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Materials for roads — High friction surfacing — Specification

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 March 2022. It was prepared by Subcommittee B/510/2, *Surface Treatments*, under the authority of Technical Committee B/510, *Road Materials*. A list of organizations represented on these committees can be obtained on request to their committee manager.

Supersession

BS 8870:2022+A1:2023 supersedes BS 8870:2022, which is withdrawn.

Information about this document

Text introduced by or altered by Amendment No. 1 is indicated in the text by tags **A1** **A1**. Minor editorial corrections are not tagged.

Amendment A1 introduces the following principal changes:

- Table 3, Aggregate specification for HFS products has been updated;
- New Clause 8, Routine installation, has been introduced; and
- Table Q.1, Example of an asseveration of quality has been updated.

Test laboratory accreditation. Users of this British Standard are advised to consider the desirability of selecting test laboratories to undertake testing of the high friction surfacing (HFS) that are accredited to BS EN ISO 17025.

Product testing. Users of this British Standard are advised to consider the desirability of having the HFS tested by an independent laboratory.

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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.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Requirements in this standard are drafted in accordance with *Rules for the structure and drafting of UK standards*, subclause **G.1.1**, which states, “Requirements should be expressed using wording such as: ‘When tested as described in Annex A, the product shall ...’”. This means that only those products that are capable of passing the specified test will be deemed to conform to this document.

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1 Scope

This British Standard specifies requirements for performance and control procedures for high friction surfacing (HFS) products containing calcined bauxite aggregate for the surface treatment of roads and other trafficked areas.

This British Standard is applicable to both hot applied and cold applied HFS products.

NOTE Data are being collected to enable the precision for the test methods (see [Annex A](#) – [Annex N](#)) to be determined.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document¹⁾. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[BS 7941-2](#), *Surface friction of pavements – Part 2: Test method for measurement of surface skid resistance using the GripTester braked wheel fixed slip device*

BS EN 932-2, *Tests for general properties of aggregates – Part 2: Methods for reducing laboratory samples*

BS EN 932-5, *Tests for general properties of aggregates – Part 5: Common equipment and calibration*

BS EN 933-1:2012, *Tests for geometrical properties of aggregates – Part 1: Determination of particle size distribution – Sieving method*

BS EN 1097-6:2022, *Tests for mechanical and physical properties of aggregates – Part 6: Determination of particle density and water absorption*

[BS EN 1097-8:2020](#), *Tests for mechanical and physical properties of aggregates – Part 8: Determination of the polished stone value*

BS EN 1463-1:2009, *Road marking materials – Retroreflecting road studs – Part 1: Initial performance requirements*

BS EN 12272-2, *Surface dressing – Test methods – Part 2: Visual assessment of defects*

BS EN 12274-8, *Slurry surfacing – Test methods – Part 8: Visual assessment of defects*

BS EN 12697-22, *Bituminous mixtures – Test method – Part 22: Wheel tracking*

BS EN 12697-27, *Bituminous mixtures – Test method – Part 27: Sampling*

BS EN 12697-33, *Bituminous mixtures – Test method – Part 33: Specimen prepared by roller compactor*

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

BS 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*

BS EN ISO 4788, *Laboratory glassware – Graduated measuring cylinders*

BS EN ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories*

BS EN ISO 13473-1, *Characterization of pavement texture by use of surface profiles – Part 1: Determination of mean profile depth*

¹⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.

BS ISO 3290-1, *Rolling bearings – Steel balls*

PD CEN/TS 12697-51, *Bituminous mixtures – Test methods – Part 51: Surface shear strength test*

Other publications

[N1] NATIONAL HIGHWAY SECTOR SCHEMES FOR QUALITY MANAGEMENT IN HIGHWAY WORKS. Sector Scheme 13. *Particular Requirements for the Application of ISO 9001:2015 for the Supply and Application of Surface Treatments to Road Surfaces*. 2021.

3 Terms and definitions

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

3.1 aggregate

refractory grade calcined bauxite of nominal size 1 mm to 3 mm

NOTE See 5.2 for aggregate requirements.

