

# GripTester trial – October 2009

## Including SCRIM comparison

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Including SCRIM comparison

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**Client: ADEPT, Devon County Council**  
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# Contents

<b>Abstract</b>	<b>i</b>
<b>Executive summary</b>	<b>ii</b>
<b>1 Introduction</b>	<b>1</b>
<b>2 Correlation Trial format</b>	<b>2</b>
2.1 Participants	2
2.2 Test sections	2
2.2.1 Track	3
2.2.2 Local roads	4
2.3 Operation	4
<b>3 Preliminary analysis of data</b>	<b>6</b>
3.1 Definition of sub-sections	6
3.2 Removal of outlying average values	7
3.3 Calculation of repeatability and reproducibility	7
<b>4 Results</b>	<b>8</b>
4.1 GripTester – GripTester comparison on track sections	8
4.1.1 Average GripNumbers on the track	8
4.1.2 GripTester precision on the track	9
4.2 GripTester – GripTester comparison on road test sections	10
4.2.1 Average GripNumbers on the road	10
4.2.2 GripTester precision on the road	11
4.3 GripTester - SCRIM comparison	12
<b>5 Discussion</b>	<b>14</b>
<b>Acknowledgements</b>	<b>15</b>
<b>References</b>	<b>15</b>
<b>Appendix A Maps</b>	<b>16</b>
<b>Appendix B Measurements made on the track</b>	<b>18</b>
<b>Appendix C Measurements made on the road</b>	<b>23</b>



## **Abstract**

A GripTester trial was carried out in Crowthorne on 13<sup>th</sup> October 2009. Members of the GripTester for roads User Group were invited to attend and eleven GripTesters participated. Skid resistance was measured by all machines, each having their own dedicated tow vehicle and crew, on sections of the TRL test track and on sections of local in-service roads. This report summarises the analysis of skid resistance results, and details the comparisons made between GripTesters, as well as estimates for the repeatability and reproducibility of the fleet.

In addition, two SCRIM (sideway force coefficient routine investigation machine) vehicles were invited to attend, and skid resistance was measured using these devices on the same surfaces. A correlation between mean SCRIM Coefficient and GripNumber has been calculated and is presented in this report.

As part of an ongoing commitment to improving the standing of the GripTester leading towards formal accreditation, recommendations for future trials are made.

## Executive summary

This report describes a comparative trial held for UK GripTester for roads fleet. It was organised by TRL under contract from the County Surveyors' Society (now ADEPT, the Association of Directors of Environment, Economy, Planning and Transport) with assistance from the project team appointed by CSS. The purpose of the trial was twofold: firstly to establish the current state of the precision of the GripTester fleet by determining estimates for repeatability and reproducibility, and secondly to review the SCRIM/GripTester comparison that was last calculated in April 2004.

Members of the GripTester for roads User Group were invited to attend the trial on 13<sup>th</sup> October 2009 at the TRL site in Crowthorne and eleven GripTesters participated. Repeatability and reproducibility were calculated following guidelines set out in the relevant Standards documents (British Standards, 1994). Two SCRIMs were hired for the trial day to run in convoy with the fleet of GripTesters, and measurements from these devices were used to derive a conversion between GripNumber and SCRIM Coefficient.

This trial differed from previous correlation trials insofar as testing was carried out for the whole system (including operating crew, tow vehicle, water delivery system, and the device itself) as opposed to testing the GripTester trailer alone, by rotating GripTesters but using the same tow vehicle etc. The value for repeatability calculated under controlled conditions using test sections on the TRL track was 0.05 GN. The equivalent value for reproducibility was 0.12 GN. The trial therefore demonstrated that GripTester operators can have confidence in measurements made by their own GripTester systems but should be mindful of possible variability when any of the influencing factors included in the GripTester 'system' are changed. However, it was noted that a proportion of the variability found could be attributed to differing operating procedures and to unfamiliarity with testing under trial conditions. Values calculated for repeatability and reproducibility using measurements on sections of the local road network were 0.10 GN and 0.17 GN respectively. These higher values are likely to be additionally influenced by variability in the road surface.

The GripTester/SCRIM conversion derived is stated as  $SC = 0.89 * GN$ . It is recommended that this conversion equation supersedes all previous versions. The conversion should be used with caution and only in conjunction with a thorough review of local skid resistance policies.

Recommendations are made for future trials designed to allow greater confidence in the data collected by GripTesters. These include the consideration of annual accreditation, development of standard operating procedures and formalisation of the trial format.



## 1 Introduction

The comparative trial for the UK GripTester fleet described in this report was organised by TRL under contract from the County Surveyors' Society (now ADEPT, the Association of Directors of Environment, Economy, Planning and Transport), with assistance from the project team appointed by CSS. The purpose of the trial was twofold: firstly to establish the current state of the precision of the GripTester fleet by determining estimates for repeatability and reproducibility, and secondly to review the SCRIM/GripTester comparison that was last calculated in April 2004 (Frankland, Report on Correlation of SCRIM with the Mark 2 GripTester Trial at TRL, Crowthorne 21 April 2004, 2004).

The format of the trial was derived from the methodologies used in previous trials. In addition to the April 2004 trial, reference has been made to the trials held in 1992 (Roe, 1993) and 2003 (Frankland, Report on GripTester Precision Trial at TRL, Crowthorne, November 2003, 2004).

Members of the GripTester for roads User Group were invited to attend the trial on 13<sup>th</sup> October 2009 at the TRL site in Crowthorne. Details of the GripTesters in attendance, as supplied by the participants, can be found in Section 2.1. One GripTester did not start due to a technical fault, so eleven GripTesters took part in the trial. In order to determine repeatability and reproducibility estimates, a Statistician was appointed, and consulted before and after the trial. Wherever practicable the principles defined in the relevant Standards documents and guidance for determination of repeatability and reproducibility were followed (British Standards, 1994). It should be noted however, that due to time and budget constraints, some concessions were made.

Two SCRIMs were hired for the trial day to run in convoy with the fleet of GripTesters, measuring skid resistance along the same test line.

## 2 Correlation Trial format

### 2.1 Participants

**Table 2.1 Attendees at the GripTester trial**

GT ID	Organisation	GT details	Date of last service	Tow vehicle
GT179	Highway Testing Laboratory	Mk1 C-type	Nov-08	VW Transporter O7 G 7465
GT332	Gwynedd Consultancy	Mk2 D-type	Jan-09	Ford Transit CY56 CFU
GT334	University of Ulster	Mk2 D-type	u/k-09	VW Crafter YEZ 8266
GT347	TRL for Highways Agency	Mk2 D-type	Mar-09	Ford Transit DA54 HFF
GT351	Derbyshire County Council	Mk2 D-type	Jan-09	Ford Transit FD56 WKL
GT353	Devon County Council	Mk2 D-type	Jun-09	Mercedes Sprinter WP54 FKT
GT363	Findlay Irvine	Mk2 D-type	Sep-09	Nissan Primastar SL09 AYA
GT370	Hampshire County Council	Mk2 D-type	Mar-09	Ford Transit GL58 AXG
GT386	Atkins	Mk2 D-type	Mar-09	Ford Transit EA07 ECJ
GT410	Jacobs Laboratories	Mk2 D-type	Apr-09	Ford Transit SJ08 UJR
GT413	Middlesbrough Council	Mk2 D-type	Mar-09	Ford Transit NU05 UJW
GT427	Staffordshire County Council	Mk2 D-type	Apr-09	Ford Transit DY58 GVO

Table 2.1 shows the list of GripTesters that attended the trial at TRL in Crowthorne on 13<sup>th</sup> October. GT334 (highlighted) did not take part in the running trials due to a technical failure.

For the remainder of this report, for purposes of anonymity, where it is necessary to refer to an individual GripTester, a letter has been randomly assigned to each.

### 2.2 Test sections

Skid resistance was measured by all participants on test sections defined on the TRL track and on a route comprising in-service local roads.

