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Skid Resistance Assessment

AM-PAV-06045
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AM Asset Management & Maintenance

Standards

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This document has been authorised by the Director of Professional Services, Transport Infrastructure Ireland. For any further guidance on the TII Publications system, please contact the following:

Contact: Standards and Research Section, Transport Infrastructure Ireland
Postal Address: Parkgate Business Centre, Parkgate Street, Dublin 8, D08 DK10
Telephone: +353 1 646 3600
Email: infoPUBS@tii.ie

TII Publications

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Contents

Updates to TII Publications resulting in changes to
Skid Resistance Assessment AM-PAV-06045

Date: June 2020

Page No:

Section No:

Amendment Details:

This Standard supersedes the March 2020 version of AM-PAV-06045. The principle changes are outlined below:

a) The level of traffic in Table 5.1 has been updated from “vehicles per lane per day” to “AADF” (Annual Average Daily Flow)

b) A definition of AADF has been included in the Table of Definitions

c) Reference to PE-SMG-02002 “Traffic Assessment” has been included in Chapter 6

d) Reference to “UK correlation trials” in Annex 2 has been updated to “Annual Accreditation Trial arranged by TRL (Transport Research Laboratory)”

e) Examples of application of Site Categories and ILs in Annex 3 have been updated to clarify whether they apply to a rural or urban setting.

Date: March 2020

Page No:

Section No:

Amendment Details:

This Standard supersedes the November 2011 version of AM-PAV-06045 (HD 28/11). The principle changes are outlined below:

a) The updated AM-PAV-06045 deals with the assessment of skid resistance including measuring equipment, data processing and assigning site categories and investigatory levels.

b) The methodology for calculation of CSC values has been updated.

c) Further guidance on the application of Site Categories and Investigatory Levels has been included.

d) The application of the standard in urban areas has been included.

e) Procedure for testing and interpreting data on roundabouts has been updated.

f) The policy for the management of skid resistance including site scoring and prioritisation, site inspection procedure, treatment programming and use of slippery road warning signs is now outlined in AM-PAV-06046.

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Table of Definitions

Heading	Definition
Annual Average Daily Flow (AADF)	Annual Average Daily Flow (AADF) is the average daily flow of traffic in one direction over a full year (refer to PE-SMG-02002)
Characteristic Skid Coefficient (CSC)	The Characteristic Skid Coefficient (CSC) is an estimate of the underlying skid resistance once the effect of seasonal variation has been taken into account. The CSC is derived from the Skid Coefficient (SC) value that has been corrected for seasonal variations following the method appropriate to the survey strategy adopted by the Overseeing Organisation.
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 SFC (Sideways Force Coefficient)	A factor applied to relate the values given by Sideway-force Coefficient Routine Investigation Machine to historic values. The Index of SFC is the ratio, expressed as a percentage, of values of SFC obtained from a current calibrated item of test equipment to values of SFC obtained from the equipment at TRL during the period 1963-1972 that was used to derive information on which to base proposals for specification. The present value in force is 78% and is valid for Sideway-force Coefficient Routine Investigation Machines in current use.
Inscribed Circle Diameter (ICD)	The inscribed circle diameter (ICD) of a roundabout is the diameter of the largest circle that can be fitted into the junction outline (refer to DN-GEO-03060).
Investigatory Level (IL)	A Investigatory Level (IL) represents a level above which the skid resistance is considered to be satisfactory and at or below which the road is judged to require further assessment of the site specific risks in more detail.
Managing Organisation	The local authority or contracted organisation commissioned to manage part or all of the national road network by the Overseeing Organisation.
National Road Network	The national primary and secondary roads network in Ireland which is operated and maintained by Transport Infrastructure Ireland (TII) and which comprises motorways and dual carriageways, including their interchanges / junctions, merge and diverge ramps, circulatory elements of roundabouts; and national primary and national secondary single carriageway roads.
Overseeing Organisation	The organisation legally responsible to the Minister for Transport, Tourism and Sport for operation of the national road network.
Raw Data	Raw Data is a general term to describe the unprocessed data as a sequence of values output by Sideway-force Coefficient Routine Investigation Machine before any analysis or value adjustments have been made.
SCRIM®	Device developed by W.D.M. Limited, Bristol, England from original research by TRL in the United Kingdom that uses the side force principle to make routine measurements of skid resistance continuously, all devices being manufactured under license from TRL Ltd UK
Sideway-Force Coefficient (SFC)	SFC is the ratio between the vertical force (load) and the horizontal force (sideway-force) normal to the test wheel maintained in a controlled slipping condition.

Heading	Definition
	The SFC is the individual frictional measurement as recorded by the Sideway-force Coefficient Routine Investigation Machine for a single sub-section (5, 10 or 20 metres long according to recorder setting). SFC is expressed as a decimal number, to two decimal places, for a pre-determined length of road, normally 10m. (Note: SFC can vary depending on the wheel angle of the type of equipment used and the survey speed).
Site Category	One of the levels within a broad classification of the road network according to the risk of skidding.
Seasonal Variation	The variation in the skid resistance measured during the course of the year due to climatic conditions, traffic, and weathering and polishing cycles.
Skid Coefficient (SC)	A Skid Coefficient (SC) is a Sideway-force Coefficient Routine Investigation Machine reading adjusted for speed correction and factored according to the Index of SFC applicable to the machine at the time of the test. Skid Coefficient values are expressed as decimal fractions, to two decimal places.
Skid Resistance	Skid resistance is the characterisation of the friction of a road surface when measured in accordance with a standardised method.
Survey Contractor	The organisation contracted to provide skid resistance measurements by either the Overseeing Organisation or the Managing Organisation.
Survey Speed	The speed of the test vehicle during the survey.
Test Lane	The lane in which the survey is carried out.
Test Line	The line within the test lane that the test wheel follows.
Test Season	The testing season for standardised test measurements is defined as the summer period 1st May to 30th September, unless otherwise agreed with the Overseeing Organisation.

Table of Abbreviations

Abbreviation	Definition
AADF	Annual Average Daily Flow
CSC	Characteristic Skid Coefficient
DMI	Distance Measuring Instrument
GPS	Global Positioning System
ICD	Inscribed Circle Diameter
IL	Investigatory Level
ITM	Irish Transverse Mercator
NSAI	National Standards Authority Ireland
SC	Skid Coefficient
SFC	Sideway-Force Coefficient
TII	Transport Infrastructure Ireland
TRL	Transport Research Laboratory
UKRLG	UK Roads Liaison Group

1. Introduction

1.1 General

1.1.1 In this standard, the term “skid resistance” refers to the characterisation of the friction of a road surface when measured using a specific device, in accordance with a standardised method. 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.

1.1.2 This document describes how measurements of skid resistance are to be made and interpreted. This standard is complimented by AM-PAV-06046, Skid Resistance Management and by DN-PAV-03023, Surfacing Materials for New and Maintenance Construction for Use in Ireland, which sets out advice on surfacing material characteristics necessary to deliver the required skid resistance properties.

1.1.3 The objectives of this standard are to

i. Maintain a consistent approach to the management of skid resistance across the national road network, so that road users find consistent friction characteristics when accelerating, braking and cornering.
ii. Provide an understanding on the methods for measuring skid resistance, processing data, and setting appropriate Investigatory Levels.
iii. Assign a level of skid resistance appropriate to the nature of the road environment at each location so that the risk of skidding collisions in wet conditions is broadly equalised across the national road network.

1.1.4 This standard assists the engineer in determining an appropriate Investigatory Level for each site. It also sets out the procedure to be used for measuring skid resistance.

1.1.5 Skid resistance surveys are sometimes carried out for special purposes, such as research or local investigations. In addition, measurements that are made outside the testing season are subject to the full uncertainty of seasonal variation. Due to the different test procedures, these measurements are subject to the full uncertainty of the factors affecting these test procedures and require careful interpretation. The procedures for such surveys do not form part of this standard.

1.2 Structure

1.2.1 Chapter 2 summarises the operation of this standard. Chapter 3 provides a description of skid resistance measuring equipment. Chapters 4 and 5 describe key components of this standard: skid resistance measurement and data processing, and the process of assigning Site Categories and setting Investigatory Levels.

1.2.2 These chapters are supported by a number of Annexes that give more detailed instructions or advice. Annex 1 provides background information relevant to the measurement and interpretation of skid resistance.

Annex 2 provides details of the strategy for reducing the influence of seasonal variation. Annex 3 describes the selection of Site Categories and Investigatory Levels.

