purchases its road surfacing materials on standard product based generic specifications developed in house, with the material purchased on tender at the lowest price. These include Heavy Duty Asphalt, Dense Graded Asphalt, Open Graded Asphalt, Fine Gap Graded Asphalt, Stone Mastic Asphalt (supplementary specification) and Sprayed Bituminous Seals and the specifications tightly define what is required with approvals for use authorised by the Department.

This leaves little room for change or compensation for industry to embark on improved, better than specified properties as the development costs are not rewarded.

Generally this means that the road authority adds or changes specification parameters with the industry gearing to meet the added or changed requirements. In the case of skid resistance the situation has been complicated by the lack of a standardised skid resistance test across the Australian jurisdictions and the lack of skid resistance performance history from the Queensland road authority.

Under normal circumstances any specification change would result from sharing performance data with the providers for the products leading to a common understanding of the basis used to establish the norm or benchmark setting. A review of the information would also permit understanding of the range of performance as well as the potential for improvements not obvious in the existing specifications. To date this has only been undertaken on a limited basis and not in a coordinated manner across the industry.

Setting specifications for skid resistance in bituminous products also requires test methods and standardised test equipment. Ideally, for the specification values adopted there should be available data linked to local materials / products. For both test method and result there should be a time series of information, linked to usage, which would allow for reasonable prediction of performance.

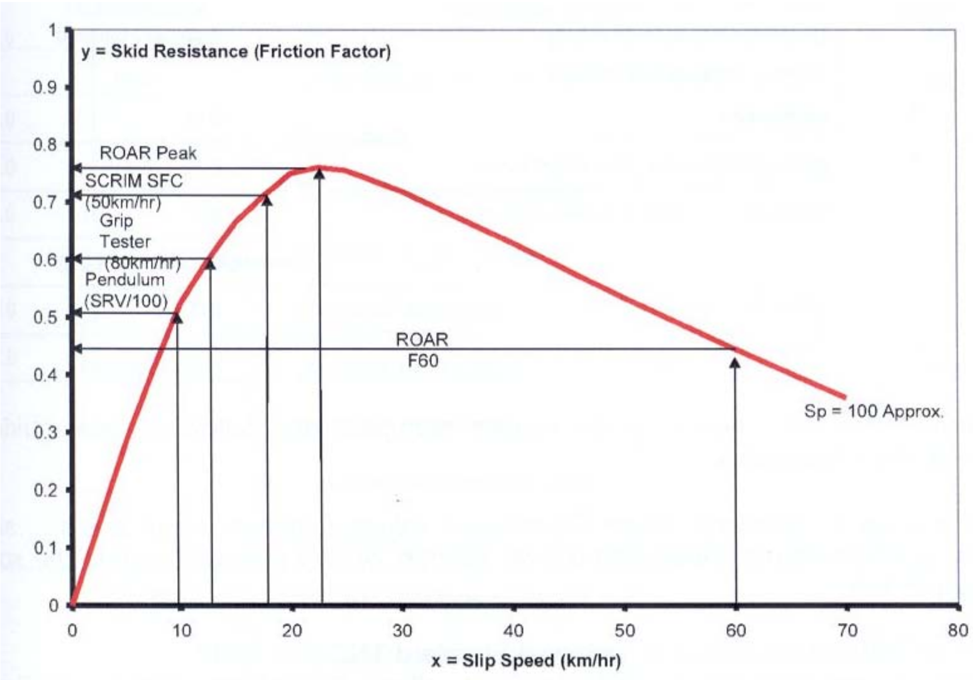


Figure 3: Slip speed and speed number for the various skid test measurement devices (Ed Baran, TMR)(2)

The choice of standard skid measurement tool for network level analysis in Queensland is not clear to industry as historical data and Queensland equipment has been the Norsemeter ROAR with results reported as F60 values. Whilst this could be considered advanced as it is the basis of the recently developed International Friction Index (IFI), there is only limited information available to evaluate and compare road surfacing products to F60 to SCRIM SF values in other road authorities in Australia. Recently QTMR considered the adoption of the SCRIM device with results reported as SF which should simplify the correlation but reduces the usability of previous ROAR data for project level evaluations. The inclusion of texture depth measurements would allow for correlation to IFI values, the robustness of this “back calculation” is unclear for Queensland conditions.

