A REVISED SKID RESISTANCE STANDARD FOR THE UK TRUCK ROADS

Ramesh Sinhal, Highways Agency, UK

Helen Viner, TRL Ltd, UK

John Donbavand, WDM Limited, UK

ABSTRACT

The standard for managing the skid resistance on the truck roads in the UK (HD28) has recently been revised. There are several differences to the previous standard issued in 2004 including the addition of new material, a revised format and some specific changes including:

- Incorporation of the Highways Agency's Interim Advice Note (IAN 98/07) for managing skid resistance. Relevant parts of this advice note have been incorporated in the new HD28 principally to facilitate a more effective and consistent application of the standard across the whole network.
- Recommended management and prioritisation procedures for investigating sites, acknowledging that it may not be possible to assess, in detail, all sites that are at or below the investigatory level;
- Different requirements for bends depending on the radius;
- The word accident has been changed to crash throughout the standard, this is because an accident is considered a random occurrence whereas most road crashes have one or more causes;
- Acknowledgement that it is not necessarily viable to equalise the risk of a skidding crash occurring over the whole network by simply applying different investigatory levels.

INTRODUCTION

The HD28/11 standard for managing the skid resistance on the truck roads has recently been issued. The standard is in 9 sections and 8 annexes. This paper outlines the standard and highlights and explains changes made.

The purpose of the standard is to describe how the provision of appropriate levels of skid resistance on in-service UK truck roads, i.e. motorways and all-purpose truck roads, will be managed.

To achieve consistency, skid resistance is measured using a specified device, under standardised conditions. These measurements are used to characterise the road surface and assess the need for maintenance, but cannot be related directly to the friction available to a road user making a particular manoeuvre at a particular time.

The objectives of this Standard are to:

- Maintain a consistent approach to the provision of skid resistance across the truck road network, so that road users find consistent friction characteristics when accelerating, braking and cornering.
- Provide a level of skid resistance appropriate to the nature of the road environment at each location. The appropriate level is determined from a combination of: network-wide analyses of crash history, consideration of friction demands by road users, local judgement of site-specific factors (by suitably experienced engineers) and that drivers are driving within the requirements of the Highway Code.

It is not possible to provide a uniform risk across the network on all sites simply by adjusting the skid resistance because certain sites such as approaches to pedestrian crossings and tight bends will generally always present a higher risk of wet skidding crashes than low risk area such as non-event sites.

The term crash rather than accident is used throughout HD28/11. This is because an accident can be considered an act of God with no direct cause whereas most crashes have one or more causes.

SUMMARY OF OPERATIONS

The summary of procedures for making and interpreting skid resistance measurements on UK truck roads and for the identification and prioritisation of sites for treatment, is described below and shown in Figure 1, which is taken from the standard.

Routine measurements of skid resistance are made and processed to derive Characteristic SCRIM Coefficient (CSC) values. The CSC is an estimate of the underlying skid resistance once the effect of seasonal variation has been taken into account. This value will be taken to represent the state of polish of the road surface. On receipt of processed survey data, the CSC values should be compared with the predetermined Investigatory Levels (ILs).

Investigatory Levels represent a limit, above which the skid resistance is considered to be satisfactory but at or below which the road is judged to require an investigation of the skid resistance requirements. Investigatory Levels are assigned by first allocating a Site Category to each length. Site Categories are chosen based on broad features of the road type and geometry plus specific features of the individual site. Investigatory Levels are assigned according to the perceived level of risk within each Site Category. Investigatory Levels will be reviewed on a rolling programme, to ensure that changes in the network are identified, local experience is applied and consistency is achieved.

Wherever the CSC is at or below the assigned Investigatory Level an investigation should be carried out, to determine whether treatment to improve the skid resistance is required or whether some other action is required.

The decision of whether treatment is necessary requires professional engineering judgement taking into account local experience, the nature of the site, the condition of the road surfacing and the crash history for the past three years. If successive investigations show that treatment is not warranted at the current level of skid resistance then consideration should be given to lowering the Investigatory Level.