Test sections on the track (described in Section 2.2.1) were included so that comparisons could be made over the full working range of the devices, under controlled conditions. The transverse variability of sections of the track is expected to be lower than on the road because of the relative lack of trafficking experienced by the surfaces.

This should reduce the variability in results that can be attributed to the road to give a more accurate indication of the variability due to the devices.

Test sections on the local roads (described in Section 2.2.2) were included so that comparisons could be made using the surfacing types that are measured by the devices in routine use.

### 2.2.1 Track

Two separate routes around the TRL track were followed, labelled as circuit A and circuit B. Circuit A included two test sections, "1" and "2", and circuit B included a further two test sections, "3" and "4". A plan of the track is shown Figure A.1 in Appendix A, on which the locations of the four test sections are highlighted. Table 2.2 gives a description of each test section, and the approximate length of each section that has been used for analysis. Note that three of the four sections are split into two sub-sections.

Test lines were defined explicitly rather than simply requiring crews to follow the normal wheel path of a road lane. Marker studs were placed at intervals along the test sections to act as a guide for the drivers. The two lines of studs were placed 1 m apart, the narrowest practical gap that would allow for the passage of the GripTester. Section 2 is a narrow strip of less than half a lane width and the test line followed the centre of this strip; marker studs were not used on the test surfaces of these two sub-sections. Participants were asked to input a location marker at the start of each of the main sections. Sub-sections were defined during post-processing using their lengths, as measured previously using a calibrated measuring wheel.

**Table 2.2 Description of test sections on the TRL track**

Route	Section	Approx. length (m)	Surface	Description
A	1a	130	Brushed concrete	Concrete surface that was smoothed and then finished by brushing on construction to give random transverse texture.
	1b	180	Grooved concrete	Concrete with random post-hardened sawn grooving.
	2a	85	"Pea gravel" dressing	An experimental surface dressing 1m wide of 3mm nominal size smooth gravel on epoxy resin binder.
	2b	90	Epoxy resin	An experimental section intended to give extremely low skid resistance, comprising a smooth layer of un-chipped epoxy resin 1.5m wide.
B	3a	180	Hot-rolled asphalt (HRA)	Hot-rolled asphalt with 20mm pre-coated chippings, typical of that used on motorways since the 1980s.
	3b	110	Stone mastic asphalt (SMA)	Stone mastic asphalt laid in 2001 for braking tests as part of the NCAP test programme. Similar to many proprietary surfacings currently being laid on the trunk road network.
	4	195	Hot-rolled asphalt	Another length of hot rolled asphalt similar to Section 3a but laid some years afterwards.

### 2.2.2 Local roads

The route map shown in Figure A.2 in Appendix A shows the start positions of ten sections (highlighted alternately blue and red), and participants were asked to mark the start of each section at the exit of each preceding roundabout. Note that there are two markers on each of Section 3 and Section 4, which is to avoid ambiguity because those sections are interrupted by a small roundabout. The marker was repeated to avoid introducing two additional short sections and increasing the number of location markers to more than ten.

The exact location and length of each section to be used for analysis was determined during post-processing, depending on the longitudinal homogeneity of the road surface. The road route included surfaces with surface dressing, thin surfacing, hot rolled asphalt and high friction surfacing (calcined bauxite) providing a range of skid resistance. Table 2.3 lists the test sections used for analysis, and their surface types.

**Table 2.3 Description of test sections on the local road route**

Section	Approx. length (m)	Surface
1	250	Surface dressing
2a	700	Surface dressing
2b	80	High friction surfacing
3	750	Thin surfacing
4	500	Thin surfacing
5a	80	High friction surfacing
5b	700	Surface dressing
6	190	Surface dressing
7a	2000	Hot rolled asphalt
7b	350	Thin surfacing
8	2000	Hot rolled asphalt

### 2.3 Operation

GripTester operators were asked to arrive ready to begin testing using the operating procedures advised in the manufacturer's instructions and according to the British Standard (British Standards, 2000). Calibration of the GripTester before arrival was also requested and the time available for last minute preparation prior to testing was limited. GripTesters were set to report average skid resistance values at 5 m intervals.

The target speed for all testing was 50 km/h. Values recorded by a GripTester at a recorded speed outside 10% of this target speed were discarded during post-processing.

The target water depth was 0.25 mm. According to the manufacturer and the Standard, a water flow rate of 10.4 litres/minute will achieve this water depth at 50 km/h. Some GripTesters do record flow rate, and it would therefore be possible to discard measurements relating to flow rates deviating from the target for these devices. However, some GripTesters attending did not report flow rate. Experience with annual SCRIM correlation trials has suggested that the volume of water on the track throughout

the running trials renders the effect of slight changes in individual machines' water depth settings negligible. For these reasons, no attempt was made to account for water depth deviations during data processing.

After a safety briefing, all participants made one familiarisation lap around each of the two routes (described in Section 2.2.1). All participants - eleven GripTesters and two SCRIMs - ran in convoy, allowing a minimum distance of 100 m between vehicles. Participants then completed three 'test sets' each consisting of three laps of each of the two routes. The running order for the familiarisation lap and for the first test set was such that the participants ran in the alphabetical order of their organisations (i.e. Atkins, followed by Derbyshire, followed by Devon etc.). For the second test set, the running order was reversed, and for the third an arbitrary running order was used, depending only on the order in which the vehicles returned from refilling with water. Exceptions to these orders were for the TRL vehicle which always led the convoy, and the two SCRIMs which always followed behind the GripTesters.

After each test set, the survey files were collected from each GripTester and participants were asked to confirm that they had sufficient water on board to complete the next test set (three laps of each route is approximately 15 km). Participants requiring more water used the water fill points available at the track side. As a further safety precaution, vehicles travelled in a clockwise direction around the track circuit at all times.

On completion of three test sets on the track, the participants were issued with a map of the pre-defined route on the local road network (described in Section 2.2.2). Participants were dispatched at two minute intervals, and requested to complete two laps of the route, marking the locations specified on their maps. After collection of test data, the participants were free to leave. There was no defined running order, but one of the SCRIMs tested the road route once before any of the GripTesters, and once after all GripTesters had returned.

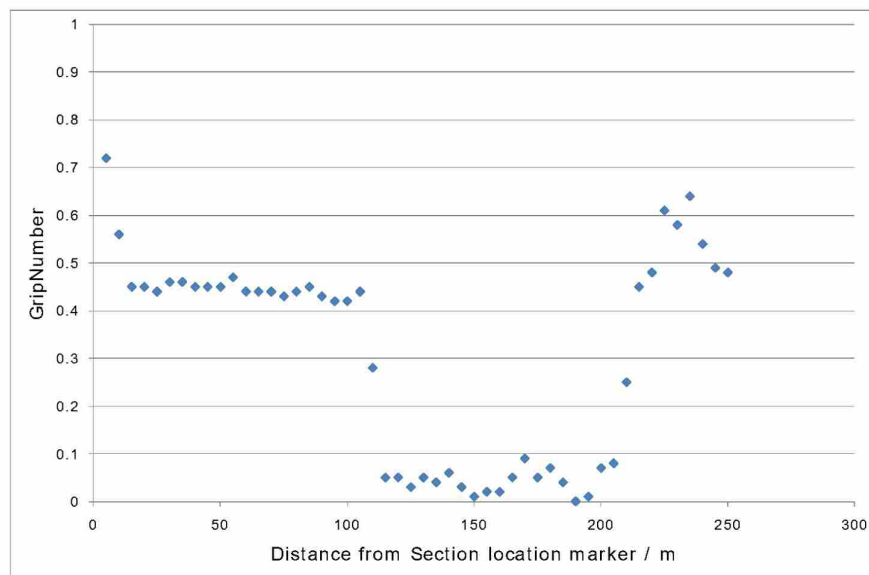
### 3 Preliminary analysis of data

The large volume of skid resistance data was first analysed so that average values from each GripTester on each section could be used for comparisons. Tables of the measured GripNumbers can be found in the Appendices, and the following paragraphs briefly describe the analyses that were applied to the GripTester data. Similar analyses were made on the SCRIM data.

