DRAFT FOR DEVELOPMENT

DD CEN/TS 13036-2:2010

Road and airfield surface characteristics — Test methods

Part 2: Assessment of the skid resistance of a road pavement surface by the use of dynamic measuring systems

ICS 17.040.20; 93.080.20

British Standards

National foreword

This Draft for Development is the UK implementation of CEN/TS 13036-2:2010.

This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature. It should be applied on this provisional basis, so that information and experience of its practical application can be obtained.

Comments arising from the use of this Draft for Development are requested so that UK experience can be reported to the international organization responsible for its conversion to an international standard. A review of this publication will be initiated not later than 3 years after its publication by the international organization so that a decision can be taken on its status. Notification of the start of the review period will be made in an announcement in the appropriate issue of *Update Standards*.

According to the replies received by the end of the review period, the responsible BSI Committee will decide whether to support the conversion into an international Standard, to extend the life of the Technical Specification or to withdraw it. Comments should be sent to the Secretary of the responsible BSI Technical Committee at British Standards House, 389 Chiswick High Road, London W4 4AL.

The UK participation in its preparation was entrusted to Technical Committee B/510/5, Surface characteristics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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.

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English Version

Road and airfield surface characteristics - Test methods - Part 2: Assessment of the skid resistance of a road pavement surface by the use of dynamic measuring systems

Caractéristiques de surface des routes et aérodromes - Méthodes d'essai - Partie 2: Évaluation de l'adhérence d'un revêtement de chaussée à l'aide de systèmes de mesure dynamique

Oberflächeneigenschaften von Straßen und Flugplätzen - Prüfverfahren - Teil 2: Verfahren zur Bestimmung der Griffigkeit von Fahrbahndecken durch Verwendung von dynamischen Messsystemen

This Technical Specification (CEN/TS) was approved by CEN on 5 June 2009 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

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Foreword

This document (CEN/TS 13036-2:2010) has been prepared by Technical Committee CEN/TC 227 "Road materials", the secretariat of which is held by DIN.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document is one of a series of standards as listed below:

— EN 13036-1, *Road and airfield surface characteristics — Test methods — Part 1: Measurement of pavement surface macrotexture depth using a volumetric patch technique*

— CEN/TS 13036-2, *Road and airfield surface characteristics — Test methods — Part 2: Assessment of the skid resistance of a road pavement surface by the use of dynamic measuring systems*

— EN 13036-3, *Road and airfield surface characteristics — Test methods — Part 3: Measurement of pavement surface horizontal drainability*

— EN 13036-4, *Road and airfield surface characteristics — Test methods — Part 4: Method for measurement of slip/skid resistance of a surface — The pendulum test*

— prEN 13036-5, *Road and airfield surface characteristics — Test methods — Part 5: Determination of longitudinal unevenness indices*

— EN 13036-6, *Road and airfield surface characteristics — Test methods — Part 6: Measurement of transverse and longitudinal profiles in the evenness and megatexture wavelength ranges*

— EN 13036-7, *Road and airfield surface characteristics — Test methods — Part 7: Irregularity measurement of pavement courses: the straightedge test*

— EN 13036-8, *Road and airfield surface characteristics — Test methods — Part 8: Determination of transverse unevenness indices*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this Technical Specification: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

The skid resistance of a surface is determined by considering the friction measurement carried out using one of a number of permitted devices, and a measurement of surface texture also carried out using one of a number of permitted procedures. The permitted devices for friction measurements are those which have their measuring principle and procedure described in CEN/TS 15901-1 to CEN/TS 15901-10.

Where required, the procedures set out in this Technical Specification may be used for the measurement of friction only.

If there is a need to compare the skid resistance of a surface measured by different devices, Annex A (informative) may be used. That annex, by combining together the friction and texture for individual measuring devices, produces a skid resistance index (*SRI*).

NOTE The use of an informative annex is not obligatory.

1 Scope

This Technical Specification describes a method for determining the skid resistance of the pavement surface of a road or airfield.

This method defines a process for comparing the friction results from a number of devices. By combining together the friction and texture from individual measuring devices, it allows skid resistance determined by different dynamic methods to be expressed on a common scale, namely the Skid Resistance Index (SRI). As its precision has not been determined, the method should not be used in specifications for surface materials.

This standard excludes surfaces when they are in winter road condition. It also excludes road marking surfaces.

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.

EN 13036-1, *Road and airfield surface characteristics — Test methods — Part 1: Measurement of pavement surface macrotexture depth using a volumetric patch technique*

CEN/TS 15901-1, *Road and airfield surface characteristics — Part 1: Procedure for determining the skid resistance of a pavement surface using a device with longitudinal fixed slip ratio (LFCS): RoadSTAR*

CEN/TS 15901-2, *Road and airfield surface characteristics — Part 2: Procedure for determining the skid resistance of a pavement surface using a device with longitudinal controlled slip (LFCRNL): ROAR (Road Analyser and Recorder of Norsemeter)*

CEN/TS 15901-3, *Road and airfield surface characteristics — Part 3: Procedure for determining the skid resistance of a pavement surface using a device with longitudinal controlled slip (LFCA): The ADHERA*

CEN/TS 15901-4, *Road and airfield surface characteristics — Part 4: Procedure for determining the skid resistance of pavements using a device with longitudinal controlled slip (LFCT): Tatra Runway Tester (TRT)*

CEN/TS 15901-5, *Road and airfield surface characteristics — Part 5: Procedure for determining the skid resistance of a pavement surface using a device with longitudinal controlled slip (LFCRDK): ROAR (Road Analyser and Recorder of Norsemeter)*

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): SCRIM®*

CEN/TS 15901-7*, Road and airfield surface characteristics — Part 7: Procedure for determining the skid resistance of a pavement surface using a device with longitudinal fixed slip ratio (LFCG): the GripTester®*

CEN/TS 15901-8, *Road and airfield surface characteristics — Part 8: Procedure for determining the skid resistance of a pavement surface by measurement of the sideway-force coefficient (SFCD): SKM*

CEN/TS 15901-9, *Road and airfield surface characteristics — Part 9: Procedure for determining the skid resistance of a pavement surface by measurement of the longitudinal friction coefficient (LFCD): DWWNL skid resistance trailer*

CEN/TS 15901-10, *Road and airfield surface characteristics — Part 10: Procedure for determining the skid resistance of a pavement surface using a device with longitudinal block measurement (LFCSK): the Skiddometer BV-8*

EN ISO 13473-1, *Characterization of pavement texture by use of surface profiles — Part 1: Determination of Mean Profile Depth (ISO 13473-1:1997)*

3 Symbols, terms and definitions

3.1 Symbols

B	Device-specific parameter
SRI	Skid Resistance Index
MPD	Mean Profile Depth
MTD	Mean Texture Depth
F	Measured friction value at speed S
F_0	Regression line intercept at speed zero
m	Number of valid results from a measurement series
M	Total number of valid results per device
N	Total number of friction testing devices meeting in a calibration exercise
N_R	Number of reference devices participating in a calibration exercise
n	Number of surfaces used for calibrating friction testing devices
r	Number of runs of a given device on a given surface
S	Slip speed
S_0	Speed parameter
V	Operating speed
β	Regression line slope
σ_{SRI}	Residual standard deviation of SRI
σ_{S_0}	Residual standard deviation of S_0

3.2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.2.1
friction
resistance to relative motion between two bodies in contact

NOTE 1 The frictional force is the force which acts tangentially in the contact area.

NOTE 2 Friction is essential for a safe grip between vehicle and surface. Surfaces can be in different conditions and of different types, which can lead to varying friction. Another important factor is the climate and weather conditions that indeed affect the friction, in most cases for the worse.

3.2.2
friction measuring device
device that measures the frictional force acting tangentially in the contact area

NOTE The results from the friction measuring device are commonly known as a "device coefficient" or "friction value".

3.2.3
skid resistance
characterisation of the friction of a road surface when measured in accordance with a standardised method

NOTE 1 Numerous factors contribute to skid resistance, in particular:

- physical properties of specific friction measuring devices − the contact pressure, contact area, tread pattern and rubber composition of the tyre, or slider in the case of a some test devices;
- slip speed of the tyre/slider over the surface and the vehicle speed;
- surface conditions, i.e. wet or dry, clean or contaminated surface, as well as air and water temperature;
- surface texture characteristics of the road surface, i.e. the microtexture and macrotexture of the surface.

If these factors are held constant for a particular measuring device, or if the conditions of test are standardized, the skid resistance of the surface can be determined.

NOTE 2 The skid resistance of a road surface in Europe varies seasonally. Generally, wet skid resistance is higher in winter as a result of the effects of wet detritus and the effects of frost and wear by tyres on microtexture and macrotexture. Wet skid resistance is lower in summer as a result of dry polishing by tyres in the presence of fine detritus.

NOTE 3 The change in skid resistance of a surface in service is affected by the volume of traffic and the composition of the traffic, i.e. cars, buses, commercial vehicles of different sizes, as the tyres of these vehicles polish and/or wear away the surfacing material in different ways. The geometry of the road will affect the change in skid resistance. Generally, tyres polish less on straight roads than on bends.

NOTE 4 Where the surface contains aggregate with a coating of binder, e.g. bitumen, resin or Portland cement, the skid resistance will change as the coating is worn away by tyres.

NOTE 5 Skid resistance is a particular friction characteristic. Devices for measuring this surface characteristic may be known as skid resistance or friction measuring devices.

3.2.4
Skid Resistance Index
SRI
objective estimate of skid resistance which is independent of the friction measuring device used

NOTE 1 Being a surface-related property, skid resistance is (ideally) independent of speed, measuring device and measuring method. Currently, there is no method available to measure it. However, a common index (Skid Resistance Index, *SRI*), which constitutes an estimate of skid resistance, can be determined as described in Clause 6.

NOTE 2 The *SRI* is intended to facilitate objective comparison of surfaces, and is based on friction and macrotexture measurements and subsequent calculations. The friction measured with a particular device is combined with corresponding macrotexture data as well as pre-determined device-related constants representing most devices used in Europe, normalized to a certain fixed slip speed, to estimate the Skid Resistance Index.

3.2.5
microtexture
deviation of a pavement surface from a true planar surface with characteristic dimensions along the surface of less than 0,5 mm, corresponding to texture wavelengths with one-third-octave bands with up to 0,5 mm of centre wavelengths

NOTE 1 Peak to peak amplitudes normally vary in the range 0,001 mm to 0,5 mm.

NOTE 2 Those devices that utilize a relatively low slip speed measure primarily the component of friction affected by microtexture. Microtexture makes the surface feel harsh but is normally too small to be observed with the unaided eye. It is produced by the surface characteristics of the individual aggregate or other particles that come into direct contact with the tyre. It is a primary component in skid resistance at slow speeds.

3.2.6
macrotexture
deviation of a pavement surface from a true planar surface with characteristic dimensions along the surface of 0,5 mm to 50 mm, corresponding to texture wavelengths with one-third-octave bands including the range 0,63 mm to 50 mm of centre wavelengths

NOTE 1 Peak to peak amplitudes normally vary in the range 0,1 mm to 20 mm.

NOTE 2 This type of texture has wavelengths of the same order of size as the tyre-tread elements. It is normally produced by suitable proportioning of the aggregate and mortar of the mix or by surface treatments. It is a major factor influencing skid resistance at high speeds but it also has an effect at low speeds.

3.2.7
wheel path
parts of the pavement surface where the majority of vehicle wheel passes are concentrated

NOTE 1 The wheel path is not a fixed location on a pavement surface. On a worn pavement, the wheel path is usually easily identified visually. On a newly laid surface, the position of the wheel path should be estimated by experienced device operators.

NOTE 2 For special circumstances such as acceptance tests, a particular path may be defined, for example, (700 ± 150) mm from the edge of the running lane of a road.

3.2.8
Mean Profile Depth
MPD
descriptor of macrotexture, obtained from a texture profile measurement as defined in EN ISO 13473-1

3.2.9
Mean Texture Depth
MTD
result of the volumetric measurement of macrotexture in accordance with EN 13036-1

3.2.10
calibration
periodic adjustment of the offset, the gain and the linearity of the output of a measurement method so that all the calibrated devices of a particular type deliver the same value within a known and accepted range of uncertainty, when measuring under identical conditions within given boundaries or range of parameters, e.g. speed, texture, wetting, temperature

NOTE The method of calibration of devices used to produce a Skid Resistance Index is given in Clause 7.