The processes of setting Investigatory Levels and undertaking investigations are complementary, since local knowledge and experience gained through conducting detailed investigations can be used to refine the criteria for setting Investigatory Levels for similar types of site.

The investigation process will result in a number of lengths being recommended for treatment to improve the skid resistance. The priority for treatment will be established through a process that takes into account the observed crash history and the need for other maintenance works in the vicinity.

In general, following the operation of the Standard, maintenance treatment will be undertaken to improve the skid resistance once investigations have identified that not to do so would expose road users to a significantly increased risk of crashes in wet conditions.

Once a site requiring treatment to improve the skid resistance has been identified, signs warning road users that the road could be slippery shall be erected.

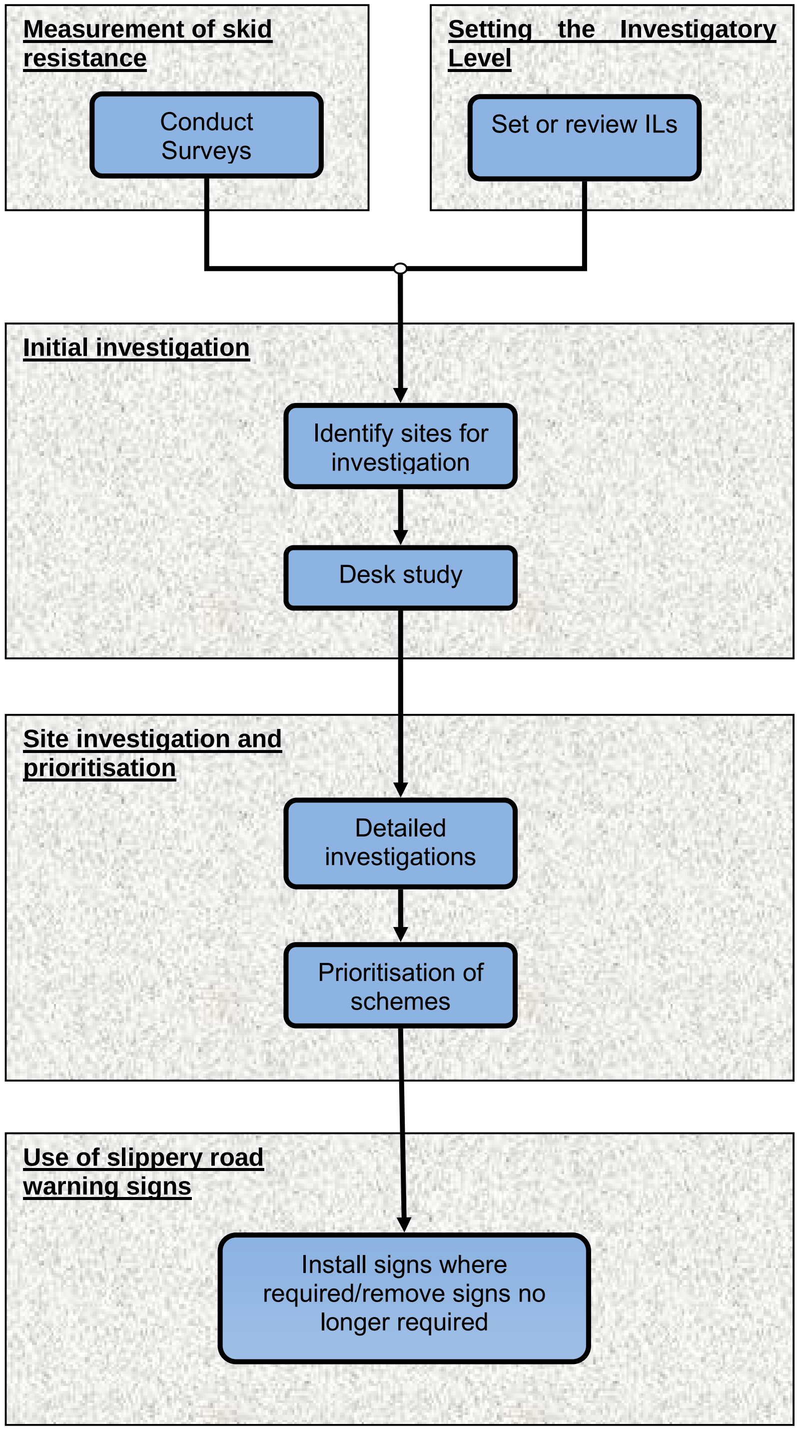


Figure 1: Summary of Operations

MEASUREMENT OF SKID RESISTANCE

The skid resistance of road surfaces can fluctuate within a year and between successive years, while maintaining a similar general level over a long period of time. By smoothing these fluctuations due to seasonal effects, sites exhibiting lower skid resistance can be identified more accurately.

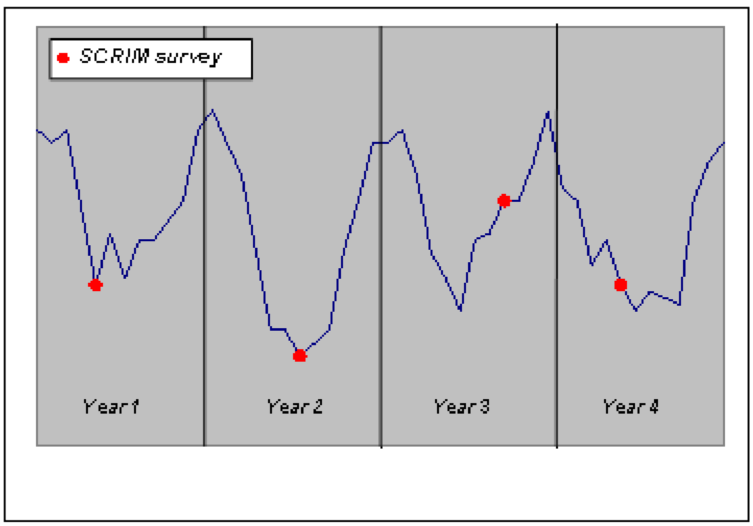
Characteristic SCRIM Coefficient

The basis of the Standard is that the overall (summer) level of skid resistance will be assessed rather than using a single measurement. This overall level of skid resistance is known as the Characteristic SCRIM Coefficient (CSC).

To obtain CSC values the whole network is tested each year and both between-year and within-year seasonal variation is addressed in reaching a best estimate of the equilibrium skid resistance of a surfacing. The method is known as the Single Annual SCRIM Survey (SASS) method. The main features of the procedure are:

