



BSI Standards Publication

**Recycling of roads and other paved
areas using bitumen emulsion, foamed
bitumen or hydraulic material —
Materials, production, installation and
product type testing — 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 30 September 2021. 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.

Relationship with other publications

This British Standard has been introduced to supersede [BS 434-2:2006](#), *Bitumen road emulsions – Part 2: Code of practice for the use of cationic bitumen emulsions on roads and other paved areas*, which has in part also been superseded by cited harmonized product standards for emulsions (BS EN 13808), surface dressing (BS EN 12271) and slurry surfacing (BS EN 12273).

[BS 434-2](#) included clauses for a number of different uses of emulsions, each of which is in the process of being updated and published as a separate British Standard. BS 9228 replaces [BS 434-2:2006](#), Clause 10, Retread and Clause 11, Deep recycling.

Information about this document

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Use of this document

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

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”).

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1 Scope

This British Standard specifies requirements for materials processed with either bituminous emulsion, foamed bitumen or hydraulic material, including their design and composition, production, installation and performance testing.

This British Standard includes requirements for mixtures prepared using bituminous binders that may also contain hydraulic material.

This British Standard describes a number of processes and methods by which existing material in the road or other paved areas is either processed in-situ or uses recycled material processed ex-situ.

NOTE 1 [BS 9227](#) specifies requirements for the production, installation, testing and conformity of hydraulically bound materials (HBM) conforming to [BS EN 14227](#) Parts 1 to 5 for pavement applications, whether constructed by the ex-situ or in-situ methods. It also includes requirements for preliminary work at the laying site, needed to ensure that the substrate is fit to receive the HBM. [BS 9227](#) includes only materials conforming with [BS EN 14227](#) Parts 1 to 5 whether from recycled or virgin materials. For the recycling of pavements, TRL Report TRL 611 [1] can be used.

NOTE 2 [BS EN 13108-31](#) specifies requirements for asphalt concrete using aggregate conforming to [BS EN 13043](#) and bituminous emulsion for use on roads, and other trafficked areas.

NOTE 3 Guidance on the selection and use of cold recycled materials is given in [Annex A](#).

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.

Standards publications

[BS 1377-3:2018](#), *Methods of test for soils for civil engineering purposes – Part 3: Chemical and electrochemical testing*

[BS 1924-1](#), *Hydraulically bound and stabilized materials for civil engineering purposes – Part 1: Sampling, sample preparation and testing of materials before treatment*

[BS 1924-2](#), *Hydraulically bound and stabilized materials for civil engineering purposes – Part 2: Sample preparation and testing of materials during and after treatment*

[BS 594987:2017](#), *Asphalt for roads and other paved areas – Specification for transport, laying, compaction and product type testing protocols*

[BS EN 932-1](#), *Tests for general properties of aggregates – Part 1: Methods for sampling*

[BS EN 933-1](#), *Tests for geometrical properties of aggregates – Part 1: Determination of particle size distribution – Sieving method*

[BS EN 12591](#), *Bitumen and bituminous binders – Specifications for paving grade bitumen*

[BS EN 12697-1](#), *Bituminous mixtures – Test methods – Part 1: Soluble binder content*

[BS EN 12697-2](#), *Bituminous mixtures – Test methods – Part 2: Determination of particle size distribution*

[BS EN 12697-6](#), *Bituminous mixtures – Test methods for hot mix asphalt – Part 6: Determination of bulk density of bituminous specimens*

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

BS EN 12697-8, *Bituminous mixtures – Test methods – Part 8: Determination of void characteristics of bituminous specimens*

[BS EN 12697-26:2018](#), *Bituminous mixtures – Test methods – Part 26: Stiffness*

BS EN 12697-32, *Bituminous mixtures – Test methods for hot mix asphalt – Part 32: Laboratory compaction of bituminous mixtures by vibratory compactor*

BS EN 12271, *Surface Dressing – Requirements*

BS EN 12273, *Slurry Surfacing – Requirements*

BS EN 13108-1, *Bituminous mixtures – Materials specification – Part 1: Asphalt Concrete*

BS EN 13108-4, *Bituminous mixtures – Materials specification – Part 4: Hot rolled asphalt*

BS EN 13043, *Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas*²⁾

BS EN 13808:2013, *Bitumen and bituminous binders – Framework for specifying cationic bituminous emulsions*

BS EN 13286-1, *Unbound and hydraulically bound mixtures – Part 1: Test methods for laboratory reference density and water content – Introduction, general requirements and sampling*

BS EN 13286-4, *Unbound and hydraulically bound mixtures – Part 4: Test methods for laboratory reference density and water content – Vibrating hammer*

BS EN 13286-41, *Unbound and hydraulically bound mixtures – Part 41: Test method for the determination of the compressive strength of hydraulically bound mixtures*

PD 6689, *Surface treatments – Guidance on the use of BS EN 12271 and BS EN 12273*

Other publications

[N1] BATEMAN, D. *Design Guide for Road Surface Dressing – Road Note 39 (Seventh Edition)*. TRL, March 2016.³⁾

[N2] Road Surface Treatments Association/Association of Directors of Environment, Economy, Planning and Transport. *Guidance for Temporary Traffic Management at Surface Dressing Sites*. RSTA/ADEP, December 2017.⁴⁾

²⁾ At the time of publication, the 2013 version is withdrawn and the 2002 version is still current.