1.3 Implementation

1.3.1 This standard shall be used forthwith for the, maintenance of national roads including motorways, provided that, in the opinion of the Overseeing Organisation this would not result in significant additional expense or delay. In such cases, Managing Organisations should confirm the application of this standard to particular schemes with the Overseeing Organisation.

2. Operation

2.1.1 This Chapter summarises the procedures for making and interpreting skid resistance measurements on national roads.

2.1.2 Routine measurements of skid resistance shall be made using the Sideway-force Coefficient Routine Investigation Machine and processed to derive Characteristic Skid Coefficient (CSC) values in accordance with Annex 2, supplemented by specific instructions that may be issued by the Overseeing Organisation.

2.1.3 The CSC is an estimate of the underlying skid resistance once the effect of seasonal variation has been taken into account. These terms are explained in the Table of Definitions, Chapter 4, Annex 1 and Annex 2 of this standard.

2.1.4 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 IL.

2.1.5 The Investigatory Level represents a level above which the skid resistance is considered to be satisfactory, and at or below which the road is judged to require further assessment of the site specific risks in more detail.

2.1.6 The outcome of the further assessment will determine whether a site inspection is required or not.

2.1.7 The outcome of a site inspection will determine whether treatment to improve the skid resistance is required or whether some other action is required. The site inspection procedure does not form part of this standard. Additional information on the further assessment of sites at or below IL is given in AM-PAV-06046, Skid Resistance Management.

3. Skid Resistance Measuring Equipment

3.1 Measurement Equipment

3.1.1 Measurements for monitoring the in-service skid resistance of national roads, in line with this standard, shall be made with a Sideway-force Coefficient Routine Investigation Machine conforming to National Standards Authority Ireland (NSAI) Standard Recommendation S.R. CEN/TS 15901-6. "Road and airfield surface characteristics - Part 6: Procedure for determining the skid resistance of a pavement surface by measurement of the sideway force coefficient (SFCS): Sideway-force Coefficient Routine Investigation Machine".

3.1.2 The Sideway-force Coefficient Routine Investigation Machine (see Figure 3.1) was introduced in the 1970s to provide a method for routinely measuring the skid resistance of the road network. This machine uses the sideway force principle to measure skid resistance. A freely rotating test wheel fitted with a smooth rubber tyre, mounted mid-machine in line with the nearside wheel path and angled at 20° to the direction of travel of the vehicle, is applied to the road surface under a known vertical load. A controlled flow of water in accordance with the requirements of NSAI S.R. CEN/TS 15901-6 wets the road surface immediately in front of the test wheel so that, when the vehicle moves forward, the test wheel slides in the forward direction along the surface.

3.1.3 Depending on the machine, the vertical load is either assumed to be constant (200 Kg) or it is measured dynamically. Only machines that are fitted with dynamic vertical load measurement capability shall be used for surveys on the national road network.

3.1.4 The force generated by the resistance to sliding is related to the wet road skid resistance of the road surface. Measurement of this sideways component allows the Sideway-Force Coefficient (SFC) to be calculated. The SFC is the ratio between the vertical load and the sideway force.

3.1.5 Raw data measurements are recorded as SFC values. The SFC value is the individual frictional measurement for a single sub section (1, 5, 10 or 20 metres long according to the recorder setting). SFC is expressed as a decimal number, to two decimal places, and for a predetermined length of road, normally 10m.

3.1.6 Measurements shall normally be carried out with the test wheel in the nearside (left) wheel path of the lane to be tested. The Overseeing Organisation may on occasion require measurements in both wheel paths. Therefore, the test machine must also be capable of measuring the SFC in either wheel path or in both wheel paths simultaneously.

3.1.7 Only Sideway-force Coefficient Routine Investigation Machines that have been accepted by the Overseeing Organisation for use on the national road network shall be used for surveys. Acceptance shall be based upon satisfactory performance at the Annual Accreditation Trial arranged by TRL (Transport Research Laboratory). The requirements for achieving and maintaining accreditation will be specified by the Overseeing Organisation.

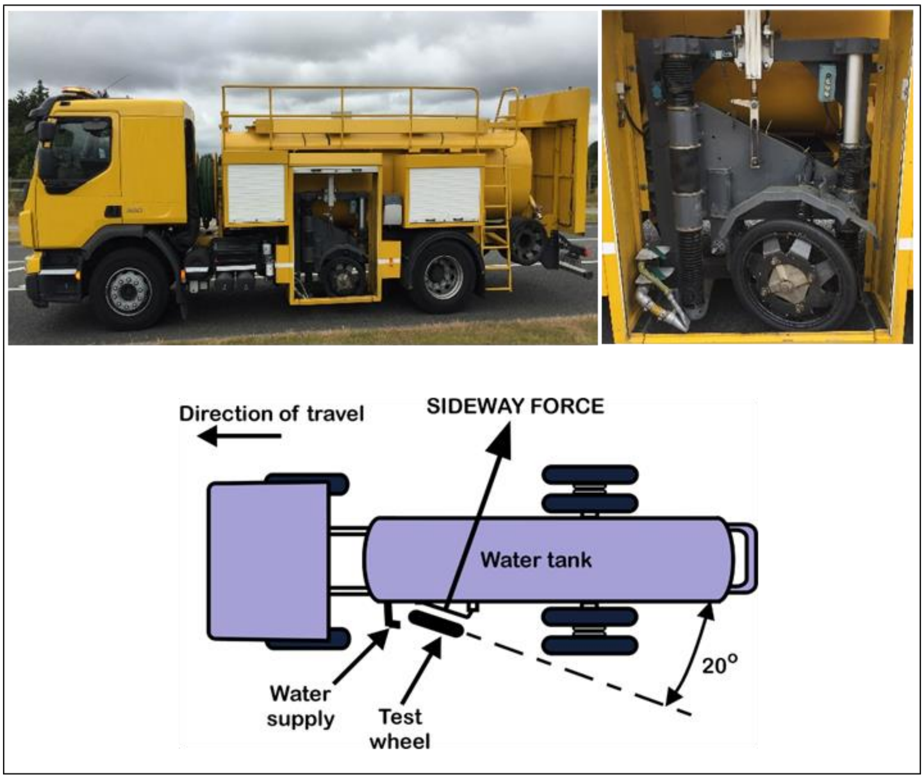

Figure 3.1 Sideway-force Coefficient Routine Investigation Machine, Test Wheel and Principle

3.1.8 An Accreditation Trial is organised annually by TRL before the start of the testing season, with additional trials as necessary. Machines that do not perform satisfactorily at the main trial will be required to attend and achieve acceptance at an additional trial(s). Machines that are unable to attend the main trial will also be required to attend a supplementary accreditation trial.

3.1.9 Skid resistance is not a constant, but is influenced by various factors, including temperature, test speed and weather conditions, plus longer-term effects such as seasonal variation and changes in traffic flow. For the purpose of this standard, Sideway-force Coefficient Routine Investigation Machine measurements will be made under standardised conditions to control these effects as far as possible, including:

- limiting the testing season to a specific time of year;
- specifying a standard test speed;
- specifying the test line to be followed;
- specifying the ambient conditions under which acceptable measurements may be made.

Further details are given in the “Conduct Surveys” section of Chapter 4 in this Standard.

3.1.10 Survey contractors shall comply with the calibration and quality assurance detailed in NSAI S.R. CEN/TS 15901-6 and the "Accreditation and Quality Assurance of Sideway-Force Skid Resistance Survey Devices" document published by the UK Roads Liaison Group (UKRLG).

3.1.11 Survey Contractors providing measurements under this standard must develop appropriate procedures to ensure that measurements are carried out safely and to a standard of quality agreed with the Overseeing Organisation or its Managing Organisation(s) and in accordance with the latest edition of IS EN ISO/IEC 17025 “General Requirements for the competence of testing and calibration laboratories”.

3.1.12 These procedures must include adhering to the procedures given in NSAI S.R. CEN/TS 15901-6 for making skid resistance measurements with a Sideway-force Coefficient Routine Investigation Machine and for calibrating and making regular checks on the equipment, and the further instructions given in the “Conduct Surveys” section of Chapter 4 in this standard.

3.2 Location Referencing

3.2.1 All data collected shall be referenced to the Network Referencing System of the Overseeing Organisation.

3.2.2 All data collected during the survey shall be referenced in relation to distance travelled within the Section and Lane. The accuracy of the Location Referencing must be unaffected by operating speed or by road geometry.

