Design Manual for Roads and Bridges

Pavement
Inspection & Assessment

CS 228
Skidding resistance

(formerly HD 28/15)

Revision 2

Summary
This document describes the requirements for the provision and management of appropriate levels of skid resistance on UK motorway and all-purpose trunk roads. It describes the requirements for making and interpreting measurements of skid resistance. It also provides a method to identify locations for treatment to improve skid resistance where that treatment is likely to reduce the risk of skidding related incidents in wet conditions. This document is complemented by DMRB document HD 36/15, which sets out the requirements and associated advice on surfacing material characteristics necessary to deliver the required skid resistance properties.

Application by Overseeing Organisations
Any specific requirements for Overseeing Organisations alternative or supplementary to those given in this document are given in National Application Annexes to this document.

Feedback and Enquiries
Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated Highways England team. The email address for all enquiries and feedback is: Standards_Enquiries@highwaysengland.co.uk

This is a controlled document.

Contents

Release notes

Version	Date	Details of amendments
2	Jan 2021	Revision 2 (Jan 2021) Revised Scotland NAA added to suite. Revision 1 (March 2020) Revision to update references only. Revision 0 (August 2019) CS 228 replaces HD 28/15. The full document has been re-written to make it compliant with the new Highways England drafting rules.

Foreword

Publishing information

This document is published by Highways England.

This document supersedes HD 28/15, which is withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

Introduction

Background

In this document, the term "skid resistance" refers to the frictional properties of the road surface in wet conditions. The skid resistance of a wet or damp road surface can be substantially lower than the same surface when dry, and is more dependent on the condition of the surfacing material. It should also be noted that there is no boundary at which the skid resistance passes from being "safe" to being "dangerous".

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 document are to:

1) maintain a consistent approach to the provision of skid resistance across the Overseeing Organisations' motorway and all-purpose trunk roads, so that road users find appropriate friction characteristics when accelerating, braking and cornering;
2) 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 and local judgement of site-specific factors.

Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 3.N] apply to this document.

Mutual Recognition

Where there is a requirement in this document for compliance with any part of a "British Standard" or other technical specification, that requirement may be met by compliance with the Mutual Recognition clause in GG 101 [Ref 3.N].

Abbreviations

Abbreviations

Abbreviation	Definition
AADF	Annual average daily flow. The number of vehicles estimated to pass a given point on the road in a 24-hour period on an average day in the year.
CSC	Characteristic skid coefficient. The SC value that has been corrected for seasonal variations following the method appropriate to the survey strategy adopted by the Overseeing Organisation.
IL	Investigatory level. The level of skid resistance at or below which an investigation of the skid resistance is to be undertaken.
SC	A friction coefficient calculated from a sideway-force coefficient routine investigation machine reading, by application of a speed correction and index of SFC.
SFC	Sideways force coefficient
SD	Skid resistance difference. The value obtained by subtracting the Investigatory Level from the CSC.
SR(s)	The sideways force coefficient, measured at test speed s, multiplied by 100.
UKRLG	United Kingdom roads liaison group

Terms and definitions

Terms

Term	Definition
Dynamic vertical load measurement	Device to measure the vertical load on the test wheel whilst the machine is in motion. This is used to compensate for variations in load.
Index of sideways force coefficient	Index of SFC (sideways force coefficient). A factor applied to relate the values given by sideway-force coefficient routine investigation machines to historic values.
Managing Organisation	The contracted organisation commissioned to manage the network by the Overseeing Organisation.
Overseeing Organisation	Highways England or the highways or road authority of the Devolved Administration for Northern Ireland, Scotland or Wales, as appropriate, and their successors.
Seasonal variation	The variation in the skid resistance measured during the course of the year due to weathering and polishing cycles.
Site category	One of the levels within a broad classification of the road network according to the risk of skidding.
Skid resistance	The contribution of the road surface to the overall friction available between the tyre and the road surface is known as skid resistance.
Survey contractor	The organisation contracted to provide skid resistance measurements by either the Overseeing Organisation or the Managing Organisation.
Survey period	The period within which the survey is carried out.
Test lane	The lane in which the survey is carried out.
Test line	The line within the test lane that the test wheel follows.

1. Scope

Aspects covered

1.1 This document provides details of the requirements that shall be used to determine appropriate levels of skid resistance on the Overseeing Organisations' motorway and all-purpose trunk roads.

NOTE *This document is not applicable to footways and cycleways that are not subject to regular trafficking by heavy vehicles.*

1.1.1 Footways and cycle-ways designed and constructed in accordance with CD 239 [Ref 2.N] should provide appropriate skidding/slip resistance for the lifetime of the surfacing provided that routine maintenance activities are undertaken in accordance with the Overseeing Organisation's requirements.

1.2 This document lays down the procedure that shall be used for measuring the skid resistance and, for cases where the measured skid resistance is at or below a predetermined level, provides a methodology to assist the engineer in assessing the requirement for remedial works.

1.2.1 Remedial works may be subject to an economic assessment of the costs and benefits before proceeding, to promote the best use of maintenance budgets.

NOTE *Skid resistance surveys can sometimes be carried out for special purposes, such as research or local investigations. Due to the different test procedures, these measurements require careful interpretation. The data from such surveys do not form part of this document.*

1.3 This document shall not be used for the identification of locations or routes where road safety engineering measures could be beneficial to reduce crashes.

NOTE *In this document, the provision of appropriate levels of skid resistance is treated primarily as an asset management issue rather than one of road safety engineering, although the crash risk is assessed in order to determine an appropriate level of skid resistance for each site.*

Implementation

1.4 This document shall be implemented forthwith on all schemes involving new construction, improvement or maintenance on the Overseeing Organisations' motorway and all-purpose trunk roads according to the implementation requirements of GG 101 [Ref 3.N].

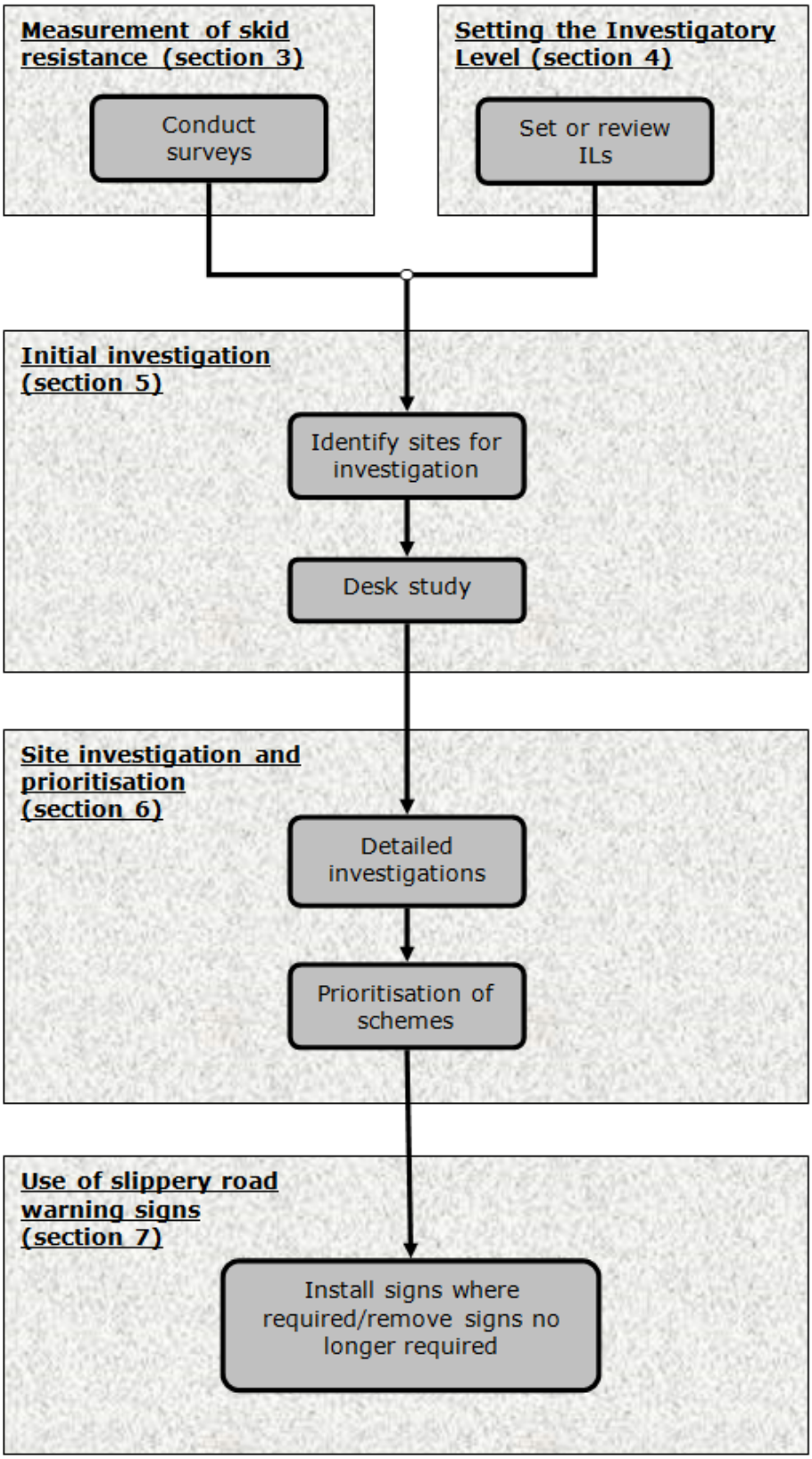
Use of GG 101

1.5 The requirements contained in GG 101 [Ref 3.N] shall be followed in respect of activities covered by this document.

2. Operation

2.1 This section summarises the procedures that shall be followed for making and interpreting skid resistance measurements and for the identification and prioritisation of sites for treatment, as indicated in Figure 2.1.

Figure 2.1 Overview of the operation of this document



2.2 Routine measurements of skid resistance shall be made using sideway-force coefficient routine investigation machines and processed to derive Characteristic Skid Coefficient (CSC) values in accordance with Section 3.

NOTE *The CSC is an estimate of the underlying skid resistance once the effect of seasonal variation has been taken into account. This value can be taken to represent the degree to which the road surface has become polished under the action of traffic.*

2.3 On receipt of processed survey data, the CSC values shall be compared with the predetermined Investigatory Levels (ILs), to identify lengths of road where the skid resistance is at or below the Investigatory Level.

NOTE *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. Site categories are assigned 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 can be reviewed on a rolling programme, to ensure that changes in the network are identified, local experience is applied and consistency is achieved. The process for setting Investigatory Levels and the normal range of Investigatory Levels for each site category are described in Section 4.*

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

NOTE *The investigation process is described in Sections 5 and 6. The decision on whether treatment is necessary is unlikely to be clear-cut, but 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 previous three years.*

2.4.1 If successive investigations show that treatment is not warranted at the current level of skid resistance then the Investigatory Level may be lowered (within the constraints of Table 4.2 and sub-clause 4.2.3 of this document).

NOTE *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.*

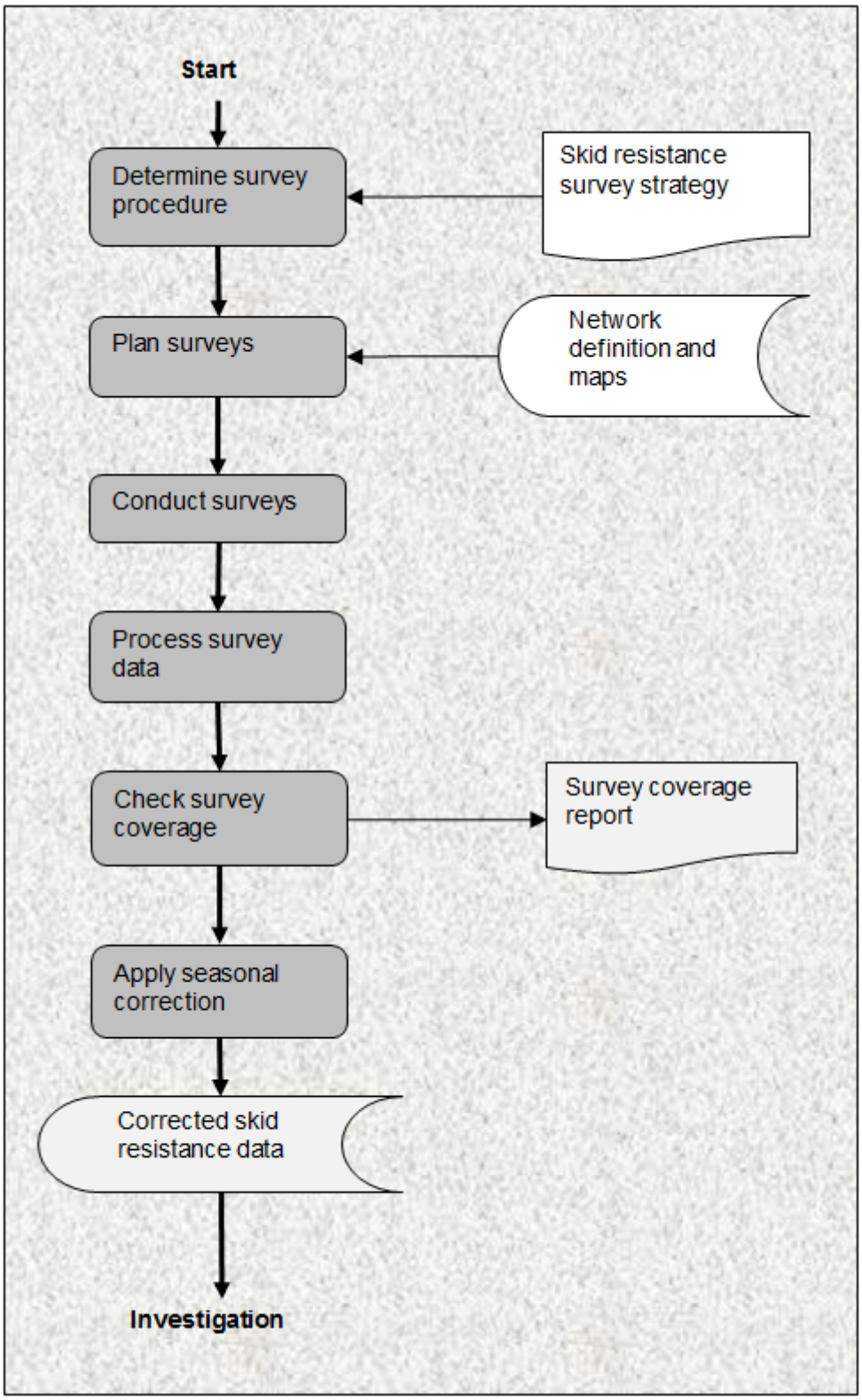
2.5 The priority for treatment for those lengths where an improvement in skid resistance is being recommended shall be established through the Overseeing Organisation's process for prioritising maintenance.

