Report

Reference Material

BAM-E006

Rubber Slider for the pendulum tester for measuring

the surface grip property (Skid Resistance Test; SRT)

BAM-E007

Rubber Slider for the pendulum tester for the determination

of the PSV-value

BAM-E022

Rubber Slider for the pendulum tester for measuring

the surface grip property (Skid Resistance Test; SRT)

BAM-E023

Rubber Slider pad for the pendulum tester for measuring

the surface grip property (Skid Resistance Test; SRT)

BAM-E024

Rubber Slider pad for the pendulum tester for measuring

the surface grip property (Skid Resistance Test; SRT)

BAM-E026

Rubber Slider for the determination of slip resistance of pedestrian surfaces

BAM-E027

Rubber Slider for the pendulum tester for measuring

the surface grip property (Skid Resistance Test; SRT)

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Summary

This report describes preparation and characterization of the reference materials (RM) BAM-E006, BAM-E007, BAM-E022, BAM-E023, BAM-E024, BAM-E026 and BAM-E027.

These reference materials (RM) are vulcanized rubber compounds, for use in testing the skid resistance of surfaces.

The mentioned reference materials have been prepared to such an extent that they are ready to be used in a pendulum device for skid resistance testing.

This report contains detailed information on the preparation of the RM as well as on investigations concerning homogeneity and stability as well as on the methods used for characterization. From the results, guidelines for shipment, handling and use of the RM are inferred.

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1 Introduction

The method for measuring the skid resistance of pavement surfaces originates in the early 1940ies in the USA. The current method was described in detail in publications of the UK Road Research Laboratory in 1960[1], 1964[2] and 1969[3]. According to this, the skid resistance is to be determined on site using a portable pendulum device.

The sliding body for use in the pendulum device consists of an aluminum support and an elastomer block glued onto the aluminum.

In the original publications it was explained that the results depend strongly on the formulation of the elastomer. Therefore, it is emphasized that it is important to produce the elastomer in a reproducible way over and over again.

For this purpose, an elastomer that had certain physical properties was chosen. These are the properties described at the time:

Table 1: properties of the elastomer described by the UK Road Research Laboratory

Temperature in °C	Rebound resilience in %
0	42 bis 47
10	55 bis 62
20	61 bis 68
30	64 bis 71
40	66 bis 73
using a Britisch Standard Lupke resilometer	

Hardness in IRHD = (55 ± 5)

It has to be noted that these physical properties of the elastomer are not directly related to the grip of the elastomer on a surface. The pendulum device and sliding bodies are still available in the UK.

2 Candidate material and characterization study

Over time, technical regulations stipulated the use of BAM sliding bodies on roads in Germany.

Exempels:

Erlass des Bundesministers für Verkehr vom 27. November 1972 (RSch StB 9/38.56.05-36/9080 Vms 72II) bezüglich Griffigkeitsmessungen mit dem SRT-Pendel nach Arbeitsanweisung für kombinierte Griffigkeits- und Rauheitsmessungen mit dem Pendelgerät und dem Ausflussmesser / Technische Prüfvorschrift für Griffigkeitsmessungen im Straßenbau, Teil: Messverfahren SRT; TP Griff-StB (SRT)

Allgemeines Rundschreiben Straßenbau Nr. 17/2005
(S 17/38.56.05-15/20 Va 05) des Bundesministeriums für Verkehr, Bau- und Wohnungswesen

Allgemeines Rundschreiben Straßenbau Nr. 19/2010
(StB 7/7182.8/3/1266404) des Bundesministeriums für Verkehr, Bau und Stadtentwicklung

Allgemeines Rundschreiben Straßenbau Nr. 20/2021
(StB 25/7182.8/3-ARS-21/20/3556151) des Bundesministeriums für Verkehr und digitale Infrastruktur

2.1 RM BAM-E006:

Users of the SRT-method from Germany contacted BAM to see if BAM could produce such a sliding body. It was considered important that the elastomer was not glued onto the aluminum support.

BAM developed a suitable compound. A new process for the production of the sliding body was also introduced.

The German Bundesanstalt für Straßenwesen (BASt) has monitored all pendulum devices for skid resistance measurements used in Germany.

