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CASE STUDY
TREATED ROADS FRICTION ANALYSIS REPORT

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REPORT PREPARED BY
MR. David Tulloch
Managing Director
RoadSafety Training Services Pty Ltd

1.0 EXECUTIVE SUMMARY

The consultant company and author of this report was engaged by Global Road Technology (GRT) to provide technical expertise for continuing assessment and management with regard to the frictional properties of wearing course characteristics for roads subject to dust suppression treatments. The report encapsulates a third round of friction test results after remedial works had been conducted on Steinohrts and Halliford Roads to improve wet surface friction performance. Halliford Road testing results improved from an average (0.31) result to a (0.36) friction level after the remedial works.

This is a 44% improvement from the original finished surface test results of (0.25) conducted on 16 October. Steinohrts Road improved from an average (0.28) to a (0.50) result which represents a significant average improvement of 78% after surface modification works and a 100% improvement on the original surface results from 16 October testing. The key learning from this third round of testing is that friction results can be materially improved with modified product application procedures.

2.0 FRICTION PROJECT PURPOSE

The purpose and objectives of the rolling resistance project are:

1. Relative appraisal of rolling resistance properties for GRT dust suppressions treatments compared against conventional sealed and unsealed road surfaces.

2. To provide a measured statistical basis for future cost benefit analysis between different road surface characteristics including relative road roughness comparisons.

To afford a strong technical and marketing position for Global Road Technology business activities.

3.0 FRICTION SUPPLY BENCHMARK DISCUSSION

It is the subject of professional judgement as to the nomination of a desirable friction supply benchmark value. The advantage of the friction measurement process used by the author of this report is the direct comparison available to match measured friction supply against vehicle operation friction demand road design principles.

In simple terms it is a case of friction demand versus friction supply. A straight level section of road requires only moderate friction supply to maintain vehicle control as it is essentially comprises inline longitudinal negative or positive acceleration forces.

Road curves are a combination (vector sum) of lateral and either positive (acceleration) or negative (braking) forces; this combination can be unpredictable and variable but in broad terms vehicle drivers have acceleration comfort levels, that is, they will adjust their speed through curves and moderate their braking/acceleration application magnitude to remain with this comfort zone.

Installed road curve speed advisory signs are based on these comfort levels that change in direct relationship to vehicle travel speed. Smaller radius curves are signed with a (0.35g) upper limit lateral acceleration comfort level although most drivers' acceptance level falls below this value. Allocating a (0.35) benchmark friction supply level based on Queensland Road Planning Design Manual (RPDM) Friction Demand guidelines provides for a defensible technical road safety position.

3.1 FRICTION SUPPLY TEST PROCESS

The friction supply test procedure utilizes a sophisticated portable tri-axis accelerometer that is attached to the test vehicle and a low speed (40km/h) full brake application skid to stop test is conducted in multiple locations at a test site while following a water truck. The test process is conducted using conventional (lock- up) non-ABS brake mode to obtain lowest friction data attributes.

The instrument records acceleration up to 1000 times each second enabling road friction supply characteristics to be analyzed in detail. The instrument can also be used to measure instantaneous in-vehicle road friction demand data under any vehicle operation simulation at any location including road roughness features. The report author has designed and established the test protocol for unsealed roads used primarily in the mining industry but applicable on any road surface.

Photograph 3.1: Depicts the friction supply test vehicle.

4.0 HALLIFORD ROAD FRICTION RESULTS

Halliford Road has been the subject of two reported wet weather crash events on consecutive curves. The initial friction test results are illustrated in Figure 4.1.1 on the following page. These results underperformed the nominated benchmark (0.35) friction value.

The second more recent test results display a significant improvement that takes in both crash locations over about 1km of treated road surface.

The 3rd round of testing and results subject of this report were conducted after remedial treatment that involved reclaiming gravel from the road shoulders, distributing it onto a scarified original surface with a reapplication of GRT product.

4.1 16/10/14 – HALLIFORD ROAD TEST LOCATION RESULTS

These results were the lowest of the test locations with an underperforming wet surface average of (0.25) which is regarded as indequate for demanding geometry road locations such as curves.

The treatment application layers have significantly reduced the road surface micro-texture and introduced a high sheen appearance. Road surface micro-texture is the main component of competent friction supply.

Photograph 4.1: Depicts the 1st round Halliford Road friction supply test location.

