BRITISH STANDARD

Methods for measuring the skid resistance of pavement surfaces –

Part 1: Sideway-force coefficient routine investigation machine

ICS 93.080.20

British Standards

Publishing and copyright information

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Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 13 and a back cover.

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Foreword

Publishing information

This British Standard was published by BSI. It was prepared by Subcommittee B/510/5, *Surface characteristics*, under the authority of Technical Committee B/510, *Road materials*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 7941 supersedes BS 7941-1:1999 which is declared obsolescent.

Information about this document

This new edition represents a full revision of the standard, and introduces the following principal changes.

- Corrects typographical errors in the 1999 edition.
- Takes account of changes that have introduced dynamic vertical load measurement (DVLM) to all UK SCRIMs.
- Changes the way in which calibration processes are covered in the document, although not in the principles involved. The standard now describes the principles of the calibration processes and cites the manufacturer's instructions for the detail of how to carry them out. This revision puts this into effect for the existing (horizontal) static calibration and adds a subclause to cover the new vertical load calibration, which has two procedures, one for full calibration and the other for a daily spot-check.

Relationship with other publications

The changes to the hardware associated with the introduction of DVLM were implemented across the whole of the UK fleet in early 2004. The changes in this revision reflect the new position. However, there may be SCRIM owners elsewhere in the world who refer to this British Standard but who will no longer be able to comply fully because their machines are not fitted with a DVLM system. They will need to continue to refer to the 1999 edition, upgrade their machines or change their operating procedures to take account of the differences.

The standard is issued in two parts:

- *Part 1: Sideway-force coefficient routine investigation machine*
- *Part 2: Test method for measurement of surface skid resistance using the GripTester braked wheel fixed slip device*

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard describes a method for determining the wet-road skid resistance of a surface using the sideway-force coefficient routine investigation machine (SCRIM). The method provides a measure of the wet-road skid resistance properties of a bound surface by measurement of sideway-force coefficient at controlled speed. The method has been developed for use on roads but is also applicable to other paved areas such as airport runways.

2 Normative references

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

BS 903-A8:1990, *Physical testing of rubber – Method of determination of rebound resilience*

3 Terms and definitions

For the purposes of this British Standard the following terms and definitions apply.

3.1 skid resistance
property of a trafficked surface that limits relative movement between the surface and the part of a vehicle tyre in contact with the surface

3.2 wet-road skid resistance
property of a trafficked surface that limits relative movement between the surface and the part of a vehicle tyre in contact with the surface, when lubricated with a controlled film of water

NOTE 1 Factors that contribute to skid resistance include the tyre pressure, contact area, tread pattern, and rubber composition; the alignment, texture, surface contamination, and characteristics of the road surface; the vehicle speed; and the weather conditions.

NOTE 2 Skid resistance is not a constant value. It varies with time, climate and traffic.

3.3 bound surface
top layer or surface course of a road

NOTE Aggregates are commonly secured in place by bitumen or cement.

3.4 sideway-force coefficient (SFC)
ratio between the vertical force and sideway-force normal to a test wheel maintained in a slipping condition

NOTE The controlled slipping condition is achieved by mounting a freely rotating test wheel with its vertical plane at an angle to the longitudinal plane of the test vehicle. When the vehicle is in motion, the test wheel slides or slips in the forward direction. SFC values depend upon the type of equipment and the way in which it is used.

3.5 subsection
length of road for which SCRIM records one SR

NOTE A subsection can be 5 m, 10 m or 20 m.

3.6 test section
length of road between defined points (e.g. location references, specific features, or measured distances)

3.7 test length
number of test sections over which a continuous sequence of measurements is made

3.8 SCRIM reading (SR)
measurement recorded by SCRIM for a single subsection

NOTE A SCRIM reading is expressed as a positive integer equal to 100 × the SFC.

3.9 corrected data
SCRIM readings altered to represent standardized conditions

NOTE Corrected data should be prefixed "corrected" and an indication given of the type of correction (e.g. "speed-corrected SR").