#### 3.1 Definition of sub-sections

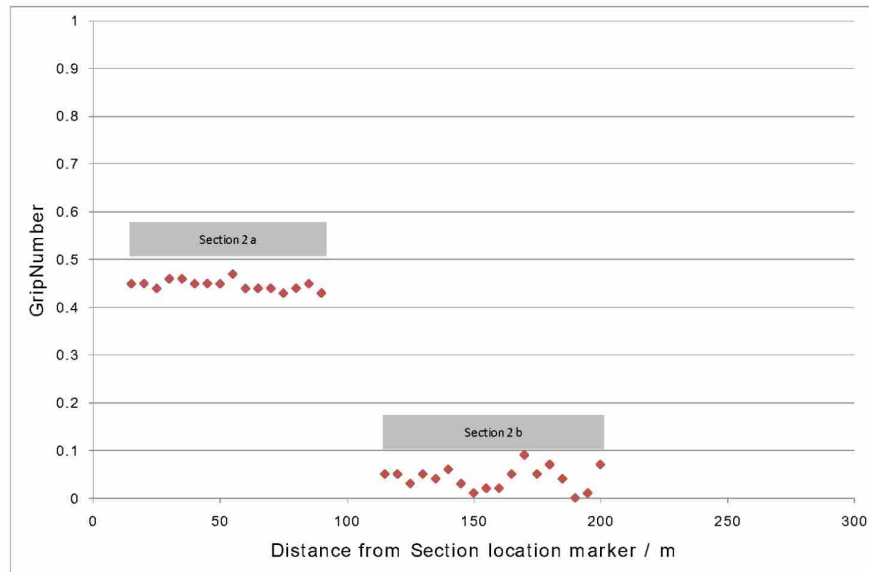
After removal of data outside the target speed range, measurements from each individual GripTester were collated. Using the location reference markers input by the operators, individual laps and then individual sections were segregated. Measurements were plotted, and using the known lengths of the sections, contiguous measurements were selected from which average values for each section or sub-section were calculated. The graph in Figure 3.1 shows the measurements made by GripTester A on Section 2 of the track for lap 2 of test set 1. The graph in Figure 3.2 shows the sub set of these measurements that were finally used to obtain average values of skid resistance for the two sub-sections, for that lap.

This process was followed for each lap, for each section and for each GripTester in turn.



**Figure 3.1 Graph showing measurements made by GripTester A before sub-sections have been defined**





**Figure 3.2 Graph showing measurements made by GripTester A after sub-sections have been defined**

### 3.2 Removal of outlying average values

The tables in Appendix B show the average GripNumbers recorded by the GripTesters during the nine test laps for each of the seven sections on the track. Cochrane's test and Dixon's test (British Standards, 1994) were used to determine whether any of the nine average values recorded for each sub-section should be discarded as an outlier for each GripTester. If an individual average recorded for the section caused one of the test statistics to be greater than the relevant 1 % critical value then that average value was discarded. The values that have been discarded in all further processing are included in the tables, but highlighted.

The tables in Appendix C show the average GripNumbers recorded by GripTesters on the road route. There are only two repeat runs, and it has therefore not been possible to determine if one or other of these measurements should be considered as an outlier.

### 3.3 Calculation of repeatability and reproducibility

Repeatability and reproducibility are the expected differences (with a probability of 95%) between two measurements made under the same conditions, within a short space of time, made by the same machine, and made by different machines, respectively.

The tables in Appendix B give values for between run standard deviation ( $s_r$ ) and between machine standard deviation ( $s_L$ ) for the track sections. The subscript 'L' stands for 'laboratory', used during inter-laboratory testing; in this case it refers to each GripTester system, including tow vehicle and crew. These have been calculated using the formulas given in the British Standard (British Standards, 1994), by pooling between-run standard deviations for each machine and taking into account the number of laps actually completed. The calculations do not use discarded values. Repeatability and reproducibility, calculated using these standard deviations, are also shown.

Similarly, the tables in Appendix C give values for the pooled between run standard deviation, between machine standard deviation and repeatability and reproducibility for each section on the road. Note, however, that the values are calculated using the range between the two repeat runs made by each GripTester, where necessary.

## 4 Results

Average skid resistance measurements from each GripTester or SCRIM have been used to make the following comparisons:

1. GripTester – GripTester comparison on track sections, including a calculation of repeatability and reproducibility.
2. GripTester – GripTester comparison on road sections.
3. GripTester – SCRIM comparison using average measurements from all test sections.

### 4.1 GripTester – GripTester comparison on track sections

#### 4.1.1 Average GripNumbers on the track

Table 4.1 shows the average GripNumbers measured by each GripTester (averaged over all valid repeat laps). The values highlighted in bold and italics are those measurements which fall more than two standard deviations from the mean. There are no measurements which fall more than three standard deviations from the mean. These two thresholds are used to demonstrate the extent of the distribution for approximately 95% and 99% of the measurements respectively. Under normal measuring conditions, it should be expected that 5% of measurements fall outside two standard deviations from the mean without any indication of outlying behaviour. In this case, only 3 of the 77 values fall outside this threshold (equivalent to only 3.9% of the data).

**Table 4.1 Average GripNumber measured on all track sections**

Section	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1a	0.56	0.67	0.53	0.59	0.55	0.55	0.62	0.63	0.57	<b>0.73</b>	0.64
1b	0.57	0.68	0.58	0.67	0.58	0.55	0.62	0.61	0.59	0.72	0.65
2a	0.44	0.46	0.47	0.48	0.46	0.46	0.51	0.54	0.48	0.54	0.52
2b	0.04	0.13	0.07	0.09	0.07	0.09	0.11	0.10	0.06	0.15	0.13
3a	0.68	0.69	0.68	0.71	0.71	<b>0.62</b>	0.70	0.74	0.71	0.77	0.74
3b	0.49	0.48	0.50	0.58	0.55	0.53	0.53	0.53	0.50	0.62	0.58
4	0.70	0.75	0.70	0.74	0.73	<b>0.64</b>	0.72	0.78	0.76	0.80	0.77

However, the 95% and 99% thresholds apply to normally distributed data and any values falling at the tails of the distribution (whether outside these limits or not) should do so randomly. The cells in Table 4.1 have been coloured to distinguish between the GripTesters and Table 4.2 shows the values ordered by GripNumber magnitude, from left to right. It is clear that GripTester K systematically measures skid resistance considerably higher than the remainder of the fleet on all sections. The most likely cause of this systematic difference is that GripTester K followed a slightly different test line on the track. The same observation cannot be made on the road test sections (see Section 4.2). When calculating the precision of the whole fleet on the track, therefore, some consideration should be given to excluding the measurements made by GripTester K. Table B.8 in Appendix B shows the distribution of these results graphically.



**Table 4.2 Average GripNumber measured on all track sections ascending order of magnitude left to right, colour-coded for GripTesters**

Section											
1a	0.53	0.55	0.55	0.56	0.57	0.59	0.62	0.63	0.64	0.67	<b>0.73</b>
1b	0.55	0.57	0.58	0.58	0.59	0.61	0.62	0.65	0.67	0.68	0.72
2a	0.44	0.46	0.46	0.46	0.47	0.48	0.48	0.51	0.52	0.54	0.54
2b	0.04	0.06	0.07	0.07	0.09	0.09	0.10	0.11	0.13	0.13	0.15
3a	<b>0.62</b>	0.68	0.68	0.69	0.70	0.71	0.71	0.71	0.74	0.74	0.77
3b	0.48	0.49	0.50	0.50	0.53	0.53	0.53	0.55	0.58	0.58	0.62
4	<b>0.64</b>	0.70	0.70	0.72	0.73	0.74	0.75	0.76	0.77	0.78	0.80

#### 4.1.2 GripTester precision on the track

Table 4.3 shows the average skid resistance measured by all GripTesters on the track sections, pooled between run standard deviation ( $s_r$ ), repeatability, pooled between machine standard deviation ( $s_L$ ) and reproducibility. Between machine standard deviation ( $s_L$ ) and reproducibility are also shown for the fleet without GripTester K. Values for  $s_r$  and repeatability have only been calculated including GripTester K because although its measurements are higher than the rest of the fleet, the variability within its own measurements was consistent with the remaining GripTesters.