2. INDUSTRY DEVELOPMENTS

2.1 Drivers for the commercial supply of road surface friction

The change in expectations of road surfacing products to ensure adequate short and long term skid resistance and to include that as a specification requirement with consequent shared responsibility for accident claims arising from inadequate skid resistance was considered a massive imposition and risk to road surfacing suppliers.

Not only was there limited ability for surfacing suppliers to improve products but there was also the lack of short term performance experience and no long term product performance data. Further the lack of agreement of test device result correlation and the fact that the QPS used a "non-standard" device / test method made the measurement and performance evaluation difficult to address.

The Queensland Government commenced co-joining AAPA members as the road surfacing suppliers when skid resistance was cited as a possible cause of an accident. This has a massive impact on the operations of road surfacing suppliers as the issue was taken to a higher management level where actions are constrained by legal avenues and not by the normal engineering response.

AAPA members in Queensland "work shopped" the issue with advisers from ARRB & skid resistance consultants to develop an approach to address the changed environment.

2.2 Changed environment arising for road surfacing suppliers

Apart from the lack of agreed test device and lack of historical information of skid resistance on current surfacing products, criteria were being included in contracts to provide short term skid resistance for 12 month and some 24 month after construction. The Troutbeck Kennedy 24 month performance warrantee was also seen as a possible intervention. Performance based contracts were being let as trials by the Metropolitan region which were expected to extend into other Regions. Skid resistance was seen as a long term performance parameter which would impact on the acceptability of the road surfacing product over time.

3. FEEDBACK ON INDUSTRY ACTIONS AND OUTCOMES

In an attempt to address the perceived issues arising from the increased attention on skid resistance it was agreed to address the "work shopped" position of AAPA Queensland members as follows:

- 3.1 Would not engage in large scale data collection until test equipment was standardised or local correlations between equipment agreed.
- 3.2 A project was to be commenced with QTMR / ARRB which supported the use of the Vericom as a device to measure specific location coefficient of friction linked to the QPS for potential prosecution against unsafe or not fit-for-purpose products.
- 3.3 Support was to be sought from QTMR for a network level assessment of the industry's products to evaluate their relative ability to provide skid resistance over time.
- 3.4 On the short term to participate with QTMR Road Asset Management (RAM) to evaluate specific products used on ramps in SEQ to determine if there were relatively high and relatively low performance over time.
- 3.5 To continue participation in Performance Based Contracts for the further development of proprietary products with improved skid resistance properties.
- 3.6 AAPA Members to individually collect project level skid resistance information on their works to generate local product performance details.
- 3.7 Skid resistance parameters and surfacing product material properties to be specified by the road authority until scientifically derived local data exists to change the specification requirements.

3.8 Promote maintenance interventions to improve skid resistance

3.1 Industry large scale / long term data collection

The change to the SCRIM as standard skid resistance test device has simplified the data correlation across Australia but the availability and cost of the test equipment will reduce the amount of data collected at project level. Performance reporting over time will have to rely on data provided by the State Road Authority. Due to the lack of ready access to this information and the tendency by State Road Authorities to not make it public will act as a barrier.

Members have test equipment used in the evaluation of skid resistance performance at airports; the Grip Tester is a pretty standard device for this purpose. If these results were accepted, or a correlation test system was established, greater testing and results management would be worthwhile. Currently this would provide project and performance based product benefits in data collection. Information is collected on the PAFV for surfacing aggregates and coarse aggregate in asphalt and texture depth is measured at reported at project level.