3.2.11
calibrated device
device that holds a valid calibration certificate following a Type 1, Type 2 or Type 3 calibration

3.2.12
new device
any device which has not been calibrated

3.2.13
reference device
any friction device calibrated in accordance with a Type 1 or Type 2 calibration procedure

NOTE The reference device is used in conjunction with the procedure to determine the Skid Resistance Index.

3.2.14
operating speed
speed at which the device traverses the surface

3.2.15
slip speed
relative speed between the tyre and the travelled surface in the contact area

3.2.16
slip ratio
slip speed divided by the operating speed

NOTE This may be expressed in tables or reports as a percentage but in any calculation, as part of the procedure of the Technical Specification, its decimal value should be used.

3.2.17
contact area
overall area of the road surface instantaneously in contact with a tyre

NOTE This term describes the overall area generally covered by the tyre. Due to the effects of surface texture or any tyre tread pattern, not all of the tyre or road surface in the contact area may be in contact at any instant.

3.2.18
test section
length of road between defined points (e.g. location references, specific features, or measured distances) comprising a number of subsections over which a continuous sequence of measurements is made

4 Safety

Appropriate safety measures shall be in place to maintain a safe working area in accordance with regulations, including measures to control traffic as necessary.

All devices should be operated safely and fitted with safety devices in accordance with the relevant procedures and regulations.

NOTE The wetting of surfaces can have an effect on other users of the site and every effort should be made to ensure that they do not have to make any sudden changes in speed or direction.

5 Measurement procedure

5.1 Friction measurement

The skid resistance of the surface at the time of test is reported as the friction measurement carried out by one of the devices included in CEN/TS 15901-1 to -10 and according to the specific procedure described in the relevant Technical Specification. The information required to be reported by the relevant specification procedure for the device and this Technical Specification shall be reported.

NOTE Measurements should not be made when rainfall significantly increases the depth of water applied by the friction measuring device.

5.2 Macrotexture measurement

The macrotexture measurement shall be carried out either in accordance with EN ISO 13473-1 or EN 13036-1.

5.3 Measurement location

Under normal circumstances the friction as well as the macrotexture measurement shall be taken along a line nominally in the nearside wheel path of the most heavily trafficked lane; the actual distance from the edge will vary. However when required other tracks across the surface may be measured. The transverse location of all tests shall be defined and reported.

NOTE 1 Other transverse locations may need to be measured for example to demonstrate that a surface is consistent transversely when first constructed.

NOTE 2 The locations for testing airfield pavements may be given in ICAO International Standards and recommended practices: Annex 14 to the Convention on International Civil Aviation.

Devices that measure macrotexture or friction as they travel, sample the surface at discrete intervals, the longitudinal test location is given in the operating procedure of the device. Static devices measure at sampling intervals defined in the procedure or as defined by the physical constraints of the site, the tests location shall be recorded. In addition for all devices, the start and finish location, referenced along the test section from a known point, shall be recorded.

5.4 Time interval between friction and macrotexture measurements

The time interval between the friction measurement, on one hand, and the macrotexture measurement, on the other hand, shall not exceed seven days.

NOTE If macrotexture measurements cannot be carried out on the same area at the same time as the friction measurement, they should be taken on the same area at a time as close as practicable.

6 Determination of the Skid Resistance Index (*SRI*)

6.1 General

Where required, this procedure enables the measurement of friction made with different devices to be brought to a common index, known as the Skid Resistance Index (*SRI*) using a complementary macrotexture measurement.

The measurement of friction shall deliver a friction coefficient value (F, dimensionless) and the actual slip speed (S, in kilometres per hour).

The slip speed (S) shall be derived from the operating speed (V) using the following formulae depending on the test principle used by the device:

— Longitudinal force measurement: $S = V$* Slip ratio;

NOTE 1 For locked-wheel systems, the slip ratio equals 1.

— Sideway force measurement: $S = V$* sin(Yaw angle).

NOTE 2 The yaw angle is the angle formed by the equatorial plane of a wheel and the direction of travel of the vehicle.

The macrotexture measurement shall deliver the Mean Profile Depth (*MPD*) of the tested section as defined in EN ISO 13473-1. This is the preferred method. If no adequate profilometer is available, the macrotexture can be measured by means of the volumetric method in accordance with EN 13036-1, which gives the Mean Texture Depth of the tested section (*MTD*, in millimetres).

6.2 Calculations

The estimate of the Skid Resistance Index (*SRI*) shall be computed by means of the following equations:

$$SRI = BFe^{[(S-30)/S_0]} \quad (1)$$

with

$$S_0 = aMPD^b \quad (2)$$

where

F is the measured friction coefficient at slip speed (S, in kilometres per hour);

a, b and B are parameters specific to the friction measuring device used.

From an *MTD* value, one can best estimate *MPD* by the formula:

$$MPD = (5\,MTD - 1)/4 \qquad \text{for } MTD > 0{,}2 \quad (3)$$

$$MPD = 0 \qquad \text{for } MTD < 0{,}2 \quad (4)$$

which has been obtained by correlating *MTD* with *MPD*.

6.3 Device-specific parameters

Parameters a, b and B are determined in the course of a calibration exercise as described in Clause 7.

6.4 Precision

The precision has not been determined. Research is still ongoing.

6.5 Test report

The report shall include the following:

a) date and time of the measurement(s);

b) identification of the operator(s);

c) identification of the test section;

d) identification of the friction testing device;

e) values of constants a, b and B together with the reference to their determination;

f) identification of the texture measuring device;

g) value of *MPD* or *MTD* of the section;

h) friction value of the section;

i) operating speed of the friction measuring device;

j) slip speed of the friction measuring device;

k) value of S_0 for the section;

l) value of SRI for the section.

NOTE The identification of the measuring devices, both for friction and texture, should indicate which version of the device has been used, if applicable. In particular, any change to the device or to the data processing since the latest calibration, should be reported.

7 Calibration of friction testing devices

7.1 General

There are two types of calibration: absolute calibration, where calibration is carried out with respect to some fixed friction coefficient values assigned to reference surfaces which do not vary in their friction properties over time, or relative calibration, where comparisons are conducted, within a given range of experimental parameters, involving any arbitrary choice of surfaces, between two or several devices with a view to determining the cross-relationships between their respective outputs.

Absolute calibration would allow single devices to be calibrated independently, in an "absolute" manner. However, relying on stable reference surfaces has proven disappointing because of seasonal as well as long term unacceptable variations of their properties.

SRI is a normalized reference value based on averaging the results of a multilateral comparison exercise involving a large set of testing methods and devices. SRI is therefore the result of a relative calibration.

The validity of relative calibration is restricted to the given set of participating devices. This comparison can be used either to translate one device output into any other or to adjust all the devices to a common, average value or to any conventional combination of their respective outputs.

NOTE SRI is an initial calibration that should be maintained without convening the whole set of devices involved. Although the more devices reviewing their results by intercomparison, the better the stability of the SRI scale, it is sufficient that three devices meet at a time provided the pairing of devices is organized in such a way as to prevent subsets from drifting from one another in the long run.

The method of maintaining the devices in calibration is described below.

7.2 Surfaces for calibration

The tests shall be carried out on at least six different surfaces covering the whole practical range of materials and of texture depths, i.e. MPD = 0 mm to 2 mm. At least one surface shall have MPD < 0,5 mm and at least one shall have MPD > 1,5 mm.

The test section shall be homogeneous over a length of 100 m with additional adequate space for acceleration and deceleration. They shall furthermore be homogeneous in the transverse direction. In any case, the measurements both of friction and texture shall be made at a lateral position which is as uniform and consistent as possible.

7.3 Test conditions

The texture measuring device shall be operated in accordance with its standard procedure to determine the MPD value of each surface. If the device does not measure the macrotexture, the MPD values may be determined by another device. If necessary, MTD values may be used instead of MPD according to

EN 13036-1. However, every effort shall be made to make *MPD* measurements rather than *MTD* measurements, the former having been found to be more precise.

The friction tests shall be performed at least three times at each of three operating speeds, namely the speed which is standard for the device and two others so that the range 30 km/h to 90 km/h is covered. Those repeated measurements by a given device on a given surface make up a "measurement series".

NOTE In order to ensure a balance between the contribution to the *SRI* of the different participating reference devices, it is recommended that the same number of runs per section be made by each of them. However, devices participating for Type 2 or Type 3 calibrations (see 7.5) may make more runs.

The surface shall be wetted in accordance with the procedure for the specific device.

All the participating devices shall make the friction tests on any given section on the same day.

Care shall be taken to avoid any excess of water left on the surface after each run by allowing a sufficient time for the water to flow away before the next run.

The surface temperature, which shall be measured on a dry spot away from the tested wheel tracks at the start and at the end of the test series, shall not exceed 35 °C nor be lower than 10 °C.

If a device needs to take account of temperature for applying corrections to the results, these corrections shall be made according to the standard procedure for that device and only the corrected results shall be reported and used in the subsequent calculations.

7.4 Calculations

Let N be the total number of participating devices, N_R the number of reference devices among the latter and n the number of surfaces tested.

For each measurement series, calculate the linear regression of ln F versus S:

$$\ln F = \ln F_0 - S/S_0 \tag{5}$$

which yields n^*N values of S_0 along with the corresponding correlation coefficients R^2.

Discard from any further calculation the measurement series with R^2 lower than 0,5.

Calculate the standard deviation σ of S_0 by means of the following formula:

$$\sigma = S_0^2 \sqrt{\frac{n\left(\sum_{02} + \sum_{11}/S_0 - \sum_{01} \ln F_0\right)}{(n-2)(n\sum_{20} - \sum_{10}^2)}} \tag{6}$$

with

$$\sum_{\mu\nu} = \sum_{k=1}^{k=r} S_k^{\mu} (\ln F_k)^{\nu} \tag{7}$$

For each device, calculate the weighted linear regression of ln S_0 versus ln MPD:

$$w \ln S_0 = w \ln a + wb \ln MPD \tag{8}$$

using the following weighting coefficient:

$$w = (S_0/\sigma_{S_0})^2 \tag{9}$$

The result of that calculation is assigning a set of specific parameters (a, b) to each device.

From each remaining measurement series, using the current ("old") B_i values and the newly determined a_i and b_i values, calculate the average of the r values of SRI, which yields SRI_{ij}.

For each surface (j), calculate the "Grand Average" SRI_j of the N_R average values of the SRI_{ij} reported by the reference devices only.

For each device (i), compute the linear regression of SRI versus SRI with zero intercept:

$$SRI = \beta_i \, SRI \qquad (i = 1, \ldots, N)$$

On completion of the calibration exercise, the old B_i value for device (i) shall be changed to the new value by means of the following formula:

$$B_{i,new} = \beta_i \, B_{i,old} \tag{10}$$

NOTE An example of those calculations is given in Annex A.

7.5 Types of calibration

7.5.1 General

A friction device can undergo three types of calibrations (see Figures 1 and 2):

— Type 1 is for a reference device to be compared to other reference devices and so contribute to the maintenance of the SRI scale.

NOTE 1 Type 1 calibration is necessary for preventing the divergence of the SRI scale between the reference devices over time.

— Type 2 is for a non-reference device to be compared to reference devices and so acquiring the status of a reference device.

NOTE 2 Type 2 calibration is necessary for including a new device in the family of devices on which SRI is built. Once calibrated in this way, it becomes a reference device. Type 2 calibration allows for the progressive integration of new devices and, hence, for the SRI to follow developments in testing methods.

— Type 3 is for non-reference devices to be compared to a reference device belonging to the same brand.

NOTE 3 Type 3 calibration allows a fleet of similar devices to calibrate themselves against a reference device of the same family without all of them having to cross borders to take part in calibration meetings of Type 1 or 2. In this case, they keep the link with the SRI scale while staying outside the set of reference devices.

NOTE 4 A calibration meeting can contain a mix of devices to be calibrated in any of the three ways. However, when only one reference device meets with one or more devices for the latter to undergo a Type 2 or 3 calibration, the reference device cannot be calibrated in this situation.

In the example of Figure 1, $R_1 \ldots R_n$ is the full set of existing reference devices. Only a subset of them, namely $R_{n-2} \ldots R_n$ are participating in a meeting for undergoing a Type 1 calibration against one another. At the same meeting, device N is a non-reference device that is participating to undergo a Type 2 calibration by comparison with the subset of reference devices. After the exercise, devices $R_1 \ldots R_n$ become $R'_1 \ldots R'_n$ where the prime indicates that their B value has been updated and device N has also become a reference device, named R'_{n+1}.