3. Measurement of skid resistance

Overview

3.1 This section details the procedure that shall be followed for planning and conducting skid resistance surveys and processing the data. The process is outlined in Figure 3.1.

Figure 3.1 Measurement of skid resistance



NOTE 1 The process is split into the following 6 steps.

1) determine the survey procedure;
2) plan surveys;
3) conduct surveys;

4) process survey data;

5) check survey coverage;

6) apply seasonal correction.

NOTE 2 The steps are detailed in turn below.

Determine the survey procedure

3.2 The basis of this document is that the overall (summer) level of skid resistance shall be assessed rather than using a single measurement. This overall level of skid resistance is referred to as the Characteristic Skid Coefficient (CSC).

NOTE 1 The skid resistance of road surfaces can fluctuate within a year and between successive years, while maintaining a similar general level over a longer period of time. By smoothing these fluctuations caused by seasonal effects, sites exhibiting lower skid resistance can be identified more accurately.

NOTE 2 The way in which surveys are planned and how seasonal variation is accounted for is provided in the National Application Annexes for each Overseeing Organisation.

3.3 Prior to the survey season, the network to be surveyed, the survey period, the test lane, the survey strategy and the method and/or the accuracy of location referencing required shall be established with the agreement of the Overseeing Organisation.

3.4 Measurements for monitoring the in-service skid resistance of motorway and all-purpose trunk roads shall be made with a sideway-force coefficient routine investigation machine that has been accredited by the Overseeing Organisation for use on its network and not with other skid resistance measurement devices.

NOTE Various types of equipment are available for measuring skid resistance. Work has been carried out that has produced some correlations between devices. However, these equations are not robust enough to allow the machines to operate interchangeably.

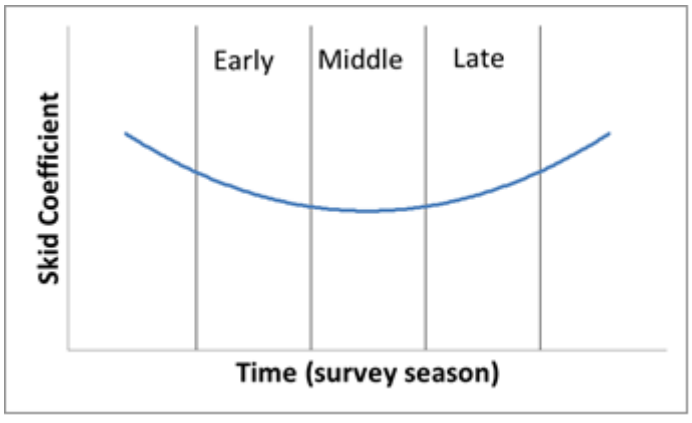
Plan surveys

3.5 The survey provider shall plan the survey routes.

3.6 Surveys shall be planned so that they will occur during the required survey period (early, middle or late) to allow for the determination of CSC values.

3.7 These survey periods shall be defined so that the low point in the summer occurs during the middle period, as shown in Figure 3.7.

Figure 3.7 Survey periods



3.8 The dates for the survey periods can differ for different geographic regions and shall be defined by the Overseeing Organisation.

NOTE *In exceptional circumstances the Overseeing Organisation can extend the testing season beyond these periods. This can only be done if the general weather conditions in the area remain unchanged and if no frosts or treatments to the road, such as gritting, have occurred.*

Conduct surveys

3.9 Survey contractors shall comply with the calibration and quality assurance detailed in British Standard BS 7941-1 [Ref 4.N] and the "Accreditation and Quality Assurance of Sideway-Force Skid Resistance Survey Devices" document available on the UK Roads Liaison Group (UKRLG) website AQA SFD 2016 [Ref 1.N].

3.10 In each direction of travel, the lane carrying the greatest number of heavy vehicles shall be tested.

NOTE *For most roads, this will be the leftmost permanent lane.*

3.10.1 Additional lanes, including the hard shoulder for sections where the hard shoulder is opened to traffic, may be surveyed only if required by the Overseeing Organisation.

3.11 If it is necessary for the machine to deviate from the test line (e.g. to avoid a physical obstruction or surface contamination such as mud, oil, grit etc.) the data shall be marked as invalid and subsequently discarded.

3.11.1 Where it is necessary for the machine to deviate from the test line, the invalid length should be resurveyed at a later date but still within the required survey period.

3.12 For the testing of roundabouts, after entering a roundabout a minimum of one complete circuit shall be tested.

NOTE *Ensuring that a complete circuit is surveyed can require the machine to complete more than one revolution of the roundabout.*

3.12.1 Where safe to do so, the preferred test line on roundabouts should be the outermost lane.

3.12.2 On multiple lane roundabouts with lane markings for different routes, it may be necessary to test an alternative lane to avoid conflict with other traffic.

NOTE *Roundabouts can present practical problems regarding potential traffic conflicts and testing speed. They range from small, mini-roundabouts to large grade-separated interchanges. Larger roundabouts can have free-flowing traffic or traffic light controls at certain times of day.*

3.13 Mini roundabouts and small island roundabouts that are physically too small to test as above shall be tested as part of the main carriageway and do not need to be tested separately.

3.14 Measurements shall not be undertaken where the air temperature is below 5˚C.

3.15 Testing shall be avoided in heavy rainfall or where there is standing water on the road surface.

NOTE *Excess water on the surface can affect the drag forces at the tyre/road interface and influence the measurements.*

3.16 Where the posted speed limit is greater than 50mph, the target survey speed shall be 80km/h.

3.17 On all other roads, the target survey speed shall be 50km/h.

3.18 The machine driver shall maintain a vehicle speed as close to the target survey speed as possible.

3.19 The survey operator shall maintain a record of weather conditions that could influence the survey results, such as heavy rainfall or strong winds.

Process survey data

3.20 On completion of the survey, the survey data shall be loaded into the Overseeing Organisation's information management systems and aligned to the road network.

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

Equation 3.21 To correct test reading speed to 50km/h for each sub-section

$$SR(50) = SR(s) \times \frac{-0.0152 \times s^2 + 4.77 \times s + 799}{1000}$$

NOTE 1 *Where: SR(50) is the value of SR(s) corrected to 50km/h*

NOTE 2 *SR(s) is the Sideways-Force Coefficient, measured at test speed s, multiplied by 100. This term is defined further in BS 7941-1 [Ref 4.N].*

3.22 Temperature correction shall not be applied.

3.23 SC values shall be calculated for each 10m sub-section for which a valid SR(s) value is available using the following equation:

Equation 3.23 To calculate SC values using a valid SR(s) value for sub-sections

$$SC = \left(\frac{\text{SR(50)}}{100}\right) \times \text{Index of SFC}$$

NOTE *The Index of SFC (Sideways Force Coefficient) is currently 0.78.*

Check survey coverage

3.24 The survey machine operator shall produce a survey coverage report detailing the network that was to be surveyed, lengths with missing or invalid data, and an explanation for the missing or invalid data.

Apply seasonal correction

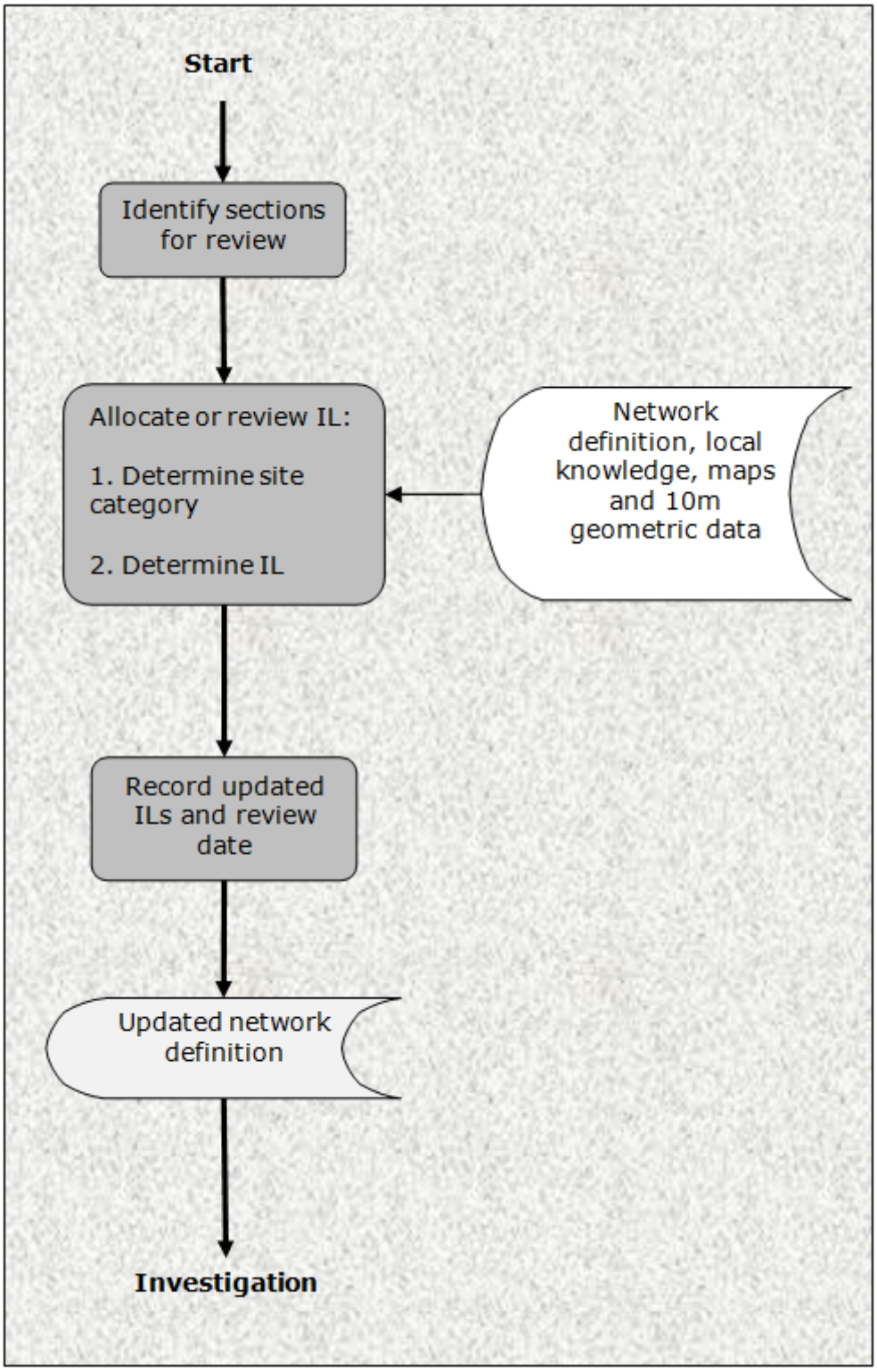
3.25 Once the data have been loaded and checked, the seasonally corrected CSC values shall be determined from the SC values following the method appropriate to the survey strategy, as described in the National Application Annexes.

4. Setting the investigatory level

Overview

4.1 The process that shall be followed for reviewing and assigning site categories and investigatory levels is outlined in Figure 4.1.

Figure 4.1 Setting the investigatory level



NOTE *The process is split into the following 3 steps.*

1) allocate site category and IL;

2) identify sections for review;

3) record updated ILs and review date.

Allocate site category and investigatory level

4.2 An investigatory level (IL) shall be assigned for every part of the network, by determining the most appropriate site category for each location and then selecting an appropriate IL from the range indicated in Table 4.2 for that site category.

Table 4.2 Site categories and investigatory levels

Site category and definition		IL for CSC data (skid 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	LR	ST						
B	Non-event carriageway with one-way traffic	LR	ST	ST					
C	Non-event carriageway with two-way traffic		LR	ST	ST				
Q	Approaches to and across minor and major junctions, approaches to roundabouts and traffic signals (see 4.5)				ST	ST	ST		
K	Approaches to pedestrian crossings and other high risk situations (see 4.5)					ST	ST		
R	Roundabout				ST	ST			
G1	Gradient 5-10%, longer than 50m (see 4.6)				ST	ST			
G2	Gradient >10%, longer than 50m (see 4.6)				LR	ST	ST		
S1	Bend radius <500m – carriageway with one-way traffic (see 4.7 and 4.9)				ST	ST			
S2	Bend radius <500m – carriageway with two-way traffic (see 4.8 and 4.10)				LR	ST	ST		

NOTE 1 *Sites with the same site category can have different levels of risk of skidding crashes. There is therefore the flexibility to set different ILs for different sites within the same category.*

NOTE 2 *This allows sites where the risk of skidding crashes is potentially higher to have a higher IL and possibly be treated to maintain a higher level of skid resistance.*

NOTE 3 *The objective of setting an IL is to assign a level of skid resistance appropriate for the risk on the site, at or below which further investigation is required to evaluate the site specific risks in more detail.*

NOTE 4 *Advice for selecting an appropriate IL is provided in Appendix A. The range of ILs for each site category has been developed as a result of UK research studies on motorway and all-purpose trunk roads and reflects the variation in crash risk within a site category.*

4.2.1 'ST' in cells within Table 4.2 indicates the range of ILs that should generally be used for roads carrying significant levels of traffic.