3.2.3 All survey machines shall be equipped with an accurate distance-measuring instrument (DMI) which is calibrated and maintained throughout the survey period so that all measured data is referenced to a longitudinal position on the road to an accuracy of 0.1% or better from the start location of that survey. This accuracy must be independent of vehicle speed and road geometry.

3.3 GPS Recording Equipment

3.3.1 The Sideway-force Routine Investigation Machine shall be equipped with GPS technology so that all recorded data is referenced to 3-dimensional spatial co-ordinates. The GPS data shall be differentially corrected in order to improve accuracy. The GPS equipment shall be integrated with an inertial measurement system in order that national grid co-ordinates can be derived from the GPS data irrespective of the quality of the satellite coverage. The minimum requirements for GPS data are:

- Irish Transverse Mercator (ITM) coordinates derived from the GPS are provided over no less than 950 metres in any 1 km length.
- ITM Co-ordinates to be provided to a coverage requirement of at least 99% of the total length surveyed.
- 95% of the measured positions in any 1 km length shall be within a horizontal error of 1 metre or better from the true position.
- 95% of the measured positions in any 1 km length shall be within a vertical error of 2 metres or better from the true position.
- The horizontal error between the measured and the true position never to exceed 10 metres.
- The vertical (altitude) error between the measured and true position never to exceed 20 metres

3.3.2 The 3-Dimensional Spatial Co-ordinates of the position of the equipment during the survey shall be measured at points separated by no more than 5.0 m of distance travelled.

3.3.3 The 3-Dimensional Spatial Co-ordinates shall be reported as ITM (Irish Transverse Mercator) Co-ordinates and Altitude, where the Altitude measurement describes the Altitude of the surface of the road being surveyed.

3.3.4 Where the survey equipment is unable to meet the accuracy requirements the 3-Dimensional Spatial Co-ordinate data shall be labelled as invalid.

3.4 Digital Video

3.4.1 The Sideway-force Coefficient Routine Investigation Machine shall be equipped with a high-resolution digital camera capable of capturing images at user-selected intervals as low as 3 metres. Video images will normally be stored at 5 metre intervals. The primary use for the camera is to capture a forward view video of the road surface.

3.4.2 The video resolution on the camera system shall be a minimum of 720 x 576 pixels. The camera software system shall be capable of adding a header with relevant information, for example, Survey Date, Route Surveyed, Chainage along route, GPS co-ordinates etc. while collecting the video information. The header must not obscure any portion of the video image. The video software must be able to add/remove/alter the header post-survey when required by the Overseeing Organisation or its Managing Organisation.

3.4.3 The video quality from the digital camera system is extremely important. Should the ambient survey visibility be reduced, due for example to adverse weather conditions, shade/shadow, sun-glare, so as to detract from the image quality of the video survey or would compromise the safety of the survey operatives or that of the public, then the survey should be abandoned until such time as survey conditions improve.

3.4.4 If the quality of the video image is not clear, then the sub-standard video survey for the section in question shall be rejected and the video shall be re-surveyed.

4. Skid Resistance Measurement And Data Processing

4.1 Overview

4.1.1 This chapter details the procedure for planning and conducting skid resistance surveys and processing the data.

4.1.2 Measurements for monitoring the in-service skid resistance of the road network, in line with this Standard, shall be made with a Sideway-force coefficient Routine Investigation Machine, as described in Chapter 3 of this standard, and shall conform to NSAI S.R. CEN/TS 15901-6.

4.1.3 The data shall be processed to derive Characteristic Skid Coefficient (CSC) values in accordance with this Chapter and Annex 2. The process is outlined in Figure 4.1.

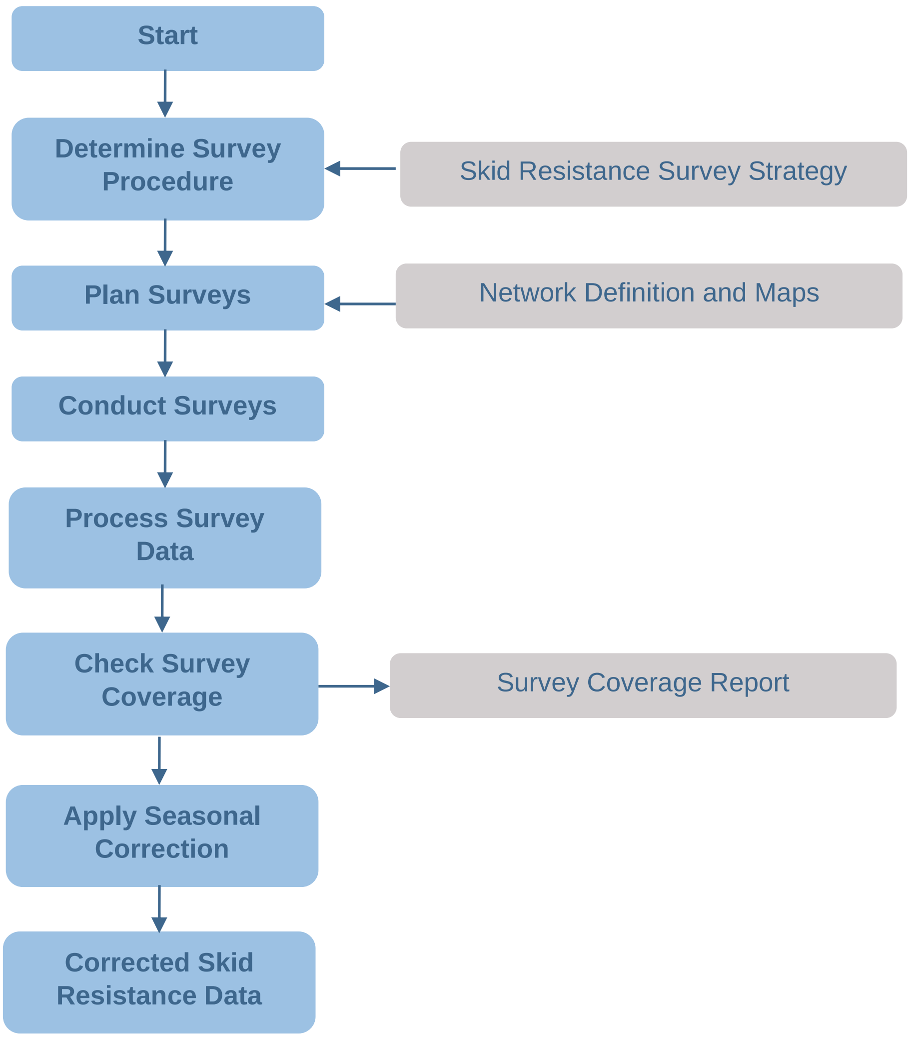

Figure 4.1 Measurement of Skid Resistance

4.2 Determine the Survey Strategy

4.2.1 As noted in Annex 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. The basis of this Standard is to assess the overall (summer) level of skid resistance, by removing the effect of seasonal variation as far as possible and smoothing these fluctuations due to seasonal effects. Accordingly, sites exhibiting lower skid resistance can be identified more accurately.

4.2.2 This overall level of skid resistance is known as the Characteristic Skid Coefficient (CSC). The CSC is an estimate of the underlying skid resistance once the effect of seasonal variation has been taken into account, and is derived from the Skid Coefficient (SC) data that has been corrected for seasonal variation.

4.2.3 The surveying strategy is planned so that the effects of seasonal variation, both within a single season and/or between successive years, are taken into account in the determination of the CSC for any particular length of road. The surveying strategy to be followed is further explained in Annex 2.

4.2.4 Prior to the survey season, the Overseeing Organisation will specify the network to be surveyed, the testing season, the test lane, the survey strategy and the method and/or the accuracy of location referencing required.

4.2.5 Only machines that have passed the Annual Accreditation Trial organised by TRL and have been accepted by the Overseeing Organisation for use on their network and are fitted with dynamic vertical load measurement capability shall be used for surveys. Refer to Chapter 3 for further detail on the requirements for achieving and maintaining accreditation.

4.3 Plan Surveys

4.3.1 The whole of the road network will be tested once in each year during the testing season or as specified by the Overseeing Organisation.

4.3.2 The machine operator shall plan survey routes that optimise the efficiency of the survey and minimise the loss of data as a result of parked cars or slow moving traffic.

4.3.3 For standardised tests, measurements shall be made during the testing season, defined as the summer period 1st May to 30th September.

4.3.4 In exceptional circumstances the Overseeing Organisation may extend the testing season beyond this period. This may 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.