Repeatability and reproducibility values, calculated for each test section on the track are independent of the level of skid resistance (plotting  $r$  or  $R$  against mean GN shows no strong correlation), and therefore an average value of repeatability and reproducibility can be calculated. In doing so, section 3b has been excluded because of the physical variability of the surface caused by repeated braking on this surface. This is in line with the practice in the annual SCRIM correlation trial when it is not used as one of the reference surfaces.

**Table 4.3 Precision of GripTesters on track sections**

Section	Mean	$s_r$	with GT K			without GT K		
			$r$	$s_L$	R	Mean	$s_L$	R
1a	0.61	0.03	0.08	0.06	0.18	0.59	0.05	0.14
1b	0.62	0.02	0.06	0.05	0.16	0.61	0.04	0.13
2a	0.49	0.02	0.05	0.04	0.11	0.48	0.03	0.10
2b	0.10	0.01	0.03	0.03	0.10	0.09	0.03	0.09
3a	0.70	0.02	0.05	0.04	0.11	0.70	0.03	0.11
3b	0.53	0.04	0.12	0.04	0.17	0.53	0.03	0.16
4	0.73	0.01	0.04	0.05	0.13	0.73	0.04	0.12

Average repeatability for the GripTester fleet, on the track is 0.05 GN.

Average reproducibility for the GripTester fleet, on the track, is 0.13 GN.

Average reproducibility for the GripTester fleet *without GripTester K*, on the track, is 0.12 GN.

## 4.2 GripTester – GripTester comparison on road test sections

### 4.2.1 Average GripNumbers on the road

Table 4.4 shows the average GripNumber measured by each GripTester. As with measurements on the track sections, values highlighted in bold and italics are those measurements which fall more than two standard deviations from the mean. There are more measurements falling outside two standard deviations from the mean – 8% of the total number of average values. There are no measurements falling more than three standard deviations from the mean. A slight increase in variability would be expected on the road sections because the road carries considerably more traffic than the TRL track; consequently the effect of varying test lines between GripTesters will be greater.

**Table 4.4 Average GripNumber measured on all road sections**

Section	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.46	0.47	0.49	0.57	0.50	0.47	0.47	<b>0.63</b>	0.54	0.55	0.55
2a	0.38	0.41	0.43	0.46	0.46	0.44	0.41	<b>0.57</b>	0.46	0.50	0.45
2b	0.76	0.79	0.79	0.81	0.90	0.75	0.79	<b>1.02</b>	0.87	0.91	0.83
3	0.60	0.61	0.60	0.65	0.62	<b>0.53</b>	0.59	0.66	0.67	0.67	0.68
4	0.62	0.62	0.61	0.65	0.64	0.55	0.61	0.70	0.68	0.70	0.67
5a	0.74	0.74	0.72	0.76	0.81	<b>0.66</b>	0.74	0.81	0.83	0.79	0.81
5b	0.42	0.44	0.45	0.48	0.49	0.45	0.43	<b>0.60</b>	0.46	0.50	0.48
6	0.45	0.46	0.48	0.48	0.46	<b>0.39</b>	0.46	0.50	0.49	0.53	0.51
7a	0.48	0.50	0.51	0.52	0.51	<b>0.42</b>	0.51	0.52	0.58	0.54	0.54
7b	0.62	0.68	0.63	0.66	0.63	<b>0.54</b>	0.65	0.66	0.70	0.71	0.71
8	0.45	0.48	0.49	0.48	0.49	<b>0.41</b>	0.46	0.50	0.54	0.53	0.52

Table 4.5 shows the same values, ordered by magnitude from left to right. When the average GripNumbers are arranged in order, it is clear that the GripTester K is no longer consistently measuring the highest skid resistance in comparison with the rest of the GripTester fleet, although it is generally above average. Testing on the road network represents normal operation for the crews. Differences between test line on the track due to the mounting point of the tow-hitch relative to the vehicle wheel path, for example, may not be reflected on the road because of each crew's experience with their own GripTester during normal operation. Table C.12 in Appendix C shows the distribution of these results graphically. It may be possible to observe patterns in the distribution of the data – for example some GTs systematically reading higher on certain surfacings, and lower on others. Investigation of these patterns is beyond the scope of this project, but this is a subject that may merit further work.

**Table 4.5 Average GripNumber measured on all road sections ascending order of magnitude left to right, colour-coded for GripTesters as above**

Section											
1	0.46	0.47	0.47	0.47	0.49	0.50	0.54	0.55	0.55	0.57	<b>0.63</b>
2a	0.38	0.41	0.41	0.43	0.44	0.45	0.46	0.46	0.46	0.50	<b>0.57</b>
2b	0.75	0.76	0.79	0.79	0.79	0.81	0.83	0.87	0.90	0.91	<b>1.02</b>
3	<b>0.53</b>	0.59	0.60	0.60	0.61	0.62	0.65	0.66	0.67	0.67	0.68
4	0.55	0.61	0.61	0.62	0.62	0.64	0.65	0.67	0.68	0.70	0.70
5a	<b>0.66</b>	0.72	0.74	0.74	0.74	0.76	0.79	0.81	0.81	0.81	0.83
5b	0.42	0.43	0.44	0.45	0.45	0.46	0.48	0.48	0.49	0.50	<b>0.60</b>
6	<b>0.39</b>	0.45	0.46	0.46	0.46	0.48	0.48	0.49	0.50	0.51	0.53
7a	<b>0.42</b>	0.48	0.50	0.51	0.51	0.51	0.52	0.52	0.54	0.54	0.58
7b	<b>0.54</b>	0.62	0.63	0.63	0.65	0.66	0.66	0.68	0.70	0.71	0.71
8	<b>0.41</b>	0.45	0.46	0.48	0.48	0.49	0.49	0.50	0.52	0.53	0.54

#### 4.2.2 GripTester precision on the road

Table 4.6 shows the average skid resistance measured by all GripTesters on the road sections, pooled between run standard deviation ( $s_r$ ), repeatability, pooled between machine standard deviation ( $s_L$ ) and reproducibility.

**Table 4.6 Precision of GripTester on road test sections**

Section	Mean	$s_r$	r	$s_L$	R
1	0.52	0.05	0.14	0.05	0.21
2a	0.45	0.04	0.11	0.05	0.18
2b	0.84	0.05	0.14	0.08	0.26
3	0.63	0.05	0.13	0.05	0.18
4	0.64	0.04	0.11	0.05	0.17
5a	0.76	0.05	0.14	0.05	0.20
5b	0.47	0.03	0.08	0.05	0.16
6	0.47	0.02	0.06	0.04	0.12
7a	0.51	0.03	0.09	0.04	0.14
7b	0.65	0.03	0.08	0.05	0.16
8	0.49	0.03	0.08	0.04	0.13

Average repeatability for the GripTester fleet, on the road is 0.10 GN.

Average reproducibility for the whole GripTester fleet, on the road, is 0.17 GN.

### 4.3 GripTester - SCRIM comparison

The SCRIM measurements were treated in a similar way to the GripTester measurements, except that the averaging length for each point is 10m and the standard speed correction to 50 km/h was applied. None of the measurements from individual runs were discarded as outliers using Dixon's or Cochrane's tests. Table 4.7 shows SCRIM coefficients from each individual SCRIM for each section along with the average SCRIM coefficient and the average GripNumber (not including GripTester K for the track sections).

Using pooled between run standard deviations for individual SCRIM measurements on each section on the track, the repeatability for SCRIM can be calculated as 0.03 SC. This is identical to the value for repeatability stated in the British Standard (British Standards, 2006). The average difference between measurements made by the two SCRIMs on the track is also 0.03 SC, and this is well within the stated reproducibility for the device. Although it was not an intended goal for the trial, these measurements of precision for the SCRIM confirm that the machines were operating normally during this running trial.

