GRITTING FOR IMPROVED EARLY LIFE SKID RESISTANCE OF STONE MASTIC ASPHALT SURFACES

Ed Baran, Queensland Department of Transport and Main Roads, Australia

Russell Lowe, Queensland Department of Transport and Main Roads, Australia

ABSTRACT

Queensland Department of Transport and Main Roads' experience with stone mastic asphalt surfaces is that they can provide a high textured, durable, rut resistant surface.

Overseas experience is that these surfaces may require up to 3 to 6 months of trafficking before their full potential skid resistance is realised. Queensland experience is that stone mastic surfaces provide good levels of skid resistance which only improve with early trafficking.

Gritting of the stone mastic surface has been found to both dramatically increase early life skid resistance and also increase the longer term skid resistance. This paper presents the results of trials carried out in Queensland, on the skid resistance performance of both gritted and un-gritted stone mastic asphalt surfaces. The paper also discusses some the construction aspects involved in the gritting process.

INTRODUCTION

Stone Mastic Asphalt (SMA) surfacing was first introduced in Queensland by Metropolitan Region, just over a decade ago in 1996, to combat rutting. Since its introduction the use of SMA had been widespread with South East Queensland and in the northern regions (Cairns &Townsville).

Local and overseas experience with Stone Mastic Asphalt indicates that initially the skid resistance of the surface improves with trafficking as the polymer on the surface aggregate is worn off and the potential skid resistance is realised. Gritting of the stone mastic surface has been found to immediately enhance early life skid resistance and eliminate the need to impose speed restrictions at very high demand sites.

This paper describes three major gritting field trials carried out on Nicklin Way (2001), Hope Island Road (2006) and Redland Bay Road (2008) that led to the development of the Queensland Department of Transport and Main Roads' (DTMR) specification for Gritting of Stone Mastic Asphalt surfaces.

NICKLIN WAY - 2001

General

This trial was carried out on the north bound lanes of Nicklin Way between chainage 12.08 and 12.49 km. The gritted section was 230 metres in length and located in the northern end. The same treatments were applied to both the outer and inner lanes (DTMR (2002)).

Mobile skid resistance testing was carried out in the outer wheel path position of each lane after 1 day, 1 week and 1, 2, 3 and 6 months. The test device was our Norsemeter (ROAR) variable slip skid tester reporting skid resistance in terms of F60, the braking force coefficient of friction at a slip speed of 60 km/h. For this paper, the historic data has been temperature corrected to a 30 oC surface temperature using the procedure outlined in Baran (2011).

Sand Patch Texture depths were measured at 8 locations in each of the gritted and un-gritted sites of the outer lane after 1 day, 1 week and 1, 2 and 3 months. The test method used was Q705 (DTMR (2010a).

Texture Depth

Texture depth results are presented against surface in the following Figure 1.