4.4 Conduct Surveys

4.4.1 This section outlines the standard testing procedures that are required to limit the variability of skid resistance measurements resulting from factors other than the road surface condition, for example, the test speed.

4.4.2 The Survey Contractor providing measurements under this standard shall develop appropriate procedures to ensure that measurements comply with the principles for calibration, testing and reporting set out in NSAI S.R. CEN/TS 15901-6.

4.4.3 The sampling interval shall be 10m unless otherwise specified by the Overseeing Organisation.

Testing Lane and Line

4.4.4 The test lane shall be as specified by the Overseeing Organisation.

4.4.5 The surveys shall normally be carried out in the left-most traffic lane in the direction of normal traffic flow.

4.4.6 Measurements shall normally be carried out with the test wheel in the nearside (left) wheel path (wheel path that is closest to the edge of the road in the normal direction of travel) of the lane to be tested.

4.4.7 If it is necessary for the Sideway-force Coefficient Routine Investigation Machine to deviate from the test line (e.g. to avoid a physical obstruction or surface contamination), it should be recorded in the operator survey notes and the data shall be marked as invalid and eliminated from the standard analysis procedure.

Testing on Bends

4.4.8 There are no special requirements for testing on bends. At locations where a sharp bend is combined with traffic braking or accelerating, the wheel paths can become more polished. This is taken into account in setting the Investigatory Level (See Chapter 5).

Testing on Roundabouts

4.4.9 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 may have free-flowing traffic or traffic light controls at certain times of day.

4.4.10 Where safe to do so, the preferred test line is the outermost lane. After entering a roundabout, a minimum of one complete circuit shall be tested. However, on multiple lane roundabouts with lane markings for different routes, it may be necessary to test an alternative lane in accordance with the Rules of the Road. Where this occurs, it shall be recorded in the operator survey notes and reported to the Overseeing Organisation. The machine operator shall ensure that the test wheel is positioned such that testing along a joint is avoided.

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

Mini roundabouts and small island roundabouts shall be defined as those with a central island of between one and four metres in diameter and/or an inscribed circle diameter (ICD) of 28 m or less.

Refer to DN-GEO-03060, Geometric Design of Junctions (priority junctions, direct accesses, roundabouts, grade separated and compact grade separated junctions), for further detail on inscribed circle diameter. (This applies to the testing procedure - the roundabout section may be assigned to a different Site Category to that of the main line.)

Ambient Conditions During Testing

4.4.12 The ambient conditions can have an effect both on the skid resistance of the road and on the measurements. The machine operator shall record the weather conditions at the time of the survey as required by NSAI S.R. CEN/TS 15901-6.

4.4.13 Measurements shall not be undertaken where the air temperature is below 5°C.

4.4.14 Testing shall be avoided in heavy rainfall or where there is standing water on the road surface. Excess water on the surface can affect the drag forces at the tyre/road interface and influence the measurements.

4.4.15 The machine operator shall maintain a record of weather conditions and any road conditions that could influence the survey results, such as heavy rainfall, strong winds and surface contamination. These records should be taken into consideration to determine the validity of survey data when processing the data.

4.4.16 Contamination of the road surface by mud, oil, grit, or other contaminants shall be noted and the affected measurements identified (in the same way as for out-of-line testing) so that results are eliminated from the standard analysis procedure.

Survey Speed

4.4.17 All surveying is typically carried out in live traffic. On Motorways and Dual Carriageway roads where the posted speed limit is greater than 80km/h, the target survey speed shall be 80km/h. On all other roads, the target survey speed shall be 50km/h.

4.4.18 The machine driver shall maintain a vehicle speed as close to the target survey speed as possible (refer to Section 4.5.5 and 4.5.6 below). However, statutory speed limits, either temporary or permanent, must be obeyed regardless of the target survey speed. In addition, if it is not safe to maintain the target speed then a different survey speed may be used. The safety of the machine driver and other road users shall take priority at all times.

4.4.19 The Investigatory Levels for the CSC values defined in Chapter 5 have been set in terms of the 50km/h standard testing speed. The method for applying speed corrections is given under Section 4.5 'Processing the Survey Data' of this Chapter.

4.5 Processing the Survey Data

4.5.1 After collection, the survey data will be validated and subject to processing to determine the CSC values that will be used for further analysis. Validation and processing will be carried out as specified below.

4.5.2 On completion of validation and processing, the survey data will be aligned to the road network and loaded into the appropriate data management system specified by the Overseeing Organisation.

4.5.3 Processing will include:

- review of operator's survey notes when checking validity of survey data

- application of speed correction factor, e.g. in circumstances where it was not possible to maintain the specified standard test speed;
- multiplication by the Index of SFC applicable to the Sideway-force Coefficient Routine Investigation Machine at the time it was making the measurement;
- calculation of the seasonally corrected CSC;
- aggregation of raw data to longer averaging lengths, typically 50m or 100m, for further analysis.

4.5.4 Temperature correction is not applied for surveys carried out under the conditions set in this Standard as outlined in Annex A1.5.

Speed Correction Factor

4.5.5 The test speed has a significant effect on the measurements of skid resistance.

4.5.6 On completion of the survey, valid measurements for each 10m sub-section collected within the speed range 25 to 85km/h shall be corrected to a speed of 50 km/h using the following equation:

$$\boldsymbol{SFC(50) = SFC(s) + \left(s \times 2.18 \times 10^{-3} - 0.109\right)}$$

Where:

SFC(50) is the Sideway-Force Coefficient (SFC) corrected to 50km/h and SFC(s) is the SFC measured at the test speed, s.

For all roundabouts, not classed as mini-roundabouts or small island roundabouts (refer to 4.4.11), the speed correction may be applied to survey speeds down to 20km/h.

Index of SFC

4.5.7 The Index of SFC was originally introduced as a factor to relate the values given by the Sideway-force Coefficient Routine Investigation Machine to the SFC obtained from the equipment at TRL during the period 1963-1972 used to derive information on which to base proposals for specification.

4.5.8 The Index of SFC currently in force is 78% (0.78) and is applicable to all machines in current use but it may be amended in the future.

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

$$\boldsymbol{SC = SFC(50) \times Index\ of\ SFC}$$

4.6 Check Survey Coverage

4.6.1 The survey contractor 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. Refer to Chapter 3 above for further detail on location referencing and accuracy of GPS recording equipment.

4.7 Apply Seasonal Correction

4.7.1 As noted in Section 4.2.1 and Annex 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 removing the effect of seasonal variation sites exhibiting a lower skid resistance can be identified more accurately.

4.7.2 Once the data have been uploaded to the appropriate data management system and checked, the seasonally corrected Characteristic Skid Coefficient (CSC) values shall be determined from the SC values following the method described in Annex 2.

5. Site Categories and Investigatory Levels

5.1 Introduction

5.1.1 Site Categories are assigned to each part of the network by the Overseeing Organisation based on the broad features of the road type and geometry in addition to specific features of the individual site.

5.1.2 Investigatory Levels (ILs) are defined for each Site Category based on the level of traffic and according to the perceived level of risk within each Site Category.

5.1.3 The Site Categories and associated ILs that have been developed for the national road network are defined in Table 5.1. Examples of assigning ILs for each Site Category are described further in Annex 3.

5.1.4 An IL shall be defined for every part of the road network, by determining which Site Category is most appropriate to each location and then selecting the appropriate IL from Table 5.1 for that Site Category based on the level of traffic.

5.1.5 The processed CSC survey data shall be compared with the predetermined ILs to identify lengths of road where the skid resistance is at or below the IL. The process is outlined in Figure 5.1.