3.2 asseveration of quality (AoQ)

solemn declaration of the performance of the HFS

3.3 auditing body

body accredited to assess and register quality management systems

NOTE The auditing body should possess and maintain the necessary assessor experience and technical understanding of the supply and application of surface treatments to roads surface treatments covered in the scope of the National Highway Sector Scheme (NHSS) 13 [N1].

3.4 binder

components of a product other than aggregate or mineral fillers

3.5 bond

adhesion strength of the HFS product to the road surface

3.6 defect

issue or fault that adversely affects the performance and function of the HFS product

3.7 factory production control (FPC)

part of the quality plan describing the internal control of production and testing adopted by the producer to assure compliance with the declared performance

3.8 high friction surfacing (HFS)

surface treatment for roads and other trafficked areas that provides and sustains a level of skid resistance in both dry and wet conditions suitable for the most demanding sites

3.9 installation method statement (IMS)

part of the quality plan setting out the specific site practices, work methods, resources and sequence of activities

NOTE The IMS supports HFS delivery in accordance with National Highway Sector Scheme (NHSS) 13 [N1].

3.10 installer

person or organization that installs the product

NOTE The installer is normally the party engaged by the overseeing organization as the contractor.

3.11 pre-heater

vessel designed to heat, mix and safely discharge hot-applied HFS

3.12 product

formulated combination of constituents produced under FPC to be installed as HFS

3.13 producer

person or organization that manufactures and supplies the product

NOTE 1 The producer may manufacture the product or be the licensee of the product.

NOTE 2 The producer may also be the installer.

NOTE 3 The producer controls how its product is installed by providing the IMS.

3.14 quality

degree to which a set of inherent characteristics of the HFS conforms to this British Standard and any additional customer requirements and expectations

3.15 quality management system (QMS)

system enabling organizations to manage their procedures

NOTE The QMS includes establishing quality policies, objectives and processes to achieve the quality objectives through planning, quality assurance, quality control and quality improvement.

3.16 quality plan

document within the QMS specifying the actions, responsibilities and associated resources to be applied to in the production of the product and its installation to form HFS

NOTE 1 This includes FPC and its IMS.

NOTE 2 The quality plan is product specific.

3.17 thermoplastic

reversible process where substances soften and melt on heating and harden on cooling

3.18 thermosetting

irreversible process where substances are chemically cured, forming a cross-linked structure

3.19 type approval installation trial (TAIT)

demonstrates that the characteristics of the HFS conforms to the declared characteristics

NOTE 1 The minimum duration of a TAIT is two years.

NOTE 2 A TAIT is used to provide confidence that a product can be effectively installed and to ascertain the level of performance.

NOTE 3 During and at the end of the TAIT, detailed information is recorded.

NOTE 4 The producer may continue to monitor the TAIT site and declare the period for which the performance characteristics have been retained.

4 Product types

4.1 Cold applied

Cold applied products shall comprise a thermosetting binder consisting of multi-component parts.

NOTE 1 The producer supplies the formulated binder components to be mixed on site.

The components of the thermosetting binder shall be accurately proportioned by volume or mass, mixed and applied by manual or mechanical means as a continuous film at a rate which varies according to the texture and porosity of the prepared existing surface, on to which aggregate is broadcast to excess.

NOTE 2 The method of proportioning should be described in the installation method statement.

The aggregate shall not be rolled.

Once cured, loose aggregate shall be removed by sweeping.

The calculated rate of spread shall be that of the binder film and not include the mass of the aggregate.

The rate of spread shall be calculated.

NOTE 3 See [Annex G](#) for an example test method for measuring the average rate of spread of installed HFS products.

4.2 Hot applied

Hot applied products supplied by the producer shall comprise pre-blended thermoplastic binder components with aggregate and mineral extenders.

Hot applied products shall be heated in a pre-heater until the material is molten, thoroughly mixed and workable.

The hot thermoplastic material shall be applied by screed onto the prepared substrate in adjoining strips to cover the whole surface.