- a single survey run is carried out for the whole network every year,
- results are converted to values of Characteristic SCRIM Coefficient (CSC) by applying a Local Equilibrium Correction Factor (LECF); The ECFs are applied by locality to produce LECF's because the influence of climate and the type of road could affect the within year skid resistance variation and hence the correction factor
- LECFs are established annually for each locality by comparing the mean skid resistance levels for the locality in the current year's survey with the corresponding values for the previous three years;
- the test period is rotated between Early, Middle and Late parts of the summer testing season, to avoid possible bias due to surveying in the same part of the testing season in consecutive years.

A diagrammatic representation of the SASS procedure is shown in Figure 2.



Calculating the CSC

The average of the previous three SC's is calculated; this is known as the Local Equilibrium SCRIM Coefficient (LESC).

The mean SC for all of the 10m readings in the locality for the current survey is calculated (LMSC).

The Local Equilibrium Correction factor (LECF) = LESC/LMSC.

The CSC = SC*LECF

Figure 2: SASS Procedure

Measuring Equipment

Various types of equipment are available for measuring skid resistance, however, the correlation between these machines is not robust enough to allow the machines to operate interchangeably. Therefore measurements for monitoring the in-service skid resistance of UK Truck Roads, in line with the Standard, can only be made with a Sideway-force Coefficient Routine Investigation Machine (SCRIM).

Also, only accredited SCRIMs, fitted with a dynamic vertical load measurement capability, shall be used for surveys on Truck Roads.

Figure 3: Sideway-force Coefficient Routine Investigation Machine (SCRIM).