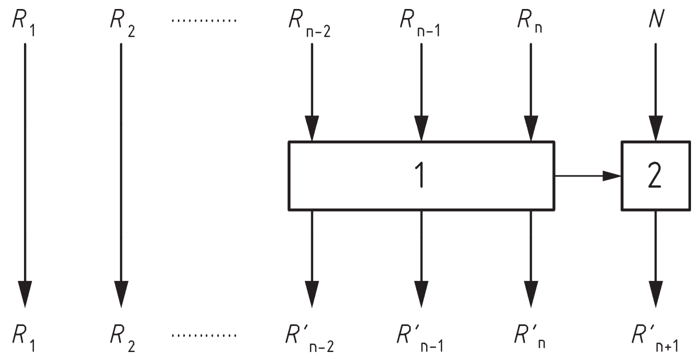


Figure 1 — Example of the arrangement of a Type 1 and Type 2 calibration meeting

In the example of Figure 2, a Type 3 calibration, devices $N_1 \ldots N_m$ are non-reference devices all of the same type as reference device R. By comparison with the latter, the N-devices will have their B value updated, which the prime denotes. However, after this exercise, they have not become reference devices, which means that they are not suitable for calibrating other devices. In this exercise, device R is not undergoing any calibration; its B value remains unchanged.

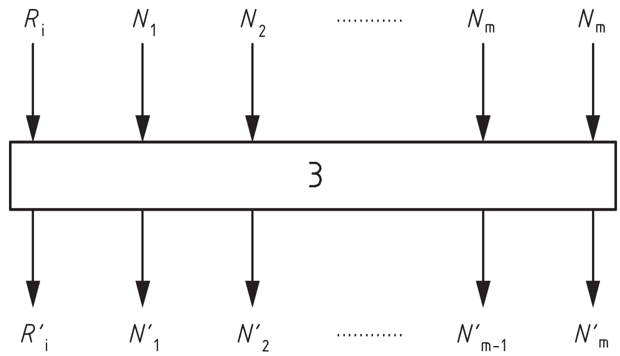


Figure 2 — Example of a Type 3 calibration meeting

NOTE 5 Before any implementation of this standard, no reference devices exist, some candidate devices need to be selected to become the first set of reference devices. They would therefore undergo a Type 1 calibration with their initial B value set to 1.

7.5.2 Type 1 calibration

In this type of calibration, the SRI values reported by the participating reference device are included in the grand average defined in 7.4.

In order to prevent subsets of reference devices from drifting from one another, the following rules shall apply:

— Rule 1: The largest possible number of reference devices shall be sought. A minimum of three is mandatory.

— Rule 2: A particular combination of reference devices, shall not meet again for at least three successive calibration meetings, unless it meets within a larger combination.

7.5.3 Type 2 calibration

In this type of calibration:

— the SRI values reported for device N are not included in the grand average, defined in 7.4;

— the "old" B value of device N is set to 1;

— rule 1 in 7.5.2 applies.

7.5.4 Type 3 calibration

In this type of calibration,

— the SRI values reported for device N_i are not included in the grand average, defined in 7.4, the latter only including the SRI values reported by the reference devices R_i belonging to the same family as the device under consideration;

— the "old" B value of device N_i is set to 1;

— the participating reference devices belonging to the same brand as the devices under consideration may be as few as one, while calibrating devices can be as numerous as required.

7.6 Calibration report

This is a joint report to be delivered to all participants. It shall include the following data:

a) friction measuring devices identification;

b) texture measuring devices identification (if not brought in with the above, indicate: "provided by (name of an organization)");

c) owners identification (companies or institutions details);

d) operators identification;

e) date(s) of testing;

f) location, e.g. country, road(s) or test facility;

g) description of the surfaces, e.g. material, relevant mix design features;

h) meteorological conditions;

i) detailed measurement data (friction and texture) (see 6.5);

j) detailed calculations giving the new a, b and B of each device (see 6.5);

k) type of calibration (1, 2 or 3).

7.7 Periodicity

Reference devices shall undergo a Type 1 calibration every second year. The calibration will be valid for a period of 26 months.

Other devices shall undergo a Type 3 calibration annually. The calibration will be valid for a period of 14 months.

Annex A
(informative)

Example of calibration calculations report

In the following example, four devices are considered to have participated in a calibration exercise. They are named here F09, F10, F12 and F13. F09, F12 and F13 are reference devices meeting for a Type 1 calibration. They already have been assigned a value for B from a preceding calibration. F10 is a new device joining in for a Type 2 calibration. Therefore, its B value is set to 1. As required in 7.3, each of them made repeated runs on each of eight surfaces named here GB01, …, GB08. The target speeds were 30 km/h, 60 km/h and 90 km/h but the actual speeds achieved, as observed on the vehicle speedometers, were reported. Device T5 carried out the texture measurements and reported the MPD values according to the specifications of EN ISO 13473-1. One measurement series (device F10 on surface GB06) had a correlation coefficient R^2 lower than 0,5 for the regression of ln F versus S and, therefore, was discarded. This example is taken over from the experimental data collected by project HERMES [2].

Table A.1 — V and F are experimental results, S is calculated from V and slip ratio and SRI is calculated using B_{old} from F and S after a and b have been determined

Table A.1a

Friction device	F09	**Surface**	GB01
Reference device?	Yes	MPD (mm)	1,09
Slip ratio	1,00	B_{old}	1,049
V (km/h)	S (km/h)	F	SRI
30	29,5	0,523	0,545
31	31,3	0,595	0,634
32	31,7	0,557	0,596
30	29,7	0,554	0,579
31	30,6	0,561	0,593
60	59,9	0,395	0,592
59	59,3	0,406	0,605
60	60,2	0,425	0,640
59	59,3	0,405	0,603
84	83,8	0,318	0,635
90	90,1	0,302	0,650
89	88,8	0,363	0,769

Table A.1b

Friction device	F09	**Surface**	GB02
Reference device?	Yes	MPD (mm)	0,57
Slip ratio	1,00	B_{old}	1,049
V (km/h)	S (km/h)	F	SRI
30	29,6	0,452	0,472
30	29,9	0,508	0,532
31	30,6	0,464	0,491
30	30,4	0,463	0,488
30	30,3	0,468	0,493
60	60,4	0,274	0,429
61	60,5	0,266	0,417
60	60,1	0,271	0,423
91	91,1	0,189	0,443
90	89,7	0,202	0,465
91	90,9	0,248	0,580

Table A.1c

Friction device	F09	**Surface**	GB03
Reference device?	Yes	*MPD* (mm)	0,48
Slip ratio	1,00	B_{old}	1,049
V (km/h)	*S* (km/h)	*F*	*SRI*
29	29,1	0,627	0,650
30	29,7	0,717	0,749
31	31,3	0,628	0,670
30	30,1	0,609	0,640
30	29,9	0,623	0,653
60	59,7	0,401	0,628
61	61,4	0,398	0,638
60	60,3	0,368	0,581
89	89,4	0,267	0,625
91	91,1	0,230	0,551
89	88,8	0,357	0,829

Table A.1d

Friction device	F09	**Surface**	GB04
Reference device?	Yes	*MPD* (mm)	0,54
Slip ratio	1,00	B_{old}	1,049
V (km/h)	*S* (km/h)	*F*	*SRI*
30	30,1	0,410	0,431
31	30,6	0,484	0,512
31	31,1	0,422	0,449
30	29,7	0,462	0,483
30	30,0	0,447	0,469
60	60,2	0,255	0,399
60	60,2	0,281	0,440
61	60,5	0,252	0,396
91	90,8	0,149	0,350
90	90,4	0,151	0,353
91	91,3	0,212	0,502

Table A.1e

Friction device	F09	**Surface**	GB05
Reference device?	Yes	*MPD* (mm)	1,54
Slip ratio	1,00	B_{old}	1,049
V (km/h)	*S* (km/h)	*F*	*SRI*
31	30,6	0,768	0,811
30	30,3	0,656	0,690
31	30,9	0,682	0,723
30	30,3	0,688	0,724
31	30,9	0,747	0,792
60	59,6	0,490	0,719
59	59,2	0,430	0,628
58	57,8	0,411	0,591
59	58,8	0,407	0,592
60	59,7	0,472	0,694
89	89,0	0,308	0,632
92	91,8	0,289	0,612
90	90,0	0,296	0,614
93	93,2	0,347	0,746

Table A.1f

Friction device	F09	**Surface**	GB06
Reference device?	Yes	*MPD* (mm)	2,23
Slip ratio	1,00	B_{old}	1,049
V (km/h)	*S* (km/h)	*F*	*SRI*
30	30,0	0,792	0,831
29	29,2	0,851	0,885
30	30,1	0,834	0,876
30	29,8	0,805	0,843
31	31,3	0,775	0,824
59	59,3	0,569	0,818
57	56,7	0,531	0,742
60	59,5	0,524	0,755
58	57,6	0,543	0,766
59	59,4	0,509	0,732
88	88,2	0,466	0,914
88	88,2	0,444	0,871
88	88,2	0,459	0,900
91	91,3	0,447	0,906

Table A.1g

Friction device	F09	**Surface**	GB07
Reference device?	Yes	*MPD* (mm)	0,19
Slip ratio	1,00	B_{old}	1,049
V (km/h)	*S* (km/h)	*F*	*SRI*
31	30,5	0,098	0,104
31	30,5	0,100	0,106
30	29,9	0,103	0,108
32	31,5	0,086	0,092
30	30,1	0,098	0,103
61	61,0	0,048	0,081
60	59,8	0,055	0,092
60	59,8	0,056	0,093
59	59,4	0,057	0,094
59	58,9	0,048	0,079
91	91,1	0,044	0,119
90	90,2	0,046	0,123
90	89,7	0,050	0,132
86	85,6	0,046	0,114
89	89,3	0,049	0,129

Table A.1h

Friction device	F09	**Surface**	GB08
Reference device?	Yes	*MPD* (mm)	1,66
Slip ratio	1,00	B_{old}	1,049
V (km/h)	*S* (km/h)	*F*	*SRI*
31	30,5	0,695	0,733
30	30,1	0,694	0,729
30	30,3	0,692	0,728
30	30,4	0,673	0,709
29	29,2	0,744	0,773
60	60,4	0,497	0,734
60	60,2	0,478	0,704
59	59,4	0,468	0,683
60	60,2	0,485	0,714
58	58,1	0,533	0,767
90	89,8	0,361	0,741
91	90,6	0,338	0,700
90	90,2	0,354	0,730
86	86,1	0,411	0,810

Table A.1i

Friction device	F10	**Surface**	GB01
Reference device?	No	*MPD* (mm)	1,09
Slip ratio	0,18	B_{old}	1,000
V (km/h)	*S* (km/h)	*F*	*SRI*
35	6,4	0,600	0,240
40	7,2	0,560	0,231
36	6,4	0,550	0,220
38	6,8	0,530	0,216
61	11,0	0,550	0,264
60	10,9	0,510	0,243
62	11,2	0,480	0,232
62	11,2	0,470	0,227
62	11,1	0,450	0,216
90	16,3	0,460	0,270
92	16,6	0,430	0,256
92	16,5	0,420	0,249
92	16,5	0,430	0,255
90	16,1	0,420	0,245

Table A.1j

Friction device	F10	**Surface**	GB02
Reference device?	No	*MPD* (mm)	0,57
Slip ratio	0,18	B_{old}	1,000
V (km/h)	*S* (km/h)	*F*	*SRI*
36	6,4	0,530	0,131
38	6,9	0,480	0,122
35	6,3	0,500	0,123
38	6,8	0,450	0,114
62	11,1	0,380	0,124
61	11,0	0,350	0,114
63	11,3	0,330	0,109
63	11,3	0,340	0,113
62	11,1	0,310	0,101
93	16,7	0,270	0,123
88	15,9	0,250	0,108
91	16,3	0,250	0,112
91	16,3	0,250	0,111
93	16,8	0,230	0,105

Table A.1k

Friction device	F10	**Surface**	GB03
Reference device?	No	*MPD* (mm)	0,48
Slip ratio	0,18	B_{old}	1,000
V (km/h)	*S* (km/h)	*F*	*SRI*
35	6,4	0,720	0,151
37	6,7	0,670	0,143
35	6,2	0,660	0,137
38	6,8	0,610	0,132
62	11,2	0,500	0,144
61	11,0	0,500	0,142
63	11,3	0,450	0,131
63	11,3	0,470	0,136
62	11,2	0,410	0,119
92	16,5	0,330	0,135
92	16,6	0,320	0,132
92	16,5	0,310	0,127
91	16,4	0,330	0,134
93	16,7	0,320	0,133