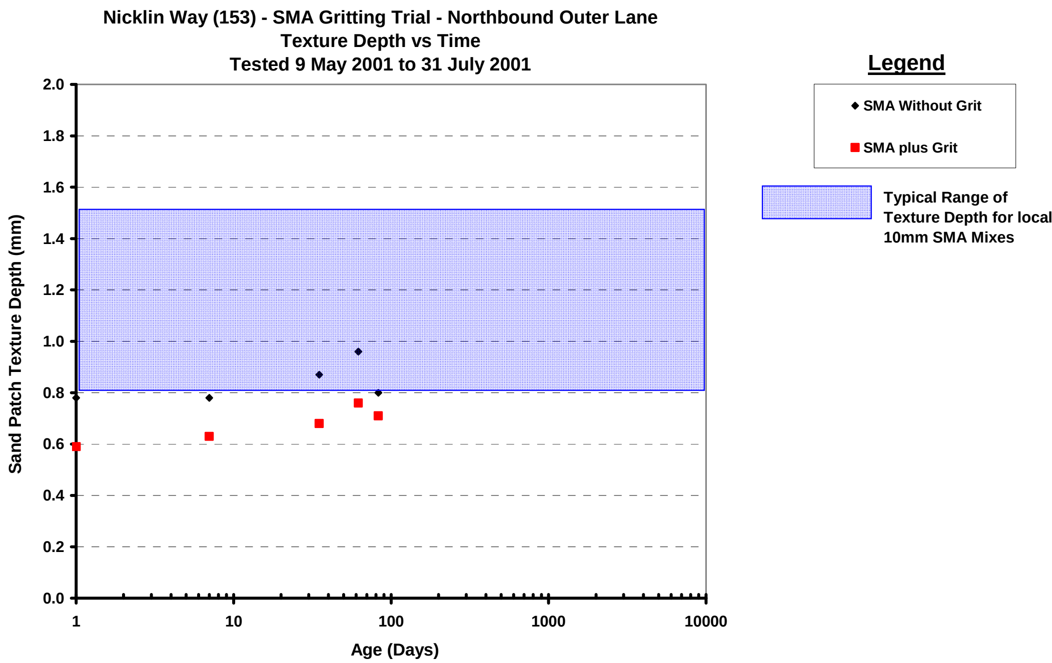

Figure 1: Texture Depth vs Age – Nicklin Way

These results indicate

- The texture depth achieved on the standard un-gritted SMA was around 0.8 mm which is at the bottom of the expected range generally achieved on this size SMA mix.
- The gritting of the SMA reduced the texture depth to 0.6 mm with the texture depth after 100 days of traffic improving to 0.7 mm. This could indicate that there has been some loss of grit.

Skid Resistance

The skid resistance results, for both northbound lanes are presented against surface age in the following Figure 2.

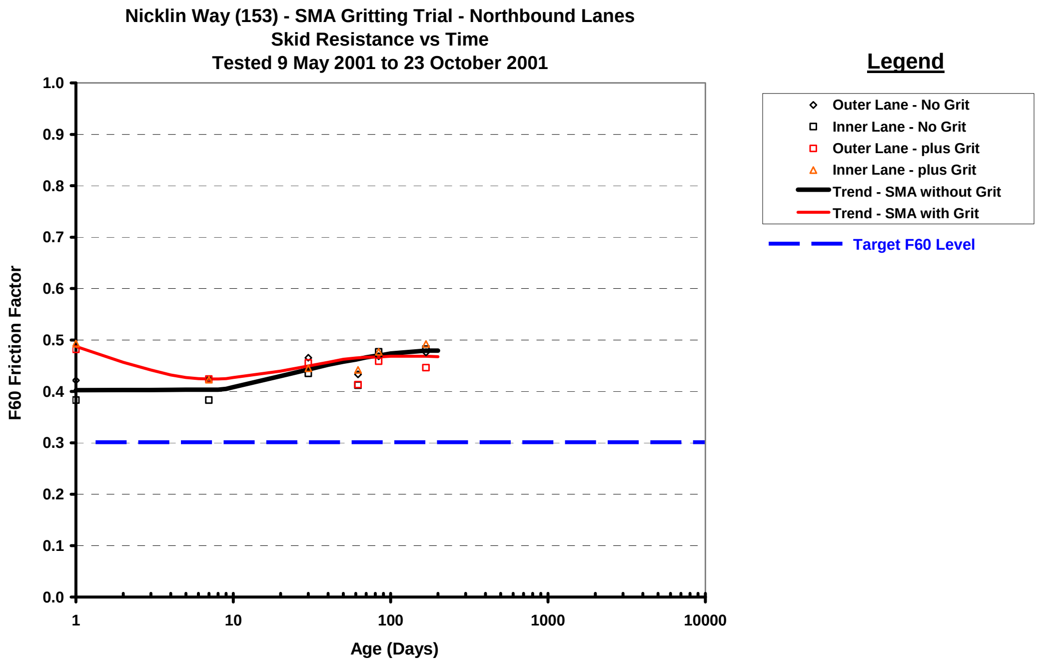

Figure 2: Skid Resistance vs Age – Nicklin Way

If we ignore the un-characteristic data obtained during the 2 month assessment, then these results indicate

- The standard un-gritted SMA surface produced an initial F60 skid resistance value of 0.4 and improved with time (traffic) and peaked at a F60 level of 0.47 after 3 to 6 months..
- The initial skid resistance achieved on the gritted SMA site was 0.49, however this was temporary and after 7 days the level reduced to 0.42. After 1 month of traffic, there was no significant observed difference in skid resistance between the gritted and un-gritted sites.

HOPE ISLAND ROAD - 2006

General

This trial was conducted by DTMR along a section of the southbound lanes of Hope Island Road between Pine Ridge Road and Harbour Town Drive. This trial incorporated hand spreading of a locally available coarse sand grit during the placement and compaction of the SMA. The SMA used was a 14 mm mix.