Timing of the Surveys

Surveys are to be planned so that they will occur during the required survey period (early, middle or late) to allow for the determination of CSC values. These survey periods will be defined so that the low point in the summer should occur during the middle period. In the standard, it states that the dates for the survey periods may be specified by the Overseeing Organisation. For the Highways Agency network the survey periods were specified in the Interim Advice Note 98/07, and in the HA's SCRIM survey contracts. The dates from these documents are are shown in Table 1 along with those used for the current Highway Agency contracts.

Table 1: Dates for Survey Periods

Survey Period	Dates in IAN 98/07 (applicable to surveys carried out before 2010 on the HA network)	Dates in the current HA Contracts (applicable to surveys carried out after 2010 on the HA network)
Early	1st May to 20th Jun	1st May to 27th Jun
Middle	21st June to 10th August	28th June to 24th August
Late	11th August to 30th September	25th August to 20th October

Note that in 2010 each of the survey periods stated in the HA contract were extended by 1 week. This was because it was found, from research carried out on the long term study of benchmark sites, that the skid resistance for the late period was not recovering to form the expected inverted bell shape. The research also included a "very late" survey conducted in October. It was found that the skid resistance did recover for these very late surveys, which consequently led to the change in the survey period dates.

Conduct surveys

The standard states that measurements shall be carried out with the test wheel in the nearside (left) wheel path of the lane to be tested unless an alternative test line has been agreed with the Overseeing Organisation. For most roads, the leftmost lane will be tested in both directions of travel. If a section has hard shoulder running (i.e. the hard shoulder is open to traffic during peak times) then the hard shoulder will be surveyed only if specified.. If a survey of the hard shoulder is specified then this should be done in addition to the standard survey.

On Motorways and Dual Carriageway All Purpose Truck Roads where the posted speed limit is greater than 50mph, the target survey speed is 80km/h. On all other roads, the target survey speed is 50km/h.

Process survey data

The SCRIM survey machines provide data in the form of SCRIM readings. Following collection, the data needs to be processed and converted into the Characteristic SCRIM Coefficient (CSC) before use. This process is outlined below.

Speed Correction

SCRIM Readings for each 10m sub-section collected within the speed range 25 to 85km/h are corrected to a speed of 50km/h using the following equation

Speed corrected SR = SR(s) +(s*0.279 - 13.97)

Where:

Speed corrected SR is the SCRIM Reading corrected to 50km/h

SR(s) is the SCRIM Reading measured at test speed s

SCRIM Coefficient

SCRIM Coefficients can be calculated for each 10m sub-section for which a valid SCRIM reading is available using the following equation:

SC = (Speed corrected SR /100) * Index of SFC

The Index of SFC (Sideways Force Coefficient) currently in force is 0.78 and is applicable to all SCRIMs in current use.

Once the data have been loaded and checked, the CSC values can be determined.

SETTING THE INVESTIGATORY LEVELS

Site categories and an associated range of ILs are defined in Table 2. These categories and ranges were developed for truck roads and may not be applicable to local authority roads, which are more diverse in nature

Table 2: Site categories and Investigation Levels reproduced from the HD28 Standard

Site Category and definition		IL for CSC data (SCRIM data speed corrected to 50km/h and seasonally corrected)							
		0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65
A	Motorway								

B	Dual carriageway non-event or single 1-way carriageway non-event								
C	Single 2-way carriageway non-event								
Q	Approaches to and across minor and major junctions, approaches to roundabouts (see note 5)								
K	Approaches to pedestrian crossings and other high risk situations (see note 5)								
R	Roundabout								
G1	Gradient 5-10% longer than 50m (see note 6)								
G2	Gradient >10% longer than 50m (see note 6)								
S1	Bend radius <500m – dual carriageway (see note 7)								
S2	Bend radius <500m – single carriageway (see note 7)								

As in the previous standard, there is assistance in the annexes on selection of the appropriate categories and ILs from the range in Table 2

The investigatory levels (IL) shown in Table 2 and defined in the HD28/11 standard have not be changed from its predecessor. However, a specific change has been made to the S1 and S2 categories in the notes. Previously the notes stated that category S1 and S2 must not be applied to bends with a speed limit below 50 mph.