Table A.1l

Friction device	F10	**Surface**	GB04
Reference device?	No	*MPD* (mm)	0,54
Slip ratio	0,18	B_{old}	1,000
V (km/h)	*S* (km/h)	*F*	*SRI*
36	6,5	0,500	0,119
37	6,6	0,480	0,115
36	6,5	0,470	0,111
38	6,8	0,440	0,106
63	11,3	0,350	0,111
62	11,1	0,320	0,101
63	11,3	0,310	0,099
62	11,2	0,310	0,098
62	11,2	0,280	0,089
91	16,5	0,240	0,105
93	16,7	0,220	0,098
92	16,5	0,220	0,097
92	16,5	0,230	0,101
93	16,7	0,220	0,097

Table A.1m

Friction device	F10	**Surface**	GB05
Reference device?	No	*MPD* (mm)	1,54
Slip ratio	0,18	B_{old}	1,000
V (km/h)	*S* (km/h)	*F*	*SRI*
37	6,6	0,680	0,330
38	6,9	0,730	0,357
37	6,7	0,740	0,360
37	6,7	0,740	0,360
36	6,5	0,730	0,353
61	10,9	0,650	0,360
61	10,9	0,630	0,349
60	10,8	0,640	0,353
61	11,0	0,610	0,339
61	11,0	0,650	0,361
71	12,7	0,640	0,375
76	13,7	0,590	0,356
75	13,5	0,590	0,354
77	13,8	0,630	0,381
77	13,8	0,610	0,370

Table A.1n

Friction device	F10	**Surface**	GB06
Reference device?	No	*MPD* (mm)	2,23
Slip ratio	0,18	B_{old}	1,000
V (km/h)	*S* (km/h)	*F*	*SRI*
35,5	6,390	0,78	×
35,6	6,408	0,74	×
35,0	6,300	0,73	×
35,7	6,426	0,73	×
35,9	6,462	0,71	×
59,9	10,782	0,74	×
57,6	10,368	0,72	×
60,7	10,926	0,74	×
61,3	11,034	0,74	×
59,9	10,782	0,75	×
77,5	13,950	0,72	×
78,6	14,148	0,72	×
79,9	14,382	0,73	×
79,5	14,310	0,74	×
78,4	14,112	0,74	×

Table A.1o

Friction device	F10	**Surface**	GB07
Reference device?	No	*MPD* (mm)	0,19
Slip ratio	0,18	B_{old}	1,000
V (km/h)	*S* (km/h)	*F*	*SRI*
36	6,5	0,086	0,005
34	6,2	0,091	0,005
38	6,8	0,084	0,005
37	6,7	0,086	0,005
36	6,5	0,083	0,005
62	11,2	0,045	0,005
61	11,0	0,049	0,005
62	11,2	0,046	0,005
63	11,4	0,048	0,005
62	11,1	0,047	0,005
86	15,5	0,035	0,006
84	15,2	0,035	0,006
87	15,6	0,037	0,006
86	15,4	0,037	0,006
86	15,5	0,038	0,007

Table A.1p

Friction device	F10	**Surface**	GB08
Reference device?	No	*MPD* (mm)	1,66
Slip ratio	0,18	B_{old}	1,000
V (km/h)	*S* (km/h)	*F*	*SRI*
39	6,9	0,710	0,360
38	6,8	0,760	0,384
37	6,7	0,760	0,382
41	7,3	0,760	0,390
61	11,0	0,680	0,388
61	11,0	0,670	0,383
60	10,7	0,720	0,408
61	11,0	0,720	0,412
62	11,1	0,730	0,418
86	15,5	0,630	0,411
82	14,8	0,670	0,428
84	15,2	0,660	0,427
89	16,1	0,660	0,438
89	15,9	0,660	0,436

Table A.1q

Friction device	F12	**Surface**	GB01
Reference device?	YES	*MPD* (mm)	1,09
Slip ratio	1,00	B_{old}	1,079
V (km/h)	*S* (km/h)	*F*	*SRI*
31	30,7	0,620	0,672
32	31,7	0,620	0,677
31	31,1	0,630	0,685
32	32,3	0,620	0,679
31	31,1	0,620	0,674
60	60,2	0,530	0,702
59	59,1	0,530	0,697
60	60,1	0,530	0,701
60	59,8	0,540	0,713
60	60,3	0,520	0,689
88	87,9	0,440	0,703
89	88,8	0,470	0,755
86	86,4	0,460	0,727
90	90,1	0,450	0,730
86	86,2	0,460	0,726

Table A.1r

Friction device	F12	**Surface**	GB02
Reference device?	YES	*MPD* (mm)	0,57
Slip ratio	1,00	B_{old}	1,079
V (km/h)	*S* (km/h)	*F*	*SRI*
30	30,4	0,630	0,682
31	31,3	0,640	0,697
33	32,6	0,640	0,704
33	32,7	0,610	0,672
32	32,0	0,610	0,668
60	59,7	0,520	0,702
60	60,1	0,530	0,718
60	60,4	0,530	0,719
60	59,7	0,530	0,715
60	59,9	0,510	0,689
86	85,5	0,440	0,721
87	87,2	0,450	0,747
88	87,6	0,440	0,733
89	88,5	0,430	0,721
88	87,8	0,400	0,667

Table A.1s

Friction device	F12	Surface	GB03
Reference device?	YES	*MPD* (mm)	0,48
Slip ratio	1,00	B_{old}	1,079
V (km/h)	*S* (km/h)	*F*	*SRI*
33	32,9	0,740	0,817
33	32,8	0,720	0,794
33	32,8	0,740	0,816
32	32,0	0,720	0,789
32	32,4	0,720	0,791
61	60,7	0,620	0,849
62	61,5	0,630	0,868
62	61,9	0,630	0,871
62	61,5	0,600	0,827
61	61,4	0,590	0,812
87	87,3	0,530	0,892
90	90,0	0,530	0,911
88	88,2	0,510	0,864
90	89,6	0,510	0,874
87	87,3	0,490	0,824

Table A.1t

Friction device	F12	Surface	GB04
Reference device?	YES	*MPD* (mm)	0,54
Slip ratio	1,00	B_{old}	1,079
V (km/h)	*S* (km/h)	*F*	*SRI*
31	30,5	0,560	0,607
32	32,1	0,570	0,625
32	32,4	0,580	0,637
33	32,6	0,560	0,616
33	33,1	0,550	0,608
61	60,9	0,460	0,628
61	61,3	0,470	0,643
62	61,8	0,460	0,632
61	60,8	0,470	0,641
63	62,5	0,440	0,608
88	88,4	0,390	0,656
88	88,0	0,380	0,637
89	89,1	0,400	0,677
90	89,9	0,380	0,647
90	90,0	0,370	0,630

Table A.1u

Friction device	F12	Surface	GB05
Reference device?	YES	*MPD* (mm)	1,54
Slip ratio	1,00	B_{old}	1,079
V (km/h)	*S* (km/h)	*F*	*SRI*
32	32,0	0,760	0,831
31	31,2	0,750	0,815
32	31,7	0,730	0,796
30	30,3	0,700	0,757
32	31,7	0,760	0,829
60	60,1	0,550	0,720
61	60,6	0,530	0,696
61	60,6	0,510	0,669
60	60,2	0,500	0,655
61	60,6	0,500	0,656
87	87,3	0,390	0,607
88	87,6	0,390	0,609
88	88,4	0,360	0,565
91	90,5	0,370	0,588
93	93,0	0,360	0,582

Table A.1v

Friction device	F12	Surface	GB06
Reference device?	YES	*MPD* (mm)	2,23
Slip ratio	1,00	B_{old}	1,079
V (km/h)	*S* (km/h)	*F*	*SRI*
31	30,8	0,720	0,781
31	31,2	0,690	0,750
30	30,3	0,680	0,735
31	30,8	0,700	0,759
31	30,8	0,690	0,748
61	61,2	0,590	0,768
60	60,4	0,600	0,778
61	60,7	0,580	0,753
61	60,8	0,570	0,740
60	60,0	0,540	0,698
89	88,7	0,530	0,815
89	89,3	0,520	0,802
93	92,5	0,470	0,739
91	91,3	0,470	0,734
93	92,5	0,490	0,771

Table A.1w

Friction device	F12	Surface	GB07
Reference device?	YES	*MPD* (mm)	0,19
Slip ratio	1,00	B_{old}	1,079
V (km/h)	*S* (km/h)	*F*	*SRI*
31	31,1	0,100	0,109
32	31,6	0,090	0,099
31	31,2	0,090	0,098
31	30,5	0,090	0,098
31	30,9	0,080	0,087
61	60,7	0,060	0,085
60	60,3	0,050	0,071
60	60,2	0,050	0,071
60	60,3	0,050	0,071
60	60,0	0,050	0,071
90	89,6	0,030	0,055
88	88,0	0,040	0,073
88	88,3	0,030	0,055
89	88,6	0,040	0,073
91	90,8	0,030	0,056

Table A.1x

Friction device	F12	Surface	GB08
Reference device?	YES	*MPD* (mm)	1,66
Slip ratio	1,00	B_{old}	1,079
V (km/h)	*S* (km/h)	*F*	*SRI*
33	32,8	0,720	0,791
31	30,7	0,730	0,791
31	30,5	0,720	0,779
32	31,7	0,720	0,785
32	32,0	0,710	0,776
61	60,8	0,610	0,800
60	60,0	0,610	0,796
60	60,3	0,610	0,797
60	60,2	0,600	0,784
61	60,7	0,610	0,799
89	89,3	0,520	0,816
91	90,5	0,530	0,839
90	89,6	0,520	0,818
90	89,9	0,510	0,804
88	88,0	0,520	0,810

Table A.1y

Friction device	F13	Surface	GB01
Reference device?	YES	*MPD* (mm)	1,09
Slip ratio	0,34	B_{old}	1,002
V (km/h)	*S* (km/h)	*F*	*SRI*
30	10,1	0,550	0,447
30	10,3	0,555	0,452
31	10,4	0,550	0,449
31	10,6	0,550	0,450
31	10,5	0,556	0,454
50	17,1	0,523	0,458
50	17,0	0,529	0,463
50	17,0	0,530	0,463
50	17,0	0,531	0,464
50	16,9	0,531	0,463
89	30,4	0,453	0,456
89	30,2	0,450	0,452
89	30,3	0,455	0,457
89	30,3	0,448	0,450
90	30,4	0,452	0,455

Table A.1z

Friction device	F13	Surface	GB02
Reference device?	YES	*MPD* (mm)	0,57
Slip ratio	0,34	B_{old}	1,002
V (km/h)	*S* (km/h)	*F*	*SRI*
29	9,9	0,546	0,367
30	10,2	0,560	0,379
30	10,3	0,548	0,371
31	10,4	0,556	0,377
30	10,2	0,555	0,375
50	17,0	0,479	0,371
50	16,9	0,493	0,381
50	17,0	0,502	0,388
50	16,9	0,495	0,382
50	17,0	0,496	0,384
90	30,7	0,349	0,355
91	30,8	0,342	0,348
89	30,4	0,358	0,361
91	30,8	0,339	0,345
90	30,6	0,340	0,345

Table A.1aa

Friction device	F13	**Surface**	GB03
Reference device?	YES	*MPD* (mm)	0,48
Slip ratio	0,34	B_{old}	1,002
V (km/h)	*S* (km/h)	*F*	*SRI*
30	10,2	0,679	0,427
30	10,2	0,695	0,437
30	10,2	0,686	0,432
30	10,2	0,688	0,432
30	10,2	0,684	0,430
50	17,1	0,625	0,463
50	16,9	0,635	0,467
50	17,0	0,642	0,474
50	16,9	0,633	0,466
50	17,0	0,636	0,469
91	31,0	0,500	0,513
90	30,6	0,503	0,511
90	30,5	0,529	0,536
90	30,7	0,511	0,520
90	30,6	0,484	0,492

Table A.1bb

Friction device	F13	**Surface**	GB04
Reference device?	YES	*MPD* (mm)	0,54
Slip ratio	0,34	B_{old}	1,002
V (km/h)	*S* (km/h)	*F*	*SRI*
30	10,2	0,529	0,350
30	10,2	0,533	0,353
30	10,2	0,525	0,347
31	10,4	0,527	0,350
30	10,2	0,525	0,347
49	16,8	0,454	0,345
50	17,0	0,456	0,348
50	17,0	0,466	0,355
50	17,0	0,460	0,351
50	16,9	0,458	0,348
90	30,5	0,354	0,359
89	30,4	0,349	0,352
90	30,5	0,361	0,366
90	30,5	0,357	0,362
90	30,6	0,348	0,353