Mobile skid resistance testing was carried out in the outer wheel path position of each lane after 1 day, 1 week and 3 months. A follow up survey was also carried out after 4 years. The test device was our Norsemeter (ROAR) variable slip skid tester reporting skid resistance in terms of F60, the braking force coefficient of friction at a slip speed of 60 km/h. For this paper, the historic data has been temperature corrected to a 30 oC surface temperature using the procedure outlined in Baran (2011).

Skid Resistance

The skid resistance results, for both southbound lanes are presented against surface age in the following Figure 3.

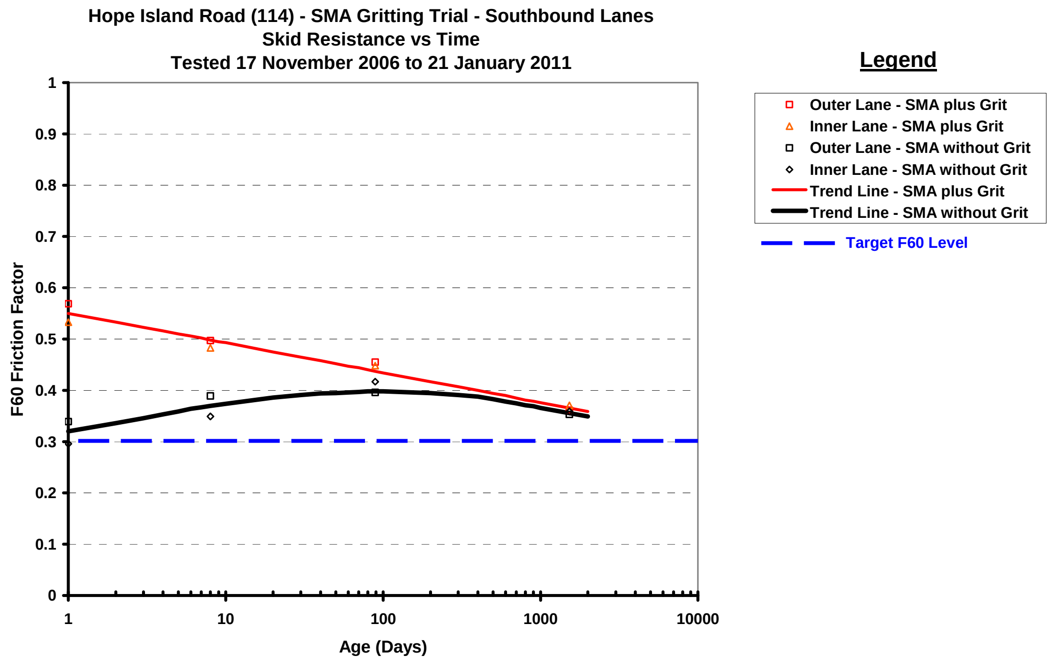

Figure 3: Skid Resistance vs Age – Hope Island Road

These results show

- The un-gritted or standard SMA surface had initial skid resistance of 0.33 and this improves with trafficking and reaches its potential skid resistance of 0.40 after 3 months.
- The gritted SMA has very high initial skid resistance and even though it reduces with time, after 3 months still has a higher skid resistance than the untreated SMA surface.
- At this site, even though the skid resistance has reduced after 4 years, the gritted site is marginally better than the un-gritted SMA surface.

REDLAND BAY ROAD - 2008

General

This trial was conducted on the eastbound lanes of Redland Bay Road between chainages 6.600 and 8.075 km (job chainages 2.0 to 3.5 km approximately). The SMA was a 14 mm mix and the grit was placed and rolled in with a CC42 roller with Grit Spreader (Pioneer Road Surfaces modified Cockrel).

Mobile skid resistance testing was carried out in the outer wheel path position of each lane after 1 and 6 days, 2 and 3 months. A follow up survey was also carried out after 3 years. The test device was our Norsemeter (ROAR) variable slip skid tester reporting skid resistance in terms of F60, the braking force coefficient of friction at a slip speed of 60 km/h. For this paper, the historic data has been temperature corrected to a 30 oC surface temperature using the procedure outlined in Baran (2011).

Sand Patch Texture depths were measured at 12 locations and 3 wheel paths over each lane of the gritted and un-gritted sites on the day after placement of the SMA. The test method used was Q705, DTMR (2010a).