5.1.6 Further information on investigatory levels is given in AM-PAV-06046, Skid Resistance Management.

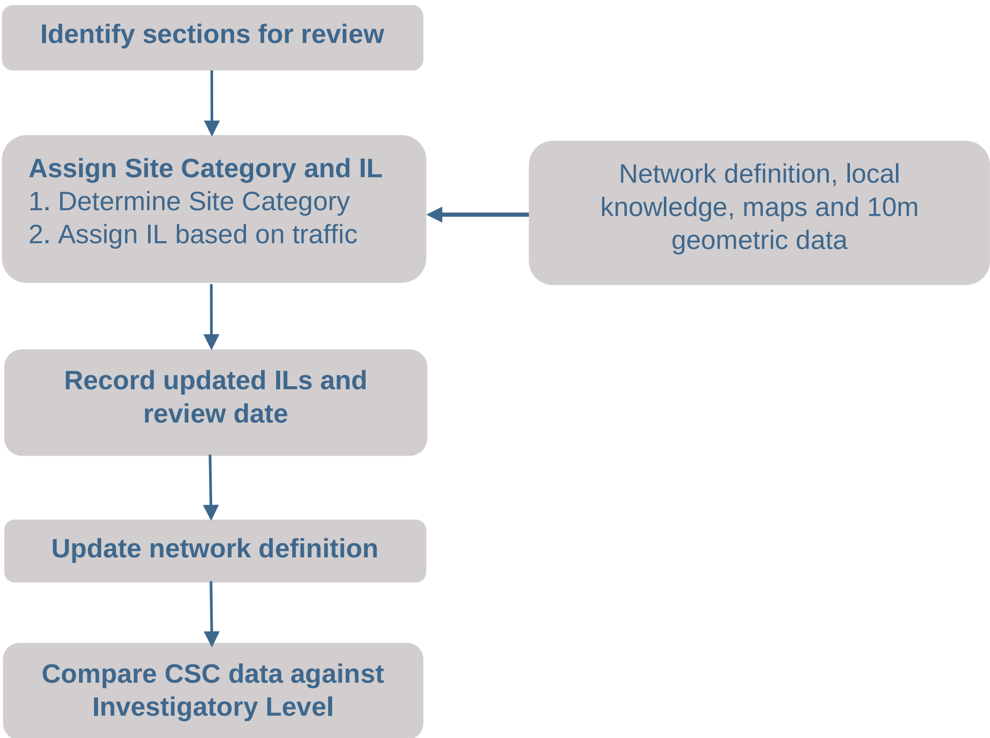

Figure 5.1 Assigning the Investigatory Level

5.2 Identify Sections for Review

5.2.1 A review of the Site Category and associated IL shall be carried out when a significant change to the network is made, for example changes to the road layout, and the Site Category and associated IL shall be updated accordingly.

5.3 Assign Site Category and IL

5.3.1 The Site Category most appropriate to the layout of the site will be selected from the list in Table 5.1.

5.3.2 After selecting a Site Category, the appropriate IL is assigned from the range available for that Site Category based on the level of traffic, following the process described in Annex 3.

5.3.3 The dark shading in Table 5.1 indicates the range of standard ILs that shall be used for national roads with an Annual Average Daily Flow (AADF) greater than or equal to 2500. The light shading indicates a lower IL that shall be used for national roads with an AADF less than 2500.

5.3.4 If more than one site category is appropriate, then the site category with the higher IL will be selected. If the higher ILs and the event averaging length are the same, then the category furthest up the Table will be selected.

5.3.5 If the event lengths differ and partially overlap, both site categories and ILs should be evaluated based on their event length as part of the data analysis.

5.3.6 The site categories for rural national roads where the speed limit is above 60km/h are A, B, C, G, K, Q, R and S.

5.3.7 There are two site categories for the urban national roads where the speed limit is at or below 60km/h, namely site categories U1 and U2.

5.3.8 Further details on the assigning of ILs can be found in Annex 3.

Table 5.1 Site Categories and Investigatory Levels

Site Category and Definition		**Investigatory Levels for CSC data (Characteristic Skid Coefficient data speed corrected to 50km/h and seasonally adjusted)**						
Rural Site Categories (> 60km/h)		0.30	0.35	0.40	0.45	0.50	0.55	0.60
A	Motorway	□	■					
B	Non-event carriageway with one-way traffic	□	■					
C	Non-event carriageway with two-way traffic		□	■				
Q	Approaches to and across major and minor junctions, Approaches to roundabouts (see note 5)			□	■			
K	Approaches to traffic signals, pedestrian crossings and railway crossings (see note 5)					□	■	
R	Roundabout (see note 6)			□	■			
G1	Gradient 5-10% longer than 50m (see note 7)			□	■			
G2	Gradient >10% longer than 50m (see note 7)				□	■		
S1	Bend radius <250m – carriageway with one-way traffic				□	■		
S2	Bend radius <250m – carriageway with two-way traffic				□	■		
Urban Site Categories (≤ 60km/h)		0.30	0.35	0.40	0.45	0.50	0.55	0.60
U1	Approaches to traffic signals, pedestrian crossings and railway crossings (see note 5)					□	■	
U2	All other urban locations		□	■				

■ AADF ≥ 2500

□ AADF < 2500

Notes applicable to all:

1. The IL should be compared with the mean CSC, calculated for the appropriate averaging length.
2. The averaging length is normally 100m or the length of a feature if it is shorter (see notes 5 and 6 for exceptions).
3. The averaging length shall be truncated on any change of Site Category or IL; 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 attached to the penultimate full averaging length, providing the Site Category is the same.

Notes applicable to specific site categories:

4. ILs for site categories A, B, C, G, S and U2 are based on 100m averaging lengths or the length of the feature if it is shorter.

5. ILs and averaging lengths for site categories K, Q and U1 are based on the 50m approach to the feature and, in the case of approach to junctions, through to the extent of the junction. The approach length may be extended when justified by local site characteristics, for example, to take into account likely regular queuing.
6. The averaging lengths for site category R are based on 10m lengths. For site category R, a further assessment is only triggered where 50% or more of the 10m lengths on the roundabout are at or below IL.
7. Categories G1 and G2 should not be applied to uphill gradients on carriageways with one-way traffic.
8. Slip roads will be allocated to categories [B, Q, K, G or S] as appropriate to their length and layout.

6. References

6.1 TII Publications

(https://www.tiipublications.ie gives access to the TII Publications documents)

a) AM-PAV-06046: Skid Resistance Management.

b) AM-PAV-06050: Pavement Assessment, Repair and Renewal Principles.

c) DN-PAV-03023: Surfacing Materials for New and Maintenance Construction, for Use in Ireland

d) DN-GEO-03060: Geometric Design of Junctions (priority junctions, direct accesses, roundabouts, grade separated and compact grade separated junctions).

e) PE-SMG-02002: Traffic Assessment.

6.2 Other Publications

a) Accreditation and Quality Assurance of Sideway-Force Skid Resistance Survey Devices, UK Roads Liaison Group (UKRLG), Issue 4.0, February 2020.

b) CS 228 Skidding Resistance Revision 0 (formerly HD 28/15), Highways England, 2019.

c) IS EN ISO/IEC 17025: 2017, General Requirements for the competence of testing and calibration laboratories.

d) LR738; Hosking JR and Woodford GC, Measurement of Skidding Resistance Part II: Factors Affecting the Slipperiness of a Road Surface, TRRL, 1976.

e) S.R. CEN/TS 15901-6: 2009, Road and airfield surface characteristics - Part 6: Procedure for determining the skid resistance of a pavement surface by measurement of the sideway force coefficient (SFCS): Sideway-force Coefficient Routine Investigation Machine, NSAI.

Annex 1:

Background Information on the Measurement and Interpretation of Skid Resistance

A1 Background Information on the Measurement and Interpretation of Skid Resistance

A1.1 General

When a vehicle travels over a road, each part of the tyre in contact with the road surface is momentarily at rest. The frictional forces generated at these stationary contact areas between the tyre and the road surface can allow vehicles to be manoeuvred. However, a vehicle will start to skid whenever the available friction between the road surface and the tyre is insufficient to meet the demands of the driver in whatever manoeuvre (including braking) they are attempting to make.

The friction available to a driver attempting a particular manoeuvre depends on many different factors. The influence of road surface characteristics which is only one of those factors is described below. Other factors include:

- the vehicle's speed
- the vehicle's tyres, tyre properties and braking system
- the dynamic interaction of the vehicle suspension with the road geometry
- environmental factors, such as the presence of water or other contaminants between the tyre and the road surface

The objective of measurements made and interpreted under the operation of this standard is to characterise the influence of the road surface skid resistance and to assess the need for maintenance. Because the measurements indicate the general level of skid resistance under standardised conditions, the values do not relate directly to the friction available to a road user making a particular manoeuvre at a particular time or to specific collision situations, where other factors such as the tyre condition, vehicle speed and manoeuvre attempted all influence the level of friction generated at that time.

A1.2 What is Skid Resistance?

In this standard, the term "skid resistance" refers to the characterisation of the friction of a road surface when measured with a specific device in accordance with a standardised method as set out in this standard. These standardised 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 skid resistance of a wet or damp road surface will typically be lower and more variable than the same surface when dry and is more influenced by the condition of the surfacing material. For this reason, measurements of skid resistance for the purpose of routine condition monitoring are made on wetted road surfaces.