Table A.1cc

Friction device	F13	**Surface**	GB05
Reference device?	YES	*MPD* (mm)	1,54
Slip ratio	0,34	B_{old}	1,002
V (km/h)	*S* (km/h)	*F*	*SRI*
30	10,2	0,704	0,608
32	10,7	0,686	0,595
30	10,2	0,753	0,651
30	10,3	0,715	0,618
31	10,5	0,718	0,622
50	17,0	0,699	0,636
50	16,9	0,709	0,644
50	17,0	0,691	0,628
50	17,0	0,681	0,619
50	17,0	0,689	0,626
89	30,3	0,603	0,606
90	30,7	0,570	0,574
91	30,9	0,573	0,578
91	30,9	0,550	0,555
91	30,9	0,552	0,557

Table A.1dd

Friction device	F13	**Surface**	GB06
Reference device?	YES	*MPD* (mm)	2,23
Slip ratio	0,34	B_{old}	1,002
V (km/h)	*S* (km/h)	*F*	*SRI*
31	10,5	0,687	0,622
31	10,5	0,718	0,650
31	10,5	0,718	0,650
30	10,2	0,737	0,666
30	10,3	0,739	0,669
50	16,9	0,652	0,610
50	17,0	0,691	0,647
50	17,1	0,708	0,663
50	16,9	0,688	0,644
50	17,0	0,700	0,656
89	30,4	0,611	0,613
90	30,6	0,610	0,613
91	30,9	0,605	0,609
88	30,0	0,602	0,603
93	31,6	0,584	0,590

Table A.1ee

Friction device	F13	Surface	GB07
Reference device?	YES	*MPD* (mm)	0,19
Slip ratio	0,34	B_{old}	1,002
V (km/h)	*S* (km/h)	*F*	*SRI*
31	10,5	0,134	0,043
31	10,5	0,157	0,050
30	10,3	0,141	0,045
30	10,2	0,144	0,045
31	10,5	0,142	0,045
51	17,3	0,071	0,034
50	17,1	0,079	0,037
51	17,2	0,078	0,037
50	17,0	0,075	0,035
50	16,9	0,095	0,044
92	31,2	0,028	0,030
92	31,1	0,029	0,031
90	30,5	0,030	0,031
91	31,1	0,035	0,037
90	30,6	0,026	0,027

Table A.1ff

Friction device	F13	Surface	GB08
Reference device?	YES	*MPD* (mm)	1,66
Slip ratio	0,34	B_{old}	1,002
V (km/h)	*S* (km/h)	*F*	*SRI*
30	10,3	0,653	0,571
31	10,4	0,642	0,561
30	10,3	0,661	0,578
31	10,5	0,662	0,580
31	10,5	0,666	0,583
50	17,1	0,647	0,593
50	16,9	0,684	0,626
50	17,0	0,683	0,625
50	17,0	0,700	0,641
50	17,0	0,682	0,624
88	29,8	0,595	0,595
90	30,4	0,606	0,609
91	30,8	0,606	0,611
90	30,7	0,601	0,605
91	30,8	0,599	0,604

Table A.2 — Correlation coefficient of the regression of ln *F* versus *S*

R^2	F09	F10	F12	F13
GB01	0,935	0,806	0,986	0,981
GB02	0,927	0,951	0,968	0,985
GB03	0,918	0,969	0,967	0,976
GB04	0,941	0,959	0,981	0,996
GB05	0,936	0,841	0,985	0,903
GB06	0,920	0,032	0,937	0,908
GB07	0,834	0,952	0,941	0,980
GB08	0,974	0,768	0,994	0,613

Table A.3 — Speed parameter determined from the regression of ln *F* versus *S*

S_0	F09	F10	F12	F13
GB01	106	38	182	97
GB02	74	15	149	43
GB03	71	14	161	66
GB04	62	14	148	51
GB05	73	39	85	85
GB06	102	X	176	112
GB07	81	10	59	13
GB08	90	66	178	198

Table A.4 — Standard deviation of S_0 with respect to the regression of ln *F* versus *S*

σ_{S_0}	F09	F10	F12	F13
GB01	8,80	5,30	6,00	3,80
GB02	6,90	0,97	7,50	1,40
GB03	7,00	0,71	8,20	2,80
GB04	5,20	0,82	5,60	0,95
GB05	5,50	4,80	2,90	7,80
GB06	8,30	×	12,60	9,90
GB07	10,00	0,64	4,10	0,52
GB08	4,20	10,40	4,00	43,00

Table A.5 — Weight applied in the regression of S_0 versus *MPD*

w	F09	F10	F12	F13
GB01	143	50	926	654
GB02	115	231	398	880
GB03	101	374	381	534
GB04	143	279	687	2 863
GB05	176	69	869	121
GB06	150	×	194	128
GB07	65	257	208	637
GB08	457	40	2 022	21

Table A.6 — Number *m* of valid measurements

m	F09	F10	F12	F13
GB01	12	14	15	15
GB02	11	14	15	15
GB03	11	14	15	15
GB04	11	14	15	15
GB05	14	15	15	15
GB06	15	×	15	15
GB07	15	15	15	15
GB08	14	14	15	15

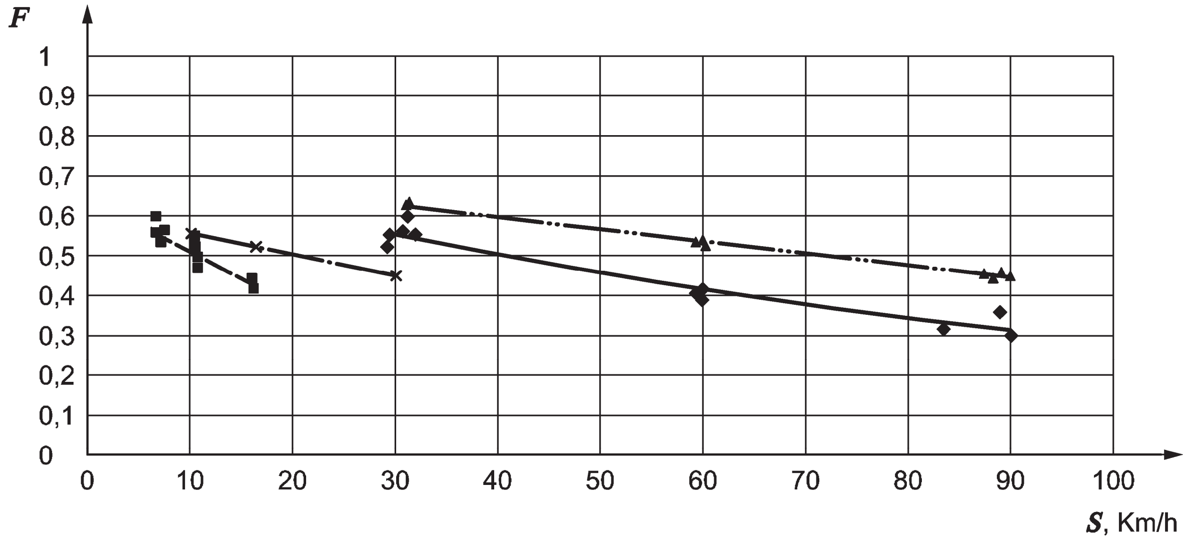
Table A.7 — Average values of *SRI*

SRI	F09	F10	F12	F13	*SRI*
GB01	0,620	0,240	0,702	0,456	0,591
GB02	0,476	0,115	0,704	0,369	0,520
GB03	0,656	0,135	0,840	0,471	0,656
GB04	0,435	0,103	0,633	0,352	0,477
GB05	0,683	0,357	0,692	0,608	0,660
GB06	0,837	×	0,758	0,634	0,743
GB07	0,105	0,005	0,078	0,038	0,074
GB08	0,733	0,405	0,799	0,600	0,710

Table A.8 — Summary of calibration results [a]

Device	F09	F10	F12	F13
Ref.	Yes	No	Yes	Yes
B_{old}	1,049	1,000	1,079	1,002
β	0,962	2,198	0,851	1,229
B_{new}	1,009	2,198	0,918	1,231
σ_{SRI}	0,039	0,212	0,061	0,054
M	103	100	120	120
a	83	24	145	87
b	0,15	0,65	0,16	0,98

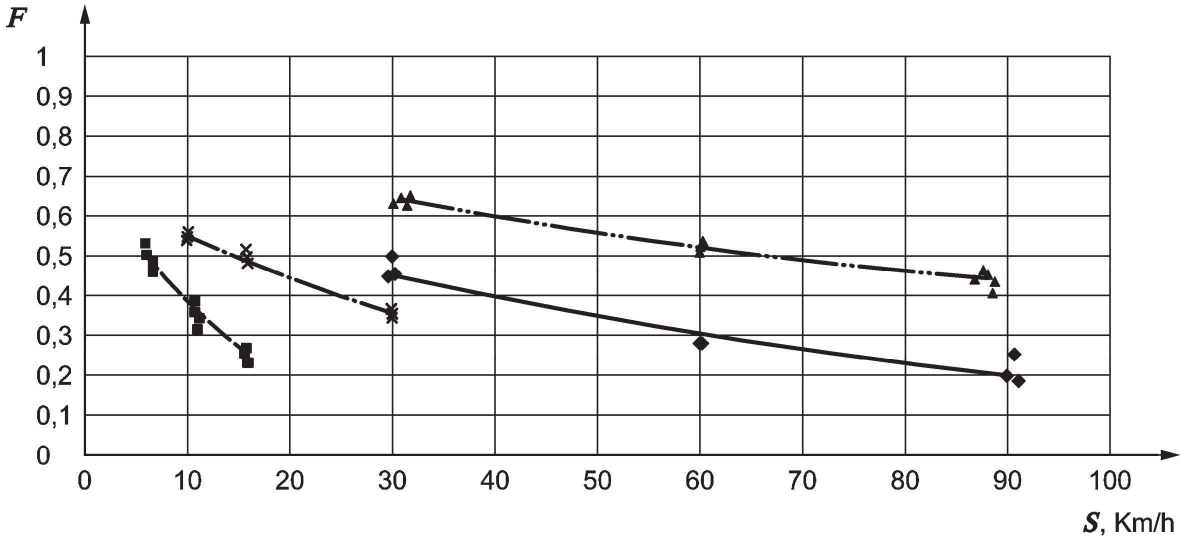
[a] β comes from the regression of *SRI* versus *SRI*, B_{new} was calculated from B_{old} and β, *a* and *b* were derived from the regression of S_0 versus *MPD* and σ_{SRI} is the standard deviation of the regression of *SRI* versus *SRI*, which is a measure of the precision of the calibration. *M* is the number of valid measurements per device.



Key

◆	F09	■	Expon. (F09)
▲	F10	×	Expon. (F10)
————	F12	— — — —	Expon. (F12)
——··——	F13	——·——	Expon. (F13)

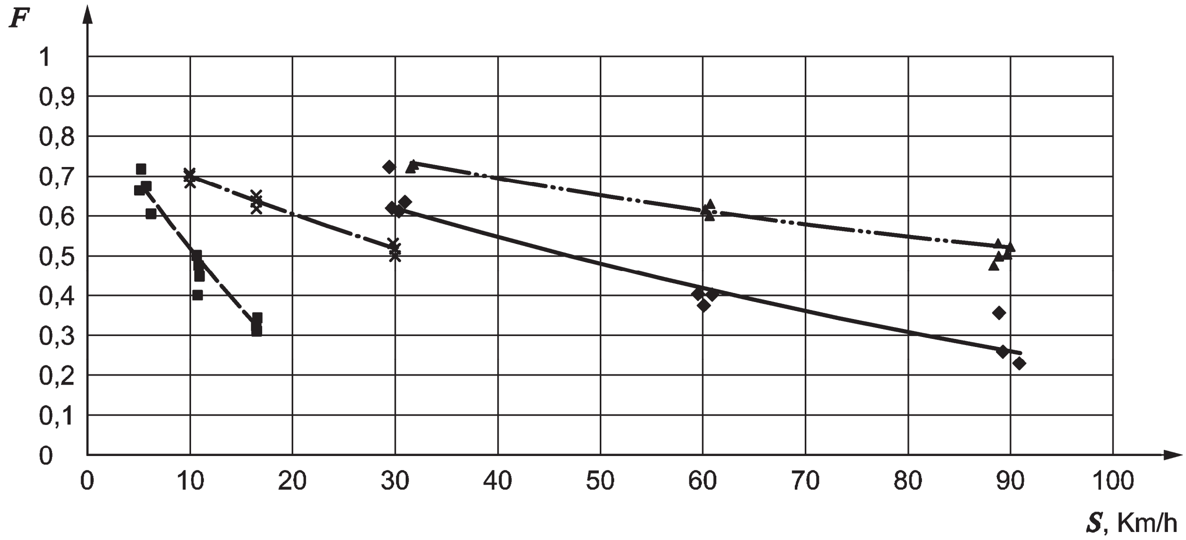
Figure A.1 — Exponential curve fitting on *F* versus *S* from measurements made on surface GB01