4.2.2 'LR' in cells indicates a lower IL that may be appropriate in lower risk situations, such as low traffic levels or where the risks present are mitigated by other means, providing this has been confirmed by the crash history.

4.2.3 Exceptionally, an IL higher or lower than those indicated in Table 4.2 may be assigned if justified by the observed crash record and local risk assessment.

4.3 If more than one site category is appropriate then the site category with the highest recommended IL shall be selected.

4.4 If the highest recommended IL for the site categories are the same then the category highest up the table shall be selected (A being the highest on the table and S2 the lowest).

4.5 ILs for site categories Q and K shall be based on the 50m approach to the feature and, in the case of approach to junctions, through to the extent of the junction.

4.5.1 The approach length may be extended when justified by local site characteristics.

4.6 Categories G1 and G2 shall not be applied to uphill gradients on carriageways with one-way traffic.

4.7 Category S1 shall be applied to all bends on carriageways with one-way traffic where the radius of curvature is <100m.

4.8 Category S2 shall be applied to all bends on carriageways with two-way traffic where the radius of curvature is <100m.

4.9 Category S1 shall be applied to bends on carriageways with one-way traffic with a radius of curvature $\geq$ 100m but <500m where the speed limit is $\geq$ 50mph.

4.10 Category S2 shall be applied to bends on carriageways with two-way traffic with a radius of curvature $\geq$ 100m but <500m where the speed limit is $\geq$ 50mph.

4.11 The site category and IL applied to a length shall be applied to all lanes of the carriageway that have traffic running in the same direction.

4.11.1 All lanes of the carriageway (with the same direction of traffic) should be included when identifying what site category and IL will be applied. This includes the hard shoulder where hard shoulder running is implemented.

4.12 The site category and IL information shall be recorded together with the date of assessment.

Identify sections for review

4.13 A review of the IL shall be carried out when a significant change to the network is made, for example changes to the road layout.

4.14 A procedure shall be put in place for reviewing the IL at least every three years.

NOTE *The review of the IL can be done by reviewing one third of the network each year or all of the network every three years.*

4.15 Lengths with missing IL data, or where the IL lies outside the range specified in Table 4.2, shall be included in each review.

Record updated ILs and review date

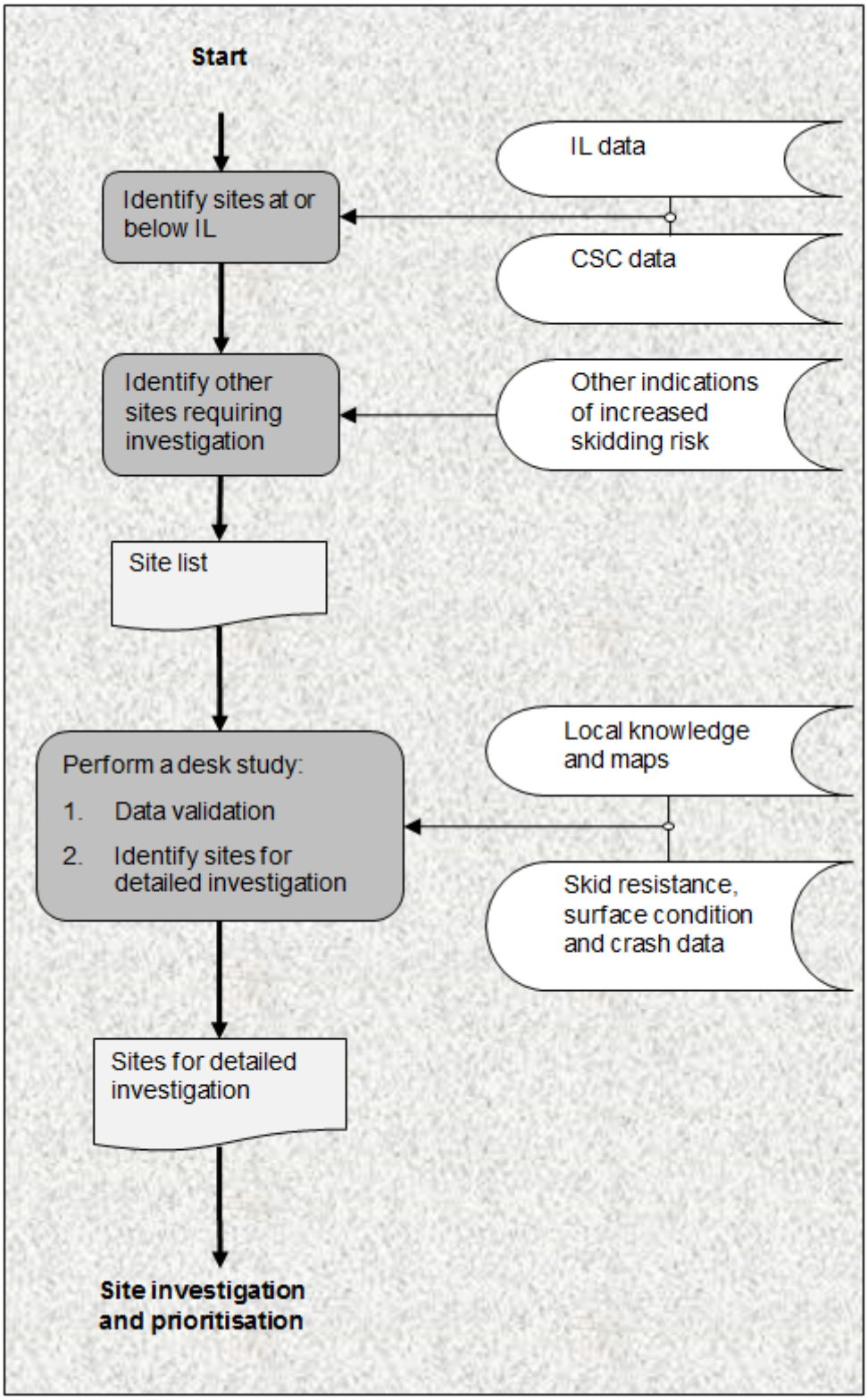
4.16 The sections reviewed shall be recorded, together with the review date and any changes to the site categories and ILs.

5. Initial investigation

Overview

5.1 The process that shall be followed for the initial investigation is outlined in Figure 5.1.

Figure 5.1 Initial investigation



NOTE *The process is split into the following steps.*

1) identify sites at or below the IL;

2) identify other sites requiring investigation;

3) data validation;

4) identify sites for detailed investigation.

5.2 All sites where the measured CSC is at or below the IL shall be investigated.

NOTE *The objective is to determine whether a surface treatment is justified to reduce the risk of vehicles skidding, whether some other form of action is required, or whether no action is currently required. If no action is taken, sites will automatically be reviewed again following the next skid resistance measurement if they remain at or below the IL.*

5.3 The investigation shall be undertaken in two stages: an initial investigation, described in this section, to check the data and assess the need for a detailed investigation and, secondly, a detailed investigation to assess the justification and priority for treatment, which is described in Section 6.

Identify sites at or below the IL

5.4 The CSC value, calculated for the appropriate averaging length, shall be compared against the IL.

NOTE *The appropriate averaging length is normally 100m or the length of a feature if it is shorter, except for roundabouts, where the averaging length is 10m.*

5.5 The averaging length shall be truncated on any change of site category or IL.

5.5.1 Consequently, the averaging length will be shorter where the site category is less than 100m long or at the end of a site category longer than 100m. Residual lengths less than 50% of a complete averaging length may be appended to the penultimate length, if both the lengths have the same site category and IL.

NOTE *If the skid resistance is close to the IL, successive 10m or 100m lengths can fall alternately above and below the IL. These lengths can be combined into a single site for investigation. The longer lengths are also more robust for crash analysis. Subsequent detailed investigations can show that only part of this length would require treatment.*

Identify other sites requiring investigation

5.6 An investigation shall also be carried out if, as a result of processes separate from those detailed in this document, sites are identified where increased wet or skidding crash levels have been observed.

5.6.1 Examples of the processes referred to in clause 5.6 may include annual safety reports, police complaints, Managing Organisation observations and damage to roadside furniture.

Data validation

5.7 Basic data validation checks shall be conducted for sites that have been identified as at or below the IL, including confirmation that the IL has been assigned correctly in accordance with current guidance and that the skid resistance recorded is within the normal range expected.

5.8 If the IL is incorrect then it shall be updated and recorded together with the date of the change.

5.8.1 If the skid resistance is 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

5.9 Sites at or below IL requiring detailed investigation shall be identified based on the site category, IL, current skid resistance and observed crash history.

NOTE *Further details of how to identify sites requiring detailed investigation are provided in the National Application Annexes.*

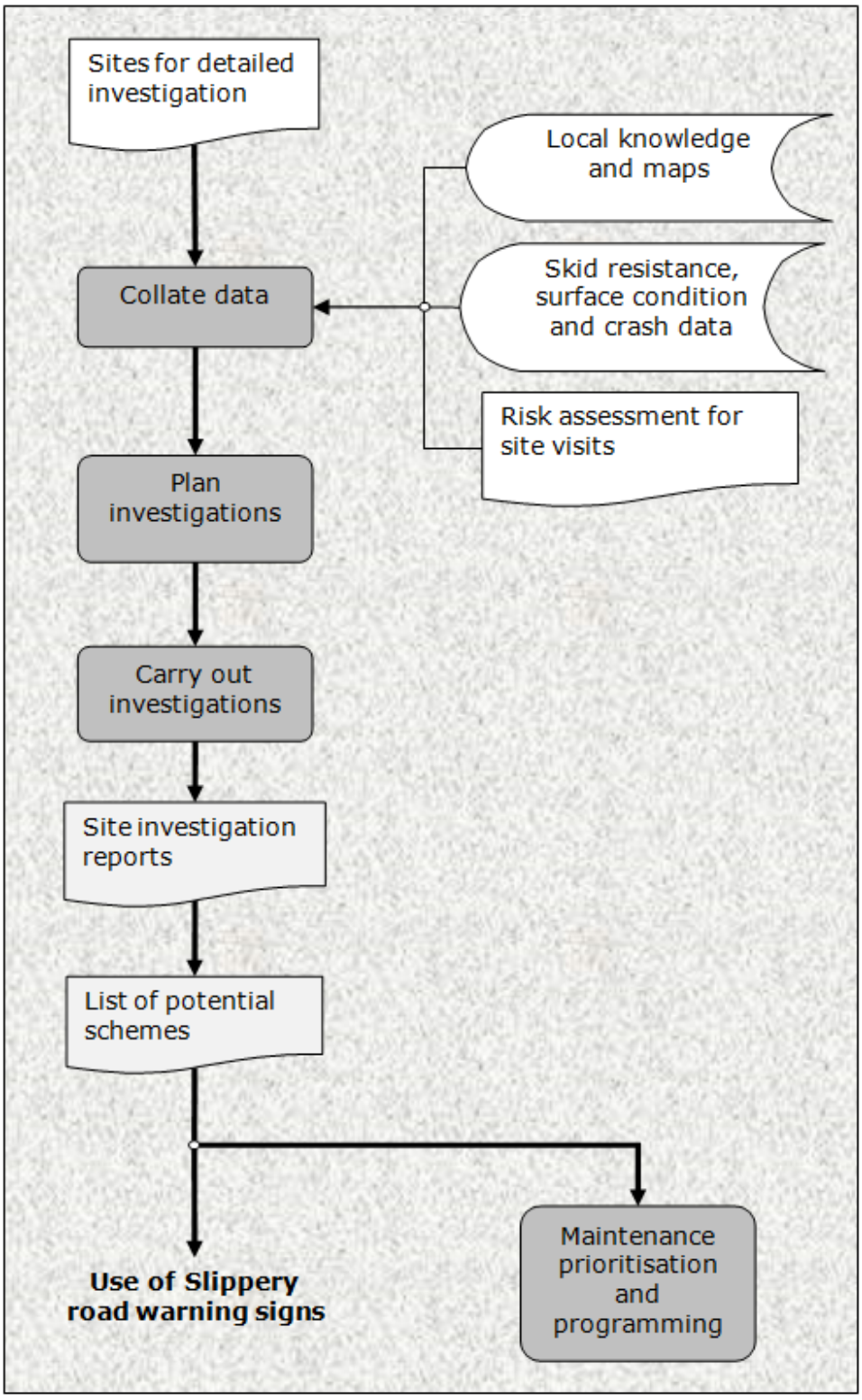
5.10 Sites identified for reasons other than skid resistance (see clause 5.6) shall always be subject to a detailed investigation.

5.11 On receipt of the CSC data, a list of sites requiring detailed investigation shall be produced.

6. Detailed site investigation and prioritisation

6.1 A detailed investigation shall be carried out on sites identified from the outcome of the process in Section 5.

Figure 6.1 Detailed site investigation and prioritisation



NOTE The process is outlined in Figure 6.1 and is split into the following four steps.

1) collate data;

2) plan investigations;

3) carry out investigations;

4) Prioritise and programme maintenance.

