

BRITISH STANDARD

Bitumen road emulsions –

Part 2: Code of practice for the use of cationic bitumen emulsions on roads and other paved areas

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 34, an inside back cover and a back cover.

Foreword

Publishing information

This part of BS 434 was published by BSI and came into effect on 29 December 2006. It was prepared by Technical Committee B/510, *Road materials*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 434 supersedes BS 434-2:1984, which is withdrawn.

Information about this document

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

- refers to BS EN 13808;
- covers the use of polymer modified bitumen emulsions;
- includes guidance on the use of bitumen emulsions in the construction and maintenance of footways and cycleways;
- includes guidance on the use of bitumen emulsions as bond or tack coats;
- includes reference to permanent cold lay surfacing materials;
- includes a bibliography containing sources of further information on the various techniques included in this British Standard.

As a code of practice, this part of BS 434 takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

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.

Any user claiming compliance with this part of BS 434 is expected to be able to justify any course of action that deviates from its recommendations.

Assessed capability. Users of this British Standard are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series by an accredited third-party certification body.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

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

Contractual and legal considerations

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

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

1 Scope

This part of BS 434 provides recommendations and guidance on the general usage of cationic bituminous emulsions on roads and other paved areas. The emulsions covered conform to BS 434-1, or BS EN 13808 (modified and non-modified), or are proprietary emulsions.

This British Standard provides guidance on where the various processes using bituminous emulsions are suitable for use and indicates where suitable design procedures may be found. Advice is also given on those situations in which the processes are unsuitable or marginally suitable.

Where there is an option, performance or outcome specifications have been used rather than input or recipe specifications. This follows the general approach adopted for European Standards and the general move towards performance specifications by many specifiers.

Anionic emulsions are covered only for exceptional circumstances. Cationic emulsions have been specified for most purposes, although in some cases an anionic alternative may be used.

2 Normative references

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

BS 434-1:1984, *Bitumen road emulsions (anionic and cationic) – Part 1: Specification for bitumen road emulsions*

BS 594-2:2003, *Hot rolled asphalt for roads and other paved areas – Part 2: Specification for transport, laying and compaction of hot rolled asphalt*

BS 598-108, *Sampling and examination of bituminous mixtures for roads and other hard paved areas – Part 108: Methods for determination of the condition of the binder on coated chippings and for measurement of the rate of spread of coated chippings*

BS 1377-3:1990, *Methods of test for soils for civil engineering purposes – Part 3: Chemical and electro-chemical tests*

BS 3136-2, *Specification for cold emulsion spraying machines for roads – Part 2: Metric units*

BS 3892 (all parts), *Pulverized-fuel ash*

BS 4987-2:2003, *Coated macadam (asphalt concrete) for roads and other paved areas – Part 2: Specification for transport, laying and compaction*

BS 6463 (all parts), *Quicklime, hydrated lime and natural calcium carbonate*

BS EN 197-1, *Cement – Part 1: Composition, specifications and conformity criteria for common cements*

BS EN 12271 (all parts), *Surface dressing – Specifications*

BS EN 12272-1:2002, *Surface dressing – Test methods – Part 1: Rate of spread and accuracy of spread of binder and chippings*

prEN 12273, *Slurry surfacing – Specifications*¹⁾

BS EN 12274 (all parts), *Slurry surfacing – Test methods*

BS EN 12697-26, *Bituminous mixtures – Test methods for hot mix asphalt – 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 13808, *Bitumen and bituminous binders – Framework for specifying Cationic bitumen emulsions*

NOTE See the Bibliography for sources of further information on the various techniques included in this British Standard.

3 Terms and definitions

For the purposes of this part of BS 434, the following terms and definitions apply.

3.1 bitumen

virtually involatile, 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

3.2 bituminous binder

adhesive material containing bitumen

3.3 polymer modified bitumen

bitumen whose rheological properties have been modified during manufacture by the addition of one or more polymers

3.4 bitumen emulsion

dispersion of bitumen in water, which usually contains an emulsifier to assist in maintaining the stability of the emulsion

NOTE This term embraces emulsions in which the bitumen contains a small amount of flux derived from petroleum which has been added to facilitate emulsification and/or to enhance in-service characteristics.

3.5 anionic bitumen emulsion

emulsion in which the emulsifier imparts negative charges to the dispersed emulsion particles

3.6 cationic bitumen emulsion

emulsion in which the emulsifier imparts positive charges to the dispersed bitumen particles

3.7 polymer-modified bitumen emulsion

emulsion in which the dispersed phase is a polymer-modified bitumen or a bitumen emulsion modified with latex

¹⁾ prEN 12273 is currently still a draft European Standard. To be published by CEN as EN 12273 and adopted in the UK as BS EN 12273.

4 Emulsion types

4.1 General

The UK specification for bitumen emulsion (BS 434-1) was last published in 1984 and has remained substantially unchanged since then apart from two minor amendments. It has recently been replaced by BS EN 13808 which is a significantly different document. This clause attempts to explain the differences within the context of the changes that have occurred since 1984.