A1.3 How is Skid Resistance Generated?

The level of wet road skid resistance is influenced by two key properties of the surface, the microtexture and the macrotexture (texture depth). The fine scale microtexture, provided by the surface of aggregate particles is the main contributor to skid resistance at lower speeds and the main property measured in wet skid resistance tests. Greater texture depth generates friction by physically deforming the tyre surface and also provides rapid drainage routes between the tyre and road surface.

Refer to DN-PAV-03023, Surfacing Materials for New and Maintenance Construction for Use in Ireland, for further advice on microtexture and macrotexture.

The effects of microtexture and macrotexture combine to influence the skid resistance at higher speeds.

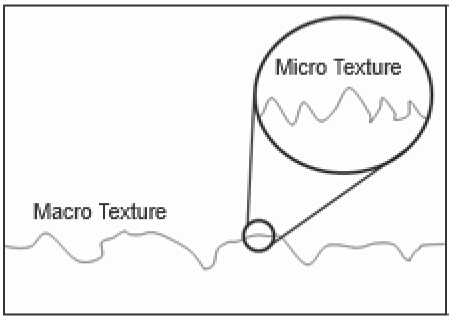

Figure A1.1 Macro-Texture and Micro-Texture

Under the action of traffic, the microtexture “polishes”, leading to a reduction in skid resistance. DN-PAV-03023 requires the components of the surfacing mixture to satisfy certain criteria in relation to their resistance to polishing, so that surfacing materials generally provide adequate skid resistance during their service lifetimes.

A1.4 Relationship to Collision Risk

Within normal ranges, low skid resistance does not cause collisions on its own, although, depending on the particular circumstances, it may increase the risk of a collision. The level of skid resistance, even on a surface where polishing has occurred, will generally be adequate to achieve normal acceleration, deceleration and cornering manoeuvres on sound surfaces that are wet but free from other contamination. However, higher skid resistance can allow manoeuvres that demand higher friction to be completed, e.g. to stop quickly or corner sharply.

Collision analyses have shown that there are relationships between measured skid resistance and collision risk. These relationships are not precise, in that differences in skid resistance may account for only a relatively small part of the difference in collision risk between individual sites because of all the other factors involved. Nevertheless, they have allowed general observations to be drawn that make it possible to provide guidance for managing the provision of skid resistance on the network.

On roads where vehicles for the most part follow a straight path at constant speed, skid resistance requirements are at their lowest. At locations where severe braking, cornering or accelerating occur, the polishing action of traffic is greater and skidding resistance reduces to a lower level than at easier sites. Consequently, the greatest difficulty in obtaining the required performance of materials is encountered at the more difficult sites where higher skidding resistance is necessary.

Heavily trafficked urban roads may require a different Investigatory Level from rural roads as frictional demand may not be as high because of lower speeds.

The influence of skid resistance on collision risk is markedly different for roads with different characteristics. For this reason, Site Categories have been defined to identify road sections with similar characteristics.

For some Site Categories, no statistically significant relationship, or only a weak relationship, is observed between skid resistance and collision risk. A good example of this is motorways, where the characteristics of the infrastructure have effectively reduced the potential for conflict between road users. Although the skid resistance is still important, because of the need to provide uniform road characteristics, the level of skid resistance can be lower than other categories.

For other Site Categories, progressively more wet skid collisions are observed, on average, as the skid resistance reduces. For these categories, there are benefits in maintaining a higher level of skid resistance to contribute to reducing the risk of collisions at these sites.

A1.5 Measuring Skid Resistance

Road surface skid resistance is monitored to identify areas where the microtexture has reduced as the surface has been polished by traffic and treatment may be needed to improve the skid resistance. This is necessary because the performance in service cannot be predicted precisely from the properties of the surfacing components and traffic levels, and the effects of manoeuvring vehicles at the location may be greater than was anticipated at the time the surfacing was designed.

Similarly, the texture depth of road surfacings can reduce with time under the combined influences of traffic flow, environmental factors and the nature of the surface. Therefore, texture depth is also regularly monitored in accordance with AM-PAV-06050, Pavement Assessment, Repair and Renewal Principles.

Under this Standard, routine measurements of skid resistance shall be made using Sideway-force Coefficient Routine Investigation Machine and processed to derive Characteristic Skid Coefficient (CSC) values in accordance with Annex 2, supplemented by specific instructions that may be issued by the Overseeing Organisation.

Skid resistance is also influenced by temperature, although this effect is relatively small for the normal temperature range in Ireland. The temperature of the air or road can have a small effect on the tyre rubber and the measurements made. It has been found that under normal conditions, the influence of temperature is not of practical significance in comparison with other factors affecting the measurements. Temperature correction will not be applied for surveys carried out under the conditions set in this standard.

A1.6 Seasonal Variation of Skid Resistance

Under trafficking, road surfaces reach an equilibrium state of polishing over time. For roads where the traffic level is constant, the skid resistance will then fluctuate through seasonal weathering and polishing cycles but will remain at about a constant level for many years. If the traffic level subsequently increases or decreases, the position of the equilibrium will shift so that a lower or higher overall level of skid resistance may be observed, but with the same seasonal fluctuation.

An example of long-term variation in skid resistance is shown in Figure A1.2. A suggested explanation for the annual variation is that in the winter (October to March) when the roads are wet for much of the time, the detritus is mainly gritty so that the road surface becomes harsh and the skid resistance rises. The lowest skid resistance which varies from year to year is generally observed in the summer period, when the roads are wet for a relatively short time, the detritus on them is mainly dusty so that the road surface becomes polished and the skid resistance falls.

Also, other contaminants, such as oil and tyre rubber (which act as lubricants and hence reduce the available skid resistance) can build up on the surface.

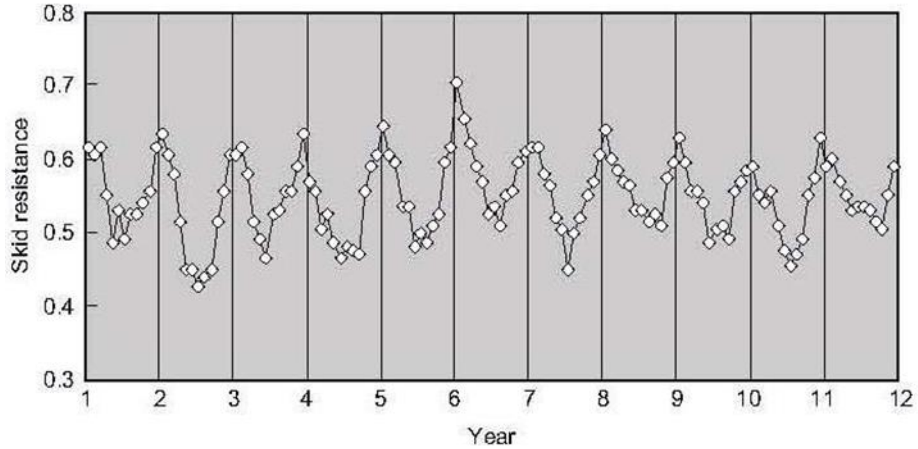

Figure A1.2 Example of Long-Term Variation in Skid Resistance (from LR 738)

Because the skid resistance varies continuously, various strategies have been developed to provide a measurement that characterises the state of polish of the microtexture. Survey strategy and processing procedures are designed to reduce the effect of the variation within a year and between successive years, so the sites with low skid resistance can be identified more accurately. Typically, measurements are made during the summer period (May to September), when the lowest values are generally observed.

The survey strategy and analysis method to be used for the purposes of this standard are detailed in Annex 2.

Annex 2:

Benchmark Sites Approach to Calculation of CSC

A2 Benchmark Sites Approach to Calculation of CSC

A2.1 Overview of Control Benchmark Site Approach

This approach for seasonal correction is based upon a single annual survey of the entire network every year combined with twice weekly data (at the beginning and end of each week) from a designated site named the “Control Benchmark Site”.

The Control Benchmark Site must cover a range of SFC values and shall be identified in consultation with the Overseeing Organisation prior to commencement of the annual survey. The Control Benchmark Site shall be stable in terms of traffic levels and equilibrium skid resistance with little or no treatment in the previous 4 years, or planned treatment over the course of the current testing season.

The purpose of the Control Benchmark Site is to ensure the consistency of the equipment and results over the testing season; to ensure the machine is measuring SFC accurately, and that the machine, DMI and GPS systems are performing within specifications; and to indicate seasonal variation.