Collate data

6.2 The data collected at the start of a detailed investigation shall include skid resistance, texture depth and the most recent three years of crash data available.

NOTE *For new construction or changes in layout, three years of relevant crash data are likely to not be available.*

6.2.1 In cases where three years of crash data are not available, data since the date of construction or change in layout should be used.

6.3 Skid resistance data at 10m intervals shall be obtained for bends and roundabouts.

NOTE *Short lengths with low skid resistance could be hazardous for vehicles cornering and can be disguised by averaging over a longer length.*

6.3.1 Skid resistance data at 10m intervals should also be obtained if the condition of the surfacing material is known to be variable over local areas.

6.3.2 If the site has poor transverse or longitudinal evenness, or bends or gradients, data for these features should be obtained.

NOTE *In some instances these data can assist in checking whether the site category and/or Investigatory Level are correct or need amending.*

6.3.3 Information on the date of the last surface treatment may also be relevant to the investigation and the interpretation of collision data.

6.4 For each site, the relevant data shall be collated to show the location of lengths with poor surface condition relative to the location of previous crashes and features such as bends and junctions.

6.4.1 This relevant data may be collated as strip maps, GIS mapping or spreadsheets.

6.4.2 The location of crashes occurring in wet conditions, irrespective of whether skidding was reported, should be identified specifically.

6.4.3 Given the limited accuracy of locating accident positions, it may be assumed for the purpose of the detailed investigation that the position of a crash coincides with the location of poor surface condition if it occurred within 200m.

6.5 The overall crash risk shall be calculated for the site for comparison with control data.

6.5.1 The crash risk should be calculated as the total number of crashes per 10^8vehicle-km, if traffic data are available, or otherwise as the total number of crashes per year, per 100 km.

6.6 For this calculation the choice of whether to use carriageway length or route length, and the choice of units (km or miles) shall be consistent with the method used for the calculation of control data.

Plan investigations

6.7 Greater priority shall be given to completing investigations for sites that are substantially below the IL or where the crash history indicates that there is a risk of wet skidding crashes occurring.

6.7.1 Investigations should be planned primarily to maximise efficiency.

6.7.2 A physical visit to the site should be made.

NOTE *Different investigation methods can be used, with differing advantages:*

1) on foot (this allows the condition of the road to be observed in detail);

2) *from a parked or moving vehicle (this allows the pattern of traffic movement and speed to be observed during the visit);*
3) *from recent local knowledge of the site (this can provide a more general knowledge of the road usage under a wider range of traffic, weather and lighting conditions);*
4) *from video records and maps. Maps cannot be used in isolation as they do not show obstructions to visibility, drainage issues, field accesses, hidden dips, etc.*

Carry out site investigations

6.8 Site investigations shall determine whether treatment to improve the skid resistance is required or whether some other action, including no action, is required.

6.8.1 The full carriageway width should be included in the investigation, that is all lanes of a dual carriageway and both directions of a single carriageway.

NOTE 1 *Skid resistance and texture depth are generally measured in the nearside wheel track in lane one. If, during a site investigation, the rest of the pavement is not visually consistent then it is possible that the skid resistance of the rest of the lane or other lanes can be lower than the line tested.*

NOTE 2 *Guidance for the assessment of texture depth is given in CS 230 [Ref 1.I].*

NOTE 3 *If a site contains a sharp bend to the left in combination with traffic braking or accelerating then the offside wheel path can become more polished and the CSC can be up to 0.05 units lower than in the nearside wheel path.*

6.8.2 If the pavement is not visually consistent, it may be necessary to carry out additional surveys to investigate potential variations in skid resistance.

6.8.3 All junction approaches within the site should also be investigated to determine whether the advance signing/alignment is appropriate or could be improved.

6.8.4 The investigation should determine if the skid resistance is likely to be representative for the site.

6.8.5 In particular very low values of skid resistance should be viewed with caution.

NOTE *Localised reduction in the skid resistance can be caused by contamination or by flushing of the binder to the surface. Alternatively, it is possible that there has been an error in the survey. In this case, the data can be compared to data measured in previous years and also with adjacent lengths with the same surfacing material, to determine if the skid resistance is representative of the condition of the surfacing material.*

6.9 If it is determined that the reduction in skid resistance is temporary and not representative for the site, then this shall be recorded with reasons.

6.9.1 Further investigation is not needed at determination that the reduction in skid resistance is temporary and not representative for the site time, but if subsequent surveys continue to appear unrepresentative then the causes should be investigated.

6.10 As a result of the detailed site investigation, a clear recommendation shall be recorded of the actions to be taken (including if no immediate action is required).

NOTE *An example template of a site investigation form is given in Appendix B.*

6.10.1 Treatment to improve the skid resistance should be recommended if, taking into account the nature of the site and the observed crash history, it is likely to reduce the risk of crashes in wet conditions.

NOTE *Based on knowledge of skid resistance and crash risk trends, sites that can be recommended for treatment include locations where the position of crashes in wet conditions (whether or not skidding was reported) appears to be linked to surface condition, or where the overall crash risk is higher than average when compared with suitable control data.*

6.10.2 The Overseeing Organisation may be referred to for the provision of appropriate control data for the purpose of making this assessment.

6.10.3 For sites where neither of the above conditions apply (see sub-clause 6.10.1), treatment should be recommended if the skid resistance, combined with the nature of the individual site, suggest that the observed crash count underestimates the actual level of risk.

NOTE *In such cases, preventive treatment can be justified to pre-empt a potential increase in crashes.*

6.10.4 If treatment is only required on part of the site then those lengths should be clearly identified.

6.11 If the site investigation identifies any characteristic of the site or road-user behaviour that suggests other road safety engineering measures could be appropriate, then persons with relevant local experience, such as the person locally responsible for crash investigation and prevention, shall be notified.

6.12 If the site investigation identifies requirements for additional routine highway maintenance, such as sweeping, renewal of markings etc. then persons with relevant local experience, such as the person locally responsible for routine maintenance shall be notified.

6.13 If there is no justification for treatment then no further action shall be required.

NOTE *If the site remains below the Investigatory Level after the next measurement of skid resistance then it will automatically become subject to a further investigation.*

6.13.1 If the skid resistance and crash pattern of a site at or below the IL have remained stable for more than three years, then the IL may be lowered by 0.05 units CSC providing it remains within the range of ILs specified in Table 4.2.

6.14 The results of the detailed site investigation shall be documented and retained together with the identity of the assessor and other parties consulted.

Maintenance prioritisation and programming

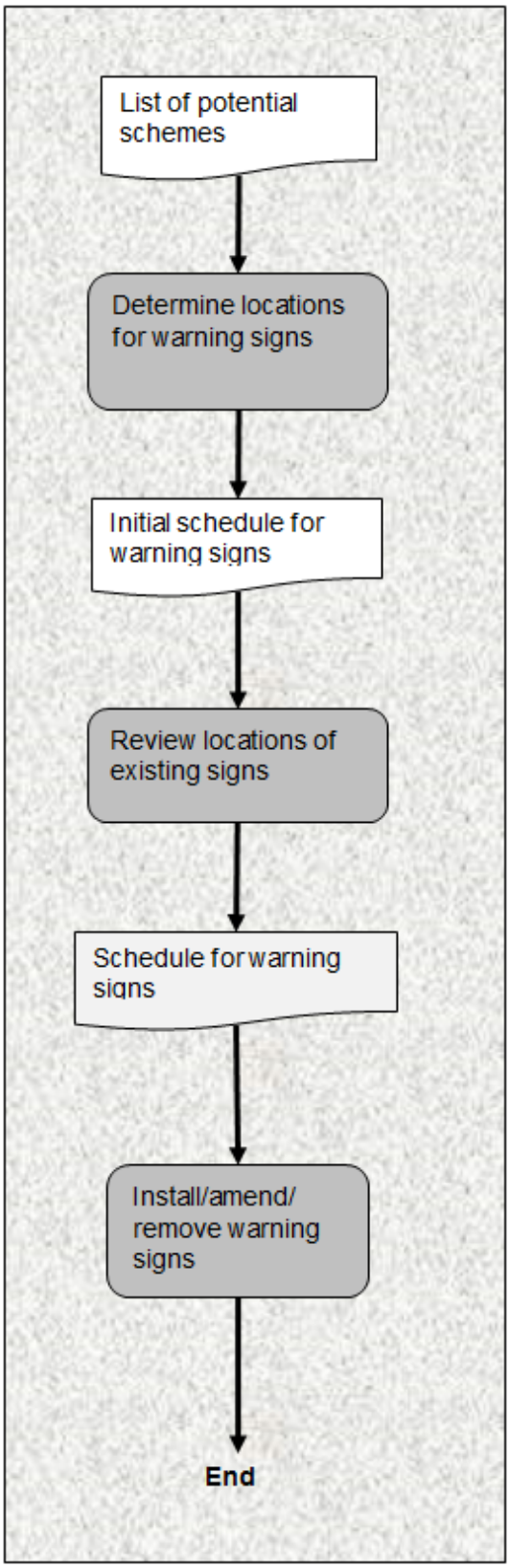
6.15 Budgeting and programming issues will influence when the treatments are carried out and this process shall be managed through the Overseeing Organisation's process for prioritising maintenance.

7. Use of slippery road warning signs

Overview

7.1 The process that shall be followed for erecting and managing slippery road warning signs as part of this document is outlined in Figure 7.1.

Figure 7.1 Use of slippery road warning signs



NOTE The process is split into the following three steps:

1) determine locations requiring warning signs;

2) review locations of existing signs;

3) install /amend /remove signs as necessary.

Determine locations requiring warning signs

7.2 Once the locations of sites requiring warning signs have been identified a schedule for warning signs shall be produced.

NOTE Details of which sites require warning signs are provided in the National Application Annexes.

Review locations of existing signs

7.3 The skid resistance at the location of all existing slippery road warning signs shall be reviewed to determine whether the sign is still needed.

7.3.1 The review of the need for existing slippery road warning signs should occur annually.

7.4 Once the review is completed the schedule for warning signs shall be updated to include the signs which require removal.

Install / remove signs as necessary

7.5 Warning signs shall be installed at sites where the need for them has been identified.

7.5.1 Short individual lengths requiring warning signs should be merged if they are separated by less than 1km.

7.6 Warning signs shall then be removed after treatment has been applied.

7.7 The slippery roads warning sign (Diagram 557) in conjunction with an appropriate supplementary plate (Diagram 570) must be used in accordance with the SI 2016/362 [Ref 5.N] and Chapter 4 of the Traffic Signs Manual TSM Chapter 4 [Ref 6.N].

7.8 For the purpose of legal proceedings it is essential that records of the erection and removal of slippery road warning signs shall be kept, including works orders issued and inventories.

7.9 A visual inspection of the site shall be made after the signs are erected to confirm that they have been erected and correctly placed.

7.10 A record of this observation shall be made and retained.

8. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	UK Roads Liaison Group. TRL on behalf of Highways England. AQA SFD, 'Accreditation and Quality Assurance of Sideways Force Skid Resistance Survey Devices' , 2016
Ref 2.N	Highways England. CD 239, 'Footway and cycleway pavement design'
Ref 3.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 4.N	BSI. BS 7941-1, 'Methods for measuring skid resistance of pavement surfaces. Sideway-force coefficient routine investigation machine'
Ref 5.N	SI 2016/362, 'The Traffic Signs Regulations and General Directions 2016'
Ref 6.N	TSO. TSM Chapter 4, 'Traffic Signs Manual Chapter 4 - Warning Signs'

9. Informative references

The following documents are informative references for this document and provide supporting information.

Ref 1.I	Highways England. CS 230, 'Pavement maintenance assessment procedure'

Appendix A. Application of site categories and Investigatory Levels

A1 Overview

This Appendix provides detailed guidance on the selection of appropriate site categories and ILs from the range in Table 4.2. These are then followed by some examples. Where appropriate, supplementary guidance is provided within the relevant National Application Annex.

Lengths with no specific risk of skidding crashes should be assigned the lowest IL with 'ST' cell indication from the appropriate site category. Where identified risks exist, a higher IL should be selected from within the range. The guidance given in this section is not exhaustive and therefore judgement of the risks specific to each location should be exercised.

Additional information, such as safety reports and congestion reports may be useful when setting site categories and the IL. They may be used to help identify higher risk situations and where queuing is likely.

A2 Category A: Motorway

This site category should be used for all sections of main carriageway that meet motorway standards of geometric design, including merging and diverging areas of the carriageway. Motorway slips roads should not have category A applied but instead should have category B (or the appropriate event category) applied.

If the motorway length under consideration does not meet motorway standards of geometric design then the length should be treated as a carriageway with one-way traffic (either event or non-event depending on the situation).

An IL of 0.35 should be appropriate in almost all circumstances.

The IL can be changed to 0.30 in exceptional cases if, following a detailed site investigation, it is clear that the crash risk associated with a skid resistance below 0.35 is low.

A3 Category B: Non-event carriageway with one-way traffic

This site category should be used for all non-motorway dual carriageways and other lengths with one-way traffic, including motorway slip roads. Note that other events on lengths with one-way traffic, such as approaches to roundabouts/junctions, bends or gradients should be considered and categorised accordingly.

At junctions, category B should be used for areas where traffic merges or diverges if:

1) the junction layout allows traffic leaving or joining the mainline to match the speed of the mainline traffic; and
2) there is adequate taper length for merging to occur.

For category B an IL of 0.35 should be appropriate in most circumstances.

The IL can be reduced to 0.30 only following a detailed site investigation and it is clear that the crash risk associated with a skid resistance below 0.35 is low.