The rate of spread shall be calculated.

NOTE See [Annex G](#) for an example test method for measuring the average rate of spread of installed HFS products.

5 Constituents

5.1 Binder types

COMMENTARY ON 5.1

Each binder type possesses unique characteristics in terms of physical and chemical properties for a given product which are not necessarily relevant for other products or a measure of on-site performance.

Once the level of performance has been determined from a TAIT and related performance testing, the specific characteristics and properties shall be declared by the producer against specific test requirements in accordance with FPC procedures to achieve and maintain product consistency and quality.

NOTE 1 Typical thermosetting binders include

- a) extended epoxy resin;*
- b) polyurethane;*
- c) polyurea; and*
- d) modified methyl methacrylate (MMA).*

NOTE 2 Typical thermoplastic binders include:

- 1) rosin ester; and*
- 2) hydrocarbon resin.*

The specific binder type selected shall be declared.

Physical and chemical characteristics and properties of the binder type for thermosetting and thermoplastic products shall be determined and the data recorded in accordance with [Table 1](#) and [Table 2](#).

Table 1 — Thermosetting binder properties

Property	Typical test method ^{A)}
Tests on individual uncured components	
Infra-red (IR) spectroscopy	Declared
Density	BS EN ISO 1183-1
Viscosity	BS EN 12092
Ash content	BS EN ISO 3451-1
Tests on curing binder	
Pot life	BS EN ISO 9514
Set time	Declared
Trafficking time	Declared
Tests on cured binder	
Tensile strength and elongation	BS EN ISO 527-3
Density	BS EN ISO 1183-1
^{A)} Alternative test methods, in part or in full, might be suitable.	

Table 2 — Thermoplastic binders and products properties

Property	Typical test method ^{A)}
Tests on binder component (no aggregate)	
Infra-red (IR) spectroscopy	Declared
Softening point (Ring and ball)	BS EN 1238
Density	BS EN ISO 1183-1
Ash content	BS EN ISO 3451-1
Flow resistance at 60 °C	BS EN 13880-5
Tests on product	
Softening point (Wilhelmi)	BS EN 1871
Density	BS EN ISO 1183-1
Ash content	BS EN ISO 3451-1
Flow resistance at 60 °C	BS EN 13880-5
^{A)} Alternative test methods, in part or in full, might be suitable.	

Where the test method is not listed in [Table 1](#) and [Table 2](#), the procedure shall be documented by the producer of the particular binder so that it can be made available for auditing purposes.

For each property, the test methods shall be declared and their results monitored by the producer under FPC procedures to maintain consistent product quality.

5.2 Aggregate requirements

The aggregate to be used in HFS products shall be selected in accordance with [Table 3](#).

Table 3 — Aggregate specification for HFS products

Physical property	Limits	Test method
Modified PSV	≥70	Annex A
Modified Micro-Deval value ^{A)}	$\boxed{A_1} \leq 6 \boxed{A_1}$	Annex B
Apparent particle density	$\boxed{A_1} \geq 2.8 \boxed{A_1}$	BS EN 1097-6:2000
Water absorption	Declared	BS EN 1097-6:2000
Particle angularity	Cubic or angular shape (not flakes)	Visual assessment
Grading % passing:		BS EN 933-1:2012
6.3 mm	100%	
4.00 mm	98%–100%	
2.8 mm	70%–95%	
2.0 mm	23%–53%	
1.0 mm	0%–5%	
0.50 mm	0%–0.5%	
Mineralogy:		
Diasporic or Gibbsite corundum	60%–85%	X-ray diffraction (XRD)
Chemical composition:		X-ray fluorescence (XRF) spectrometry
Al ₂ O ₃	≥82.0%	
Fe ₂ O ₃	≤4.5%	
SiO ₂	≤12.5%	
K ₂ O+Na ₂ O	≤0.5%	
<i>NOTE 1 The effects of precoating of calcined bauxite aggregate prior to use have not been assessed.</i>		
<i>NOTE 2 Calcined bauxite is typically available in buff or grey.</i>		
<i>A) Further data is required to confirm an acceptable limit.</i>		

6 Laboratory testing

6.1 General

Prior to carrying out a TAIT, laboratory tests shall be carried out in accordance with [6.2](#) to [6.5](#).