3.10 SCRIM coefficient (SC)
corrected data multiplied by the index of SFC (see **3.11**) applicable to the SCRIM during the test

NOTE SCRIM coefficients are expressed as decimal fractions to two places.

3.11 index of SFC
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 used to derive information on which to base proposals for specification

NOTE The present index of SFC is 78% and is valid for all UK SCRIM machines in current use.

3.12 theoretical water film thickness
theoretical thickness of a water film between a measuring tyre and a test surface, assuming the surface has zero texture depth

4 Safety

NOTE 1 When measuring skid resistance on trafficked roads the SCRIM may operate at speeds different to normal road speeds and as a result may create a hazard to other road users.

Safety measures shall be in place to maintain safe working practice in accordance with current regulations, and to ensure the safety of other road users.

NOTE 2 Testing should not be carried out if there is a risk of water freezing on the road.

5 Principle

A freely rotating wheel fitted with a pneumatic, smooth rubber tyre, mounted mid-machine in line with the nearside wheeltrack 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 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. The force generated by the resistance to sliding is related to the wet-road skid resistance of the surface and measurement of this sideways component gives the SR.

The SCRIM reading is affected by the speed of the test vehicle. Testing should be carried out at a specified speed.

6 Test equipment

6.1 SCRIM test equipment

The SCRIM test equipment shall include the following features:

a) test wheel assembly;

b) water supply and flow control mechanism;

c) electronic recorder and measurement control system.

NOTE A machine conforming to the general characteristics of the SCRIM designed by the Transport Research Laboratory[1)] should be used for the tests. SCRIM test equipment has been built onto a number of different vehicle chassis and functions independently of vehicle choice.

6.2 Test wheel assembly

Mount the test wheel assembly on a frame within the wheel-base of the vehicle. Attach two vertical shafts to the frame and locate the test wheel assembly in the appropriate wheelpath. The assembly shall be free to move vertically when the test wheel is in contact with the surface (to minimize the effects of vehicle chassis movements). The test wheel assembly shall comprise a back plate for location on the vertical shafts, a swinging arm, hub, test wheel and tyre, electrical load-cell to measure the horizontal load, an electrical load-cell to measure the vertical load and a single damper/spring suspension unit. The mass of the test wheel assembly shall provide a static vertical load of (2.00 ± 0.08) kN. Fix the vertical plane of the test wheel at $(20\ ^{+1.0}_{-0.5})°$ to the line of the chassis.

NOTE This angle is the "slip angle".

A mechanism shall be provided for raising and lowering the test wheel assembly to and from the ground.

1) Contact TRL Ltd., Crowthorne House, Nine Mile Ride, Wokingham, Berkshire RG40 3GA United Kingdom. Email: enquiries@trl.co.uk. Website: www.trl.co.uk

6.3 Test tyre

The test tyre shall be tubed, pneumatic, natural rubber, (3.00/20) in, smooth treaded. The tyre resilience shall be in the range 40% to 49% as measured by the Lupke test (see BS 903-A8:1990). Inflate the tyre to (350 ± 20) kPa, measured at ambient temperature. Test for at least 2 km with a new SCRIM test tyre before results are recorded. Discard the test tyre when it loses 6 mm in diameter (3.0 mm tyre wear), or if otherwise damaged.

Date stamp all tyres and store vertically in a cool dry environment away from direct sunlight. Do not use a tyre that is more than 2 years old.

6.4 Water supply and flow control

The pattern and flow of water shall be controlled by a manually set control valve and fan shaped nozzle. The manual control valve shall include an indicator that allows the water flow to be adjusted depending on test speed.

To prevent accidental dry testing, a separate valve shall be provided that turns on the water supply before the tyre touches the ground. The valve shall remain open so that water continues to flow until the tyre has completely lost contact with the ground when the test wheel assembly is raised.