Key

◆	F09	■	Expon. (F09)
▲	F10	×	Expon. (F10)
———	F12	– – – –	Expon. (F12)
—··—	F13	—·—	Expon. (F13)

Figure A.2 — Exponential curve fitting on *F* versus *S* from measurements made on surface GB02



Key

◆ F09

■ Expon. (F09)

▲ F10

× Expon. (F10)

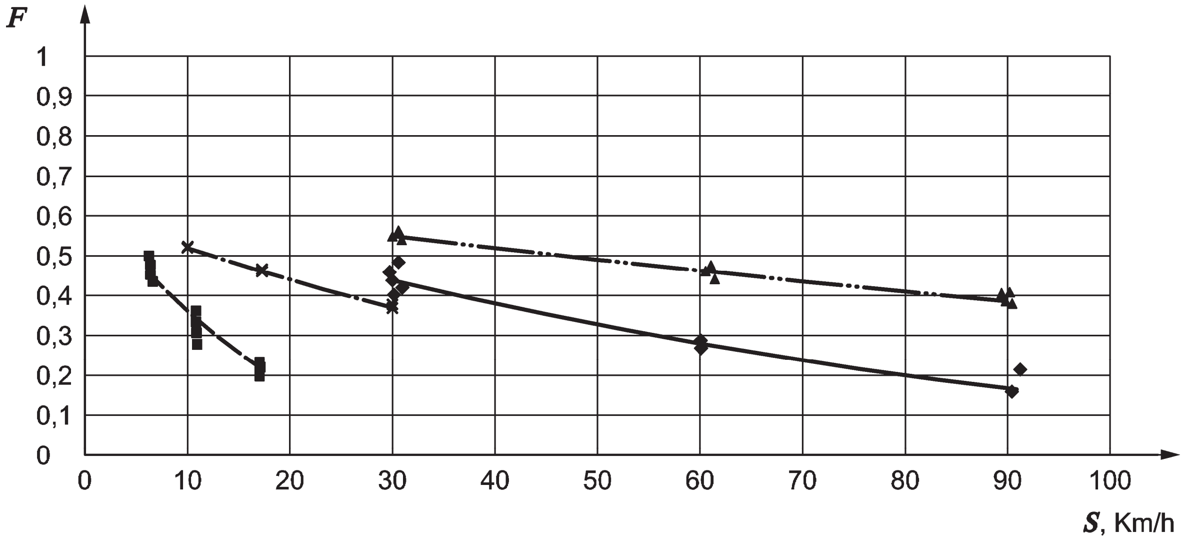
———— F12

— — — — Expon. (F12)

——··—— F13

——·—— Expon. (F13)

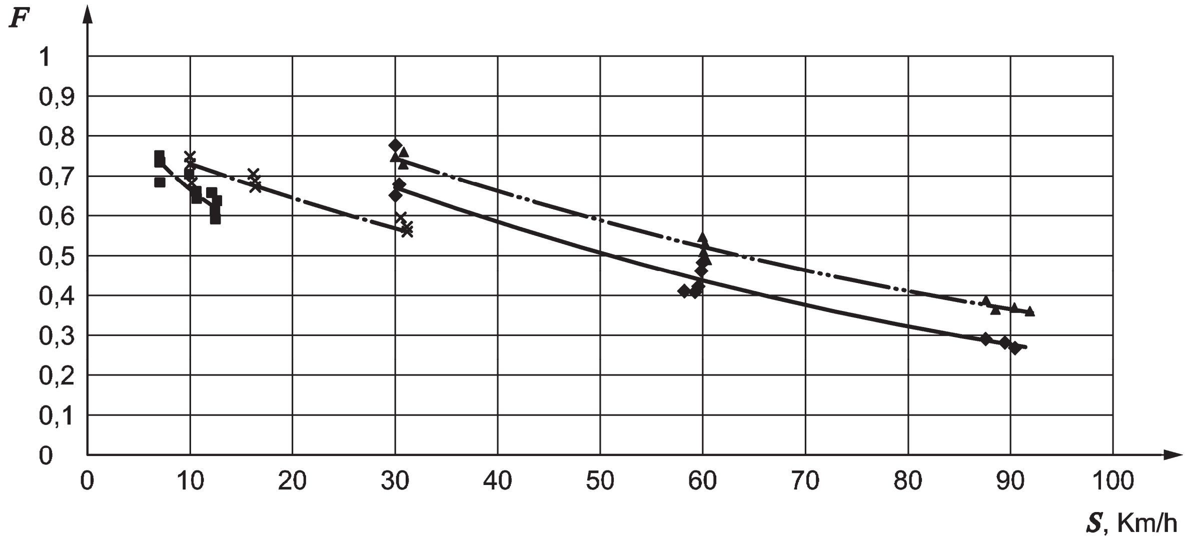
Figure A.3 — Exponential curve fitting on *F* versus *S* from measurements made on surface GB03



Key

◆	F09	■	Expon. (F09)
▲	F10	×	Expon. (F10)
————	F12	— — — —	Expon. (F12)
——··——	F13	——·——	Expon. (F13)

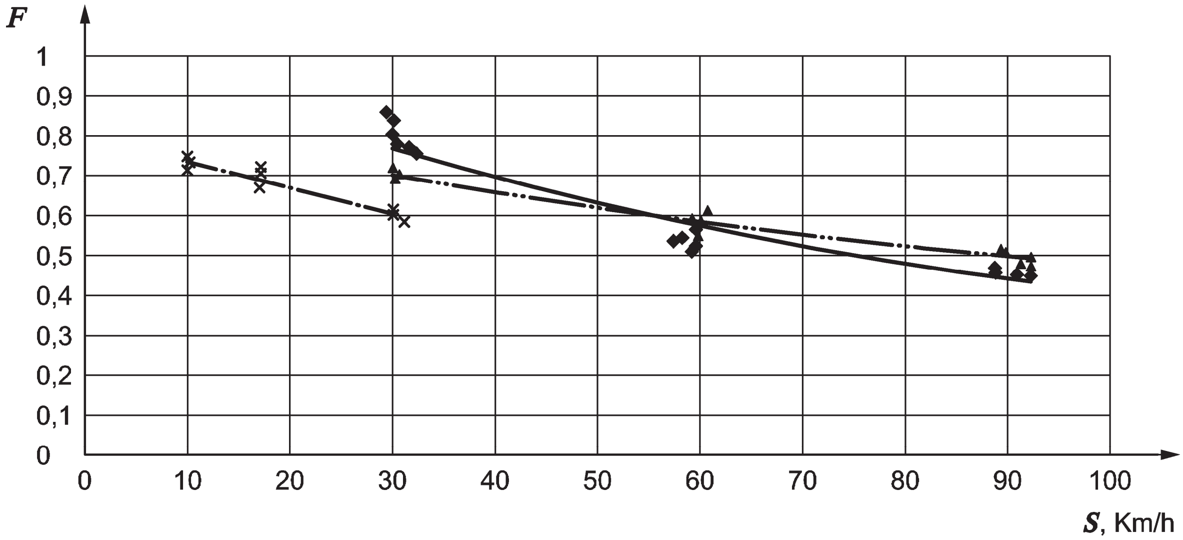
Figure A.4 — Exponential curve fitting on *F* versus *S* from measurements made on surface GB04



Key

◆	F09	■	Expon. (F09)
▲	F10	×	Expon. (F10)
————	F12	— — — —	Expon. (F12)
——‥——	F13	——·——	Expon. (F13)

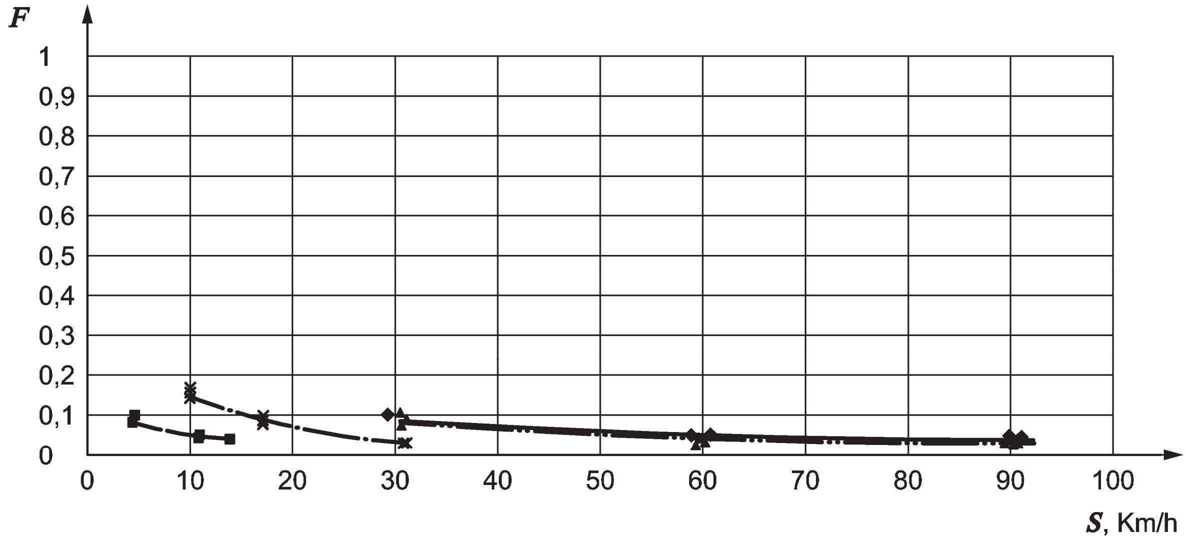
Figure A.5 — Exponential curve fitting on *F* versus *S* from measurements made on surface GB05



Key

◆	F09	▲	Expon. (F09)
×	F12	————	Expon. (F12)
—··—	F13	—·—	Expon. (F13)

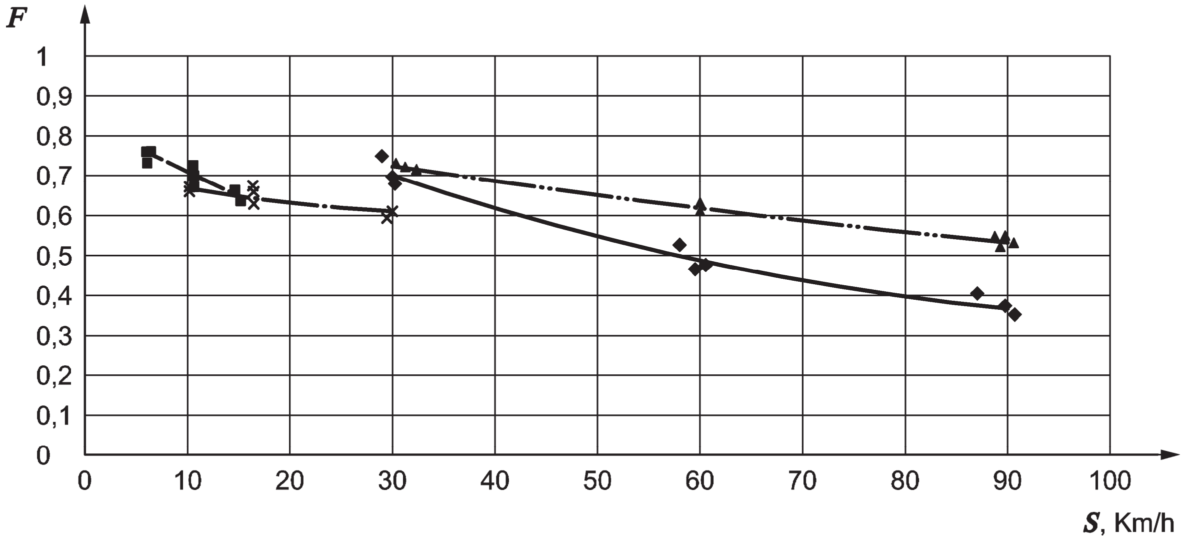
Figure A.6 — Exponential curve fitting on *F* versus *S* from measurements made on surface GB06



Key

◆	F09	■	Expon. (F09)
▲	F10	×	Expon. (F10)
————	F12	— — — —	Expon. (F12)
——..——	F13	——.——	Expon. (F13)

Figure A.7 — Exponential curve fitting on *F* versus *S* from measurements made on surface GB07