**Table 4.7 Average SCRIM Coefficients and GripNumbers for all sections**

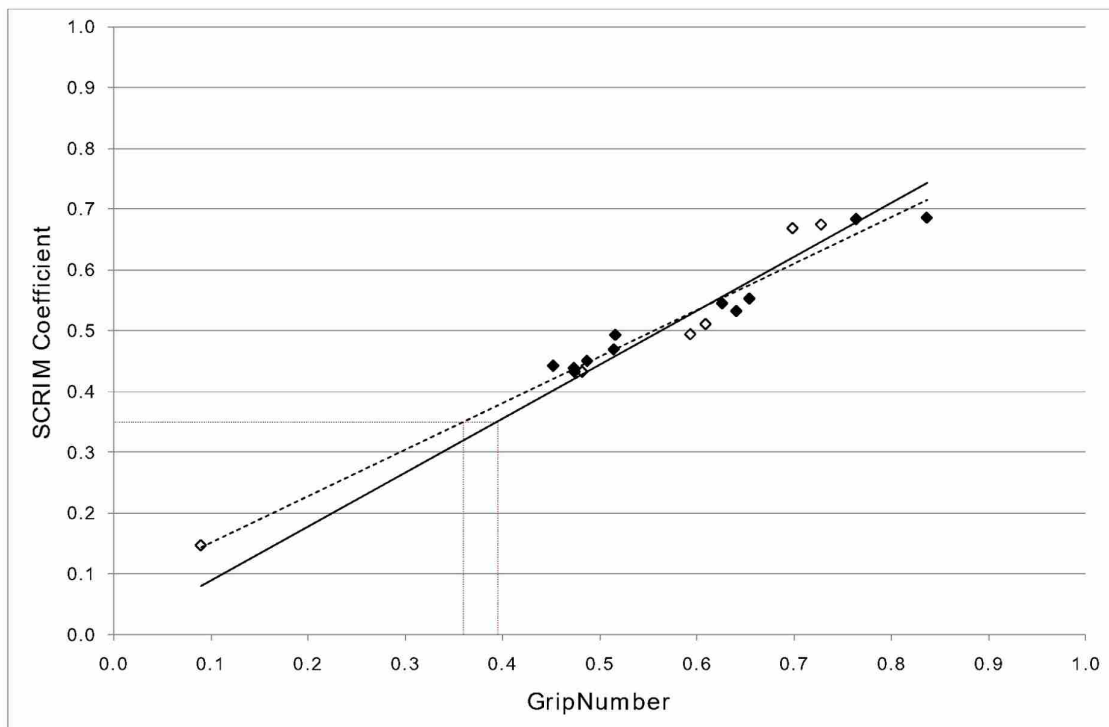
	Section	SCRIM		Mean SC	Mean GN
		X	Y		
Track sections	1a	0.49	0.50	0.49	0.59
	1b	0.50	0.52	0.51	0.61
	2a	0.41	0.45	0.43	0.48
	2b	0.14	0.16	0.15	0.09
	3a	0.64	0.70	0.67	0.70
	3b	0.56	0.62	0.59	0.53
	4	0.66	0.69	0.68	0.73
Road sections	1	0.48	0.51	0.49	0.52
	2a	0.45	0.44	0.44	0.45
	2b	0.67	0.71	0.69	0.84
	3	0.55	0.54	0.55	0.63
	4	0.53	0.54	0.53	0.64
	5a	0.70	0.66	0.68	0.76
	5b	0.43	0.44	0.43	0.47
	6	0.45	0.43	0.44	0.47
	7a	0.47	0.47	0.47	0.51
	7b	0.58	0.53	0.55	0.65
	8	0.46	0.44	0.45	0.49

The graph in Figure 4.1 shows SCRIM coefficient against GripNumber for test sections on the track (open symbols) and on the road (filled symbols). Section 3b on the track and all measurements from Griptester K on the track have been excluded. Two linear trend



lines have been drawn on the graph. The solid line has been forced to pass through the origin and the broken line has not.

It is possible that the devices would not give the same reading on a theoretical zero-friction surface, and the SCRIM-GripTester relationship below the lowest mutually recorded skid resistance may not be linear. The measurements do suggest that a relationship not passing through the origin is valid. However, a conversion based on the zero-intercept correlation is simpler, and more similar to the most recent previous correlation:  $SC = 0.85 * GN$  (Frankland, 2004). It also represents the fail-safe position - if this format is used for comparison against skidding standards then the risk of overestimating a surface's skid resistance is reduced. This is demonstrated by the construction lines drawn on the graph for conversion of the investigatory level  $SC=0.35$ .



**Figure 4.1 SCRIM coefficient vs GripNumber**

It is recommended that the conversion formula for GripTester to SCRIM be updated to reflect these findings:

$$SC = 0.89 * GN$$

This conversion should be used with caution and only in conjunction with a thorough review of local skid resistance policies.

## 5 Discussion

This trial tested the performance of the GripTester as a whole system, including operating crew, tow vehicle, water delivery system, and the device itself. This differs from the most recent trial (Frankland, 2004) which compared a relatively small number of GripTesters, and used a rotating running order to minimise the number of different tow vehicles involved.

Values for repeatability and reproducibility were calculated separately for the track and for the road test sections. The values derived from measurements on the track are likely to be closer to the variability of the GripTester system alone, with less influence from the measured surface. Repeatability, calculated on the track, is 0.05 GN. In order to compare this directly with repeatability for SCRIM, the conversion calculated in Section 4.3 should be applied, and this yields a repeatability of 0.04 SC. The reproducibility, calculated on the track, is 0.12 GN, or 0.10 SC.

In the case of SCRIM, annual correlation trials are carried out in order to ensure that variability within and between machines falls within defined boundaries. This is significant when comparing skid resistance measurements against investigatory levels set out in policy (Design Manual for Roads and Bridges, 2004), and the purpose is to control the risk of overestimating the skid resistance on a road surface. Since investigatory level boundaries are set at 0.05 SC intervals, it is desirable to target variability within this range.

Any variability observed will necessarily be influenced by the GripTester trailer, the tow vehicle (including the towing arrangement), the operator, the driver, the water flow system and natural variation on the surface. The trials have shown that operators can have confidence in measurements made by their own GripTester systems and repeat measurements should be easily comparable. However, care should be taken when any of the influencing factors listed are changed, and measurements made by different GripTester systems may not be so consistent.

A significant factor in the variability is likely to be as a result of differing operating practices, including the exact test line followed. It should be noted that an observation made during the running trial was that the SCRIM crews, who had both previously attended SCRIM correlation trials, were more experienced at the operation of their vehicles in this situation, and were more familiar with the test sections, and the test lines to be followed. Similar observations have been made in previous GripTester trials (Roe, 1993), and this will only be mitigated through regular attendance at future trials.

The two SCRIMs measured skid resistance on the same sections following the same prescribed test line. An updated conversion equation was calculated:  $SC = 0.89 * GN$ . It is recommended that this conversion equation supersedes all previous versions and that it is used with caution, in conjunction with a thorough review of local skid resistance policies.

It is further recommended that:

- A trial of this type should be held annually. It is likely that reproducibility (at least from measurements made on a test track) will naturally decrease as GripTester operators become familiar with the trial format
- The GripTester for roads User Group establishes a standard operating procedure for use during all survey work and during future trials
- Future trials should include both road and track test sections, but more repeat runs should be carried out on the road test sections so that repeatability can be calculated more accurately on these sections

- Objective measurements to identify outlying GripTesters should be developed for use in future trials. The data collected during this trial is a valuable resource and could be used for development and validation of trial methodologies
- GripTester users should be encouraged to attend future trials and voluntary, independent, device accreditation should be considered.