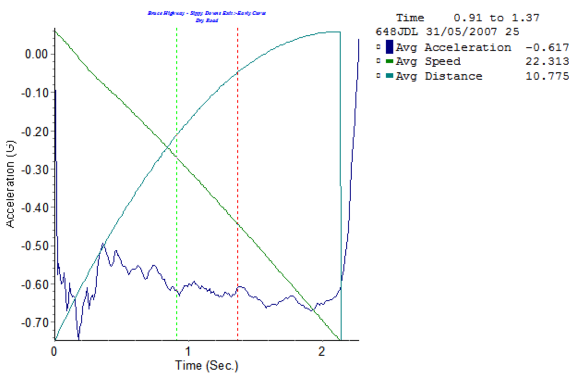
AAPA members are involved in long term pavement maintenance projects in Western Australia and in New Zealand with skid resistance and texture depth as some of the required performance measures. Information gathered to date has largely been to trigger intervention or to address localised defects / inadequacies. The use of the results to identify better performing materials or systems has been limited.

3.2 Vericom test method and use

A QTMR project was supported where ARRB evaluated the Vericom as a measurement device, to determine suitable boundary condition to its use (vehicle type, loads, tyres used etc . .) and to formalise a test method for use in Australia. This has progressed to a "tentative" or draft test method which is currently in the evaluation phase within QPS and QTMR. A number of Vericom test devices have been deployed in Queensland.

Instrument Set Up in Vehicle (Dual axis bubble levels)

Early Curve (Dry)



Vericom test device and output – David Tulloch, QTMR/QPS

Future action includes an evaluation of the effect of different the vehicles used.

3.3 QTMR feedback on network level assessment of industry products

Through the Strategic Alliance Board and Management, QTMR continues to be encouraged to systemise their skid resistance data collection and reporting, and then making this information available to the road surfacing industry.

A few of the Regions share their product specific skid resistance measurements with AAPA members providing the products, but this is currently undertaken on an ad hoc basis with limited availability to build into a coordinated reporting system linked to asphalt or sprayed seal specifications or materials used. This area could benefit from a shared approach to collection and sharing of skid resistance data.