The Control Benchmark Site shall be surveyed immediately following the Annual Accreditation Trial arranged by TRL (Transport Research Laboratory) before any other routine testing is carried out to establish baseline data and to evaluate the repeatability of the equipment.

If required by the Overseeing Organisation, other Benchmark Site approaches may be used for the annual network survey in consultation with the Overseeing Organisation.

A2.2 Process

During the testing season, the Control Benchmark Site(s) must be surveyed at the beginning and end of each survey week in the case of a continuous survey programme.

The Control Benchmark Site approach requires one survey for each section on the network each year along with twice weekly surveys for the Control Benchmark Site. It is therefore viable to survey the whole network each year and produce yearly CSC values.

The Control Benchmark Site used to calculate the correction factors is based in a single location to represent the network. Accordingly, determination of CSC using this approach can be carried out throughout the testing season, and it is not necessary to wait until after the end of the testing season when the final Benchmark Site survey has been completed to determine the CSC data.

The survey of the network can be spread over the testing season and the choice of survey period within the testing season has no impact on the CSC value calculated.

A2.3 Calculation Procedure Using Control Benchmark Site Approach

In general, the control benchmark site approach produces two correction factors for each year. The annual survey with Control Benchmark Site Approach is implemented as follows:

The Control Benchmark Site shall be tested at the beginning and end of each week throughout the testing season to provide Weekly Average Skid Coefficient (WASC) values for the Control Benchmark Site and an overall average Mean Summer Skid Coefficient (MSSC) value for the testing season. MSSC values are calculated by taking the average of valid measurements for each 10m length for each Benchmark Site.

With this method, the average behaviour of the Control Benchmark Site is considered to be representative of the network.

By surveying the Control Benchmark Site twice each week throughout the testing season, the effects of within-year variation can be taken into account. Comparing the Control Benchmark Site data in successive years allows the effects of between-year variation to be reduced.

The CSC is calculated in five steps as follows:

i. The **Weekly Average SC (WASC)** of the Control Benchmark Site is determined to represent the average skid resistance level of the Control Benchmark Site at the time of the relevant survey. The WASC is the average SC, calculated for all valid 10m measurements on the Control Benchmark Site measured at the beginning and end of each survey week.

ii. The **Mean Summer SC (MSSC)** is determined to represent the overall average skid resistance level of the Control Benchmark Site for the entire testing season. The MSSC is the overall average of the WASC values for the Control Benchmark Site through the testing season.

iii. The **Mean Summer Correction Factor (MSCF)** is 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. The MSCF is derived as the ratio of the MSSC to the WASC for the survey week of the relevant survey. i.e.:

$$MSCF = \frac{MSSC}{WASC}$$

iv. The **Local Equilibrium SC (LESC)** is determined to represent the average skid resistance level for the network over recent years. The LESC is the average of the MSSC on the Control Benchmark Site for each of the three years that precede the current testing season. Valid measurements are those that were made as 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. This means that if a length of road has been resurfaced within the last 4 years then that length should be excluded from the LESC calculation.

v. The **Local Equilibrium Correction Factor (LECF)** is the correction factor determined for the network to bring the current year data to a level consistent with the long-term average. The LECF is determined by dividing the LESC by the MSSC, i.e.:

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

The CSC for each 10m sub-section shall be determined by multiplying the SC for each 10m sub-section by the factors MSCF and LECF, i.e.:

$$CSC = SC \times MSCF \times LECF$$

Annex 3:

Application of Site Categories and Investigatory Levels

A3 Application of Site Categories and Investigatory Levels

A3.1 Overview

Site categories and associated Investigatory Levels are defined in Table 5.1. This Annex provides detailed guidance on the selection of appropriate site categories and ILs from Table 5.1. These are then followed by some examples. Further information on investigatory levels is given in AM-PAV-06046, Skid Resistance Management.

A3.2 Category A: Motorway (main carriageway)

Use Site Category **A** for all sections of main carriageway that meet motorway standards of geometric design, including merging and diverging areas of the carriageway. Motorway slips roads shall not have category **A** applied but will be allocated to categories [B, Q, K, G or S] as appropriate to their length and layout.

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** will be appropriate on motorway sections with an AADF greater than or equal to 2500. An IL of 0.30 will be appropriate on motorway sections with an AADF less than 2500.

A3.3 Category B: Non-event carriageway with one-way traffic

Use Site Category **B** 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, use category **B** for areas where traffic merges or diverges if:

- The junction layout allows traffic leaving or joining the mainline to match the speed of the mainline traffic, and
- There is adequate taper length for merging to occur.

For category B, non-event carriageway with one-way traffic, an IL of 0.35 will be appropriate for locations with an AADF greater than or equal to 2500. An IL of 0.30 will be appropriate on Non-event carriageway with one-way traffic locations with an AADF less than 2500.

A3.4 Category C: Non-event carriageway with two-way traffic

Use category **C** for all non-event carriageway sections with two-way traffic.

At junctions, use category **C** for areas where traffic merges or diverges if:

- The junction layout allows traffic leaving or joining the mainline to match the speed of the mainline traffic, and
- There is adequate taper length for merging to occur without the mainline being forced into avoiding action.

An IL of **0.40** will be appropriate for non-event carriageway with two-way traffic locations with an AADF greater than or equal to 2500. The IL can be reduced to **0.35** for locations with an AADF less than 2500.

A3.5 Category Q: Approaches to and across major and minor junctions, approaches to roundabouts

Use Site Category **Q** for:

- Major / minor priority junctions
- Other significant accesses
- Approaches to roundabouts.

If the junction design and traffic volume allows the traffic to merge with/diverge from the mainline traffic without changing speed, this Site Category is not needed (use category B or C instead).

Approaches to Junctions:

For the purposes of this standard, 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:

- 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 collision is likely to be severe.
- 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 apply Site Category **Q** to the 50m approach (in the direction of travel) to the junction and across the extent of the junction.

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.

On the minor roads apply Site Category **Q** to the 50m approach to the stop/give way line. Extend the distance, if necessary, to take into account likely regular queues.

For category **Q**, approaches to major and minor junctions, use an IL of **0.45** for locations with an AADF greater than or equal to 2500. The IL can be reduced to 0.40 for locations with an AADF less than 2500.

Approaches to roundabouts:

Apply Site Category **Q** to the 50m approach to the stop/give way line. Extend the distance, as necessary, to take into account likely regular queuing.

Do not use this Site Category for signal-controlled pedestrian crossings – use category **K** instead.

For category **Q**, approaches to roundabouts, use an IL of **0.45** for locations with an AADF greater than or equal to 2500. Use an IL of **0.40** for locations with an AADF less than 2500.

A3.6 Category K: Approaches to traffic signals, pedestrian crossings and railway crossings

Use category **K** for approaches to traffic signals, signal controlled pedestrian crossings and zebra crossings due to vulnerable road users, and railway crossings, where the consequences of a collision are likely to be severe.

Site Category **K** is to be applied for the 50m approach to the event.

An IL of **0.50** will be appropriate for locations with an AADF greater than or equal to 2500. Use an IL of **0.45** for locations with an AADF less than 2500.

A3.7 Category R: Roundabout

Use category **R** for roundabout circulation areas. If there are approaches to traffic lights on roundabouts or pedestrian crossings on roundabouts then use category **K**. Mini roundabouts and small island roundabouts with ICD of 28 m or less 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** will be appropriate for roundabout locations with an AADF greater than or equal to 2500. Use an IL of **0.40** for locations with an AADF less than 2500.

A3.8 Category G1: Gradient 5-10% longer than 50m

On carriageways with one-way traffic, use for lengths of at least 50m with an average downhill gradient of between 5 and 10%.

On carriageways with two-way traffic, use for lengths of at least 50m with an average uphill or downhill gradient of between 5 and 10%.

This assessment can be based on 10m gradient data from automated pavement condition annual surveys (refer to AM-PAV-06050) or from accurate topographical survey data when available.

An IL of **0.45** will be appropriate for category **G1** locations with an AADF greater than or equal to 2500. Use an IL of **0.40** for locations with an AADF less than 2500.

A3.9 Category G2: Gradient >10% longer than 50m

On carriageways with two-way traffic, use for lengths of at least 50m with an average uphill or downhill gradient greater than 10%.

On carriageways with one-way traffic, use for lengths of at least 50m with an average downhill gradient of 10% of higher.