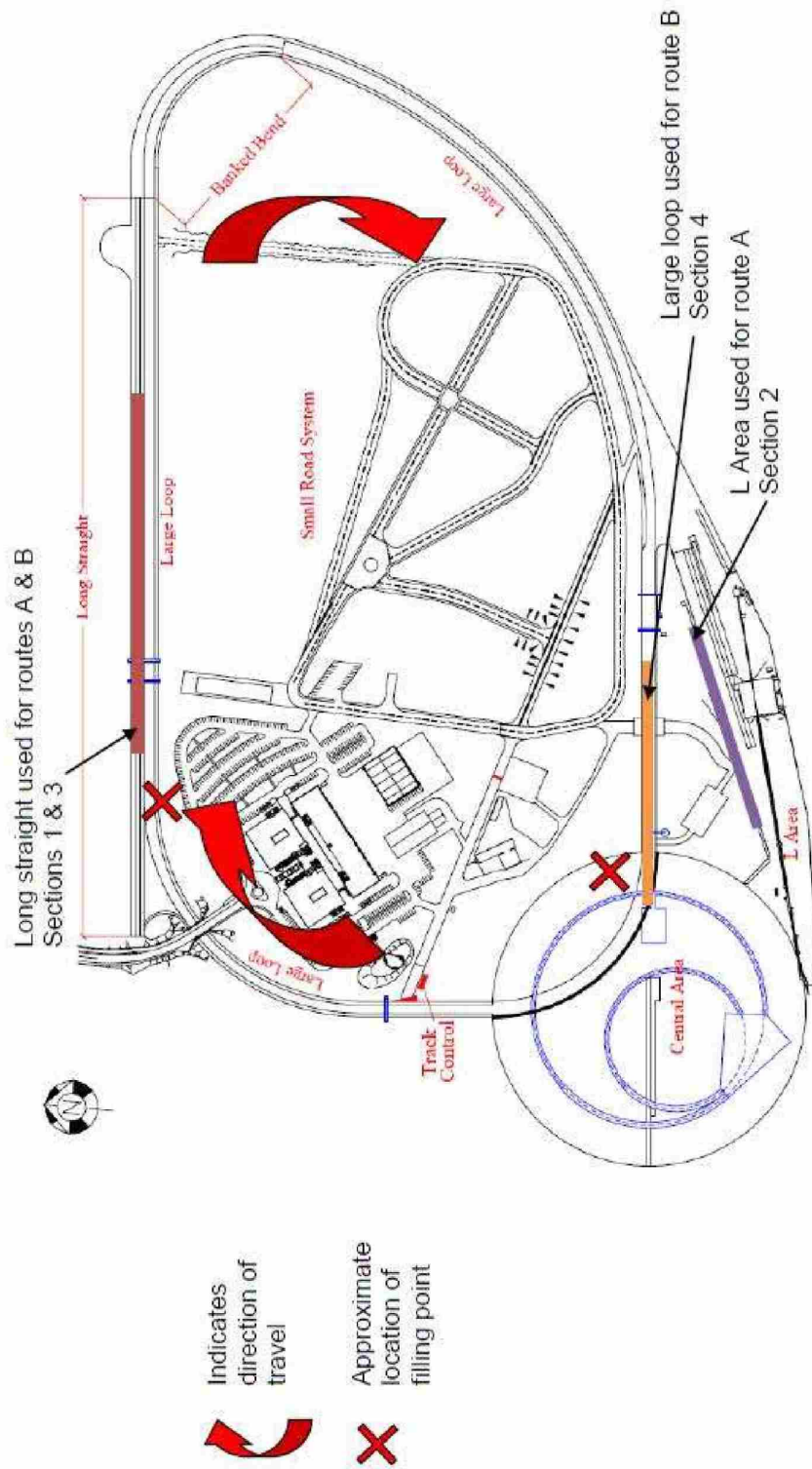
## Acknowledgements

The work described in this report was carried out in the Infrastructure Division of the Transport Research Laboratory. The author is grateful to H Viner, P Roe, and D Frankland who reviewed this report, to the ADEPT project team for advice and input, to Findlay Irvine for technical support and to all the trial attendees.

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## Appendix A Maps



**Figure A.1 Schematic plan of TRL track and location of test sections**



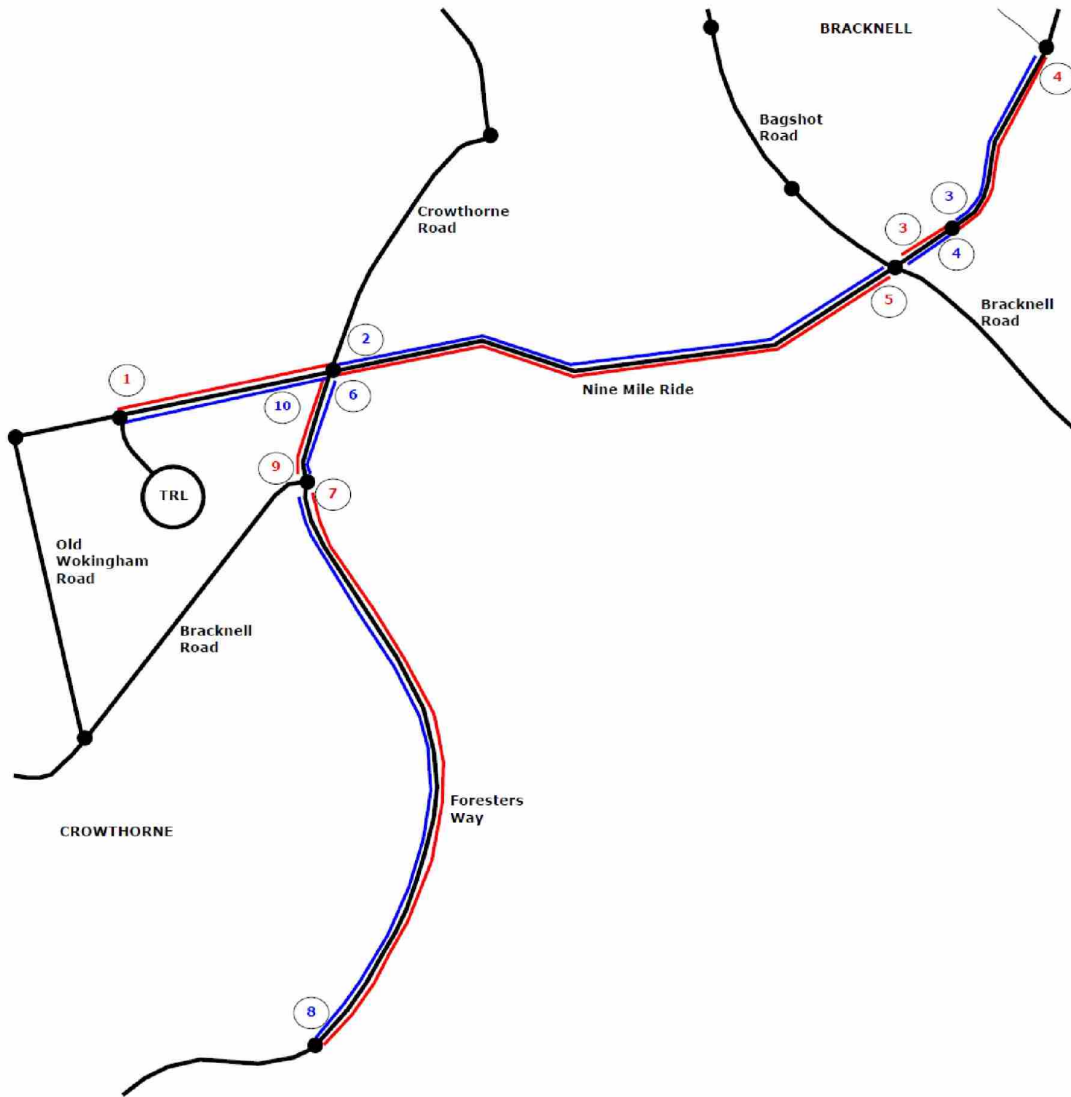


Figure A.2 Schematic map of local road route

## Appendix B Measurements made on the track

The following tables show average skid resistance values measured by all GripTesters for each sub-section on the TRL track. Cells are blank where the GripTester failed to complete a test set. Cells are highlighted in blue to show which values are judged to be outliers at the 1 % level by Cochran's and/or Dixon's tests. Values of standard deviation, repeatability and reproducibility are calculated without including these outliers.