Texture Depth

Texture depth results, in the wheel paths used for skid resistance testing, are presented against Job chainage in the following Figure 4.

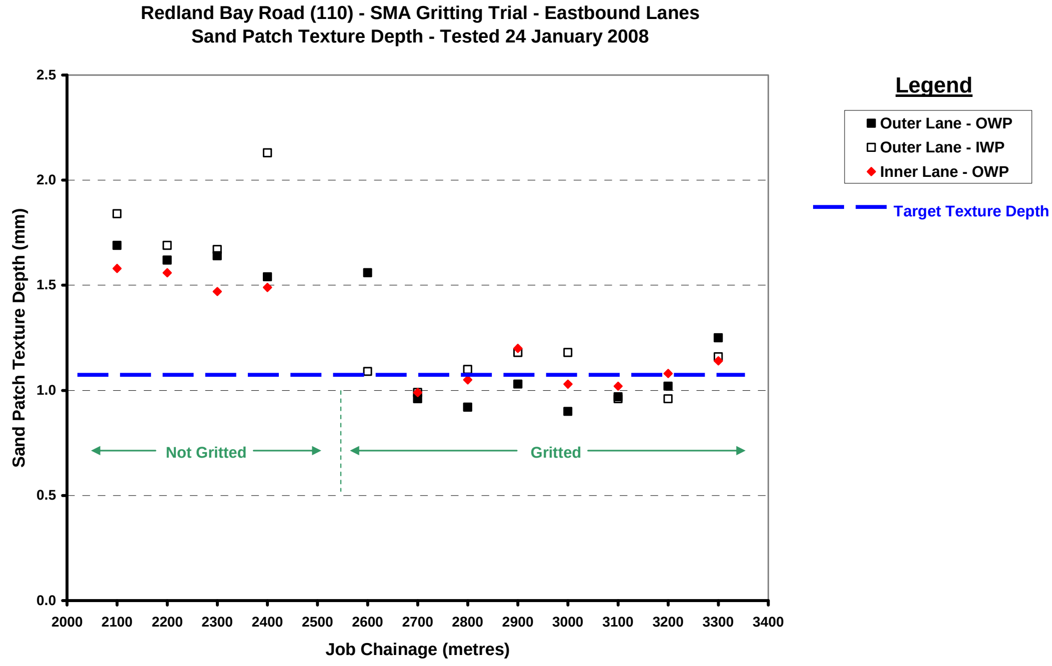

Figure 4: Texture Depth Results – Redland Bay Road

The un-gritted SMA produced a texture in excess of 1.5 mm while the gritted SMA had a texture of 1.0 mm.

Skid Resistance

The skid resistance results, for both eastbound lanes are presented against surface age in the following Figures 5 and 6.