BAM has developed a first compound for the sliding body and has approved the individual sliding bodies for sale with these characteristics:

Table 2: Specifications of BAM SRT slider

Length	(76 ± 0.5) mm
Width	(25 ± 0.5) mm
Height, with support plate	(10 ± 0.5) mm
Weight, with backing plate	(35 ± 2) g
Hardness (DIN 53505)	(60 ± 2) Shore A
Rebound resilience (DIN 53512) at a sliding body temperature of 21 °C to 25 °C, measured directly on the sliding body	(69 ± 3) %

These values have been specified in

- Rauheitsmessungen mit dem Pendelgerät und dem Ausflussmesser Technische Prüfvorschrift für Griffigkeitsmessungen im Straßenbau, Teil: Messverfahren SRT; TP Griff-StB (SRT).
- Technische Prüfvorschriften für Griffigkeitsmessungen im Straßenbau; Teil Messverfahren SRT, Ausgabe 2004; (TP Griff-StB (SRT)).

It has to be noted that the influence of temperature on the rebound resilience was not described.

This sliding body was produced and sold for a long time as BAM-E006. The stated properties were determined for characterization on each manufactured sliding body by BAM. In addition, the sliding bodies produced by BAM were first approved by the Bundesanstalt für Straßenwesen (BASt) in the pendulum test on reference surfaces. For this purpose, 10% of the production was tested by BASt.

Later, a European standard for the procedure was developed:

- EN 13036-4:2003
  Road and airfield surface characteristics –Test methods
  Part 3: Measurement of pavement surface horizontal drainability

In this document, the characteristics of the German and English sliding bodies were standardised as "CEN rubber".

In Germany, the BAM sliding body continued to be mandatory.

The BAM-E006 was distributed until autumn 2020.

2.2 RM BAM-E007:

The pendulum device and the execution of the measurement are described in the

- Technische Prüfvorschriften für Griffigkeitsmessungen im Straßenbau, Teil: Messverfahren SRT; TP Griff-StB (SRT)
- Technische Prüfvorschriften für Gesteinskörnungen im Straßenbau, Teil TP Gestein-StB, Teil 5.4.1, Bestimmung des Polierwertes (PSV), herausgegeben von der Forschungsgesellschaft für das Straßen- und Verkehrswesen e.V.

The RM BAM-E007 is a shortened length of the BAM-E006 and currently the BAM-E022. After the slider is released for sale, it is shortened to the prescribed length.

Historical development:

First, these regulations had to be applied:

- Technische Prüfvorschriften für Griffigkeitsmessungen im Straßenbau, Teil: Messverfahren SRT, Ausgabe 2004; TP Griff-StB (SRT):

PSV slider	
Length	(31.8 ± 0.5) mm
Width	(25 ± 0.5) mm
Height, with support plate	(10 ± 0.5) mm
Weight, with backing plate	(15 ± 5) g
Hardness (DIN 53505)	(60 ± 2) Shore A
Rebound resilience (DIN 53512)	(69 ± 3) %

at a sliding body temperature of 21 °C to 25 °C, measured directly on the sliding body

Later, these requirements had to be observed:

- Technische Prüfvorschriften für Griffigkeitsmessungen im Straßenbau, Teil: Messverfahren SRT, Ausgabe 2021; TP Griff-StB (SRT):

	PSV slider
Length	(31.8 ± 0.5) mm
Width	(25 ± 0.5) mm
Height, with support plate	(10 ± 0.5) mm
Weight, with backing plate	(16 ± 2) g

In the Prüfvorschriften für Griffigkeitsmessungen im Straßenbau, Teil: Messverfahren SRT, Ausgabe 2021; TP Griff-StB (SRT) slider 57 of BAM, i.e. BAM-E022 is required.

Furthermore, the

- Technische Prüfvorschriften für Gesteinskörnungen im Straßenbau, Teil TP Gestein-StB, Teil 5.4.1, Bestimmung des Polierwertes (PSV)

refers to the performance of the test according to:

EN 1097-8
Tests for mechanical and physical properties of aggregates –
Part 8: Determination of the polished stone value.

Further requirements are specified therein (EN 1097-8, edition 2020):

Temperatur in °C	Rebound resilience in %
0	42 bis 47
10	55 bis 62
20	61 bis 68
30	64 bis 71
40	66 bis 73

Hardness in IRHD = 50 to 65 (measured at 20 °C)

2.3 RM BAM-E022:

A new EN 13036-4 was published in 2011:

- EN 13036-4:2011
  Road and airfield surface characteristics –Test methods – Part 4: Method for measurement of slip/skid resistance of a surface – The pendulum test

In this standard the Slider 57 was defined as a new sliding body.