³⁾ Available from: <https://trl.co.uk/sites/default/files/Road%20Note%2039%20%287th%20ed%29%20-%20TRL%20FINAL%20copy.pdf>.

⁴⁾ Available from: <https://www.adeptnet.org.uk/system/files/documents/RSTA%20%3A%20ADEPT%20Guidance%20on%20Temporary%20Traffic%20Management%20at%20Surface%20Dressing%20Sites%20%282017%29.pdf>.

3 Terms, definitions and abbreviated terms

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

3.1 Terms and definitions

3.1.1 additive

material added to the constituents to modify or enhance a desired property of the finished product

NOTE 1 Common properties that are modified include: setting time (by use of retarders or accelerators), moisture content improved tensile and compressive strength, adhesion of bituminous binder to aggregate, properties of bitumen as described in BS EN 14023.

NOTE 2 Hydraulic material can be an additive in a bituminous mixture or a binder in its own right.

3.1.2 adhesion

property which enables a binder to stick to the surface of a solid body

NOTE This could be the road or aggregate.

3.1.3 bitumen

virtually in-volatile, adhesive and waterproofing material derived from crude petroleum, or present in natural asphalt, which is completely or nearly completely soluble in toluene and very viscous or nearly solid at ambient temperatures

3.1.4 bituminous binder

binder comprising foamed bitumen or bitumen emulsion

NOTE This can be modified with polymer and other additives.

3.1.5 bituminous emulsion

liquid product in which a substantial amount of bitumen is suspended in a finely divided condition in an aqueous medium by means of one or more suitable emulsifying agents

3.1.6 breaking characteristics

rate of setting of the bitumen emulsion

3.1.7 durability

ability of a product to maintain its required performance, under the influence of environmental and mechanical loading, separately or in combination

3.1.8 ex-situ manufacture

technique where the materials are processed away from the place of extraction

NOTE It can be treated by screening and crushing to provide a suitable feed material.

3.1.9 fly ash

pulverized fuel ash from coal-fired energy production

NOTE Fly ash can be either calcareous or siliceous. However, it is the latter that is the appropriate type of fly ash (or PFA) for this British Standard.

3.1.10 foamed bitumen

bitumen expanded to a foam by the injection of a small quantity of water into a hot bitumen stream

3.1.11 grading

particle size distribution expressed as the percentages by mass passing a specified set of sieves

NOTE Unless stated otherwise, for the purposes of this British Standard, the term relates to the total mixture, not just the aggregate or soil that is being treated.

3.1.12 hydraulic material

material or a combination of materials that sets and hardens by chemical reaction with water and remains stable

NOTE This includes portland cement, (coal) fly ash, granulated blast furnace slag (GBS), ground granulated blast furnace slag (GGBS), lime, air cooled steel slag (ASS) and hydraulic road binder.

3.1.13 in-situ recycling

technique where materials are mixed in place, typically at the position of final use, with specialized equipment and then compacted by roller

3.1.14 indirect tensile stiffness modulus (ITSM)

procedure for measuring the stiffness modulus of the material

3.1.15 layer

compacted thickness of bound material

3.1.16 liquid content

total liquid in the mix comprising the base bitumen and water from all sources

3.1.17 lime

quick lime [calcium oxide (CaO)] or hydrated lime {calcium hydroxide [$\text{Ca}(\text{OH})_2$]}

NOTE Hydrated lime is also known as slaked lime. Lime referred to in this British Standard does not include agricultural lime (ground CaCO_3), which is inert.

3.1.18 mix design

laboratory process for determining the optimum combination of mixture constituents necessary to achieve the desired level of in-service performance

3.1.19 primary aggregate

aggregate from mineral sources which have been subjected to nothing more than mechanical processing

3.1.20 process control

permanent internal control of production exercised by the producer when all the elements, requirements and provisions adopted by the producer are documented in a systematic manner in the form of written policies and procedures

3.1.21 quick hydraulic (QH)

material containing portland cement binder and excluding bituminous binders

3.1.22 quick viscoelastic (QVE)

material containing combination of bituminous binder and portland cement

3.1.23 recycled aggregate

aggregate resulting from the processing of inorganic or mineral material previously used in construction

3.1.24 slow viscoelastic (SVE)

material containing bituminous binder either solely or in combination with hydraulic material, excluding portland cement

3.2 Abbreviated terms

CBR	California bearing ratio
DCP	Dynamic cone penetrometer
HBM	Hydraulically bound materials
LWD	Lightweight deflectometer

4 Constituent materials

4.1 Bitumen emulsion binder

The binder shall be cationic bituminous emulsion conforming to BS EN 13808.

NOTE 1 This can be modified with polymers and other additives.

NOTE 2 Guidance is given in BS EN 13808:2013, Table NB.2.