Key

◆	F09	■	Expon. (F09)
▲	F10	×	Expon. (F10)
————	F12	— — — —	Expon. (F12)
——··——	F13	——·——	Expon. (F13)

Figure A.8 — Exponential curve fitting on *F* versus *S* from measurements made on surface GB08

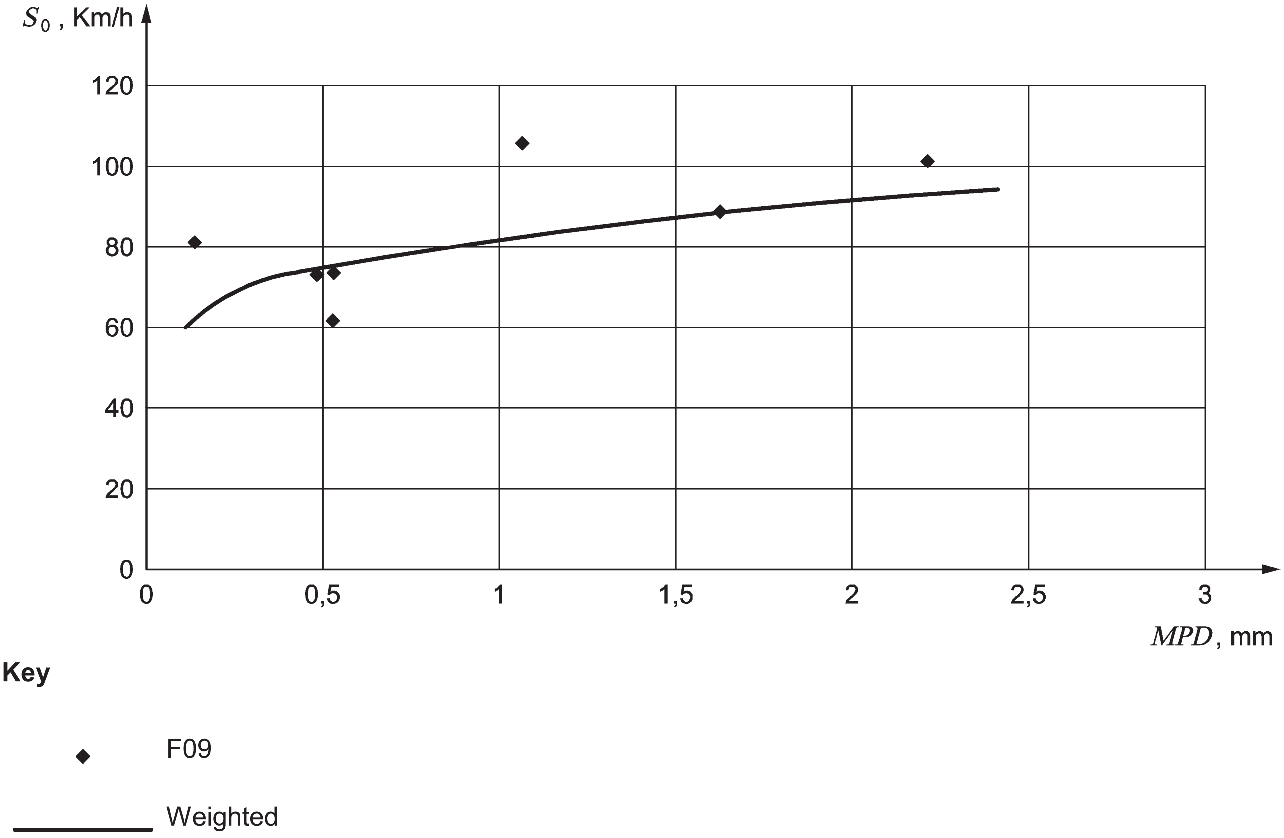
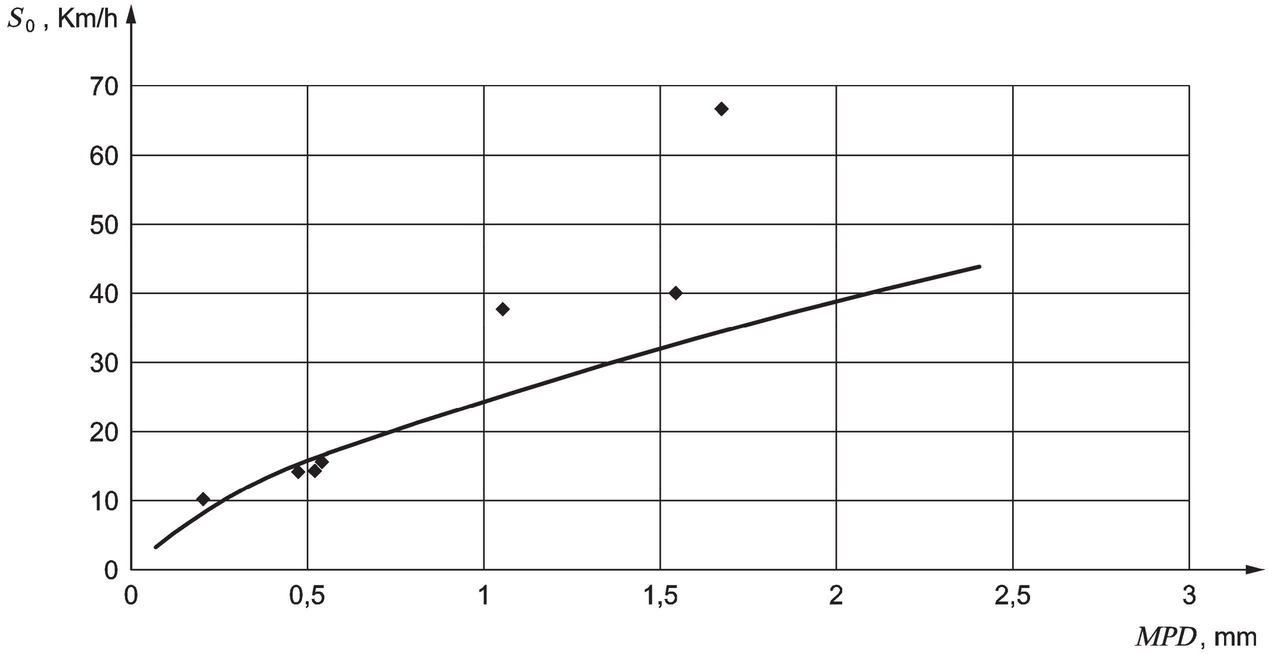


Figure A.9 — Weighted power-law curve-fitting on S_0 versus MPD for device F09

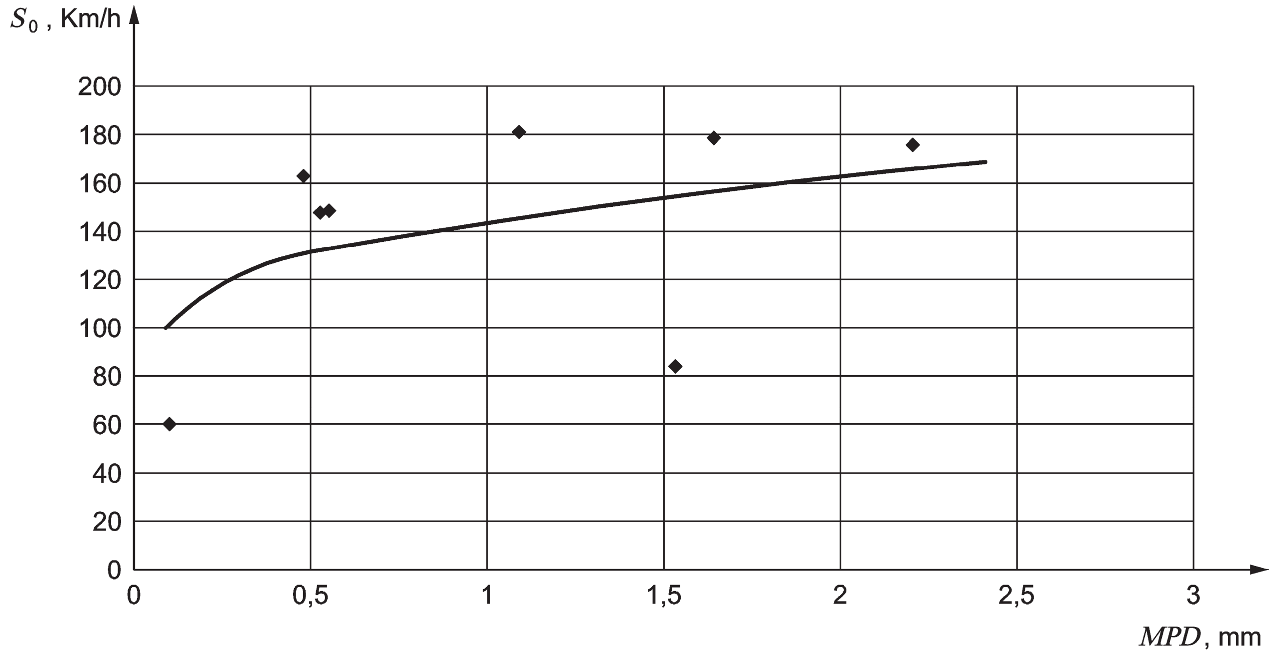


Key

◆ F10

——— Weighted

Figure A.10 — Weighted power-law curve-fitting on S_0 versus MPD for device F10



Key

◆ F12

——— Weighted

Figure A.11 — Weighted power-law curve-fitting on S_0 versus *MPD* for device F12