The IL should be increased to 0.40 for:

1) areas where pedestrians or other vulnerable road users are common but category K is not appropriate;
2) hazards where the speed limit is 50mph or above and where category Q is not appropriate, including:
   a) junctions where the geometry does not justify using category Q;
   b) bus stops, laybys, etc;
   c) other accesses, e.g. private roads/drives, depending on the volume of traffic and vehicle types using the access;

3) bends on roads with a radius >100m and a speed limit below 50mph if they present a particular hazard in spite of the lower speed;
4) uphill sections that give rise to a speed differential between vehicles that could result in increased risk;
5) the approach to the end of a dual carriageway where a lane drop occurs.

A4 Category C: Non-event carriageway with two-way traffic

This site category should be used for all non-event carriageway sections with two-way traffic.

At junctions, category C should be used for areas where traffic merges or diverges if:

1) the junction layout allows traffic leaving or joining the mainline to match the speed of the mainline traffic; and
2) there is adequate taper length for merging to occur without the mainline being forced into avoiding action.

An IL of 0.40 should be appropriate in most circumstances.

The IL can be reduced to 0.35 following a detailed site investigation.

The IL should be increased to 0.45 for:

1) areas where pedestrians or other vulnerable road users are common but category K is not appropriate;
2) hazards where the speed limit is 50mph or above (over the braking area) and where category Q is not appropriate, including:
   a) junctions where the geometry does not justify using category Q;
   b) bus stops, lay-bys, etc;
   c) other accesses, e.g. private roads, depending on the volume of traffic and vehicle types using the access;
3) bends on roads with a radius >100m and a speed limit below 50mph if they present a particular hazard in spite of the lower speed;
4) uphill sections that give rise to a speed differential between vehicles that could result in increased risk, but category G1 or G2 is not appropriate.

A5 Category Q: Approaches to and across minor and major junctions, approaches to roundabouts and traffic signals

This site category should be used for:

1) major / minor priority junctions;
2) other significant accesses;
3) approaches to roundabouts and traffic signals (except for high risk circumstances such as pedestrian crossings etc.).

If the junction design and traffic volume allows the traffic to merge with / diverge from the mainline traffic without changing speed, this site category should not be used (use category B or C instead).

A5.1 Approaches to junctions:

For the purposes of this document, roads involved in a junction are split into two types, the major road and the minor road(s). The major road is the road where traffic has permanent priority. The minor road(s) are where traffic is required to give way.

Drivers on the major road have permanent priority and are not expecting to give way, but may have to brake sharply if a vehicle emerges unexpectedly from the minor road or turns right across their path. Factors to consider are:

1) right turning vehicles from a minor road are at risk of a side impact with traffic on the major road, and the outcome of this type of crash is likely to be severe;
2) the risks increase where the speed of traffic joining or leaving the main carriageway differs greatly from those continuing straight on. This is heavily influenced by the taper length, provision of dedicated lanes for right-turning traffic, etc.

On the minor road, the risk of having to brake unexpectedly is lower since the need to give way is indicated clearly in advance of the junction.

On the major road site category Q should be applied to the 50m approach (in the direction of travel) to the junction and across the extent of the junction. For roads with a speed limit of 50mph or above, consider extending the approach distance, depending on the risk of traffic having to brake unexpectedly.

For major roads with two-way traffic, consider the two directions separately to determine the overall extent of the site category. The two directions should be assigned the site category and IL independently so that site category Q is not applied on the length following a junction.

For major roads, an IL of 0.45 should be used if:

1) the speed limit is below 50mph;
2) the speed limit is 50mph or above but the traffic volume and speed differential between the major and minor traffic streams results in an acceptably low risk.

For major roads, an IL of 0.50 should be used if the speed limit is 50mph or above and:

1) the combination of speed differential and traffic volume result in a moderate level of risk;
2) sight lines on the minor road are poor, leading to the possibility of driver error;
3) right-turning traffic from the major road is not adequately catered for;
4) high levels of traffic on the mainline may induce drivers joining it to take risks when pulling out.

For major roads, an IL of 0.55 should be used only in exceptional circumstances where the risk is high. Consider whether the high risk could be mitigated more appropriately by other means.

On the minor road, site category Q should be applied to the 50m approach to the stop/give way line. Extend the distance, if necessary, to take into account likely queues.

For minor roads, an IL of 0.45 should be used in most circumstances.

The IL should be increased for minor roads to 0.50 if the sight lines (on the minor road) approaching the junction are poor, leading to the possibility of a driver having to brake suddenly.

Where the volume of traffic using the access warrants it, other significant accesses (petrol stations, superstores etc.) should be treated as for major/minor priority junctions, above. If the volume of traffic is low, use the appropriate non-event categories instead.

A5.2 Approaches to roundabouts and traffic signals:

Site category Q should be applied to the 50m approach to the stop/give-way line. Extend the distance, as necessary, to take into account likely regular queuing.

This site category should not be used for signal-controlled pedestrian crossings or for other high risk situations. Category K should be used instead.

An IL of 0.45 should be used if the speed limit is below 50mph, or if there is a higher speed limit but actual traffic speeds are low, e.g. because the road layout does not lend itself to higher speed.

An IL of 0.50 should be used if the speed limit is 50mph or above unless actual traffic speeds are low.

An IL of 0.55 should be used only in exceptional circumstances where the risk is high. Consider whether the high risk could be mitigated more appropriately by other means.

A6 Category K: Approaches to pedestrian crossings and other high risk situations

Site category K should be applied where the consequences of a crash are likely to be severe, including:

1) signal controlled pedestrian crossings and zebra crossings;
2) railway crossings;
3) other situations where there is both a likelihood of vulnerable users in the road and a high risk of injury in the event of a crash.

Site category K should be applied for the 50m approach to the event. Consider extending this distance for roads with speed limits of 50mph or above, depending on the likelihood of traffic having to brake unexpectedly.

An IL of 0.50 should be appropriate in most circumstances.

The IL should be increased to 0.55 where there is reason to believe pedestrians or other vulnerable road users may misjudge the speed of oncoming traffic, such situations include:

1) near schools or other facilities for children;
2) near public houses;
3) where the speed of approaching traffic is high.

A7 Category R: Roundabout

Site category R should be used for roundabout circulation areas, including approaches to traffic lights on roundabouts. If there are specific, high-risk situations then category K should be used. Mini roundabouts should be excluded from this site category; in this instance category Q should be applied to the approach and across the mini-roundabout.

An IL of 0.45 should be appropriate in most circumstances.

The IL should be increased to 0.50 under the following circumstances:

1) high speed of circulating traffic;
2) high incidence of cyclists or motorcyclists;
3) absence of signalised control on roundabouts at grade separated interchanges.

A8 Category G1: Gradient 5-10% longer than 50m

Site category G1 should be used on carriageways with two-way traffic, for lengths of at least 50m with an average uphill or downhill gradient of between 5 and 10%.

Site category G1 should be used on carriageways with one-way traffic, for lengths of at least 50m with an average downhill gradient of between 5 and 10%.

This assessment may be based on 10m gradient data from traffic-speed surveys or from accurate topographical survey data when available.

An IL of 0.45 should be appropriate in most circumstances.

The IL should be raised to 0.50 if there are other risk factors also present such as poor visibility etc.

A9 Category G2: Gradient >10% longer than 50m

Site category G2 should be used on carriageways with two-way traffic, for lengths of at least 50m with an average uphill or downhill gradient greater than 10%.

Site category G2 should be used on carriageways with one-way traffic, for lengths of at least 50m with an average downhill gradient of 10% of higher.

This assessment may be based on 10m gradient data from traffic-speed surveys or from accurate topographical survey data when available

An IL of 0.50 should be appropriate in most circumstances.

The IL can be reduced to 0.45 only after a detailed site investigation.

The IL should be raised to 0.55 if there are other risk factors also present such as poor visibility etc.

A10 Category S1/S2: Bend radius < 500m

This Site category should be used for bends on carriageways with one-way traffic (category S1) and on carriageways with two-way traffic (category S2).

For bends with radii between 100m and 500m the S1 and S2 categories should only be applied where the speed limit is 50mph or above. For roads with lower speed limits, use the non-event site category B or C. For bends that have radii less than 100m, S1 and S2 should apply at all speeds.

This category should not generally be used for:

1) short lengths, for example less than 100m, with a radius of curvature between 250m and 500m;
2) roundabout exits.

The site category should be extended upstream and downstream to where the radius of the road has exceeded 500m or 100m for bend radii where S1 or S2 is used at speeds lower than 50mph.

The lower, cells with 'ST' indication for each category should be appropriate in most circumstances (IL of 0.45 for category S1, or 0.50 for category S2).

The IL should be raised if there are other risk factors also present (IL of 0.50 for category S1, or 0.55 for category S2), or particular potential for loss of control, including if:

1) the geometry of the bend is particularly hazardous, taking into account the traffic speed;
2) adverse camber is present.

For category S2, the IL can be reduced to 0.45 only after a detailed site investigation.

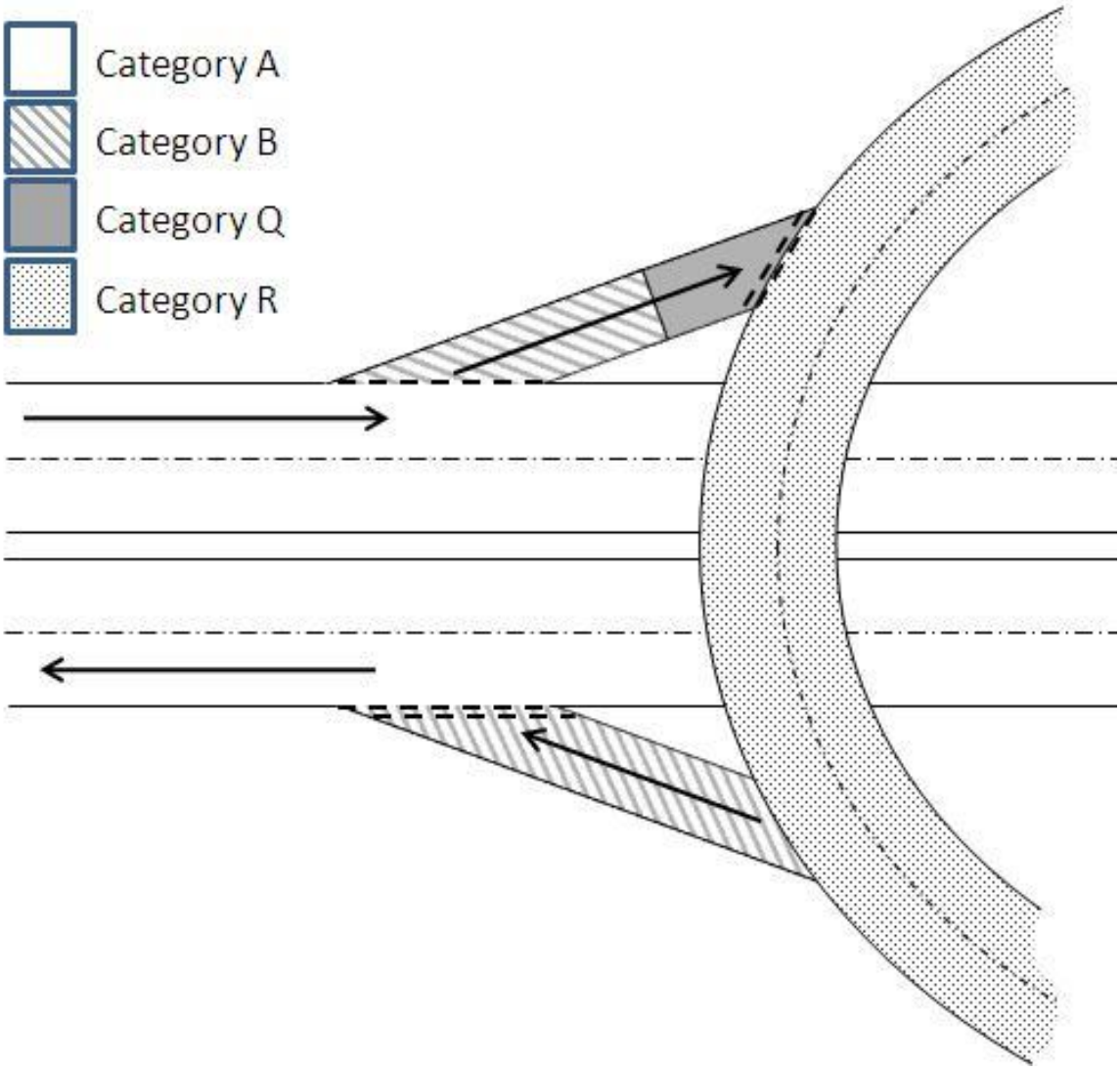
This assessment may be based on 10m curvature data from traffic-speed surveys, drawings or from accurate topographical survey data when available.

A11 Examples

A11.1 Example: Motorway grade separated junction

For generic motorway grade separated junctions there are four different site categories in effect, as described below and shown in Figure A.1. In some cases other site categories may also be required due to other events occurring in the vicinity.