Test laboratory accreditation. Users of this British Standard are advised to consider the desirability of selecting test laboratories to undertake testing of the HFS that are accredited to BS EN ISO 17025.

6.2 Manufacture of slabs

Asphalt slab test substrates shall be manufactured in accordance with [Annex C, C.1](#).

Where the producer intends to claim additional suitability of the product for use on concrete, concrete test substrates shall be manufactured in accordance with [Annex C, C.2](#).

NOTE Where the producer intends to claim additional suitability on other substrates, slabs could be manufactured to replicate the site substrate using a similar method described in [Annex C](#).

Where the producer intends to claim additional suitability of the product for installation on a substrate with a texture depth higher than 2 mm, an asphalt slab shall be manufactured with the proposed maximum texture depth.

Where the producer intends to claim suitability of the product for installation outside of the range of 5 °C – 35 °C, additional asphalt slabs shall be prepared in accordance with [Annex C, C.1](#), and the system applied to the substrate maintained at the claimed minimum or maximum temperature.

6.3 Product application

The product shall be applied to the slabs in accordance with the installation method statement by:

- a) for cold applied products: mixing the components of the binder before spreading the binder and broadcasting the aggregate to excess; or
- b) for hot applied products: heating the bagged material and spreading the heated mixture across the slab.

Product testing. *Users of this British Standard are advised to consider the desirability of having the product application witnessed by an independent laboratory.*

Test laboratory accreditation. *Users of this British Standard are advised to consider the desirability of selecting test laboratories to undertake testing of the HFS that are accredited to BS EN ISO 17025.*

6.4 Pre-TAIT testing

Slabs with the HFS product applied shall be tested in accordance with the following tests:

- a) texture depth (TD) in accordance with BS EN 13036-1;
- b) pendulum test value (PTV) in accordance with BS EN 13036-4;
- c) scuffing test in accordance with [Annex L](#);
- d) surface shear strength in accordance with [Annex M](#);
- e) determination of the erosion index (EI) in accordance with [Annex E](#); and
- f) wear test in accordance with [Annex N](#).

The results of the tests shall meet the performance criteria in accordance with [Table 4](#).

Product testing. *Users of this British Standard are advised to consider the desirability of having the HFS tested by an independent laboratory.*

Test laboratory accreditation. *Users of this British Standard are advised to consider the desirability of selecting test laboratories to undertake testing of the HFS that are accredited to BS EN ISO 17025.*

NOTE [Table 4](#) applies to both hot and cold applied products.

Table 4 — *Laboratory tests*

Laboratory performance criteria	Parameter	Performance designation ^{A)}		
		A	B	C
Initial texture depth (TD)	TD (mm)	≥1.4	≥1.4	≥1.4
Initial wet skid resistance	PTV	≥70	≥70	≥70
Scuffing: After 500 wheel passes	TD (mm)	≥1.2	≥1.2	≥1.2
	EI ^{B)}	≤8	≤4	0
Scuffing ^{C)} : After heat ageing	TD (mm)	≥1.2	≥1.2	≥1.2
	EI ^{B)}	≤10	≤6	≤2
Scuffing ^{D)} : After freeze-thaw	TD (mm)	≥1.2	≥1.2	≥1.2
	EI ^{B)}	≤10	≤6	≤2
Scuffing ^{E)} : After diesel conditioning	TD (mm)	≥1.2	≥1.2	≥1.2
	EI ^{B)}	≤10	≤6	≤2
Surface shear strength (T_{SSS}) at 20 °C	T_{SSS} (kPa)	≥1 500	≥2 000	≥2 500
Wear test: after 100 000 wheel passes	TD (mm)	≥1.1	≥1.2	≥1.3
	EI ^{B)}	0	0	0
	PTV	≥70	≥74	≥78

NOTE The TD patch covers both the eroded and uneroded surface of the specimen.