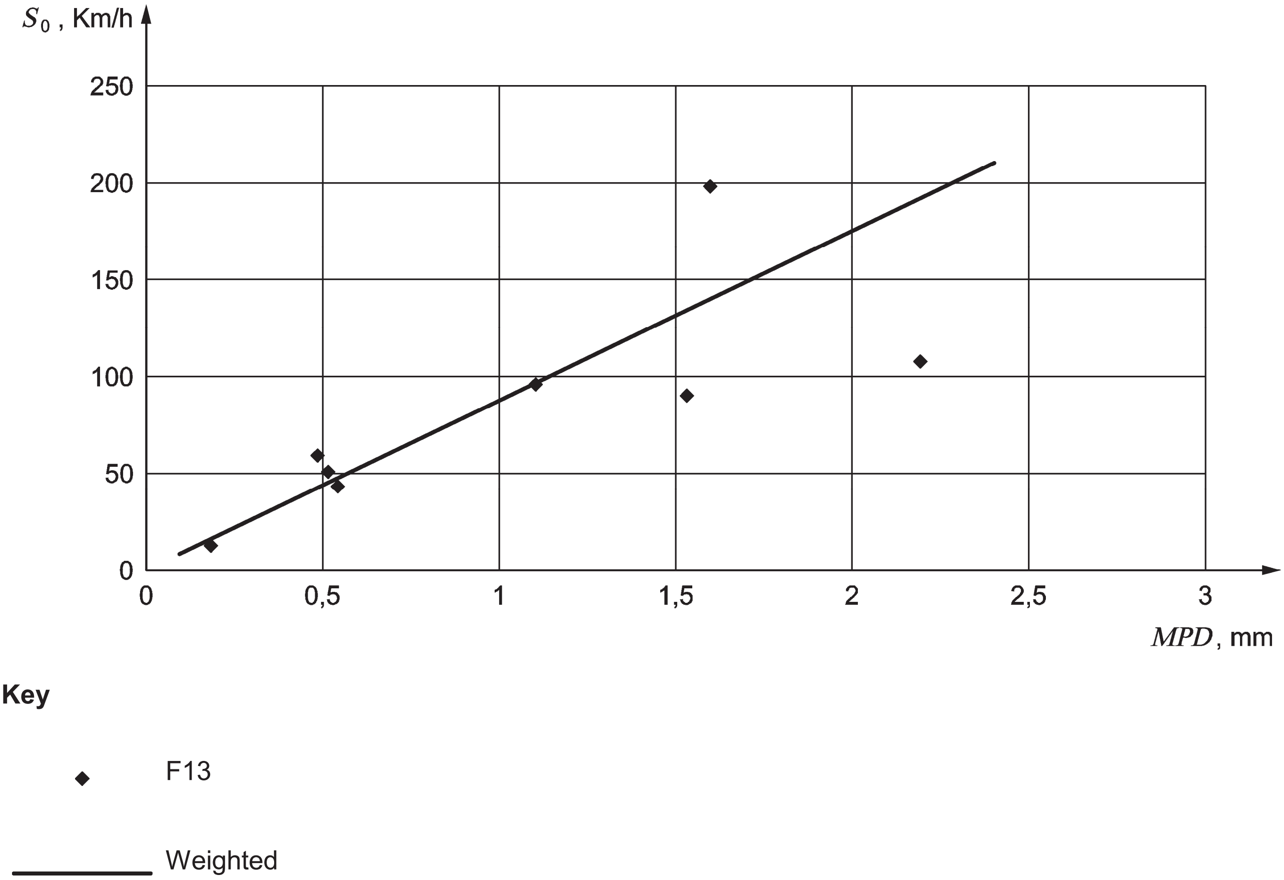
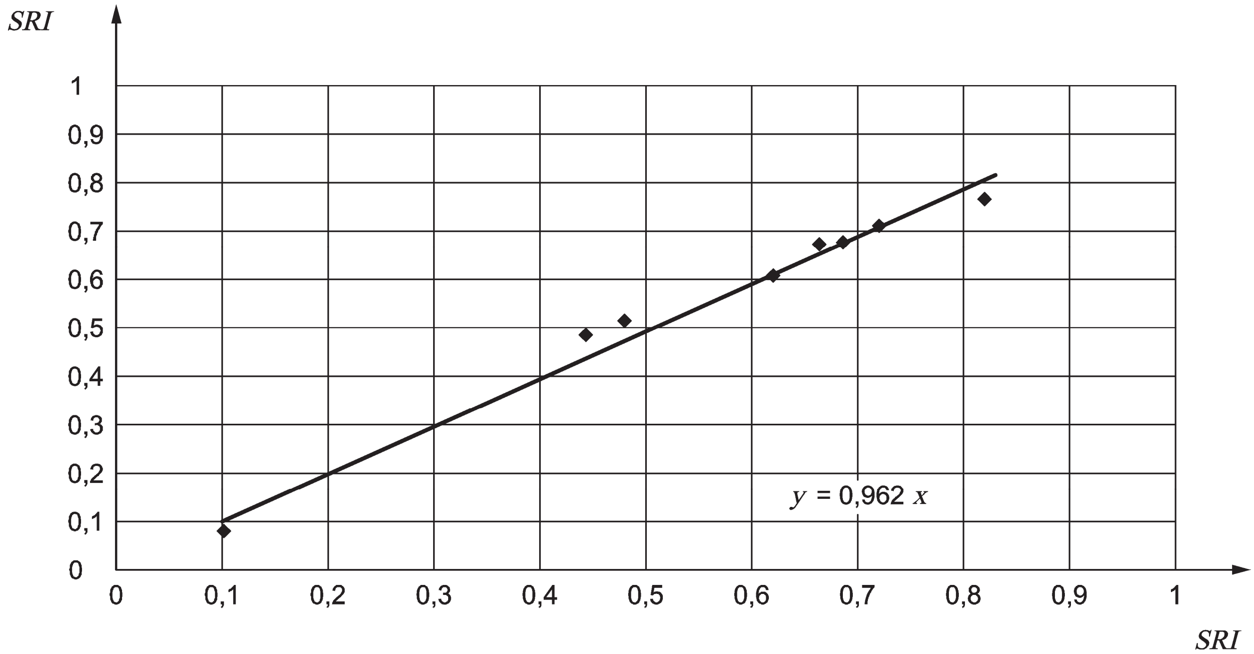


Figure A.12 — Weighted power-law curve-fitting on S_0 versus MPD for device F13



Key

◆ F09

——— Linear (F09)

Figure A.13 — Calibration line for the determination of β for device F09

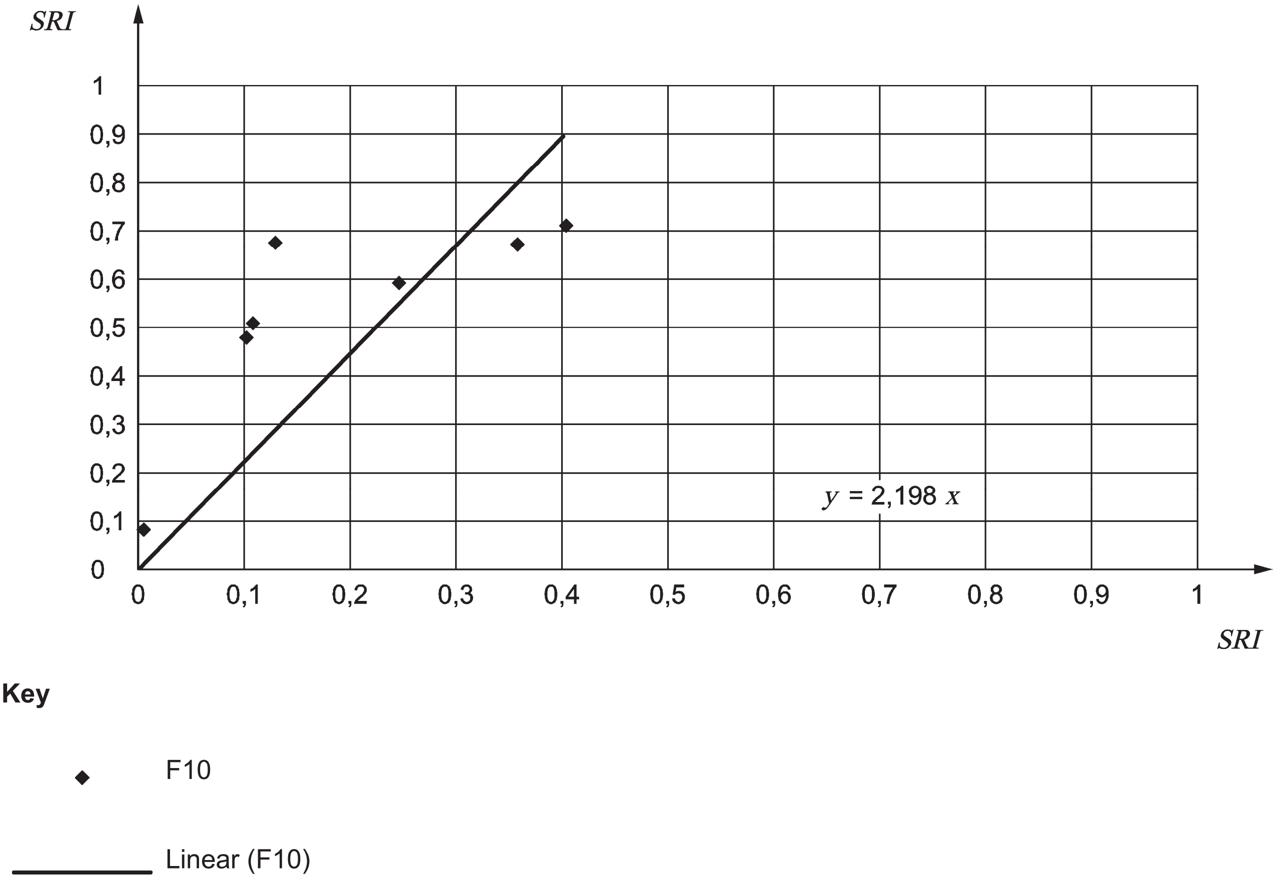
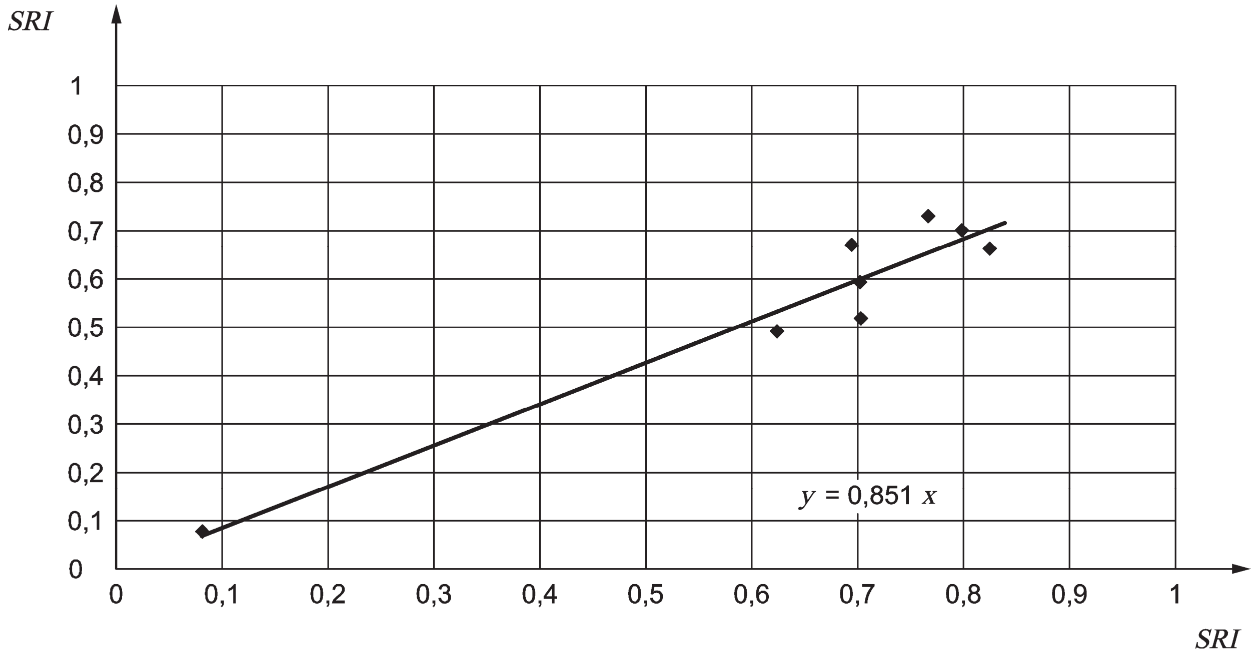


Figure A.14 — Calibration line for the determination of β for device F10

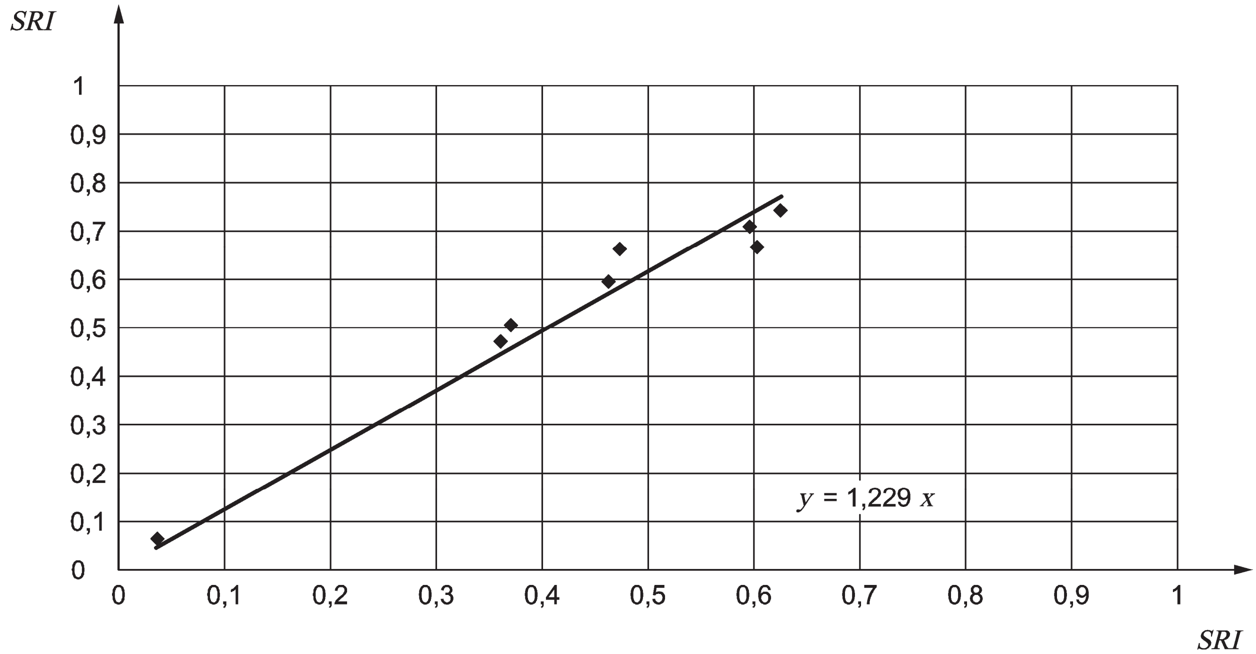


Key

◆ F12

——— Linear (F12)

Figure A.15 — Calibration line for the determination of *β* for device F12



Key

◆ F13

——— Linear (F13)

Figure A.16 — Calibration line for the determination of β for device F13

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