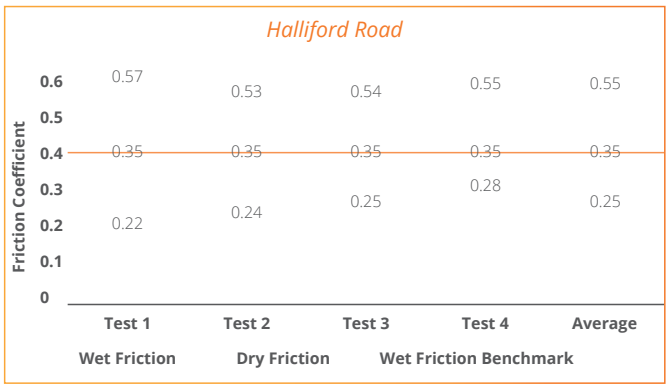

Figure 4.1.1: Friction supply results within a week of surface treatment.

4.2 30/10/14 – HALLIFORD ROAD TEST LOCATION RESULTS

These results were more extensive in number and road surface length but displayed very consistent friction values slightly under the benchmark value as illustrated in Figure 4.2.1 on the following page. Noticeably the road surface exhibited less sheen than when tested two weeks prior.

The test procedure was extended to include testing to identify of a time period for friction to improve back to dry condition friction values. The weather was fine, hot and with moderate winds, conditions that resulted in dry friction results within a 5-10 minute period after water application.

Photograph 4.2: Depicts the 2nd round Halliford Road friction supply test location.

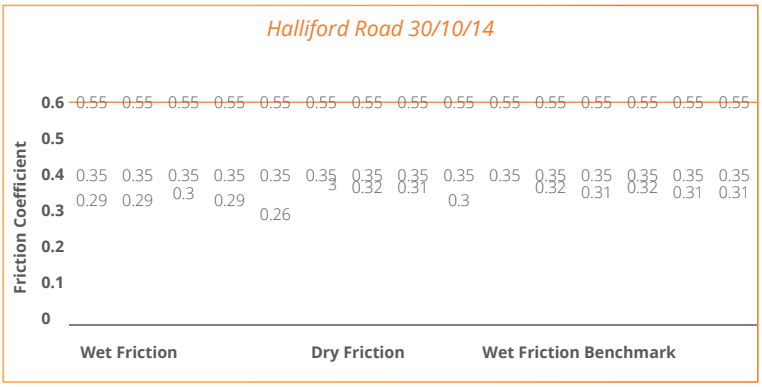

Figure 4.2.1: Friction supply results 3 weeks after treatment = 24% Improvement.

4.3 18/11/14 – HALLIFORD ROAD TEST LOCATION RESULTS

The most recent test results after remedial works have displayed a 16% improvement from the last test results but a 44% improvement on the original surface testing from a low (0.25) to an average (0.36); slightly above the benchmark (0.35) level.

The Figure 4.3.1 graph results show a 50-100m section where the results display a minor dip under the benchmark (0.35) level. This friction change was associated with observed visual reduction in micro-texture prominence as a result of increased product application and/or a less effective introduced reclaimation material from the road shoulders.

Photograph 4.3: Depicts the 3rd round Halliford Road friction supply test surface.

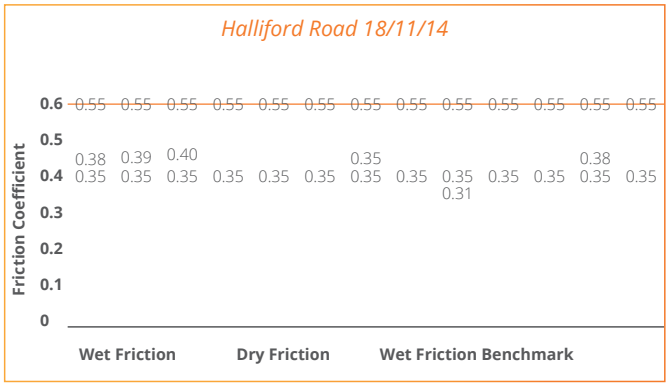

Figure 4.3.1: Friction supply results after remedial work = 16% Improvement.

5.0 STEINOHRTS ROAD FRICTION RESULTS

Steinohrts Road has been the subject of a reported crash event in wet weather conditions also on a curve. The initial test friction results conducted within a week of treatment application display the same low friction (0.25) average as Halliford Road. These results are depicted in Figure 5.1.1 below together with a photograph taken after testing. The 3rd and most recent test results are depicted on page 10 conducted after surface remediation works.