^{A)} See [7.4](#) for performance designation.

^{B)} See [Annex E](#) for the procedure for determination of the degree of erosion and visual observations

^{C)} See [Annex D](#) for the procedure for conditioning by heat ageing samples for scuffing test.

^{D)} See [Annex I](#) for the procedure freeze-thaw conditioning.

^{E)} See [Annex J](#) the procedure for diesel susceptibility conditioning.

6.5 Reporting

A TAIT witness report shall confirm the results of laboratory testing and include the following information:

- reference to this British Standard, including confirmation of the performance designation;
NOTE See [7.4](#).
- identification of the producer and type of product, i.e. hot applied or cold applied HFS;
- type of substrate for which the HFS is designed or suitable for, i.e. asphalt, concrete or both;
- test report in accordance with [Annex C](#) for the preparation of the slabs;
- test report in accordance with BS EN 13036-1 for the determination of texture depth, with the exception of site-related factors, e.g. weather conditions;
- test report in accordance with [Annex M](#) for the determination of mechanical integrity and adhesion by the surface shear strength test;
- test report in accordance with [Annex D](#), [Annex E](#), [Annex I](#), [Annex J](#) and [Annex L](#) for the determination of erosion indices following scuffing tests; and
- test report in accordance with [Annex E](#) and [Annex N](#) for the determination of erosion indices following wear test.

7 Site performance – type approval installation trial (TAIT)

7.1 General

The producer shall carry out at least one TAIT to cover each HFS product.

NOTE A TAIT demonstrates that the installation and quality control procedures, including the characteristics of the HFS conform to the declared characteristics.

The TAIT shall consist of a defined section of road where HFS has been installed and which has been subjected to an in-service performance assessment after a minimum of two years.

The installation of the HFS product for the TAIT shall be carried out in accordance with [7.5](#).

The performance of the HFS product for the TAIT shall be recorded in accordance with [7.7](#).

The TAIT process shall be repeated if:

- a) a change of the constituents leads to a change in the performance characteristics of the proposed product;
- b) an installation is proposed on a higher site performance designation category, as given in [Table 5](#) to that already installed; or
- c) there is a change to the documented FPC system that leads to a change in the performance characteristics of the proposed product.

7.2 Site requirements

The minimum length of a TAIT section shall be 50 m, up to a maximum of 100 m. The width of a TAIT section shall be one lane width of road on single carriageways or extend across all lane widths on dual carriageways or motorways.

The TAIT shall be carried out either within a representative HFS contract, or in a special section of work in accordance with [Table 5](#).

NOTE In [Table 5](#), the site category and traffic volume define the performance designation.

7.3 Product requirements

In advance of the works, the producer shall submit a quality plan containing an installation method statement giving details of the product and method of installation, in accordance with the documented FPC system in *NHSS 13* [N1].

The quality plan shall also contain the following information:

- a) recording of product batch numbers;
- b) recording of perceptible properties of the calcined bauxite;
NOTE Perceptible properties include source, grading, shape and impurities.
- c) storage, handling and transport procedures and requirements suitable for installing the HFS product;
- d) test frequency for constituents and installed product;
- e) suitable installation conditions of weather, including road surface and air temperatures; and
- f) trafficking requirements for the HFS to include the duration between completion of installation to opening to restricted and unrestricted traffic, noting any restrictions.

7.4 Performance designation

COMMENTARY ON 7.4

This subclause details the performance designation in terms of traffic and site categories.

Site categories are more fully detailed in CD 236 of the Design Manual for Roads & Bridges [1].

The performance designation shall be defined by the site category and traffic. Combinations of site category and traffic which generate the same performance designation shall be deemed to be equivalent.

The performance designations in Table 5 shall correspond to the laboratory performance test data for that same performance designation in Table 4.

The hierarchy of performance designations shall be such that, in accordance with Table 5:

- a) A forms the minimum;
- b) B is more onerous than A; and
- c) C is more onerous than B.