The point where the centre of the jet of water strikes the level surface shall be (400 ± 50) mm in front of the centre line of the test wheel along the direction of the line of travel, and within ±75 mm either side, with the wheel parked on the ground. Set the water control valve to provide the theoretical water film thickness at 50 km/h.

The water shall be free from salt, emulsified oils or suspended solids.

The theoretical water film thickness for the SCRIM test shall be 0.5 mm at 50 km/h.

NOTE SCRIM operates with a nominally constant water flow rate. The theoretical water film thickness varies with vehicle test speed and may vary with the level of water in the tank. On a textured road surface, water drains into the texture and so the actual water film thickness in the tyre contact area during a test is variable. It has been found that if the average flow, measured over the discharge of a full tank is (0.95 ± 0.19) l/s then the theoretical water film thickness can be achieved at 50 km/h. Tests have shown that, for typical UK road surfaces, this flow rate is acceptable, for speeds from 25 km/h, when the theoretical water film thickness is 0.9 mm, up to a maximum speed of 85 km/h, when the theoretical water film thickness is 0.3 mm.

6.5 Measurement control system

The measurement control system shall enable the operator to raise and lower the test wheel and ensure that the water supply valve is opened or closed as required. It shall ensure that water flow commences before the wheel touches the road surface and ceases after the wheel is raised.

6.6 Electronic recorder

An electronic recorder shall be provided, capable of measuring the horizontal load, vertical load and distance travelled. The electronic recorder shall display the speed, SR, and length for the subsection and the distance travelled from a predetermined reference point. The recorder shall be capable of accurately recording automatic or manual input reference points.

7 Calibration

7.1 Static calibration of horizontal load measurement

Static calibration of the horizontal load measurement shall be carried out using the "rolling trolley" principle, not more than 24 h before commencement of measurements. Lower the test wheel on to a trolley that is capable of moving freely on a level surface in the line of the test wheel axle and that has a flange that rests against the test tyre. Apply a known horizontal load to the trolley so that it is then transmitted directly to the test tyre along the line of the test wheel axle. Apply the load progressively at intervals from 0 kg to 200 kg in 20 kg steps as measured by the calibration load-cell.

NOTE 1 This procedure requires purpose-made equipment. Suitable equipment that conforms to this principle is normally supplied by the SCRIM manufacturer. The calibration equipment and electronic recorder should be operated in accordance with the manufacturer's instructions for horizontal load calibrations.

NOTE 2 The majority of SCRIM recorders use a linear response curve to determine the horizontal load from the electrical output from the load-cell when the machine is operating normally and automatically correct the load-cell output by storing the response to the known loads applied during the calibration process. Refer to the manufacturer's instructions for any necessary settings to be made at this stage.

Before carrying out a static calibration, check that the test wheel assembly moves freely by lowering the tyre to the road.

NOTE 3 It should be possible to create an oscillatory movement by lifting and then lowering the back-plate. If this is not possible, the reason should be investigated or the manufacturer consulted.

Static calibration shall conform to Table 1.

Table 1 **Static calibration**

Horizontal load applied in line with test wheel axle kg	**Recorder output**
0	0 to 2
20	8 to 12
40	18 to 22
60	29 to 31
80	39 to 41
100	49 to 51
120	59 to 61
140	69 to 71
160	78 to 82
180	88 to 92
200	98 to 102

7.2 Static calibration of vertical load measurement

A full static calibration of the vertical load measurement shall be carried out using the following principle at least monthly when the SCRIM is in regular use.

*NOTE 1 Ideally, the vertical load should be calibrated whenever the horizontal calibration is carried out. However, it is not always practical to carry out a full vertical load static calibration, particularly when the SCRIM is not at its normal base. A vertical load static check (see **7.3**) should be used as necessary between full calibration procedures.*

For a full static vertical load measurement calibration, position the SCRIM on a level surface such that the test wheel can be lowered, when required, on to a weigh pad that is calibrated, readable and accurate to 0.5 kg. The weigh pad should be positioned such that the wheel is at the level that it would normally be when in contact with a road. This can be achieved either by letting the weigh pad into a recess in the ground or by driving the SCRIM on to lifting ramps (positioned under each wheel) that are the same thickness as the weigh pad. Lower the test wheel onto the weigh pad and apply a known vertical load from 0 kg to 200 kg in increasing steps of 20 kg, as indicated by the weigh pad display.