4.2 BS 434-1 classification

In BS 434-1:1984 emulsions are classified on the basis of:

- a) polarity – anionic or cationic (A or K);
- b) emulsion stability (on a scale of 1-rapid, 2-medium, 3-slow breaking);
- c) binder content.

Thus a K1:70 emulsion is a rapid breaking cationic emulsion with a nominal binder content of 70%. An A2:50 emulsion is a medium breaking anionic emulsion with a nominal binder content of 50%.

The stability of emulsions can be changed by altering the type or quantity of emulsifier used in their manufacture. In recent years the development of tests to measure the break of the emulsion has resulted in numerical values, of breaking value or breaking index, being attributed to emulsion. This more accurately reflects their stability than the traditional allocation of 1, 2 or 3 in BS 434-1:1984 (see above) as an indication of stability, and has allowed the stability of emulsion to be defined numerically (breaking index) in BS EN 13808.

4.3 BS EN 13808 classification

BS EN 13808 classifies emulsions in a more detailed way than BS 434-1 utilizing up to seven characters, on the following basis:

- polarity, e.g. C;
- nominal binder content, e.g. 67;
- indicate type of binder:
 - B paving grade bitumen (BS EN 12591);
 - P addition of polymer;
 - F addition of more than 2% flux;
- class of breaking value (from 0 to 7) (see 4.5).

Thus for example a C70 B2 emulsion is a cationic bitumen emulsion with a 70% nominal binder content, produced from paving grade bitumen (conforming to BS EN 12591) with a class 2 breaking value.

Similarly a C60 BPF6 emulsion is a cationic bitumen emulsion with a nominal binder content of 60% containing polymer and flux and having a class 6 breaking value.

4.4 Polymer modified bitumen products

4.4.1 Background

At the time of publication of BS 434-1:1984 almost all bitumen emulsions were produced using paving (penetration) grades of bitumen. A significant change since the initial publication of that British Standard has been the introduction and development of polymer modified bitumen products, the growing use of which has presented problems of specification.

Initially these products were sold as proprietary products to specifications produced by manufacturers, a situation which leads to confusion with no standard specifications for them. This problem was recognized by the introduction of an assessment and certification scheme for such products under the HAPAS (Highway Authorities Product Approval Scheme) administered by the British Board of Agrément (BBA) which produced a list of tests, including ageing and rheology, against which emulsions can be assessed. If the performance of the emulsion satisfies the requirements of the scheme it is eligible to receive a BBA Roads and Bridges Certificate.

The testing under this scheme goes beyond the requirements of BS 434-1 in that for surface dressing, for example, it not only requires testing of the emulsion and of the recovered binder from the emulsion (as in BS EN 13808) but also evidence of two years' satisfactory performance on the road at a minimum of three appropriate sites. Many of the binder testing requirements of the HAPAS binder specifications for polymer modified bituminous emulsions are also stipulated in the *Specification for Highway Works* (SHW) [1], Clauses 919 and 922 for surface dressing, Clause 920 for bond coats and Clause 918 for slurry surfacing and the Notes for Guidance and Appendices relating to them.

NOTE The British Board of Agrément/Highway Authorities Product Approval Scheme (BBA/HAPAS) is a scheme in which proprietary products may be validated and their performance measured and published. This ensures that a product, once placed on the market, has attached to it performance criteria which can be monitored by the purchaser and ultimately by BBA/HAPAS, as an independent UK certifying body. BBA is the UK representative of the European Technical Approval (ETA) system which is set up to validate products for which it has not been possible or is not yet possible to produce a British or European Standard. Further information on BBA/HAPAS and the certification status of products can be found on the BBA website at www.bbacerts.co.uk.

4.4.2 Polymer modified bituminous emulsions

The most significant advance in bituminous emulsions in the last two decades has been the introduction of polymer modified bituminous emulsions. The effect of polymer modification is to enhance the performance on the road, which can be observed in practice. Precisely how this improved performance is achieved, however, is more difficult to define.

Bitumen is a thermoplastic material, which softens when heated and becomes hard and brittle when cooled. Thus at higher temperatures it can become too soft to hold the chippings in a surface dressing system and at cooler temperatures it can become so hard and brittle that it fractures under traffic stresses and loses chippings. One effect of polymer modification is to widen the temperature range over which bitumen exhibits good binder properties. Table 1 compares the softening point (high temperature) and Fraass brittle point (low temperature) properties of three paving grade bitumens and a polymer modified bitumen (the difference in temperature ΔT).