Whereas the revised standard states:

"Categories S1 and S2 should be applied only to bends with a speed limit of 50 mph or above, except if the radius of the bend is <100m, where the S1 and S2 categories shall be applied at all speeds".

This acknowledges that it is often not possible to travel greater than 50mph on bends with radii < 100m but these tight bends still provide a significant risk of wet skidding crashes at lower speeds.

As with the previous standard, the dark shading in Table 2 indicates the range of ILs that will generally be used for truck roads carrying significant levels of traffic. Light shading indicates a lower IL that will be appropriate in low risk situations, such as low traffic levels or where the risks present are mitigated, providing this has been confirmed by the crash history. Exceptionally, a higher or lower IL may be assigned if justified by the observed crash record and local risk assessment

INITIAL INVESTIGATION

This is a new section in the standard. Previously it was stated that a site investigation was required if the site is at or below the IL. The new standard acknowledges that the number of sites at or below the IL can be very large and it would be inefficient to expend resources to perform a detailed site investigation on every site. This section considers the validity of the data and provides a prioritisation process so that resources can be applied to the sites that have the greatest risk of wet skidding crashes occurring.

Identify Sites at or below the IL

The averaging lengths are truncated for any change of site category or IL or at 100m whichever, is the shorter. The mean CSC for the averaging length is to be examined to determine if it is at or below the IL.

Data Validation

Basic data validation checks are to be conducted for sites that have been identified as at or below the IL. This should include confirming that the IL has been assigned correctly in accordance with current guidance and that the skid resistance recorded is within the normal range expected.

If the IL is incorrect then it should be updated. If the skid resistance is then above the revised IL then further investigation is unnecessary and the change of IL should be recorded as the outcome of the investigation.

Identify sites for detailed investigation

Sites requiring detailed investigation should be identified based on the Site Category, IL, current skid resistance and observed crash history, giving greater ratings to sites that are substantially below the IL and where the crash history indicates that there is a risk of wet skidding crashes occurring.

The identification of sites requiring detailed investigation can be carried out using the TRL crash model or by an alternative ranking procedure described in the standard.

TRL Crash Model

A model that has been developed by TRL can be used to identify sites requiring detailed investigation. It utilises crash trends (both rate and severity) from historic HA truck road network data to predict the expected crash saving from the application of a surface treatment. The model requires the input of crash counts for the latest 3 years, CSC values, Site Category, IL and texture depth data. It then produces a score, which can be used to rate the particular site for a detailed site investigation.

Alternative ranking Procedure

The standard also provides an alternative scoring system which can be used to prioritise the various sites This system works by summing up the scores from the criteria in Table 3. If any site has a score greater than 6 then it should be considered for a detailed investigation.

Table 3: Scores for identification of sites requiring detailed investigation

Parameters	Scores and criteria				
Number of crashes	0	1	2	3+	
Score	0	4	8	12	
Likely impact of a crash	Slight	Slight / serious	Serious	Serious / fatal	
Score	1	2	3	4	
SCRIM Difference (SD)	>0	>-0.05 and ≤0	>-0.10 and ≤-0.05	>-0.15 and ≤-0.10	≤-0.15
Score	0	1	3	6	12
Site has SD≤0 and poor texture at the same point	No	Yes			

Score	0	1	

Explanation:

Number of crashes. Only validated crash data should be used.

Likely impact of a crash. The likely impact of a crash will vary from site to site, for example crashes on roundabouts are likely to be low speed rear or sideways collisions (i.e. slight). Whereas, a crash on a steep gradient on a single carriageway would possibly involve a head on collision which is likely to be serious or fatal.

SCRIM Difference (SD) is equal to the CSC value minus the Investigatory Level. Therefore, sites which should be investigated (CSC value at or below the Investigatory Level) will have a SCRIM Difference of zero or below (i.e. negative).