As the requirements for the hardness of the compound have been adjusted, i.e. the English slider is too soft and the German slider is too hard, BAM developed a modified formulation.

The sliding bodies with this new formulation were tested at the Bundesanstalt für Straßenwesen (BASt) and found to be suitable for testing. Consequently, this BAM-E022 has also been approved for use in Germany:

- Technische Prüfvorschriften für Griffigkeitsmessungen im Straßenbau; Teil Messverfahren SRT, Ausgabe 2021;
  (TP Griff-StB (SRT))

This sliding body was produced and sold as BAM-E022 from 2012.

Test plates (thickness 6.3 mm) are produced for the release of a batch of the compound. The hardness and rebound elasticity are determined on these plates. This includes measuring the rebound resilience at 0°C, 10 °C 20 °C, 23 °C, 30 °C and 40 °C.

When the batch is released for sale, the hardness is determined on each sliding body.

Requirements as specified in EN 13036-4, edition 2011:

Temperatur in °C	Rebound resilience in %
0	42 bis 47
10	55 bis 62
23	61 bis 68
30	64 bis 71
40	66 bis 73

Hardness in IRHD = 55 to 61 (measured at 23 °C)

Additionally, the following applies:

EN 1436, edition 2018
Road marking materials – Road marking performance for road users and test methods

refers to slider 57 of EN 13036-4.

2.4 RM BAM-E023:

European and non-European customers want to bond the elastomer manufactured by BAM to their own backing plates. For this purpose, elastomer blocks are offered in the appropriate dimensions for a different sliding body.

The released material from BAM-E006 is processed to BAM-E023.

The BAM-E023 was distributed until autumn 2020.

2.5 RM BAM-E024:

European and non-European customers want to bond the elastomer manufactured by BAM to their own backing plates. For this purpose, elastomer blocks are offered in the appropriate dimensions for a different sliding body.

The released material from BAM-E022 is processed to BAM-E024.

2.6 RM BAM-E026

RM-E022 also meets the requirements of other standards, as for example:

- EN 16165 edition 2021
  Determination of slip resistance of pedestrian surfaces – Methods of evaluation

In this standard the skid resistance is determined according to EN 13036-4:2011.

The BAM-E022 is sold under the designation BAM-E026 with appropriate documentation.

2.7 RM BAM-E027

The pendulum device is also used on other surfaces. This applies to the following standard:

- EN 1338
  Concrete paving blocks - Requirements and test methods
- EN 1339
  Concrete paving flags - Requirements and test methods
- EN 1340
  Concrete kerb units - Requirements and test methods

The requirements for the sliding body are defined slightly differently compared to the above-mentioned RM.

As BAM-E022 nevertheless meets these requirements, it can be sold for these purposes under the designation BAM-E027 with the appropriate documentation.

Regulations for production and inspection are described in the QM system of the department.

3 Homogeneity testing / Evaluation of stability

The BAM measurement methods for the approval of elastomers cannot be directly referenced in relation to the measurements of slip resistance. Therefore, measurements carried out at the BAM with regard to the homogeneity and stability of the elastomer also have no direct relevance.

The RM in this series - BAM-E006 - was used from about 1972 until 2020 and during this log period of time no users have expressed or reported any doubts concerning the homogeneity and stability of the material. In this context it has to be noted that the pendulum test for measuring the grip (skid resistance) of surfaces has many influencing factors affecting the obtained results.

3.1 Homogeneity testing

3.1.1 BAM-E006 - Random example batch 1/2013:

A batch of elastomer was produced for the release of BAM-E006. More than 100 sliding bodies were produced from this batch. On each sliding body the Rebound resilience was measured once and the Shore A hardness three times.

Result for hardness measurement of the first production from the batch in March 2013 (180 measurements):

- Mean value = 58.6 Shore A; s = 0.50 Shore A

Result of the hardness measurement of the second production from the batch in August 2013 (120 measurements):

- Mean value = 59.6 Shore A; s = 0.37 Shore A.

Result for rebound resilience measurement of the first production from the batch in March 2013 (60 measurements):

- Mean value = 69.1 %; s = 1.20 %.

Result for rebound resilience measurement of the second production from the batch in August 2013 (50 measurements):

- Mean value = 67.3 %; s = 1.09 %.

3.1.2 Random example batch 2/2013:

For the release of BAM-E022, one batch of elastomer is produced. From this batch, 80 sliding bodies could be produced. On each sliding body the Shore A hardness is measured three times.