Figure A.1 Site categories for a typical motorway grade separated junction layout



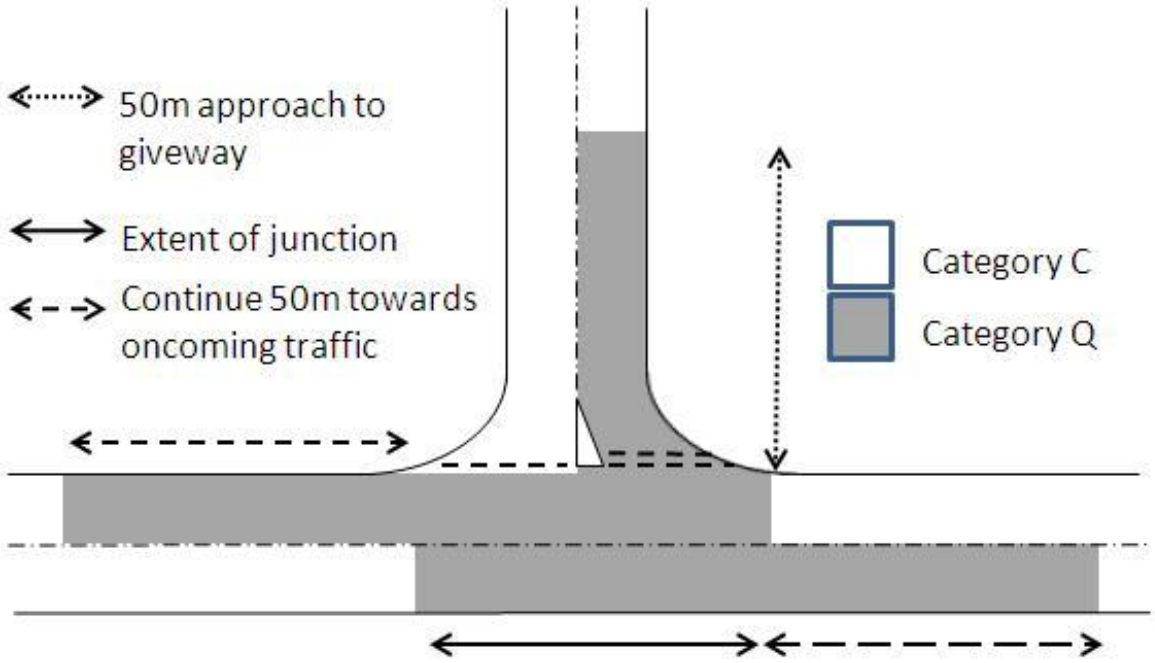
The main carriageway should have category A applied to its whole length (if appropriate to its geometry/layout). The off slip should have category B applied for the majority of its length with category Q applied to the last 50m (length of Q to be extended if queues likely).The on slip should have category B applied to its whole length unless other events for the site take precedence (e.g. high gradient or tight bend). The roundabout should have category R applied to its whole length.

A11.2 Example: T-junction on a single carriageway

For a T-junction on a single carriageway there are two different site categories in effect, as described below and shown in Figure A.2. In some cases other site categories may also be required due to other events occurring in the vicinity.

In the figure for this example the major road (where traffic has permanent priority) is the 'horizontal' road and the minor road (where traffic is required to give way) is the 'vertical' road.

Figure A.2 Site categories for junction approaches on a single carriageway



On the minor road a category of Q should be applied to the 50m approach to the junction. This length may be extended if queuing is likely. The remaining length (including the lane with traffic moving away from the junction) should be given a category of C.

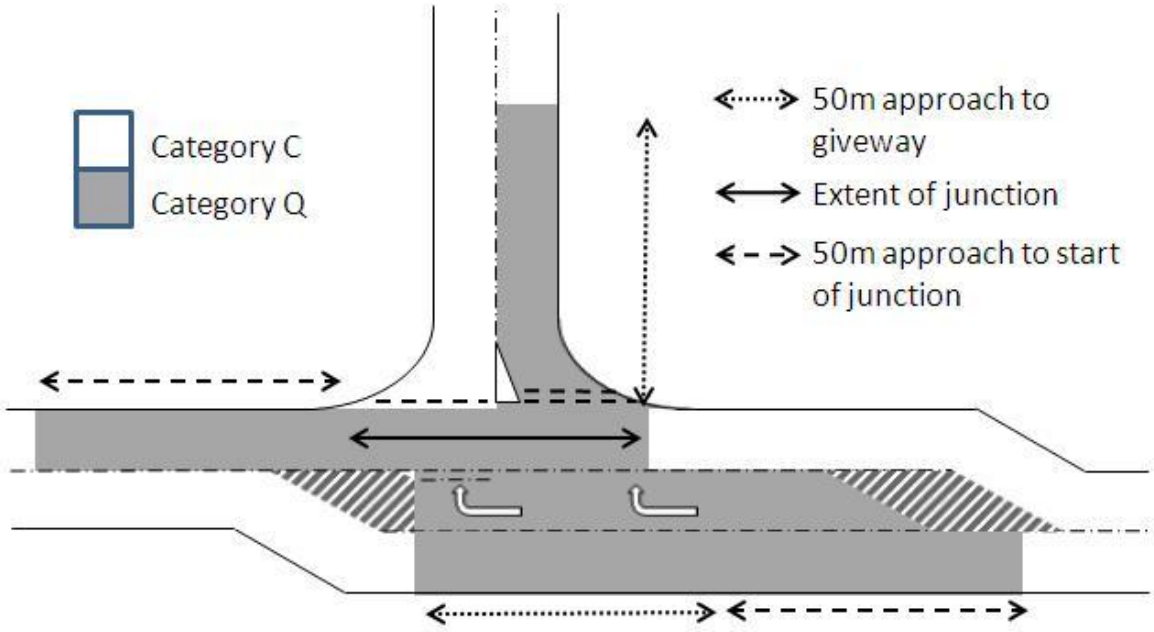
On the major road a category of Q should be applied to the extent of the junction and the 50m leading to the junction (in the direction of traffic on the major road) for both lanes. This length may be extended if the risk of traffic having to brake unexpectedly is higher than usual. The remaining length of the major road should be given a category of C (if appropriate to the site geometry/layout).

A11.3 Example: Priority junction

For a priority junction between two single carriageways there are two different site categories in effect, as described below and shown in Figure A.3. In some cases other site categories may also be required due to other events occurring in the vicinity.

In the figure for this example the "major road" (where traffic has permanent priority) is the top part of the 'horizontal' road (traffic moving from left to right) and the bottom part of the horizontal road (traffic moving from right to left). The "minor roads" are the 'vertical' road and the turn lane of the horizontal road. This example is assuming that right turns from the vertical road are prohibited.

Figure A.3 Site categories for a priority junction



The top part of the 'horizontal' road ("major road") should have a category of Q applied to the extent of the junction and the 50m leading to the junction (in the direction of traffic on the major road). This length may be extended if the risk of traffic having to brake unexpectedly is higher than usual. The remainder of the top part of the horizontal road should have the appropriate non-event category applied (in this case C).

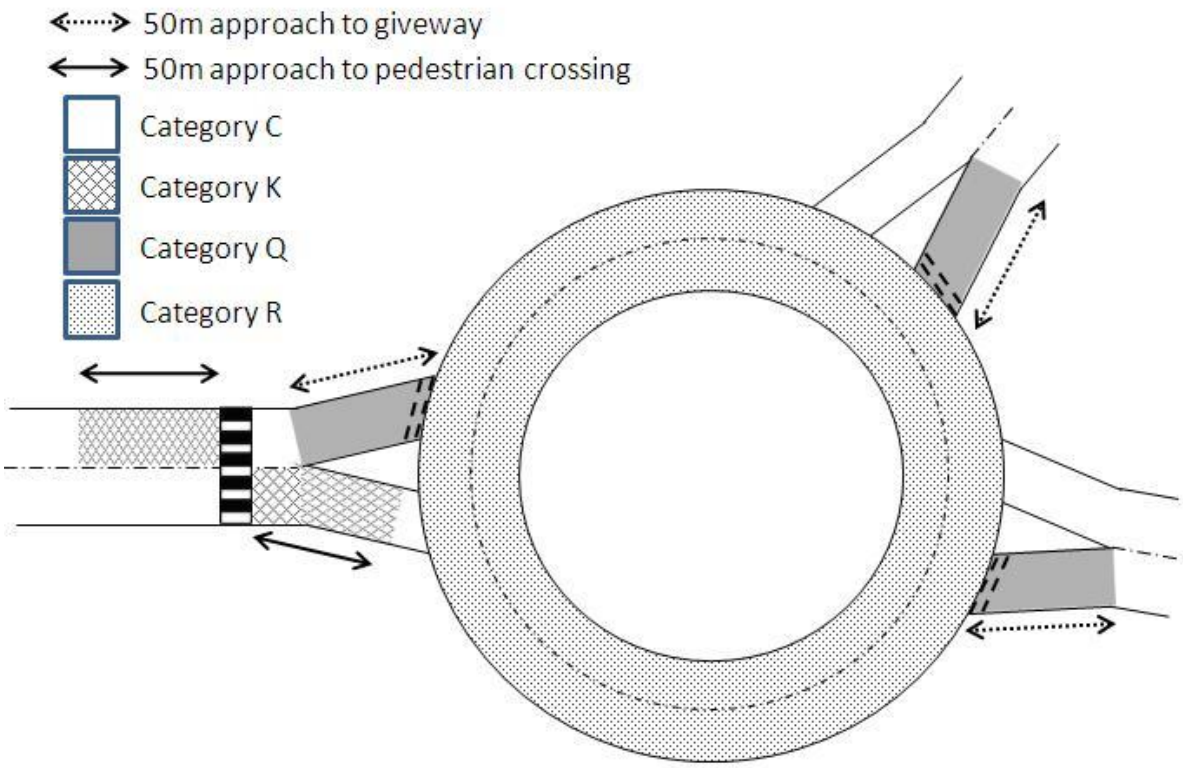
The turn lane ("minor road") should have a category of Q applied to the 50m approach to the give way. The bottom part of the 'horizontal' road ("major road") should have a category of Q applied to the 50m approach to the start of the junction and for the extent of the junction. As the two lanes described above are running lanes from the same carriageway with traffic in the same direction, they should have the same site category and IL applied along their coinciding length (see clause 4.9).

The 'vertical' road (one of the "minor roads") should have a category of Q applied to the 50-m approach to the junction. This length may be extended if queuing is likely. The remaining length (including the lane with traffic moving away from the junction) should have the appropriate non-event category applied (in this case C).

A11.4 Example: Roundabout with a pedestrian crossing

For a roundabout with a pedestrian crossing on an approach or exit, there are four different site categories in effect (if all of the roads are single carriageway), as described below and shown in Figure A.4. In some cases other site categories may also be required due to other events occurring in the vicinity.

Figure A.4 Site categories for a roundabout with a pedestrian crossing



A site category of K should be applied to the 50m approach to the pedestrian crossing. This length may be extended depending on the likelihood of traffic having to brake unexpectedly.

The roundabout should be assigned a category of R for its whole length. Note, if this was a signalised roundabout, the roundabout would still be assigned a category of R for its whole length.

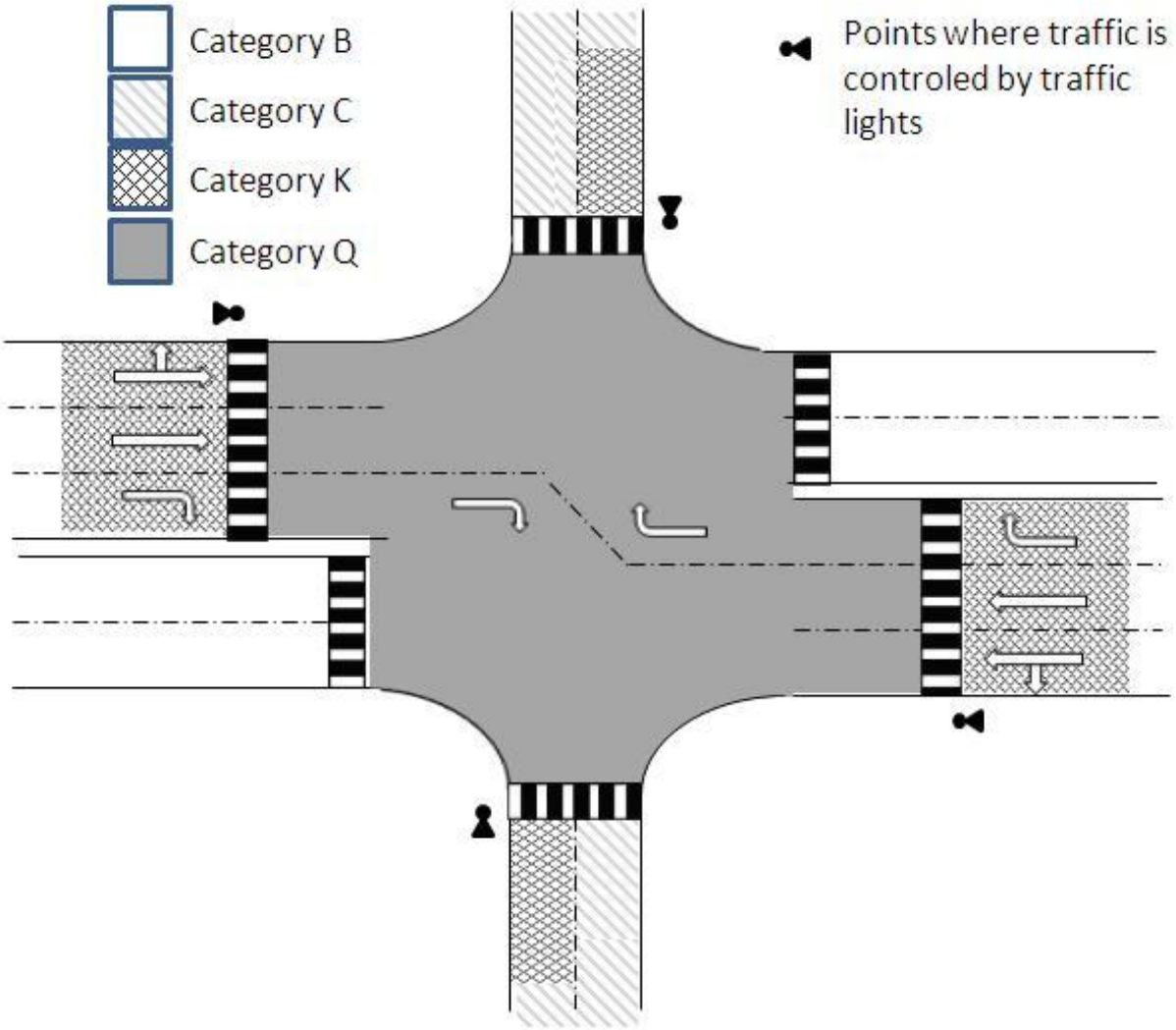
The approaches to the roundabout should all have category Q applied for the 50m approach. This length may be extended if queuing is likely. Also if the remaining distance between this category and the crossing is small then this category may be extended back to the crossing.