NOTE 2 This procedure requires purpose-made equipment. Suitable equipment that conforms to this principle is normally supplied by the SCRIM manufacturer. The calibration equipment and electronic recorder should be operated in accordance with the manufacturer's instructions for vertical load calibrations.

NOTE 3 The majority of SCRIM recorders use a linear response curve to determine the vertical load from the electrical output from the load-cell when the machine is operating normally and automatically correct the load-cell output by storing the response to the known loads applied during the calibration process. Refer to the manufacturer's instructions for any necessary settings to be made at this stage.

7.3 Vertical load static check

A static vertical load check shall be made whenever a horizontal load calibration is carried out unless a full static vertical load calibration (see **7.2**) is to be made at that time.

Park the vehicle on a generally level surface. Lower the test wheel to its normal operating position. Check the vertical load indicated by the vertical load sensor. The indicated static vertical load shall be (200 ± 8) kg.

Follow the manufacturer's instructions for operating the recorder to carry out this check.

NOTE The static vertical load calibration check does not directly compare the actual load applied with an independent reference value at the time of the test. It verifies that the static vertical load indicated by the sensor is within an acceptable range based upon the last time that the system was fully calibrated. As such it confirms that the load sensor is functioning correctly and that no mechanical fault has developed to significantly affect the static loading.

If the indicated static vertical load is outside the permitted range, do not carry out tests with SCRIM until a full vertical load calibration has been carried out and any necessary adjustments have been made.

7.4 Dynamic calibration check

Carry out a dynamic calibration check, in accordance with Annex A, at least once per week during periods of SCRIM operation and after repairs/servicing to the measuring equipment.

NOTE 1 A dynamic calibration check should also be carried out if there is any reason to suspect the validity of the test results.

NOTE 2 For use on UK trunk roads, SCRIM machines should be checked at least annually in a correlation exercise with other SCRIM machines.

7.5 Distance calibration

Carry out a distance calibration, in accordance with Annex B, at intervals not exceeding 3 months, or if the vehicle rear tyres are changed, or if a malfunction is suspected.

8 Test procedure

8.1 Prior to testing

Prior to testing check the measurement tyre for pressure and wear.

Inspect the water flow system for:

- position of nozzle;
- appropriate flow rate on the water control valve;
- obstruction or damage to the system.

8.2 Testing

On the approach to a test length, lower the wheel and allow it to run on the surface, to bring it to stable operating temperature (run for approximately 0.5 km).

Running the wheel to stable operating temperature is not required if less than 15 min elapse after completion of a previous test length.

Adjust the vehicle speed to the speed specified for the test length and start the recorder.

NOTE 1 On some machines the required length for the subsections should be selected prior to starting the recorder.

Continue with the test, maintaining the specified test speed and entering reference codes at the appropriate locations.

NOTE 2 Usually the equipment should follow the nearside wheeltrack or the path taken by normal vehicular flow (in particular the path taken by heavy goods vehicles). During the test the operator should monitor speed, test line and recorded values. The operator can also insert codes to indicate a deviation from the test line or other conditions that could affect the validity of the readings.

On completion of the test length, after the final reference point, stop the recorder and raise the test wheel.

9 Test report

A daily report shall be produced including the following information:

a) name of the organization;

b) names of SCRIM driver and operator;

c) machine reference;

d) date of test;

e) weather conditions;

f) test length description;

g) start time;

h) target speed;

i) comments.

NOTE 1 An example of a report is given in Annex C.

NOTE 2 Precision of data should conform to Annex D.

Recorded data shall be kept in an appropriate medium for subsequent processing.