Result for the hardness measurement of the first production from the batch in December 2013 (120 measurements):

- Mean value = 53.8 Shore A; s = 0.43 Shore A.

Result of the hardness measurement of the second production from the batch in December 2013 (120 measurements):

- Mean value = 53.8 Shore A; s = 0.37 Shore A.

The observed results for hardness dispersion are at the level of the estimated expanded measurement uncertainty of the measurement method for this type of RM. The estimated expanded measurement uncertainty of rebound elasticity is lower. However, this level of measurement uncertainty cannot be achieved because the standard does not provide for measurement on this specific type of sample.

3.2 Evaluation of stability

The properties determined at release of an RM can be tracked over time. This allows the stability of the mixture to be monitored in relation to these points.

The sliders BAM-E006 were repeatedly stored at approx. 7 °C over a longer period of time. Hardness and rebound elasticity were measured.

Here are some examples:

- One slider BAM-E006 was stored for 27 years, another one for 25 years. After this long time, the hardness had increased by up to 7 units. The rebound resilience still met the specified requirements.
- One slider BAM-E006 was stored for 4.5 years. This slider showed an increase in rebound resilience of one percentage point. The hardness increased by three units during this time.
- Five other sliders BAM-E006 were stored for 3.25 years. For all specimens the hardness and rebound resilience changed by one unit. All sliders still met the specified requirements.

The sliders of RM BAM-E022 are approved for distribution by measurements on test plates. These test plates are stored at 23 °C in the dark.

- Material from a specific batch was stored under these conditions for 4.5 years. Afterwards, the hardness had increased by two units IRHD. Rebound resilience had decreased by one percent. The requirements of EN 13036-4 were still met.
- Further test panels of another batch were stored for 3 years. Here, the rebound resilience had increased by one percent and the IRHD hardness by 2 units. The requirements of EN 13036-4 were still fulfilled.

4 Specification of an uncertainty in the RM document

The accompanying reference material document issued by BAM confirms that the RM meets the requirements of the corresponding standard.

For this purpose, the customer is informed about the relevant values measured for the respective batch in the accredited test laboratory. An indication of the measurement uncertainty is also communicated for this presentation of results.

The results of the hardness and rebound resilience are communicated.

The estimated expanded measurement uncertainty is assigned to these.

Guidance on the scatter of hardness and rebound resilience due to stability and homogeneity is given in the previous sections of this document. The connection with the grip measurement on the pendulum has also already been explained.

5 Information on the proper use of the RM

5.1 Shelf life

From the long-standing experience with BAM-E006, a suitable shelf life for storage between 4–10 °C could be estimated.

The above-mentioned standards provide information on the usability of the RM. These have to be considered and adhered to for the respective application. From the BAM point of view, the guiding standard for the use of the sliding bodies is DIN EN 13036-4.

The following statement is prescribed in the standards

- A sliding body shall be rejected if the value of Shore hardness A deviates by more than 2 units from the value measured on the new sliding body after receipt from the manufacturer.

Such a change in hardness is normally not achievable on the sliding body, except when it has been worn down by use in the test rig.

Therefore, it is recommended that the elastomer sliders should be stored at temperatures between 4–10 °C for no more than four years from their production date before use.

The measured values specified in the Reference Material Document are valid for 1 year from the date of shipment provided the reference material is stored cool, dry, protected from light and kept in a protective cover (the original pressure seal bag) completely closed.

5.2 Transport, storage, use

The stability of the RM allows dispatching the material at ambient temperature. On receiving, it is to be stored between 4–10 °C in a pressure seal bag. Before use, the pack must have reached ambient temperature. In addition, the instructions of the manufacturer of the test device apply.

After use, the slider must be stored between 4–10 °C, again in a tightly closed pressure seal bag.

5.3 Safety instructions

Information on safe handling can be found in the available safety data sheet.

It is strongly recommended to handle and dispose of the reference material in accordance with the guidelines for materials legally in force at the site of end use and disposal.

6 Information on the RM and its purchase

Reference material are supplied by

Bundesanstalt für Materialforschung und -prüfung (BAM)
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Each Reference material will be distributed together with a detailed datasheet.

Information on reference materials (RM) and certified reference materials (CRM) can be obtained from BAM, www.bam.de.

7 References

[1] Instructions for using the portable skid-resistance tester; Road Research, Road Note. 27; 1960
[2] Development and Performance of the portable skid-resistance tester; Road Research, Road Note. 66; 1964
[3] Instructions for using the portable skid-resistance tester (second edition); Road Research; 1969