A product satisfying a specific performance designation shall be accepted for use on sites with a less onerous performance designation.

Table 5 — Performance designation for combination of traffic and site categories

Performance designation	Traffic	Site category		
		K / Q	G2 / S2	G1 / S1
A	Commercial vehicle (cv)/lane/day	>500	>750	>1 000
B		>2 500	>2 500	>3 500
C ^{A)}		>2 500	>2 500	>3 500

NOTE 1 Traffic is cv/lane/day at design life.

NOTE 2 Site category definitions are:

- K = Approaches to pedestrian crossings and other high-risk situations;
- Q = Approaches to and across minor and major junctions, approaches to roundabouts and traffic signals;
- G2 = Gradient >10% longer than 50 m;
- S2 = Bend radius <500 m – carriageway with two-way traffic;
- G1 = Gradient 5% – 10% longer than 50 m; and
- S1 = Bends radius <500m – carriageway with one-way traffic.

^{A)} Performance designation C is to be reviewed. A higher performance is expected from the TAIT for category C.

7.5 Product installation

7.5.1 Installation method statement

The installation shall be carried out in accordance with the producer's installation method statement.

The installation method statement shall provide detailed requirements to achieve the optimum application for the product, including, as a minimum:

- a) suitability of the road surface substrate by visual inspection, surface shear strength test (see 7.5.2 and Table 6) and minimum time elapsed since substrate installation. Typical unacceptable defects observed by visual inspection include:
- b) cleanliness of the road surface and measures necessary to achieve it to facilitate the adhesion of the product;

- c) weather conditions, taking into account factors such as substrate temperature and dew point, as relevant to the product;
- d) detailed product handling, mixing and installation procedures;
- e) assessment of binder or product rate of spread, depending on the product type for each installation, including a method of calculating the minimum required product spread rate, taking into account the substrate texture depth (TD) and other factors, such as binder viscosity, ambient and substrate temperature and product temperature; and

NOTE 1 See [Annex F](#) and [Annex G](#).

- f) aftercare, including product installation checks, post-installation sweeping and maintenance/repair, if required, during service.

NOTE 2 Users of this British Standard are advised to consider the desirability of third-party certification/inspection/testing of product conformity to this British Standard.

7.5.2 Substrate condition and acceptance

Prior to the works being undertaken, a visual inspection and surface shear strength test (see [Table 6](#)) shall be carried out to assess the suitability of the substrate to receive an HFS treatment.

Table 6 — Surface shear strength of asphalt substrate (including surface dressing and microsurfacing)

Parameter	Test method	Unit	Requirement
Surface shear strength	See Annex M	kPa	T_{SSS} at 20 °C $\geq 1\,000$

NOTE For guidance on suitability of the substrate, see the RSTA/ADEPT Code of Practice for High Friction Surfacing [2].

7.5.3 Cold applied products

The binder components shall be mixed to the prescribed ratio.

The mixed binder shall be applied to the substrate as a continuous film over a proportion of the area to be treated such that an excess quantity of aggregate can be applied to fully cover the wet binder before the binder starts to cure. This process shall be repeated to cover the full area.

The quantity of binder shall be sufficient to ensure the specified rate of spread over the area to be treated, taking account of the effective texture depth as determined.

NOTE 1 An example of rate of spread is given in [Annex F](#).

The specified rate of spread shall be declared by the producer as detailed in the product's installation method statement.

Once installed and the product has been fully cured, the excess aggregate shall be removed by a suitable means, e.g. vacuum sweeper, hand sweeping.

On completion, a reconciliation of actual rate of spread shall be made.

NOTE 2 An example of a method of reconciliation is given in [Annex G](#).

7.5.4 Hot applied products

The pre-blended bagged material shall be progressively loaded into a pre-heater fitted with a suitable stirrer and progressively heated and mixed to the specified application temperature range and maintained within this range.

NOTE 1 Overheating the product creates the potential for premature failure due to the binder components being destroyed.

NOTE 2 Maintaining the product at an elevated temperature for an extended time degrades the binder component.