Site has SD≤0 and poor texture at the same point. If there is poor texture in combination with low levels of SCRIM then there is an increased crash risk due to skidding. Texture depths less than or equal to a Sensor Measured Texture Depth of 0.8mm are considered to be poor. Note, poor levels of texture combined with acceptable levels of SCRIM do not pose an increased crash risk for the purposes of the HD28 standard.

The need for a detailed site investigation of sites below the IL should be calculated by using the scoring system from either of the procedures described above.

DETAILED SITE INVESTIGATION AND PRIORITISATION

Once the sites that are going to have a detailed investigation have been identified, additional data may need to collected prior to going out on site.

Data Collation

Data that will assist decisions on site should be collated for each site investigated. The data collected should include mean CSC for the site, 10m skid resistance data for bends and roundabouts, texture depth and the last 3 years of crash data as a minimum. In addition, the following data should be considered, rut depth, longitudinal profile, gradient, crossfall and curvature data if they are relevant.

Site Investigation

The standard stipulates that site investigations should be carried out by personnel experienced in highway engineering. The standard has a template of a site investigation form as one of the annexes. This form guides the site investigator through a series of questions in order to collect the required data from the site to enable a risk assessment to be made.

Prioritising Schemes

The standard does not offer much guidance in prioritising schemes simply that any prioritisation should be based on the conclusions from the detailed site investigations and engineering judgement of the risk of road users being involved in a crash and the consequences.

This is because the individual Overseeing Organisations have separate processes for the prioritisation of maintenance schemes, including those arising from the implementation of HD28.

USE OF SLIPPERY ROAD WARNING SIGNS

The effectiveness of slippery road warning signs in reducing crash risk is unclear but it is generally believed that a proliferation of signs reduces the impact of the message and too many signs can simply be seen as clutter.

The standard stipulates that all sites that have been identified as requiring treatment to improve the skid resistance shall have warning signs erected. However, to stop a plethora of signs, short individual lengths requiring warning signs should be merged if they are separated by less than 1km.

In addition, the skid resistance at the location of all existing slippery road warning signs must be reviewed to determine whether the sign is still needed. This review should occur annually and once completed the schedule for warning signs shall be updated to include the signs that require removal.

AUTHOR BIOGRAPHIES

Ramesh Sinhal

Ramesh Sinhal currently works for the Highways Agencies and has held the position as Head of Pavements for the last 14 years. He is responsible for policies and standards for the strategic road network of England and indirectly supports the policies for the Scottish, Welsh and Northern Ireland road networks. Ramesh sits on the UK Department of Transport Roads Board as an advisor on policies for local roads. Ramesh has had many experiences on national and international transport related assignments throughout his career, which spans almost 40 years

Helen Viner

An experienced scientist and research manager, Helen joined TRL in 1997 following two years of post-doctoral research. Since then she has worked primarily in the field of pavement surface characteristics, where she has been responsible for innovative research and developing associated advice and standards. Her range of experience includes tyre-road interaction (friction, splash/spray and noise), crash trends, condition monitoring and performance indicators for pavement management. Helen has contributed to European projects on skid resistance and performance indicators, is a member of the TRB AFD90 committee on surface properties and chaired the technical committee of the 2008 conference on Safer Roads and Runways. Helen now leads the Safety and Consultancy Group at TRL, which delivers a portfolio of projects for Government, private sector and overseas clients, and has a strategic role in developing collaboration with Universities

John Donbavand

John began work in NZ after completing his PhD in the UK in 1983. John worked in NZ for 18 years and has held a number of positions including research scientist studying bitumen for the New Zealand Ministry of Works, Surfacing Scientist for the National Roads Board and Transit New Zealand and Engineering Policy Manager for Transit New Zealand. John returned to the UK in 2001 to take up the position as Project Development Manager at W.D.M. Limited in 2001. In this position, John has been involved with a wide range of projects, including: developing procedures to estimate the national maintenance budgets for Highway Agencies, asset valuation for local roads, providing scheme prioritisation techniques for Highway Authorities, providing skid policies and training for site investigation. John was also a member of the TRL group that assisted the Highway Agency to develop the latest HD28, to be published in 2011.