The remaining lengths should have category C applied (if appropriate to its geometry/layout), as they are all non-event carriageways with two-way traffic.

A11.5 Example: Signal controlled crossroads involving a dual carriageway road and a single carriageway road

For this type of crossroads there are four different site categories in effect, as described below and shown in Figure A.5. In some cases other site categories may also be required due to other events occurring in the vicinity.

Figure A.5 Site categories for a signal controlled crossroads between a dual carriageway road and a single carriageway road



A site category of K should be applied to the 50m approach to the pedestrian crossings. This length may be extended depending on the likelihood of traffic having to brake unexpectedly.

The extent of the junction (i.e. in this case, the area enclosed by the pedestrian crossings) should have a category of Q applied to it. The remaining lengths should have the appropriate non-event site categories applied (B for the dual carriageway and C for the single carriageway).

Appendix B. Site investigation report template

Figure B.1 Site investigation report template

Skid site investigation report			**Survey year:**			
Unit	**Route**	**Site ID**			**Location**	
Name of Managing Organisation and Overseeing Organisation's area/region designation	Road code	Reference no.			Section(s)/ chainage	
Site location and use						
Location and nature of site:						
State the limits of and nature of the site including speed limit and environment List hazards e.g. junctions, lay-bys, other accesses, crossings, bends or steep gradients.						
Current site category and IL:						
State current site category and Investigatory Level. Are these consistent with current guidance?						
Pavement condition data						
Skid resistance and texture depth:						
Attach plot or spread sheet showing the skid resistance, texture depth and other data if relevant. State here if low skid resistance or texture depth occurs where road users need to stop or manoeuvre						
Other aspects of pavement condition:						
Note if there any extreme values of rut depth or longitudinal profile variance that could affect vehicle handling or drainage of water from the carriageway. Attach data if relevant.						
Crash data						
Period		**Number of crashes**			**Analysis length**	
From:	To:	Total:	Wet:	Wet skid:	Length (km):	Traffic (AADF):

	Site data	**Control data**		
		Similar sites	**Route data**	**National data**
Crashes/year				
Crashes/year/100km				
Crashes/10^8 veh-km				
Crashes linked to surface condition?	Y / N	Does the position of wet or wet-skid crashes coincide with the lengths with low skid resistance?		
Other comments on crash data:				

Figure B.2 Continuation of site investigation report template

Site investigation		
Date:	Inspected by:	Method:
	Name	On site / desk study
Visual assessment		
Type and condition of surfacing:	Consider variations across whole carriageway width	
Any inconsistencies with survey data:		
Presence of debris or other contamination:	Consider likely route taken by different road users	
Local defects (potholes, fatting-up etc.):	Indicate position, extent and severity of defects	
Is drainage adequate?	List any indications that road does not drain adequately	
Road users		
Volume and type of traffic:	Consider heavy vehicles and vulnerable road users	
Traffic speeds in relation to road layout:	Consider peak, day time and night time	
Type of manoeuvres and consequences of driver error:	Evidence of crash damage or near miss e.g. tyre tracks in the verge	
Road layout		
Does it appear to meet current design specification?	Note unusual or confusing layouts	
Is layout appropriate for vulnerable road users?	Consider volume and type of vulnerable road users expected	
Are junctions appropriate for turning manoeuvres?	Note if junction sizes are appropriate for all vehicle movements and right turning vehicles are adequately catered for. Note whether traffic signals are operating correctly and are clearly visible	
Markings signs and visibility		
Are markings and signs clear and effective in all conditions?	Sometimes old pavement markings have not been removed properly or there are redundant signs that could cause confusion.	
Roadside objects protected from vehicle impact?		
Clear sight lines / visibility of queues / vegetation	Consider sight lines through junctions / accesses. Is the end of likely vehicle queues visible? Will vegetation growth affect visibility or obscure signage?	
Additional information and other observations		
Please indicate if any:	Are any other sources of information available, such as reports or visual evidence of damage only crashes, or reports from the Police?	
Recommendation		
Is treatment required?	Y / N	State why treatment is justified
What type of treatment?	Y / N	State if surface treatment is required or if any other treatment/actions can be applied instead to mitigate the existing risk.
Change IL?	Y / N	State reasons for changing IL
Other action required?	Y / N	State what other action should be considered and why

Approval		
Print name:	Signature:	Date:

Pavement
Inspection & Assessment

CS 228
England National Application Annex to CS 228 Skidding resistance

(formerly HD 28/15)

Revision 0

Summary
This National Application Annex sets out the Highways England specific requirements on applying seasonal correction to skid resistance measurements, the process for identifying sites that require a detailed investigation and for identifying sites where slippery road warning signs are required.

Feedback and Enquiries
Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated Highways England team. The email address for all enquiries and feedback is: Standards_Enquiries@highwaysengland.co.uk

This is a controlled document.

Contents

Release notes

Version	Date	Details of amendments
0	Aug 2019	Highways England National Application Annex to CS 228.

Foreword

Publishing information

This document is published by Highways England.

This document supersedes HD 28/15, which is withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

Introduction

Background

This National Application Annex gives the Highways England-specific requirements related to the application of seasonal correction to skid resistance measurements, the process for identifying sites that require a detailed investigation and the identification of sites where slippery road warning signs are required.

Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 1.N] apply to this document.

Abbreviations

Abbreviations

Abbreviation	Definition
CSC	Characteristic Skid Coefficient. The SC value that has been corrected for seasonal variations following the method appropriate to the survey strategy adopted by the Overseeing Organisation.
LECF	Local Equilibrium Correction Factor
LESC	Local Equilibrium SC
LMSC	Local Mean SC
SASS	Single Annual Skid Survey
SC	A friction coefficient calculated from a sideways-force coefficient routine investigation machine reading, by application of a speed correction and Index of SFC.
SFC	Sideways Force Coefficient

Terms and definitions

Terms

Term	Definition
Index of SFC	Index of Sideways Force Coefficient. A factor applied to relate the values given by sideways-force coefficient routine investigation machines to historic values.

E/1. Single annual skid survey (SASS) approach to calculation of CSC

Overview of SASS approach

E/1.1 The method shall use measurements from the preceding three years to characterise the long-term skid resistance of the network.

E/1.2 The long-term value of skid resistance shall be used, with the mean network skid resistance in the current year, to calculate a correction factor that is applied to the current year's data to make current values consistent with the long-term average.

E/1.3 Sections which have had resurfacings carried out in the last three years shall be identified and removed from the calculation procedure for the correction factors.

NOTE *The SASS approach takes account of yearly variation and therefore the calculations are affected by maintenance carried out in the last three years.*

E/1.4 Larger highway networks shall be split into smaller localities.

E/1.5 The correction factor shall be determined and applied separately within each locality.

NOTE *The effect of seasonal variation will vary in different geographical areas (such as due to different amounts of rainfall), therefore necessitating the need for a local approach.*

E/1.6 The whole network shall be surveyed once during the test season in each year.

E/1.7 Surveys shall be planned such that in successive years each road length is tested in the early, middle and late parts of the season.

E/1.7.1 As a route tested in the early part of the season in year 1 could be tested in the late part of the season in year 2 and in the middle part of the season in year 3, in year four, it should be tested in the early part of the season again, and so forth.

E/1.8 Each site on the network shall be allocated to a locality by the Overseeing Organisation.

NOTE *A locality is a collection of road sections or routes for which a correction factor can be determined.*

E/1.9 A locality shall be small enough so that similar weather conditions would normally be experienced within it and large enough so that a stable value can be calculated to represent the long-term skid resistance.

NOTE *This approach is based on the assumption that the climatic effects leading to seasonal variation can influence all the roads in a local area in a similar way.*

E/1.10 All the road sections within each locality shall be surveyed within the same part of the test season.

NOTE *By surveying all road sections within a locality at the same time, this method can remove a component of the within-year seasonal variation as well as the variation between years.*

E/1.11 The local equilibrium correction factor (LECF) is the correction factor that shall be used within each locality to bring the current year data to a level consistent with the long-term average.

NOTE *The LECF is calculated in three stages.*

E/1.12 The local equilibrium SC (LESC) shall be determined to represent the average skid resistance level for the locality over recent years.

NOTE *The LESC is the average SC, calculated for all valid 10-m sub-section measurements in the defined locality over the three years that precede the current testing season.*

E/1.13 The LESC shall contain surveys from each of the three parts of the test season with valid measurements being those that were made in the required part of the test season, on the required test line, and on road surfaces that were at least 12 months old at the time of testing.

E/1.13.1 As a consequence of Cl. E/1.12, if a length of road has been resurfaced within the last four years then that length should be excluded from the LECF calculation.

E/1.14 The Local Mean SC (LMSC) shall be determined for the current survey. The LMSC is the average of all valid 10-m sub-sections in the locality in the current year survey.

E/1.15 The LECF shall be determined by dividing the LESC by the LMSC, that is:

Equation E/1.15 Calculation of LECF

$$LECF = \frac{LESC}{LMSC}$$

E/1.16 The CSC for each 10-m sub-section shall be determined by multiplying the corrected SC by the LECF.

E/2. Procedure for identifying sites requiring detailed investigation

Highways England crash model

E/2.1 A crash model which has been developed for Highways England shall be used to identify sites requiring detailed investigation on motorway and all-purpose trunk roads managed by Highways England.

NOTE 1 Further information about the crash model, its development and testing can be found in TRL report TRL CPR 1308 2009 [Ref 1.I] and TRL report TRL CPR921 2010 [Ref 2.I].

NOTE 2 The crash model can be obtained from Highways England.

NOTE 3 The crash model utilises crash trends (both rate and severity) from historic Highways England 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 and Site Category. It then produces a score which can be used to identify if the site requires detailed investigation. The documentation supplied with the crash model gives guidance on the site scores that trigger a detailed site investigation.

E/2.2 Sites that have been identified for reasons other than skid resistance (see Cl. 5.6 of main document) shall not be removed by this process.

E/3. Determining locations requiring warning signs

E/3.1 Sites which, as a result of a detailed investigation, have been identified as requiring treatment to improve skid resistance shall have warning signs erected.

E/4. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'

E/5. Informative references

The following documents are informative references for this document and provide supporting information.

Ref 1.I	Transport Research Laboratory. Coyle F and Viner H. TRL CPR 1308, 'Accident model for prioritising treatments to improve road surface skid resistance' , 2009
Ref 2.I	Transport Research Laboratory. Brittain S and Coyle F. TRL CPR921, 'Development and trial of procedures for identifying sites requiring a detailed skid resistance investigation' , 2010

Department for Infrastructure
An Roinn Bonneagair

Pavement
Inspection & Assessment

CS 228
Northern Ireland National Application Annex to CS 228 Skidding resistance

(formerly HD 28/15)

Revision 0

Summary
This National Application Annex sets out the Department for Infrastructure Northern Ireland specific requirements on applying seasonal correction to skid resistance measurements for identifying sites where slippery road warning signs are required.

Feedback and Enquiries
Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated team in the Department for Infrastructure, Northern Ireland. The email address for all enquiries and feedback is: dcu@infrastructure-ni.gov.uk

This is a controlled document.

Contents

Release notes

Version	Date	Details of amendments
0	Aug 2019	Department for Infrastructure Northern Ireland National Application Annex to CS 228. A new National Application Annex under the DMRB 2020 programme.

Foreword

Publishing information

This document is published by Highways England on behalf of the Department for Infrastructure, Northern Ireland.

This document supersedes HD 28/15, which is withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

Introduction

Background

This National Application Annex sets out the Department for Infrastructure Northern Ireland-specific requirements on applying seasonal correction to skid resistance measurements and for identifying sites where slippery road warning signs are required.

Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 1.N] apply to this document.

Abbreviations

Abbreviations

Abbrevia-tions	Definition
CSC	Characteristic Skid Coefficient. The SC value that has been corrected for seasonal variations following the method appropriate to the survey strategy adopted by the Overseeing Organisation.
LECF	Local Equilibrium Correction Factor
LESC	Local Equilibrium SC
LMSC	Local Mean SC
MSSC	Mean Summer Skid Coefficient
MSCF	Mean Summer Correction Factor
SC	A friction coefficient calculated from a sideway-force coefficient routine investigation machine reading, by application of a speed correction and Index of SFC.

Terms and definitions

Terms

Term	Definition
Index of SFC	Index of Sideways Force Coefficient. A factor applied to relate the values given by sideways-force coefficient routine investigation machines to historic values.

NI/1. Benchmark sites approach to calculation of CSC

Benchmark sites approach calculation procedure

NI/1.1 A number of benchmark sites to cover a relevant geographical area shall be agreed with the Overseeing Organisation.

NI/1.2 The benchmark sites shall all be tested three times with surveys spread through each testing season to provide mean summer skid coefficient (MSSC) values.

NOTE MSSC values are calculated by taking the average of the three survey periods for each 10m length.