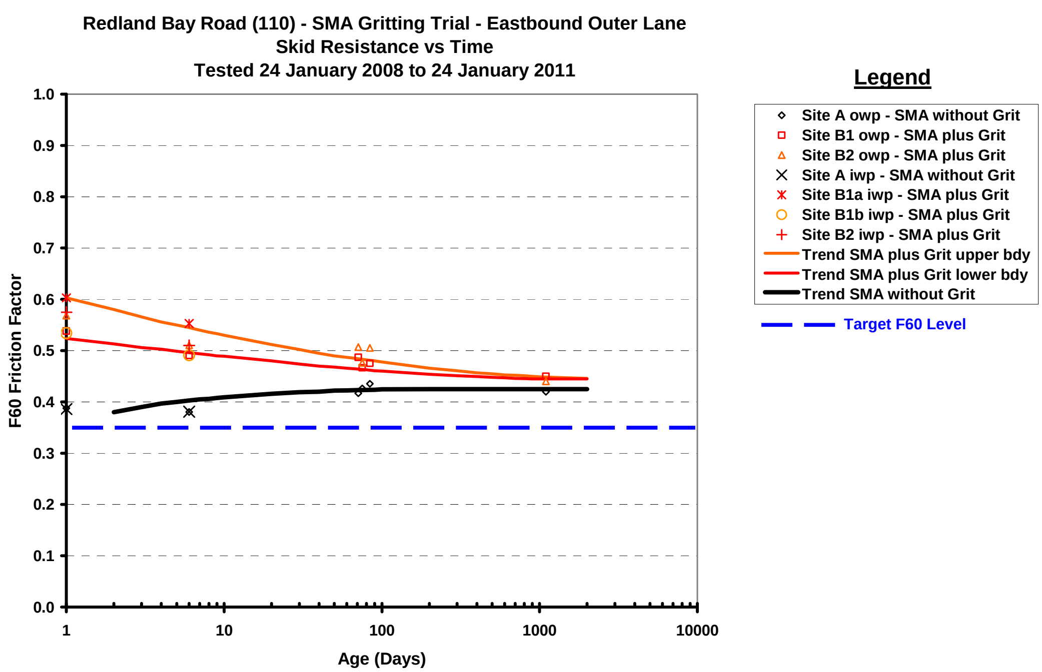

Figure 5: Skid Resistance vs Age – Outer Lane - Redland Bay Road

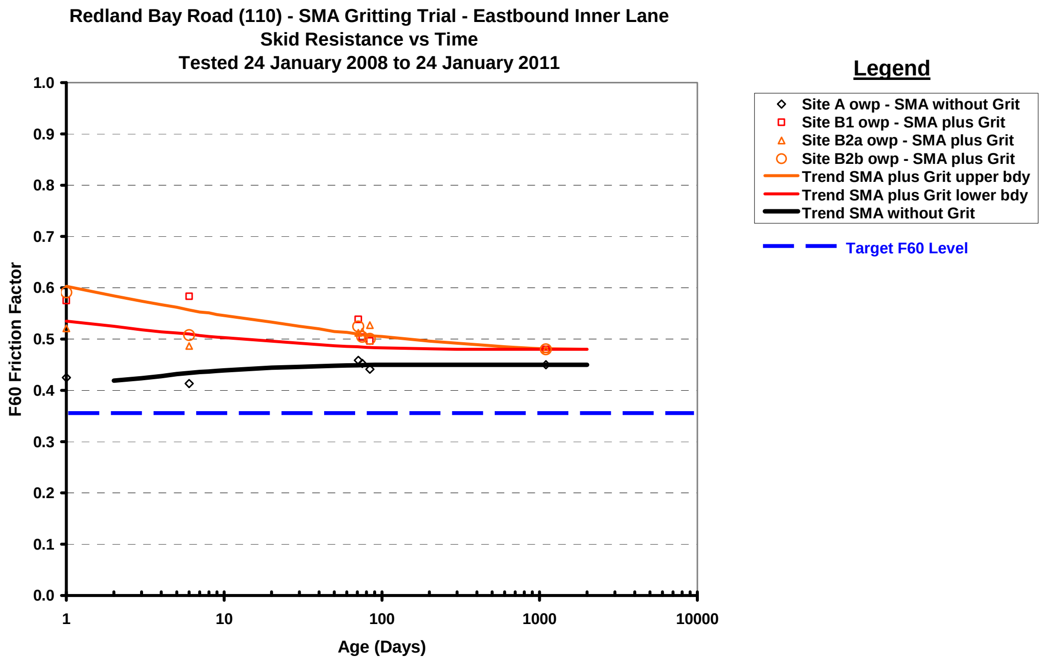

Figure 6: Skid Resistance vs Age – Inner Lane - Redland Bay Road

These results show

- The un-gritted or standard SMA surface had an initial skid resistance of 0.42 and improves with trafficking and reaching its potential skid resistance of 0.46 after 3 months. Follow up testing after 3 years shows that this level has not changed.
- The gritting produced high early F60 skid resistance levels of 0.5 to 0.6.
- Early trafficking produced a reduction in skid resistance levels and although this reduction has continued, the gritted SMA, even after 3 years, has better skid resistance than the standard (un-gritted) SMA surface.

DISCUSSION OF RESULTS

The test results for the gritted sections upon the Hope Island Road and Redland Bay Road trials unlike the earlier Nicklin Way trial indicate that the effect of gritting has potential to improve longer term skid resistance.

The type of grit utilised on the Nicklin Way trial comprised a very fine crushed slag aggregate applied with a tractor mounted agricultural fertiliser spreader. This fine slag grit was rolled in with multi rubber tyred roller following primary compaction with the steel drum roller. However on the Hope Island Road and Redland Bay Road trials a locally sourced medium sized washed and dried sand grit was utilised. The “rolling in’ of the grit on these trials was performed with heavy steel drum rollers and commenced immediately after spreading operations. This final gritting process, adopted by TMR, was based on European experience with SMA.