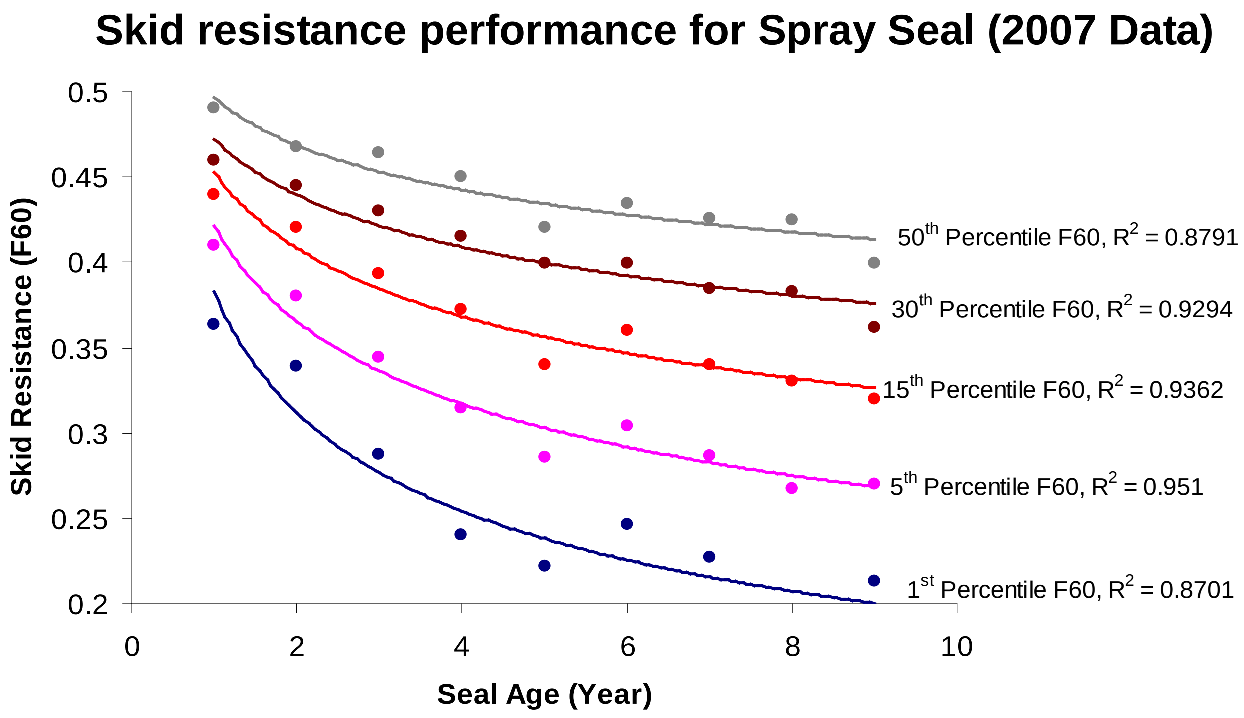


Figure 4: Skid resistance performance for spray seal based on 2007 data

Work has been undertaken with some funding support by AAPA to analyse network level skid resistance data against sprayed seals. The work [(2), (3)] provides a probabilistic analysis for performance modelling of ROAR based F60 data for seals and skid resistance profiles for the Queensland network. Whilst of value for sprayed seals, the analysis of asphalt products remains open for more work.

3.4 Short term analysis of SEQ ramps linked to local products

In an attempt to promote a standardised reporting system and gather available performance data on skid resistance a project was undertaken with QTMR RAM. The focus was on skid resistance measurements on 238 ramps in South East Queensland (SEQ) which were analysed for the need for early intervention to promote surface friction. The skid resistance data along the ramps reflects the variable wear imposed by braking and turning vehicles which is further impacted by the speed limits, geometrics and radius of the corners. Some of the pavement surfaces had been in place for 20 years or more indicating good service under the conditions imposed.

Materials used included, dense grades asphalt, stone mastic asphalt, open graded asphalt and sprayed seals and have been assessed by source linked to material properties. It is hoped that this will provide:

1. High and low performance indicators
2. A rough approximation of generic performance caused by variations in surfacing types as a function of materials used and traffic loading / geometrics.