NOTE 3 Conversion of measurements of distance, vertical load and horizontal load into speed and SCRIM readings is carried out automatically by the recording system. SCRIM testing produces large quantities of data that require further analysis, including verification of reference points, and this may provide average values for selected sections. Analysis packages are available that apply any necessary corrections and calculate SCRIM coefficients for the test length. These packages are beyond the scope of this British Standard.

Annex A (normative) Dynamic calibration check

A.1 General

The purpose of the dynamic calibration check is to test the SCRIM equipment under dynamic conditions to ensure consistency of results.

Select a stretch of pavement where a convenient check can be carried out to establish consistency over time.

NOTE 1 The following should be considered when selecting a site for dynamic calibration checks.

- *The check site should have separate sections to check SCRIM at a low (but safe), medium, and high level of skidding resistance. Such a site may be difficult to locate and separate sites may be required for the different levels of skidding resistance.*
- *Sections should be at least 100 m long, have a generally uniform skidding resistance along the whole length, and should already have reached the equilibrium value. The horizontal alignment of the section should not be curved with a radius less than 300 m.*
- *The vertical alignment should not have a gradient greater than 1/20.*
- *The road profile should be even, with no rutting, potholes, or patching, and no areas where water can stand during rainfall. The site should be structurally sound.*
- *Preferably the traffic loading should not fluctuate unduly throughout the testing season.*

Carry out dynamic calibration checks at least once per week.

NOTE 2 To carry out dynamic calibration checks the site should be close to where the SCRIM is based. If the SCRIM operates away from its base for more than a week, a site close to the area where it is working should be used for daily comparisons, and the machine should be run on the base site at the earliest opportunity.

A.2 Operational procedures for dynamic comparison checks

Carry out SCRIM testing in accordance with Clause **8**, at a test speed of (50 ± 2) km/h and with a subsection of 10 m.

Calculate the average SR for each section on completion of the test runs. The average value for each section should be not more than 5 units' difference to the previous reading on the same section.

NOTE 1 Variations between comparisons as a result of seasonal variation should be taken into account. For example, large variations attributable to the site, such as heavy rain following a long dry spell, may occur.

NOTE 2 If problems with dynamic comparison runs are encountered, remedial action should be taken and if necessary the manufacturer consulted.

Annex B (normative) Distance calibration check

Ensure vehicle tyre pressures are correct according to the vehicle manufacturer's instructions.

Select a straight, level stretch of road of known length (at least 1 km; see note).

Start the recorder. Drive the SCRIM along the length and record the distance at the start and end of the test section. Repeat the test three times and average the results. (The average shall be within ±2% of the known length. If values are outside 2%, consult the manufacturer for remedial action.)

NOTE If there is no 1 km site available, a motorway may be used with marker posts giving the distance reference. A minimum test length of 10 km should be used on two separate sites, and the average of the two sites calculated.

Annex C (informative) Report format

This annex provides an example of a test report.

Name of organization ..... Date of test .....

SCRIM driver ..... SCRIM operator.....

Machine reference ..... Weather conditions.....

Test length description	Start time	Target speed	Comments

Annex D (informative) (informative) Precision of data

The repeatability r is the maximum difference expected between two measurements made by the same machine, with the same tyre, using the same crew on the same section of road in a short space of time, with a probability of 95%.

The reproducibility R is the maximum difference expected between two measurements made by different machines with different tyres using different crews on the same section of road in a short space of time, with a probability of 95%.

Data from the 1996 group correlation trials at the Transport Research Laboratory were used to calculate repeatability and reproducibility, following the principles of BS ISO 5725 (parts 1 to 6). For a 100 m section of chipped hot-rolled asphalt with a mean SCRIM coefficient (SC) of 0.59, the following values were obtained:

- $r = 0.03 \times \text{SC}$;
- $R = 0.07 \times \text{SC}$.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS ISO 5725 (all parts), *Accuracy (trueness and precision) of measurement methods and results*

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