NI/1.3 An overall average MSSC value for each area shall be calculated.

NI/1.4 The whole of the selected network shall be tested once in each year.

NI/1.4.1 Different parts of the network may be surveyed in different parts of the testing season.

NI/1.5 Whenever a part of the network is surveyed, all the benchmark sites shall be tested at the same time.

NOTE 1 The LECF is the correction factor determined for the network area to bring the current year data to a level consistent with the long-term average.

NOTE 2 With this method it is assumed that the average behaviour of the benchmark sites is representative of the area and that the climatic effects leading to seasonal variation between years will have influenced all of the benchmark sites in an area in a similar way.

NOTE 3 By surveying the benchmark sites three times each season, some account can be taken of the within-year variation.

NOTE 4 Comparing the benchmark sites in successive years allows the effects of between-year variation to be reduced.

NI/1.6 The LECF shall be calculated in five stages:

1) the mean summer correction factor (MSCF) to be determined in order to take account of the variation in skid resistance between the time of a particular survey and the average during the testing season;
2) the MSSC for each 10-m sub-section in the survey to be estimated by multiplying the SC for each valid 10-m sub-section by the MSCF;
3) the LESC to be determined to represent the average skid resistance level in the area over recent years;
4) the LMSC to be determined to represent the average skid resistance level in the area for the current testing season; and
5) the LECF to be determined by dividing the LESC by the LMSC, that is:

Equation NI/1.6 Calculation of LECF

$$LECF = \frac{LESC}{LMSC}$$

NOTE 1 The MSCF is the overall average of the benchmark sites in the same area for the testing season, divided by the average of all of these benchmark sites for the survey period of the relevant survey.

NOTE 2 The LESC is the overall average MSSC for all of the benchmark sites over the three years that precede the current testing season (with lengths that have undergone treatment in the last four years excluded).

NOTE 3 The LMSC is the average MSSC of all benchmark sites in the area for the current testing season (with lengths that have undergone treatment in the last four years excluded).

NI/1.7 The CSC for each 10-m sub-section shall be determined by multiplying the estimated MSSC for each 10-m sub-section by the LECF.

NI/2. Determining locations requiring warning signs

NI/2.1 Sites which, as a result of a detailed investigation, have been identified as requiring treatment to improve skid resistance shall have warning signs erected.

NI/3. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'

Pavement
Inspection & Assessment

CS 228 SNAA
Scotland National Application Annex to CS 228 Skidding resistance

(formerly HD 28/15)

Revision 1

Summary
This National Application Annex sets out the Transport Scotland specific requirements on applying seasonal correction to skid resistance measurements, the process for identifying sites that require a detailed investigation and for identifying sites where slippery road warning signs are required.

Feedback and Enquiries
Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated Transport Scotland team. The email address for all enquiries and feedback is: TSStandardsBranch@transport.gov.scot

This is a controlled document.

Contents

Release notes

Version	Date	Details of amendments
1	Jan 2021	Revision 1 (Jan. 2021) to correct reference 'typo' for Transport Scotland Interim Amendment - Skidding Resistance; Revision 0 (March 2020) Transport Scotland National Application Annex to CS 228.

Foreword

Publishing information

This document is published by Highways England on behalf of Transport Scotland .

This document supersedes part of HD 28/15, which is withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

Introduction

Background

This National Application Annex gives the Transport Scotland-specific requirements related to the application of seasonal correction to skid resistance measurements, the process for identifying sites that require a detailed investigation and the identification of sites where slippery road warning signs are required.

Additional guidance on the application of site categories and investigatory levels to the Scottish trunk road network is provided in the Transport Scotland Interim Amendment - Skidding Resistance TSIA 51/20 [Ref 2.N].

The guidance document can be obtained from Transport Scotland.

Assumptions made in the preparation of the document

The assumptions made in GG 101 [Ref 1.N] apply to this document.

Abbreviations

Abbreviations

Abbreviation	Definition
CSC	Characteristic skid coefficient. The SC value that has been corrected for seasonal variations following the method appropriate to the survey strategy adopted by the Overseeing Organisation.
LECF	Local equilibrium correction factor
LESC	Local equilibrium SC
LMSC	Local mean SC
SASS	Single annual skid survey
SC	A friction coefficient calculated from a sideways-force coefficient routine investigation machine reading, by application of a speed correction and index of SFC
SFC	Sideways force coefficient

Terms and definitions

Terms

Term	Definition
Index of SFC	Index of sideways force coefficient. A factor applied to relate the values given by sideways-force coefficient routine investigation machines to historic values

S/1. Single annual skid survey (SASS) approach to calculation of CSC

S/1.1 The method shall use measurements from the preceding three years to characterise the long-term skid resistance of the network.

S/1.2 The long-term value of skid resistance shall be used, with the mean network skid resistance in the current year, to calculate a correction factor that is applied to the current year's data to make current values consistent with the long-term average.

S/1.3 Sections which have had resurfacings carried out in the last three years shall be identified and removed from the calculation procedure for the correction factors.

NOTE *The SASS approach takes account of yearly variation and therefore the calculations are affected by maintenance carried out in the last three years.*

S/1.4 Larger highway networks shall be split into smaller localities.

S/1.5 The correction factor shall be determined and applied separately within each locality.

NOTE *The effect of seasonal variation will vary in different geographical areas (such as due to different amounts of rainfall), therefore necessitating the need for a local approach.*

S/1.6 The whole network shall be surveyed once during the test season in each year.

S/1.7 Surveys shall be planned such that in successive years each road length is tested in the early, middle and late parts of the season.

S/1.7.1 As a route tested in the early part of the season in year 1 could be tested in the late part of the season in year 2 and in the middle part of the season in year 3, in year 4, it should be tested in the early part of the season again, and so forth.

S/1.8 Each site on the network shall be allocated to a locality according to the Overseeing Organisation.

NOTE *A locality is a collection of road sections or routes for which a correction factor can be determined.*

S/1.9 A locality shall be small enough so that similar weather conditions would normally be experienced within it and large enough so that a stable value can be calculated to represent the long-term skid resistance.

NOTE *This approach is based on the assumption that the climatic effects leading to seasonal variation can influence all the roads in a local area in a similar way.*

S/1.10 All the road sections within each locality shall be surveyed within the same part of the test season.

NOTE *By surveying all road sections within a locality at the same time, this method can remove a component of the within-year seasonal variation as well as the variation between years.*

S/1.11 The local equilibrium correction factor (LECF) is the correction factor that shall be used within each locality to bring the current year data to a level consistent with the long-term average.

NOTE *The LECF is calculated in three stages.*

S/1.12 The local equilibrium SC (LESC) shall be determined to represent the average skid resistance level for the locality over recent years.

NOTE *The LESC is the average SC, calculated for all valid 10-m sub-section measurements in the defined locality over the three years that precede the current testing season.*

S/1.13 The LESC shall contain surveys from each of the three parts of the test season with valid measurements being those that were made in the required part of the test season, on the required test line, and on road surfaces that were at least 12 months old at the time of testing.

S/1.13.1 As a consequence of clause S/1.12, if a length of road has been resurfaced within the last four years then that length should be excluded from the LECF calculation.

S/1.14 The local mean SC (LMSC) shall be determined for the current survey.

NOTE *The LMSC is the average of all valid 10-m sub-sections in the locality in the current year survey.*

S/1.15 The LECF shall be determined by dividing the LESC by the LMSC, that is:

Equation S/1.15 Calculation of LECF

$$LECF = \frac{LESC}{LMSC}$$

S/1.16 The CSC for each 10-m sub-section shall be determined by multiplying the corrected SC by the LECF.

S/2. Procedure for identifying sites requiring detailed investigation

S/2.1 The Transport Scotland Interim Amendment - Skidding Resistance TSIA 51/20 [Ref 2.N] shall be used to identify sites requiring detailed investigation on the Scottish Trunk Road Network.

NOTE *The document can be obtained from Transport Scotland.*

S/3. Determining locations requiring warning signs

S/3.1 The Transport Scotland Interim Amendment - Skidding Resistance TSIA 51/20 [Ref 2.N] shall be used to determine where warning signs are necessary on the Scottish trunk road network.

NOTE *The document can be obtained from Transport Scotland.*

S/4. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 2.N	Transport Scotland. TSIA 51/20, 'Transport Scotland Interim Amendment 51/20 – Skidding Resistance '

Llywodraeth Cymru
Welsh Government

Pavement
Inspection & Assessment

CS 228
Wales National Application Annex to CS 228 Skidding resistance

(formerly HD 28/15)

Revision 0

Summary
This National Application Annex sets out the Welsh Government specific requirements on applying seasonal correction to skid resistance measurements, the process for identifying sites that require a detailed investigation and for identifying sites where slippery road warning signs are required.

Feedback and Enquiries
Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated Welsh Government team. The email address for all enquiries and feedback is: Standards_Feedback_and_Enquiries@gov.wales

This is a controlled document.

Contents

Release notes

Version	Date	Details of amendments
0	Aug 2019	Welsh Government National Application Annex to CS 228. A new publication within the DMRB 2020 editorial revision programme.

Foreword

Publishing information

This document is published by Highways England on behalf of the Welsh Government.

This documents supersedes HD 28/15, which is withdrawn.

Contractual and legal considerations

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

Introduction

Background

This National Application Annex gives the Welsh Government-specific requirements related to the application of seasonal correction to skid resistance measurements, the process for identifying sites that require a detailed investigation and the identification of sites where slippery road warning signs are required.

Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 1.N] apply to this document.

Abbreviations

Abbreviations

Abbreviation	Definition
CSC	Characteristic Skid Coefficient. The SC value that has been corrected for seasonal variations following the method appropriate to the survey strategy adopted by the Overseeing Organisation.
LECF	Local Equilibrium Correction Factor
LESC	Local Equilibrium SC
LMSC	Local Mean SC
SASS	Single Annual Skid Survey
SC	A friction coefficient calculated from a sideways-force coefficient routine investigation machine reading, by application of a speed correction and Index of SFC.

Terms and definitions

Terms

Term	Definition
Index of SFC	Index of Sideways Force Coefficient. A factor applied to relate the values given by sideways-force coefficient routine investigation machines to historic values.

W/1. Single annual skid survey (SASS) approach to calculation of CSC

Overview of SASS approach

W/1.1 The SASS approach shall use measurements from the preceding three years to characterise the long-term skid resistance of the network, based upon a single annual survey of the network.

W/1.2 The long-term value of skid resistance shall be used, with the mean network skid resistance in the current year, to calculate a correction factor which is applied to the current year's data to make current values consistent with the long-term average.

W/1.3 Network sections that have had resurfacings carried out in the last three years shall be identified and removed from the calculation procedure for the correction factors.

NOTE *The SASS approach takes account of yearly variation and therefore the calculations are affected by maintenance carried out in the last three years.*

W/1.4 Larger networks shall be split into smaller localities.

NOTE *The effect of seasonal variations will vary in different geographical areas (such as due to different amounts of rainfall) necessitating a more local approach.*

W/1.5 The correction factor shall be determined and applied separately within each locality.

W/1.6 The whole network shall be surveyed once during the test season in each year.

W/1.7 Surveys shall be planned such that in successive years each road length is tested in the early, middle and late parts of the season.

W/1.7.1 For example, a route may be tested in the early part of the season in year 1, tested in the late part of the season in year 2 and in the middle part of the season in year 3.

W/1.7.2 In year four the same route should be tested in the early part of the season again, and so forth.

NOTE *Road sections are located within localities for North, Mid and South Wales.*

W/1.8 A correction factor for each locality shall be calculated to represent long-term skid resistance appropriate to the climatic region.

NOTE *This approach is based on the assumption that the climatic effects leading to seasonal variation can influence all the roads in a local area in a similar way.*

W/1.9 All the road sections within each locality shall be surveyed within the same part of the test season.

NOTE *By surveying all road sections within a locality at the same time, this method can remove a component of the within-year seasonal variation as well as the variation between years.*

W/1.10 The local equilibrium correction factor (LECF) is the correction factor that shall be used within each locality to bring the current year data to a level consistent with the long-term average.

W/1.11 The LECF shall be calculated in three stages:

1) the local equilibrium SC (LESC) is determined to represent the average skid resistance level for the locality over recent years;
2) the Local Mean SC (LMSC) is determined for the current survey as the average of all valid 10-m sub-sections in the locality in the current year survey;
3) the LECF is determined by dividing the LESC by the LMSC, as:

Equation W/1.11 Calculation of LECF

$$LECF = \frac{LESC}{LMSC}$$

W/1.11.1 If a length of road has been resurfaced within the last four years then that length should be excluded from the LECF calculation.

NOTE 1 The LESC is the average SC, calculated for all valid 10m sub-section measurements in the defined locality over the 3 years that precede the current testing season.

NOTE 2 The LESC contains surveys from each of the three parts of the test season with valid measurements being those that were made in the required part of the test season, on the required test line, on road surfaces that were at least 12 months old at the time of testing.

W/1.12 The CSC for each 10-m sub-section shall be determined by multiplying the corrected SC by the LECF.

W/2. Procedure for identifying sites requiring detailed investigation

W/2.1 The Welsh Government method shall be used to identify sites requiring detailed investigation on motorway and all-purpose trunk roads managed by Welsh Government.

NOTE *The Welsh Government method can be obtained from Welsh Government.*

W/2.2 Sites that have been identified for reasons other than skid resistance (see main document cl. 5.6) shall not be removed by this process.

W/3. Determining locations requiring warning signs

W/3.1 Sites which, as a result of a detailed investigation, have been identified as requiring treatment to improve skid resistance shall have warning signs erected.

W/4. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref 1.N	Highways England. GG 101, 'Introduction to the Design Manual for Roads and Bridges'