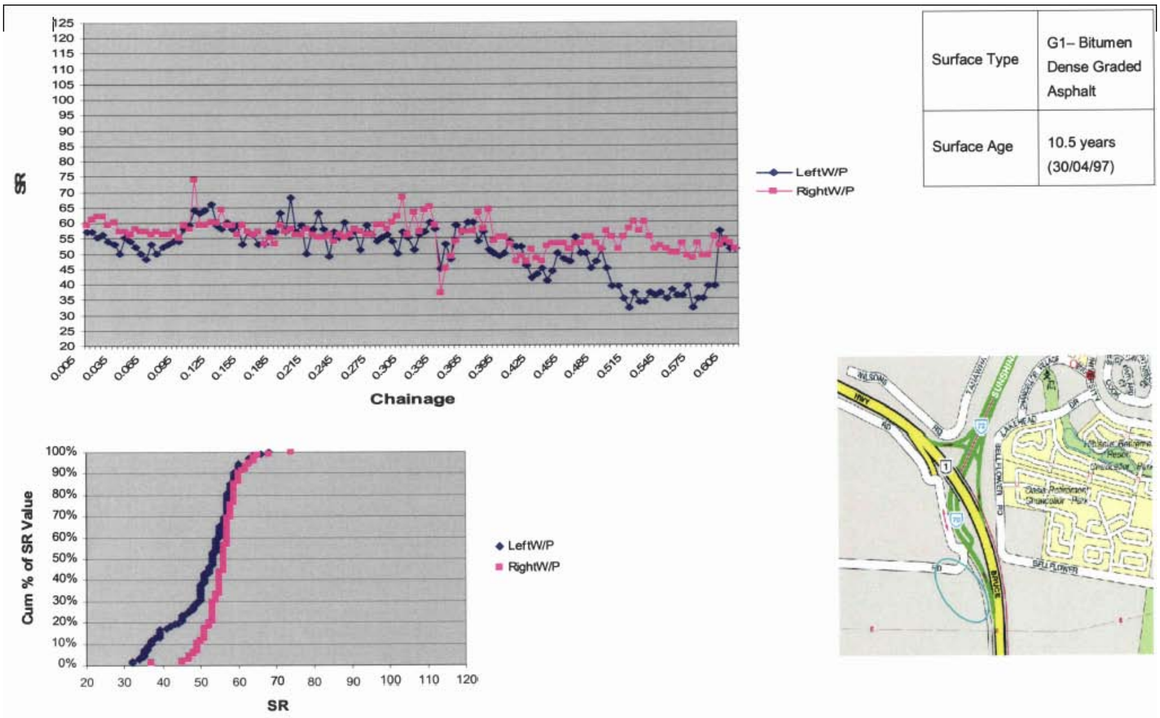


Figure 5: Typical data available for characterisation of South East Queensland surfacings

3.5 Proprietary Products

Proprietary asphalt products offer one of the better opportunities for industry managing skid resistance properties on the long term. When specified as a longer term performance property, higher PAFV and texture depth products could be used and their extra benefit versus cost assessed. When the costs of testing and evaluation is included in the contract, the data acquisition becomes considerably easier.

Recommendation 18.

It is recommended that the Department of Main Roads further develop a performance based specification for asphalt surfacings.

Figure 6: Troutbeck & Kennedy Report – Review of SMA surfacings – Recommendation (1)

Currently three products on separate projects are being evaluated in Queensland for the Metropolitan Region. Skid resistance properties will be measured over a 24 month period. Whilst a start, this is a very limited data set and would only start providing value of better than intended service after 10 years.

Another avenue for skid resistance management is in the use of franchised products which have been produced in other countries and generally have a longer timeframe of performance data. This approach has not yet been adopted in Queensland although aggregate friction values and texture depths are required in some of the franchised products.

Locally developed products have a short history 2 to 3 years with results generally recorded and reported by roads authorities but seldom directly provided to the product supplier.

3.6 Individual member data collection

Independent testing of skid resistance on public roads is complicated and it is difficult to access sites after construction. During the maintenance period it requires significant operational and organisational costs to be incurred. On major construction works AAPA members are merely subcontractors and have limited influence to support post construction skid resistance testing.

The availability of skid resistance measurement devices for short term use and the non-support of QTMR for test measurement by devices other than the approved SCRIM (and previously ROAR) has limited member driven testing.

Individual project specific data collection has been the basis of information supplied during contracts where skid resistance results were required as part of the contract with limits established for opening to traffic and for specified speed limits on the works.

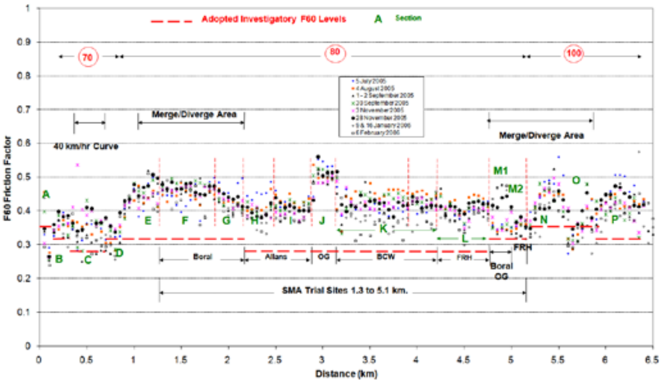


Figure 7: Comparative skid resistance data has been collected to a limited extent

This information has highlighted the lower initial skid resistance measurement on the negatively textured stone mastic asphalt which has lead to the inclusion of a light spread of sand / grit to assist in the removal of the bitumen and exposure of the micro texture of the aggregate in the tyre contact zone.