**Table B.1 Average GripNumbers measured on Section 1 a**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.61	0.31	0.58	0.63	0.56	0.58	0.64	0.65	0.58	0.71	0.67
2	0.56	0.66	0.55	0.60	0.56	0.58	0.65	0.65	0.57	0.76	0.65
3	0.57	0.71		0.62	0.54	0.58	0.61	0.63	0.57	0.76	0.63
4	0.61	0.69	0.55	0.59	0.57	0.51	0.62	0.63	0.60	0.79	0.64
5	0.54	0.65	0.53	0.56	0.54	0.55	0.62	0.59	0.57		0.67
6	0.52	0.66	0.51	0.59	0.56	0.57	0.58	0.60	0.59		0.58
7	0.57	0.73	0.54	0.61	0.55	0.54	0.61	0.64	0.57	0.74	0.63
8	0.52	0.62	0.51	0.62	0.54	0.51	0.64	0.66	0.55	0.70	0.65
9	0.52	0.67	0.50	0.54	0.54	0.54	0.64	0.62	0.56	0.66	0.64
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>	<b>R</b>						
	0.03	0.06		0.08	0.18						

**Table B.2 Average GripNumbers measured on Section 1 b**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.62	0.54	0.61	0.67	0.61	0.53	0.62	0.64	0.60	0.76	0.67
2	0.58	0.74	0.59	0.66	0.58	0.59	0.61	0.61	0.60	0.70	0.65
3	0.55	0.69		0.65	0.56	0.57	0.65	0.61	0.60	0.70	0.68
4	0.56	0.67	0.58	0.70	0.59	0.53	0.61	0.59	0.61	0.71	0.66
5	0.57	0.68	0.59	0.69	0.58	0.55	0.62	0.61	0.60		0.65
6	0.58	0.67	0.57	0.67	0.56	0.54	0.62	0.59	0.60		0.65
7	0.55	0.68	0.58	0.63	0.58	0.55	0.62	0.60	0.57	0.73	0.61
8	0.55	0.64	0.57	0.71	0.57	0.54	0.60	0.62	0.59	0.72	0.64
9	0.53	0.66	0.56	0.61	0.56	0.53	0.63	0.62	0.59	0.72	0.62
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>	<b>R</b>						
	0.02	0.05		0.06	0.16						

**Table B.3 Average GripNumbers measured on Section 2 a**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.46	0.32	0.49	0.48	0.48	0.46	0.52	0.55	0.49	0.53	0.54
2	0.45	0.48		0.51	0.50	0.49	0.58	0.54	0.50	0.54	0.54
3	0.46	0.46		0.51	0.47	0.46	0.45	0.55	0.49	0.56	0.52
4	0.43	0.46	0.46	0.49	0.46	0.48	0.55	0.54	0.48	0.55	0.53
5	0.44	0.47	0.47	0.49	0.47	0.43	0.53	0.53	0.48		0.54
6	0.44	0.46	0.47	0.48	0.46	0.43	0.50	0.55	0.49		0.53
7	0.43	0.45	0.47	0.45	0.45	0.48	0.49	0.52	0.46	0.53	0.52
8	0.41	0.47	0.46	0.46	0.45	0.43	0.47	0.52	0.47	0.53	0.49
9	0.41	0.45	0.46	0.46	0.44	0.46	0.48	0.55	0.47	0.58	0.52
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>					
	0.02	0.04		0.05		0.11					

**Table B.4 Average GripNumbers measured on Section 2 b**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.05	0.01	0.07	0.10	0.07	0.11	0.08	0.10	0.06	0.14	0.13
2	0.04	0.12		0.09	0.07	0.08	0.07	0.08	0.06	0.16	0.15
3	0.05	0.10		0.11	0.08	0.09	0.11	0.08	0.06	0.16	0.14
4	0.04	0.14	0.08	0.10	0.08	0.10	0.13	0.09	0.06	0.16	0.13
5	0.04	0.11	0.06	0.12	0.07	0.10	0.11	0.09	0.06		0.13
6	0.04	0.12	0.08	0.09	0.08	0.09	0.13	0.11	0.07		0.14
7	0.05	0.14	0.07	0.09	0.07	0.10	0.12	0.10	0.06	0.13	0.13
8	0.03	0.15	0.06	0.08	0.06	0.06	0.12	0.10	0.06	0.14	0.12
9	0.03	0.12	0.07	0.08	0.07	0.09	0.10	0.10	0.07	0.16	0.15
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>					
	0.01	0.03		0.03		0.10					

**Table B.5 Average GripNumbers measured on Section 3 a**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.69	0.71		0.74	0.73	0.61	0.71	0.74	0.72	0.78	0.76
2	0.69	0.69		0.74	0.71	0.62	0.74	0.75	0.72	0.91	0.77
3	0.69	0.69		0.74	0.74	0.64	0.71	0.75	0.74	0.80	0.75
4	0.66	0.68	0.67	0.73	0.71	0.62	0.69	0.73	0.71	0.77	0.73
5	0.68	0.70	0.69	0.72	0.69	0.63	0.69	0.74	0.71	0.89	0.75
6	0.68	0.70	0.69	0.71	0.69	0.63	0.71	0.74	0.72		0.75
7	0.67	0.68	0.68	0.68	0.69	0.62	0.69	0.74	0.70	0.75	0.72
8	0.65	0.67	0.68	0.68	0.70	0.61	0.67	0.73	0.71	0.75	0.71
9	0.68	0.68	0.68	0.68	0.69	0.62	0.68	0.74	0.71	0.74	0.73
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>					
	0.02	0.04		0.05		0.11					

**Table B.6 Average GripNumbers measured on Section 3 b**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.52	0.58		0.62	0.65	0.62	0.58	0.58	0.54	0.61	0.67
2	0.49	0.49		0.64	0.57	0.59	0.53	0.57	0.53	0.66	0.64
3	0.49	0.48		0.60	0.63	0.58	0.53	0.54	0.51	0.61	0.59
4	0.45	0.47	0.48	0.63	0.49	0.52	0.55	0.52	0.49	0.64	0.59
5	0.47	0.46	0.52	0.65	0.53	0.57	0.51	0.55	0.51	0.65	0.57
6	0.52	0.47	0.51	0.58	0.51	0.54	0.52	0.54	0.49		0.58
7	0.55	0.48	0.51	0.52	0.56	0.45	0.49	0.50	0.46	0.64	0.53
8	0.43	0.50	0.47	0.53	0.50	0.44	0.52	0.51	0.47	0.58	0.53
9	0.49	0.47	0.49	0.49	0.48	0.43	0.50	0.50	0.48	0.60	0.56
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>					
	0.04	0.04		0.12		0.17					

**Table B.7 Average GripNumbers measured on Section 4**

<b>Lap</b>	<b>GripTester</b>										
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>J</b>	<b>K</b>	<b>L</b>
1	0.72	0.75		0.75	0.74	0.64	0.73	0.79	0.76	0.83	0.78
2	0.72	0.76		0.75	0.74	0.65	0.73	0.79	0.77	0.82	0.79
3	0.72	0.76		0.74	0.74	0.65	0.73	0.79	0.76	0.82	0.78
4	0.71	0.73	0.70	0.73	0.73	0.64	0.72	0.78	0.75	0.80	0.76
5	0.70	0.77	0.71	0.73	0.73	0.64	0.72	0.78	0.74	0.81	0.78
6	0.70	0.76	0.71	0.73	0.72	0.65	0.72	0.78	0.77	0.80	0.78
7	0.67	0.72	0.69	0.72	0.71	0.63	0.70	0.77	0.75	0.79	0.76
8	0.68	0.73	0.69	0.72	0.72	0.63	0.71	0.77	0.77	0.77	0.76
9	0.68	0.73	0.69	0.74	0.72	0.63	0.70	0.77	0.77	0.79	0.77
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>	<b>R</b>						
	0.01	0.05		0.04	0.13						