The bituminous emulsion binder used shall be formulated to give optimum coating and breaking characteristics.

NOTE 3 The bituminous emulsion binder used can be varied throughout the year to take account of seasonal conditions.

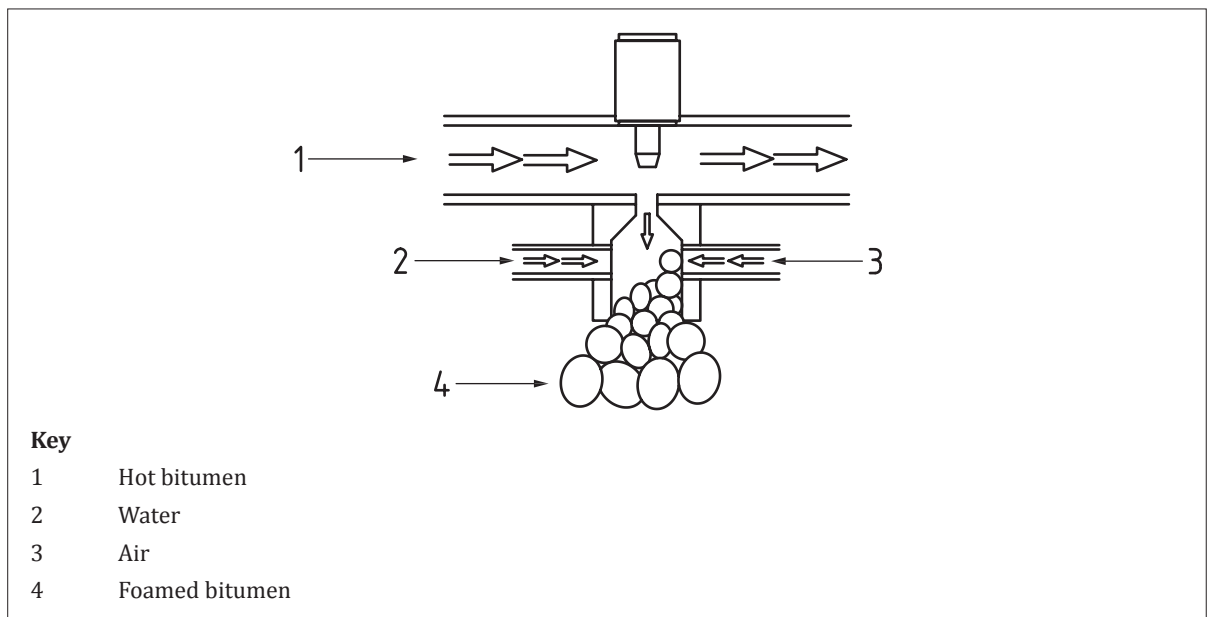
4.2 Foamed bitumen binder

NOTE 1 Foamed bitumen is produced by injecting a small amount of water to a hot bitumen stream, approximately 2% to 3% by weight of bitumen, under pressure, as shown in [Figure 1](#).

NOTE 2 When water is injected into the hot bitumen at approximately 180 °C, the water becomes steam, causing foaming of the bitumen. The steam is the carrier of the atomized bitumen and within only a few seconds the bitumen expands by a ratio of 15 to 20 times its original volume.

The water percentage added and the air pressure shall be checked regularly and adjusted, as necessary, to optimize the expansion ratio and half-life.

NOTE 3 The foamed bitumen thus produced escapes the expansion chamber through a nozzle and is immediately mixed with the cold damp graded aggregate. The foam collapses so that the bitumen is dispersed evenly throughout the mix. The time taken for foamed bitumen to collapse to half its maximum volume is known as the half-life.

Figure 1 — Schematic of the foam bitumen process

NOTE 4 Foaming of the bitumen results in a number of benefits, including:

- a) the foaming process reduces the bitumen viscosity and improves its dispersion properties and coating of the aggregate in the mix; and
- b) a considerably larger surface area than liquid bitumen which significantly improves the coating particularly of cold, damp fine aggregate.

The binder used for this process shall be paving grade bitumen, conforming to BS EN 12591.

NOTE 5 Typically 100/150 grade is used but the use of a harder grade of bitumen can be advantageous on heavier trafficked carriageways.

4.3 Primary aggregates

Primary aggregates, including fillers, shall be natural aggregate conforming to BS EN 13043, with grading to conform to the desired mix design as appropriate for the intended use and the performance required.

NOTE Specific requirements for primary aggregates, including fillers, are given in BS EN 13043:2002, Clause 4.

4.4 Recycled aggregates

Recycled aggregates shall include but are not limited to:

- a) pulverized pavement material, including asphalt, concrete or granular material;
- b) processed secondary or recycled aggregate from other sources;
- c) fillers from primary or secondary sources, e.g. fly ash; and
- d) manufactured aggregate.

4.5 Hydraulic material

Hydraulic material shall be added, if required to:

- a) adjust the moisture content and grading of the material;
- b) improve adhesion between aggregates and emulsion;
- c) help reduce segregation; or
- d) as a binder.