Some AAPA members own skid test equipment which could be utilised if agreement could be reached on the acceptance of their test results. Typically the Grip Tester is available from Fulton Hogan and Downer Australia who use them for skid resistance testing on their airport operations. There are over 20 Vericom units in Queensland but appear to be in limited use.

3.7 Skid Resistance, Texture Depth and performance of available products

After taking legal advice it was agreed by AAPA members that AAPA would not make recommendations proposing lower standards or specification limits than those proposed by the road authority.

This was done even though it was clear that certain proposed material properties would be expensive or logistically very difficult to supply. Industry left the material standards setting to the technical advisors of QTMR.

This was also applied to the selection of road surfacing types, the downgrading of the dense graded asphalt to an 80 km/h speed restriction even though very significant lengths of the product is in use at higher speed limits across Queensland, Australia and the rest of the world. It is expected that more reliable data collection and balanced evaluation of skid demand as a function of traffic accidents will allow this situation to be reviewed.

With time the collection of skid resistance data should lift the dependence of the surrogate Polished Aggregate Friction Value (PAFV) and texture depth to an evaluation of the product being used. This is likely to be more evident with the expansion of performance based contracts where more freedom will be available for aggregate size and production changes to be used in the thin and ultra thin surfaces.

TMR Initial Standards for Macrotexture and New Road Surfacings
Table 5.3-1 Surface Texture Depth Requirements: New Surfaces [(4)]
with possible surfacing types added

Posted Speed	Minimum Austroads Sand Patch Texture Depth [1] (Test Method AG:PT/T250) (mm)		
> 80 km/h	Seal 14mm+	1.1	SMA+, OGA, UTFC
> 60 km/h and ≤ 80 km/h	Seal 10mm+	0.4	DGA, SMA, OGA, UTFC
≤ 60 km/h	Seal	NA	DGA, SMA, OGA, UTFC
Note 1. These are minimum values; higher values could provide a longer period before an intervention is required. This is to be part of the whole-of-life assessment.			

Figure 8: TMR surface texture requirements and impact on possible surfacings

3.8 Skid resistance improvements through rehabilitation techniques

Regions in Queensland have evaluated the used of techniques to reinstate skid resistance.[(5)] In Metro there has been a comprehensive evaluation and trials of various techniques available to reinstate skid resistance through improving macro texture and in some cases micro texture of the aggregates. This information was published and includes a comparison of costs and effectiveness.

Typical examples are:

1. Water Blasting or Water cutter – ultra high pressure water removes excess bitumen reinstating the texture and so some extent the microtexture.
2. Fine milling – applicable to asphalt and concrete surfaces can provide surface texture with depths of over 1mm, reinstate aggregate micro texture and leave a smooth level surface. The ability to remove bumps has an important bonus when reinstating skid resistance in high demand areas.

Figure 9: Maintenance interventions for surface friction – Russell Lowe, TMR Metro Region: AAPA IFPC 2009 [(5)]

Used for either short term early interventions or as part of the ongoing management of surface friction, skid resistance improvement measures on asphalt surfaces and seals are cost effective and will improve the life of the investment.

4. INDUSTRY ACTION OUTCOMES

4.1 Skid resistance test device

Industry as access to a simple and available surface fiction test device (Vercom) which is used in Queensland court proceedings when surface friction is under consideration. Whilst not fully linked to network type skid resistance measuring devices it does provide adequate comparisons when reviewing the safe use of the road surface.

4.2 Network level analysis

The review of available data has provided limited opportunities to manage overall skid resistance data for the sealed network in Queensland. The limitations of the amount of data and the change in testing devices has not made this applicable to asphalt surfaces

4.3 Surfacings characterisation

Whilst promising this aspect of the project has been delayed by lack of human resources capable of undertaking the work. The potential to identify better performing surfacings remains possible and will play a role in the management of surface friction against usage.