It is possible that the difference in the skid resistance results mentioned above could be related to the actual gritting process and the type of grit used.

GRIT PROPERTIES

General

The positive effect gritting has on early life skid resistance led to the development of a specification (DTMR (2008)) for the grit and the requirement that gritting be included with the placement of all SMA surfaces.

The specification requires that the grit shall consist of dry, angular sand with a minimum quartz content of 70% and have the following grading properties.

Table 1: Grit Particle Size Distribution

AS Sieve Size (mm)	% Passing by Mass
4.75	100
2.36	95 – 100
0.600	0 – 20
0.075	0 – 1

Microtexture

To determine the microtexture properties of the grit, samples of grit from the Hope Island and Redland Bay Road trials were glued to aluminium plates and tested with a Portable or British Pendulum Tester (DTMR (1982)). PIARC, in its 1995 International Trial (PIARC (1995)), suggested that the Pendulum Tester, because of its low operating slip speed, provided a good indication of microtexture.

A summary of these results is presented in the following Table 2.

Table 2: Grit Microtexture Properties

							SRV Statistics			
Grit Type - Source	Operator	Skid Resistance Value - Results					No.	Mean	SD	C of V
Fine Grit - Hope Island	#1 #2	77 77	76 75	76 74	76 74	78 74	10	75.7	1.4	1.9%
Coarse Grit - Redland Bay Rd.	#1 #2	70 71	70 68	73 73	73 73	73 73	10	71.7	1.8	2.6%

Portable Pendulum testing was carried out during the 2001 Nicklin Way trial. These results indicated that the un-gritted SMA that was used there had a SRV of 50 after 3 months of trafficking. At the time of these trials, the PAFV (PSV) (DTMR (2010b)) requirement for the coarse aggregate in SMA mixes was 50. Since then, it has been proposed that this be raised to 58 for high demand situations. The microtexture properties of the grit, as reflected by the Pendulum test results in Table 2, are well above these limits.

SUMMARY

These trials have confirmed that gritting has a positive effect on the early life skid resistance of SMA surfaces. Whilst early gritting trials showed that the improvement in early life skid resistance was only temporary, later trials with improved gritting techniques showed that gritting could not only produce high early life skid resistance but can also contribute to improved longer term skid resistance performance.

Although gritting does reduce the macrotexture of the surface, the improved microtexture more than compensates producing a better end product in terms of skid resistance.

Future trials, using calcite bauxite as the grit, are planned to evaluate the use of this material, with SMA, for very high skid demand situations.

REFERENCES

Baran (2011), Temperature Influence on Skid Resistance. Paper prepared for 3rd International Skid Conference, Gold Coast May 2011.

DTMR (1982), Skid Resistance (Portable Pendulum) - Test Method No. Q704-1982, Department of Main Roads Material Testing Manual. 1982.

DTMR (2002), Steel Slag Asphalt Trial – Nicklin Way. Pavement Testing Report No. RP3929C, January 2002.

DTMR (2008), Stone Mastic Asphalt Specification – SM14 Mix Design. Interim Specification MDSS548, December 2008.

DTMR (2010a), Texture Depth (Sand Patch) - Test Method No. Q705-2010. Department of Transport and Main Roads Material Testing Manual. 2010.

DTMR (2010b), Polished Aggregate Friction Value. - Test Method No. Q203-2010. Department of Transport and Main Roads Material Testing Manual. 2010.

PIARC (1995), International PIARC Experiment to Compare and Harmonise Texture and Skid Resistance Measurements. PIARC Technical Committee on Surface Characteristics (C.1) 1995.

AUTHOR BIOGRAPHY

Ed has worked in the Materials and Pavements field with the Queensland Transport and Main Roads Department for the past 33 years. As Principal Engineer (Pavement Testing) he is currently responsible for the technical management of a specialist pavement testing service for the Department throughout the State as well as providing a routine pavement testing service for local Departmental Regions and Branches.

The Department's field test units provide a variety of unique test facilities to meet varied client's requirements from pavement investigation and pavement condition data collections to data input for rehabilitation design and specification compliance requirements.

In recent years, Ed has also been involved in the development, modification and upgrading of pavement test equipment, calibration and operational procedures including the commissioning of the new Network Survey Vehicles.