Table 1 **Temperature susceptibility of bitumen**

Binder	Softening point °C	Fraass °C	ΔT °C
50 pen	50	−10	60
200 pen	38	−20	58
450 pen	28	−30	58
Polymer modified binder	76	−25	101

From Table 1 it is clear that the polymer modified material exhibits a good level of performance over a wider temperature range than the paving grade binders. In addition to increasing the useful temperature range, polymer modification also enhances the performance over this range. Enhancement of a number of physical properties has been recognized and measured including the following:

- cohesion (Vialit pendulum);
- adhesion;
- tensile strength (toughness/tenacity);
- viscosity (sliding plate rheometer);
- ductility/elastic recovery (ductilometer);
- forced ductility;
- cold temperature bending (bending beam rheometer);
- rheology (DSR).

4.4.3 Validation and use

While all of these improvements in the physical properties of polymer modified binders can be demonstrated, there is little validation of the direct relationship between any of the physical properties and performance on the road. Currently, cohesion (as measured by the Vialit pendulum test) is taken as a measure of performance for surface dressing binders, slurry surfacing binders and of bond and tack coats.

A number of different polymer types have been used in the modification of bitumen including:

- SBS (styrene butadiene styrene);
- SBR (styrene butadiene rubber);
- EVA (ethylene-vinyl acetate co-polymer);
- PB (polybutadiene).

All of the above polymers (and others) can be shown to modify the properties of bitumen, each modifying different properties to a different extent. In general, increasing the amount of polymer in a blend increases the change in properties. However, since polymers are significantly more expensive than bitumen, this tends to limit the amount of polymer in a blend, balanced against the level of improvement in properties.

Since different locations for surface dressing, for example, exhibit conditions which differ in severity, all do not require binders of the highest performance. The recommendations given in Road Note 39 [2] Figures 7.3a and 7.3b illustrate this by indicating the type of binder (conventional, intermediate and premium) that should be used on sites of differing severity and Figure 9.1.2 which defines the three grades of binder on the basis of their cohesion (in J/cm²) as measured by the Vialit pendulum test.

4.5 BS EN 13808

BS EN 13808, the European specification for bitumen emulsion, replaces BS 434-1:1984. Its purpose is to bring together all the existing CEN member country specifications into one standardized specification to apply throughout Europe. In order to achieve this standardization, EN 13808 has been developed as a framework specification, which includes a number of classes for each property of bitumen emulsions. Each country may select from the framework specification those classes for properties it considers appropriate (including class 0 – no performance determined), based on climate, local conditions and experience. Thus each country's specifications for apparently similar materials may differ considerably.

It should be noted, however, that some properties, i.e. those specified by Mandate M/124, Road Construction Products, need to be measured on all bitumen emulsions. This is to ensure that the products conform to the essential requirements of the EU Construction Products Directive (89/106) [3].

The mandated properties to be measured in the specifications are:

- consistency at intermediate service temperature;
- consistency at elevated service temperature;
- cohesion (modified bitumen emulsions only);
- durability of consistency at intermediate service temperature;
- durability of consistency at elevated service temperature;
- durability of cohesion (modified bitumen emulsions only).

Satisfying the requirements of the Mandate ensures that bitumen emulsions are eligible for CE marking.

4.6 Emulsions volume/weight conversions

Emulsions are normally sold by mass, but for practicality rates of application are measured in litres per square metre (l/m^2). 1 kg of cold emulsion is approximately (0.98–1.0) l at ambient temperature, depending on the binder content. Similarly, 1 kg of 70% nominal binder content emulsion is approximately (1.02–1.03) l at a spraying temperature of (75–85) °C. As most applications fall within these limits, increments of 0.1 for both litres and kilograms can be considered synonymous.

Some standards specify emulsion rates of spread as kilograms per square metre (kg/m^2) of residual binder, which allows a choice of emulsion binder content. For example, the rate 0.15 kg/m^2 residual would approximately equate to 0.35 l/m^2 of emulsion with a 40% nominal binder content, or 0.25 l/m^2 of an emulsion with a 60% nominal binder content.

5 Handling, storage and safety

NOTE This British Standard cannot purport to cover all the issues of health, safety and environment associated with the various emulsion products. However, generic guidelines are available from the Road Emulsion Association [4], [5]. Furthermore, specific reference should be made to the Material Safety Data Sheets provided by suppliers.

5.1 Safe handling

Good hygiene practices should be exercised when dealing with emulsion products. In particular, relevant personal protective equipment should be worn to restrict contact with the skin (gloves, glasses, boots, etc.). Hands should be regularly washed, particularly before consumption of food or drink. The use of barrier creams is recommended. Solvents should never be used for skin cleaning.

5.2 Storage

The following key points should be considered when storing emulsions and emulsion products.

- In storage and use, cationic and anionic emulsions are incompatible and should be segregated.
- All emulsion products should be protected from frost and agitated according to manufacturer's recommendations to avoid excess settlement.
- When heating emulsions, there should be agitation to avoid localized overheating and the emulsions should never be heated in excess of 90 °C to avoid boiling.
- Drums should be protected, if possible, from high temperatures which could cause pressure hazards when the drum is opened. Bungs should remain tight.

NOTE Further guidance can be obtained from Road Emulsion Association publications [4] listed in the Bibliography.