5.1 15/10/14 – STEINOHRTS RD TEST LOCATION RESULTS

Photograph 5.1: Depicts the Steinohrts Road test location.

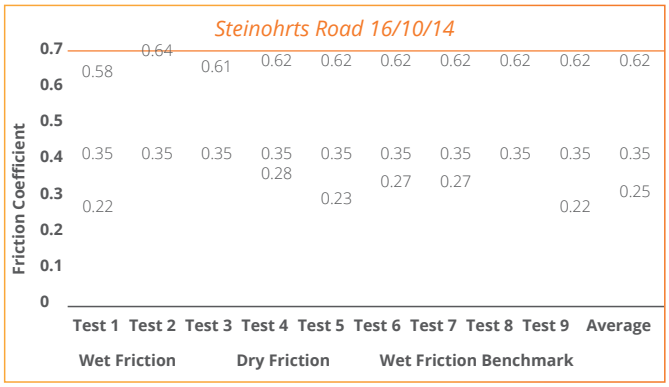

Figure 5.1.1: Friction supply results within 1 week of treatment.

5.2 30/10/14 – STEINOHRTS RD TEST LOCATION RESULTS

The second round of test results is displayed in Figure 5.2.1 below depicting the average 10% improvement in friction performance as a result of traffic wear and weathering.

Photograph 5.2: Depicts the Steinohrts Road test location.

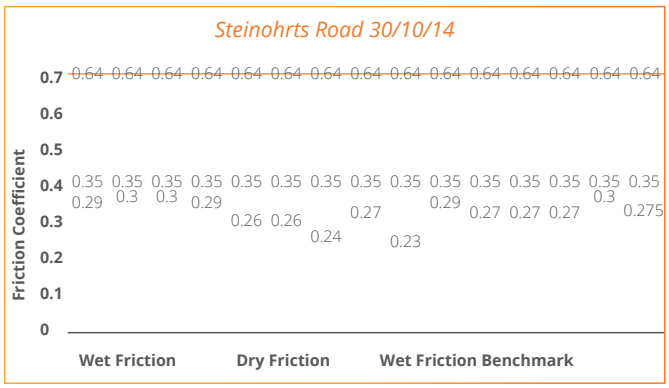

Figure 5.2.1: Friction supply results 3 weeks after treatment = 10% Improvement

5.3 18/11/14 - STEINOHRTS RD TEST LOCATION RESULTS

A significant 5-6km section of Steinohrts Road from the intersection with Tara-Kogan Road was tested after significant surface remediation and shoulder gravel reclamation works. Due to the length of road and number of tests conducted a test averaging protocol has been adopted. The reclaimed surface depicted in the photograph below resulted in an average 100% friction improvement at (0.50) from the original surface friction performance of (0.25). This is a very robust friction performance which is appropriate as some sections of this road have moderate friction demand horizontal road geometry. The friction trend change depicted below was observed to coincide with sections of more competent road shoulder gravel material that had been dispersed onto the travel surface before reapplication of GRT product.

Photograph 5.3: Depicts the Steinohrts Road test location.

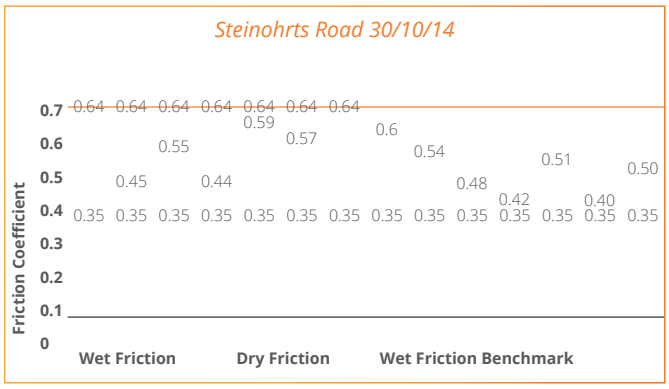

Figure 5.3.1: Friction supply results after remedial works = 78% Improvement.

6.0 RECOMMENDATIONS & COMMENTARY

The following comments are provided for consideration by Global Road Technology (GRT) management:

- The current extent of the friction test program to date provides confirmation data to establish potential friction improvement parameters based on the remedial works undertaken on Halliford and Steinohrts Roads.
- Additional independent surface friction quality control testing is recommended on new and reclaimed road surfaces at regular bi-monthly interim periods of road works to provide supplementary data to support road safety performance measures at or above the nominated benchmark level.