This assessment can be based on 10m gradient data from automated pavement condition annual surveys (refer to AM-PAV-06050) or from accurate topographical survey data when available.

An IL of **0.50** will be appropriate for category **G2** locations with an AADF greater than or equal to 2500. Use an IL of **0.45** for locations with an AADF less than 2500.

A3.10 Category S1/S2: Bend radius < 250m

Use for bends on carriageways with one-way traffic (category **S1**) and on carriageways with two-way traffic (category **S2**).

This category should not generally be used for Roundabout entrances and exits.

The lower, light shaded band (IL of **0.45**) for category S1/S2 will be appropriate for locations with an AADF less than 2500. Raise the IL to **0.50** for S1/S2 locations with an AADF greater than or equal to 2500.

This assessment can be based on 10m curvature data from automated pavement condition annual surveys (refer to AM-PAV-06050, Pavement Assessment, Repair and Renewal Principles), drawings or from accurate topographical survey data when available.

A3.11 Category U1: Urban – Approaches to traffic signals, pedestrian crossings and railway crossings

Use in urban areas for approaches to traffic signals, signal controlled pedestrian crossings and zebra crossings due to vulnerable road users, and railway crossings, where the consequences of a collision are likely to be severe.

Site Category **U1** is to be applied for the 50m approach to the event. Consider extending this distance, if necessary, to take into account likely regular queues.

An IL of **0.55** will be appropriate for locations with an AADF greater than or equal to 2500. Use an IL of **0.50** for locations with an AADF less than 2500.

A3.12 Category U2: Urban – All other urban locations

Use for all other urban locations except approaches to traffic signals, signal controlled pedestrian crossings and zebra crossings, and railway crossings.

Site Category **U2** is to be applied for the 50m approach to the event. Consider extending this distance, if necessary, to take into account likely regular queues.

An IL of **0.40** will be appropriate for locations with an AADF greater than or equal to 2500. Use an IL of **0.35** for locations with an AADF less than 2500.

A3.13 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.3.1. In some cases, other site categories may also be required due to other events occurring in the vicinity.

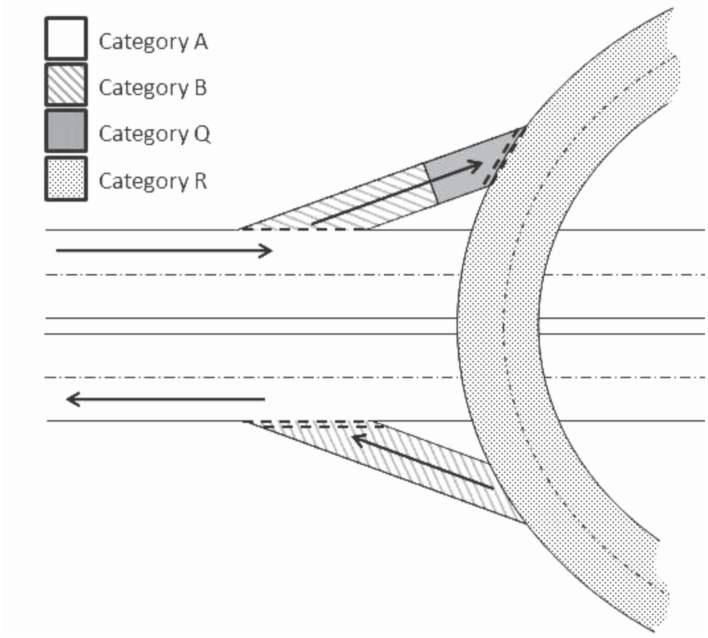

Figure A.3.1 Site categories for a typical motorway grade separated junction layout

The main carriageway will have category **A** applied to its whole length (if appropriate to its geometry/layout).

The off slip will have category **B** applied for the majority of its length with category **Q** applied to the last 50m unless other events for the site take precedence (e.g. high downhill gradient or tight bend). Length of **Q** is to be extended if queues are likely.

The on slip will have category **B** applied to its whole length unless other events for the site take precedence (e.g. high downhill gradient or tight bend).

The roundabout will have category **R** applied to its whole length.

A3.14 Example: T-junction on a rural single carriageway (> 60km/h)

For a T-junction on a single carriageway there are two different site categories in effect, as described below and shown in Figure A.3.2. 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.

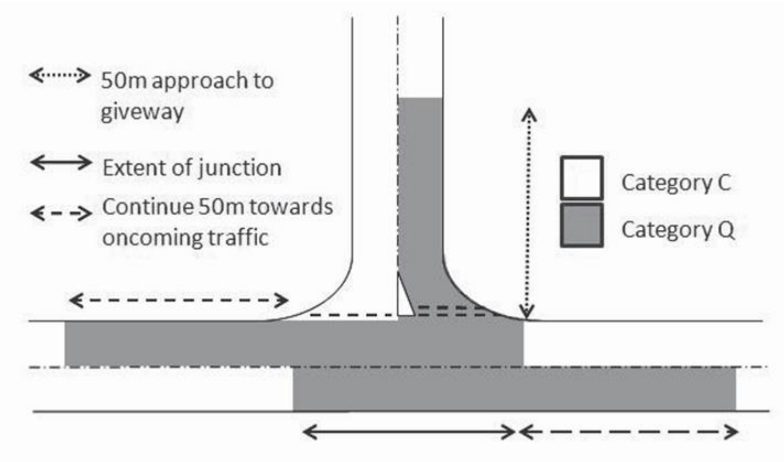

Figure A.3.2 Site categories for junction approaches on a single carriageway

On the minor road, a category of Q is 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) is given a category of C.

On the major road, a category of Q is 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 is given a category of C (if appropriate to the site geometry/layout).

A3.15 Example: Priority junction on a rural single carriageway (> 60km/h)

For a priority junction between two single carriageways there are two different site categories in effect, as described below and shown in Figure A.3.3. 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.

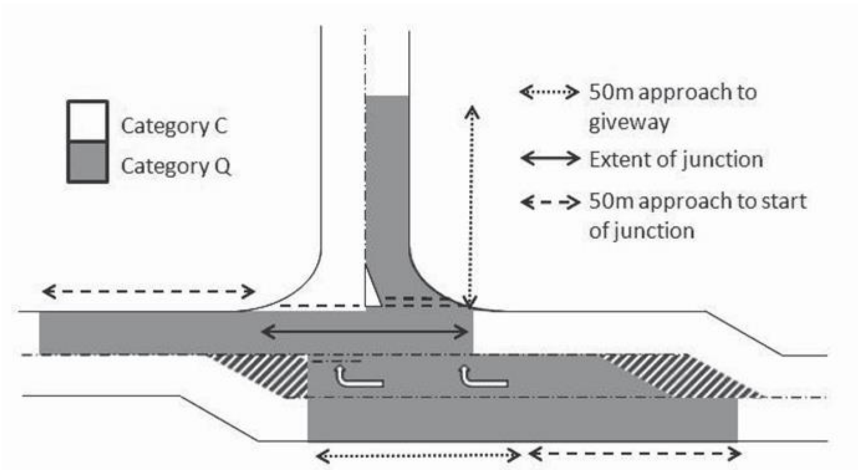

Figure A.3.3 Site categories for a priority junction

The top part of the horizontal road ("major road") will 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 will have the appropriate non-event category applied (in this case C).

The turn lane ("minor road") will have a category of Q applied to the 50m approach to the give way. The bottom part of the horizontal road ("major road") will 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 will have the same Site Category and IL applied along their coinciding length.

The vertical road (one of the "minor roads") will have a category of **Q** 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) will have the appropriate non-event category applied (in this case **C**).

A3.16 Example: Roundabout with a pedestrian crossing in an urban setting (≤ 60km/h)

For a non-signalised roundabout in an urban setting (≤ 60km/h) with a pedestrian crossing on an approach or exit, site categories U1 and U2 are in effect.

A Site Category of **U1** will be applied to the 50m approaches to the pedestrian crossing. This length may be extended depending on the likelihood of traffic having to brake unexpectedly.

The remaining lengths, including the whole length of the roundabout and its approaches, will be assigned a site category of **U2** if they are in an urban setting (≤ 60km/h).

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Ionad Ghnó Gheata na Páirce,
Stráid Gheata na Páirce,
Baile Átha Cliath 8, D08 DK10, Éire

Parkgate Business Centre,
Parkgate Street,
Dublin 8, D08 DK10, Ireland

www.tii.ie

info@tii.ie

+353 (01) 646 3600

+353 (01) 646 3601