5. OBSERVATIONS

5.1 Lack of understanding of skid resistance – principles must be understood

It is clear that with the inclusion of extra performance requirements that link to potentially vast claims by the road user against the road provider, the need for interpretation of test results and the limited funds available to achieve high levels of skid resistance across an entire road networks makes for a complex environment. New Zealand members emphasise the following lesson which has taken over ten years to address:

LESSON 1:
"Everyone involved in skid resistance must be adequately trained and educated in the principles" *Bryan Pidwerbesky – Fulton Hogan*

There is a general lack of understanding of skid resistance, the terms, the theory, the principles and the practice of measuring and managing. This has lead to expensive wrong directions in New Zealand and in Queensland. Effort should be applied to ensure those specifying and managing the network are aware of the reliability and value of skid resistance measurements and the way the road surfacing products can be modified to provide greater skid resistance. Manufacturing limits exist in all products, frequently increased performance expectations and narrower tolerance bands will result in products that no longer perform.

5.2 Skid resistance at any cost can be very expensive

In New Zealand, the drive for a high texture surface in seals lead to decreases in the binder application rate. This continued until the seals becoming permeable, water penetrating to the granular base which resulted extensive failure of the base. The remedy was the removal of the surfacing, reworking and drying of the damaged base and the resealing of the surface with higher binder contents. This resulted in a reduced skid resistance life and the resurfacing at shorter intervals to achieve the required skid resistance.

In Queensland, the desire for texture has lead to asphalt surfaces which have allowed the ingress of water. This has resulted in thermal and traffic related binder separation and failure of the SMA or underlying pavement layers where inadequate SAMI layers were used. Many kilometres of pavements have suffered this fate resulting in significant additional costs.

Figure 10: Asphalt deterioration due to the ingress of water in high texture surfaces with too little binder

Lesson 2:
"All performance requirements of surfaces must be optimised, not just maximise skid resistance properties to the exclusion of others." *Bryan Pidwerbesky – Fulton Hogan*

This caution has been endorsed by members locally and in New Zealand, drifting too far in one direction will compromise performance in another. Expensive early failures will occur.

6. CONCLUSION

Skid resistance is a functional property of the road surfacing with safe use implications for the road user. Collaboration and partnerships are necessary between road surfacing researchers, contractors and road agencies to ensure best local practice is integrated with asset management and the use of innovative techniques, systems and products. [3]

The management of any performance parameter of a specified product requires agreed and reliable test methods with specification properties that are achievable and the risk / variability understood.

To enable road surfacing product suppliers to meet the increased expectations of skid resistance, greater sharing of available skid resistance data is required and opportunities need to be provided to determine where better than predicted and worse than expected performance can be rapidly detected and learnings shared. Agreement should be reached on the suitability of alternate skid test equipment as well as the potential for regular benchmarking of equipment.

Queensland is still at the early stages of this journey and has the potential to develop industry's capability through performance based contracts and placing a monetary value on better than expected skid resistance performance.

Acknowledgments

The contribution by AAPA members is gratefully acknowledged.

Thanks to Trevor Distin -Boral, Warren Carter - Downer EDI Works, Bryan Pidwerbesky - Fulton Hogan, John Vicars - SAMI / SRS Roads and Craig Roubin – RPQ for their support.

References

1. Review of the use of Stone Mastic Asphalt (SMA) surfacings by the Queensland Department of Main Roads, R. Troutbeck, C. Kennedy, 2005
2. Skid resistance performance profiles, N. Piyatrapoomi, J. Weligamage & R. Vos, 3rd International Surface Friction Conference, Gold Coast, Australia, 2011.

3. Collaboration and partnership in managing skid resistance for TMR Queensland, J. Weligamage & N. Piyatrapoomi, 3rd International Surface Friction Conference, Gold Coast, Australia, 2011
4. Initial Standards for Macrotexture and Microtexture for New Road Surfacings – Summary Report, Version: 8 Aprl 2009, Pavements and Materials Branch, Roads & Delivery Performance Division, Engineering and Technology Group, Qld Transport and Main Roads, 2009
5. Maintenance interventions for surface friction, R. Lowe, AAPA international Flexible Pavements Conference, Gold Coast, 2009