**Table B.8 Table showing distribution of average GripNumbers for each GripTester on all track sections**

GN	Track section						
	1a	1b	2a	2b	3a	3b	4
0.01							
0.02							
0.03							
0.04				A			
0.05				J			
0.06				E C			
0.07				F D			
0.08				H			
0.09				G			
0.1				B L			
0.11				K			
0.12							
0.13							
0.14							
0.15							
<hr/>							
0.44			A				
0.45			F B E				
0.46			C				
0.47			J D				
0.48						B	
0.49						A	
0.5						C J	
0.51			G				
0.52			L				
0.53	C					G F H	
0.54	F E	F	H K				
0.55	A					E	
0.56	J	A					
0.57		E C				L D	
0.58	D	J					
0.59							
0.6							
0.61	G	H			F	K	
0.62	H	G					
0.63	L						F
0.64		L					
0.65							
0.66	B	D					
0.67		B					
0.68					A C		
0.69					B		
0.7					G		C A
0.71					E D J		
0.72		K					G
0.73	K						E
0.74					H L		D
0.75							B
0.76							J
0.77					K		L
0.78							H
0.79							
0.8							K
0.81							
0.82							
0.83							
0.84							
0.85							

## Appendix C Measurements made on the road

The following tables show average skid resistance values measured by all GripTesters for each sub-section on the local road route.

**Table C.1 Average GripNumbers measured on Section 1**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.43	0.45	0.46	0.54	0.50	0.46	0.46	0.59	0.49	0.55	0.53
2	0.49	0.48	0.51	0.59	0.49	0.48	0.48	0.66	0.59	0.56	0.56
	<b>s<sub>r</sub></b>		<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>				
	0.05		0.05		0.14		0.21				

**Table C.2 Average GripNumbers measured on Section 2 a**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.36	0.40	0.43	0.46	0.49	0.41	0.40	0.53	0.45	0.52	0.43
2	0.40	0.43	0.44	0.46	0.43	0.47	0.42	0.61	0.47	0.48	0.48
	<b>s<sub>r</sub></b>		<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>				
	0.04		0.05		0.11		0.18				

**Table C.3 Average GripNumbers measured on Section 2 b**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.73	0.75	0.78	0.81	0.91	0.78	0.77	1.00	0.87	0.91	0.78
2	0.79	0.82	0.80	0.80	0.89	0.72	0.81	1.03	0.87	0.91	0.88
	<b>s<sub>r</sub></b>		<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>				
	0.05		0.08		0.14		0.26				

**Table C.4 Average GripNumbers measured on Section 3**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.56	0.59	0.58	0.65	0.61	0.51	0.58	0.65	0.63	0.65	0.64
2	0.63	0.63	0.63	0.66	0.63	0.55	0.60	0.68	0.70	0.69	0.72
	<b>s<sub>r</sub></b>		<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>				
	0.05		0.05		0.13		0.18				

**Table C.5 Average GripNumbers measured on Section 4**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.58	0.61	0.59	0.64	0.64	0.54	0.60	0.69	0.65	0.70	0.63
2	0.65	0.63	0.63	0.66	0.64	0.57	0.61	0.72	0.71	0.71	0.71
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>					
	0.04	0.05		0.11		0.17					

**Table C.6 Average GripNumbers measured on Section 5 a**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.71	0.73	0.70	0.73	0.80	0.68	0.73	0.78	0.81	0.77	0.77
2	0.78	0.75	0.74	0.79	0.81	0.64	0.76	0.84	0.85	0.81	0.85
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>					
	0.05	0.05		0.14		0.20					

**Table C.7 Average GripNumbers measured on Section 5 b**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.39	0.43	0.43	0.48	0.48	0.45	0.43	0.60	0.45	0.50	0.46
2	0.45	0.46	0.46	0.47	0.50	0.45	0.43	0.61	0.48	0.50	0.51
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>					
	0.03	0.05		0.08		0.16					

**Table C.8 Average GripNumbers measured on Section 6**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.43	0.46	0.49	0.48	0.46	0.38	0.45	0.50	0.49	0.54	0.49
2	0.47	0.46	0.47	0.48	0.45	0.40	0.47	0.50	0.50	0.52	0.53
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>					
	0.02	0.04		0.06		0.12					



**Table C.9 Average GripNumbers measured on Section 7 a**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.47	0.49	0.49	0.52	0.50	0.42	0.50	0.53	0.56	0.54	0.51
2	0.50	0.51	0.53	0.52	0.52	0.42	0.52	0.52	0.60	0.55	0.58
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>					
	0.03	0.04		0.09		0.14					

**Table C.10 Average GripNumbers measured on Section 7 b**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.61	0.67	0.62	0.65	0.62	0.53	0.64	0.66	0.69	0.70	0.68
2	0.64	0.69	0.65	0.67	0.63	0.55	0.66	0.67	0.72	0.72	0.73
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>					
	0.03	0.05		0.08		0.16					

**Table C.11 Average GripNumbers measured on Section 8**

Lap	GripTester										
	A	B	C	D	E	F	G	H	J	K	L
1	0.44	0.46	0.49	0.49	0.47	0.41	0.46	0.50	0.53	0.53	0.49
2	0.46	0.49	0.50	0.48	0.50	0.41	0.46	0.50	0.55	0.54	0.56
	<b>s<sub>r</sub></b>	<b>s<sub>L</sub></b>		<b>r</b>		<b>R</b>					
	0.03	0.04		0.08		0.13					

**Table C.12 Table showing distribution of average GripNumbers for each GripTester on all road sections**

GN	Road section										
	1a	2a	2b	3a	4a	5a	5b	6a	7a	7b	8a
0.35											
0.36											
0.37											
0.38		A									
0.39								F			
0.4											
0.41		G B									F
0.42							A		F		
0.43		C					G				
0.44		F					B				
0.45		L					C F				
0.46	A	D J E					J	A	B E G		A
0.47	B G F										G
0.48							D L	D C	A		B D
0.49	C						E	J			E C
0.5	E	K					K	H	B		H
0.51								L	E C G		
0.52								K	H D		L
0.53				F							K
0.54	J								L K	F	J
0.55	L K				F						
0.56											
0.57	D	H									
0.58									J		
0.59				G							
0.6				A C			H				
0.61				B	G C						
0.62				E	A B					A	
0.63	H									E C	
0.64					E						
0.65				D	D					G	
0.66				H		F				D H	
0.67				J K	L						
0.68				L	J					B	
0.69											
0.7					H K					J	
0.71										L K	
0.72						C					
0.73											
0.74						B G A					
0.75		F									
0.76		A				D					
0.77											
0.78											
0.79			B C G			K					
0.8											
0.81			D			H E L					
0.82											
0.83			L			J					
0.84											
0.85											
0.86											
0.87			J								
0.88											
0.89											
0.9		E									
0.91		K									
0.92											
0.93											
0.94											
0.95											
0.96											
0.97											
0.98											
0.99											
1											
1.01											
1.02			H								
1.03											
1.04											
1.05											



A GripTester trial was carried out in Crowthorne on 13th October 2009. Members of the GripTester for roads User Group were invited to attend and eleven GripTesters participated. Skid resistance was measured by all machines, each having their own dedicated tow vehicle and crew, on sections of the TRL test track and on sections of local in-service roads. This report summarises the analysis of skid resistance results, and details the comparisons made between GripTesters, as well as estimates for the repeatability and reproducibility of the fleet.

In addition, two SCRIM (sideway force coefficient routine investigation machine) vehicles were invited to attend, and skid resistance was measured using these devices on the same surfaces. A correlation between mean SCRIM Coefficient and GripNumber has been calculated and is presented in this report.

As part of an ongoing commitment to improving the standing of the GripTester leading towards formal accreditation, recommendations for future trials are made.

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