

SURFACE DRESSING BINDERS

1. INTRODUCTION

Surface dressing comprises spraying the road surface with a film of binder followed by the application of a layer of stone chippings. After rolling and light trafficking, any excess of chippings is swept up. After the dressing has stabilised it is opened to traffic. The main functions of surface dressing are:

1. To seal the road surface against ingress of water
2. To arrest any surface disintegration
3. To improve skid resistance and texture

It is the combination of chippings of suitable quality and size, held in place by an effective binder, which results in satisfactory surface dressing. Road Note 39 provides sound guidance on surface dressing design and practice.

In Road Note 39, which should be considered as essential reading, the selection of the correct size of chippings and the required rate of binder application is based on:

1. The number of medium and heavy vehicles of more than 1.5 tonnes unladen weight per lane, per day.
2. The hardness of the road relative to surface temperature characteristics.
3. The degree of difficulty – i.e. to what extent it is subjected to braking, turning and accelerating stresses
4. The existing condition of the road to be re-surfaced.
5. Precise requirements or specification of the finished dressing.

It should be noted that Road Note 39 contains essentially general and “target” recommendations providing sound overall basic guidance. These recommendations must be considered, together with any specialised information available on binders or local conditions, in order that the best possible work specification is devised.

2. THE FUNCTIONS AND PROPERTIES OF BINDERS

2.1 Functions:

The functions of the binder in surface dressing are

- to provide adequate adhesion between the chippings and the road surface
- to seal the surface of the road against ingress of water
- To arrest disintegration of the existing road surface

Any other function of the binder is dependent on the nature of the road and the traffic stresses applied to the surface dressing. It is unlikely that all binders will prove to have properties which will give optimum performance under all

conditions. Nevertheless, to achieve the benefits of these functions, certain properties will be common to all binders.

2.2. Properties

The following properties are necessary if binders are to be used successfully for surface dressing:

- they must be sufficiently fluid to spray
- they must be sufficiently fluid to “wet” the road surface and the chippings
- they must be sufficiently stiff (i.e. have sufficient cohesive strength) to hold the chippings against traffic forces in both the early stages and longer term
- they must not become so brittle in cold weather that chipping loss occurs
- they must not become so soft in hot weather that loss of chippings and bleeding occurs

2.3 Viscosity

The word “fluid” as used in the paragraph above indicates the ease with which a binder can flow. Fluidity can be considered in terms of viscosity.

From January 2009 the European Standard BS EN 13808 :2005 “Framework for Specifying Cationic Bituminous Emulsions” became mandatory.,

BS434-1:1984 “Specification for Bitumen Road Emulsions” has been superseded by BS434-1:2011 “Specification for anionic bitumen road emulsion”

Under the new framework specification the method of testing for the viscosity of Cationic emulsions will change and the Redwood II @85°C will no longer apply¹.

For emulsions with binder content (determined by water content to BS EN 1428) the new method of measurement shall be:

Binder content 58-62	S.T.V (2mm cup) seconds @40°C
Binder content 63-71	S.T.V (4mm cup) seconds @40°C
Binder content ≥ 70	S.T.V (4mm cup) seconds @50°C
	Or Dynamic viscosity @40oC

¹ The use of the redwood II viscosity @85°C for surface dressing emulsions may still be used voluntarily by agreement between the purchaser and supplier provided the requirements for transverse distribution of binder to BS 1707 are met; however; no viscosity specifications will exist.

Cutback binders are no longer generally available in the UK and are no longer included in Road Note 39.

The binder supplier will specify proprietary materials which will also be identified under BS EN13808 nomenclature.

The viscosity of surface dressing binders varies with temperature. As the temperature rises, the viscosity decreases. Use is made of this property in order to select the appropriate temperature for spraying each binder. The spraying temperature is regulated to provide the correct viscosity, to achieve good transverse distribution across the spraybar and to secure “wetting” of the road surface and the chippings (i.e. to achieve a good “bond”).

If the viscosity is too high, it is unlikely that an even transverse distribution will be achieved. Furthermore, good wetting will not occur and chippings will be lost. However, if the viscosity is too low the material could flow off the high points of the road and pool in the low spots, or run off the road altogether. Once again, the transverse distribution could be compromised.

3 BINDERS AVAILABLE

The binders used contain bitumen either as its normally unmodified penetration grade or modified using polymeric additives. When in their normal state the binders will be too viscous to spray and therefore have to be treated to allow application at lower temperatures.

In order to achieve a workable viscosity for application, bituminous binders are treated using the process of emulsification:

The process of emulsification allows the bitumen to be dispersed as very small micron sized droplets in an aqueous soap solution. The low viscosity of the water aids application, yet once applied, the water is lost leaving only the stiff bitumens.

3.1 Properties associated with Emulsions

Emulsions have traditionally been defined according to BS434 part 1:1984 by chemical nature, breaking rate and bitumen content. Such that a K1-70 emulsion is cationic or acidic in nature (K), rapid break (1) and contains nominally 70% bitumen.

However, since BS434 part1:1984 is no longer valid and has been replaced by BS434-1:2011, cationic emulsions are now classified according to BS EN13808 nomenclature which uses 7 characters, namely:

Polarity

Nominal bitumen content

Bitumen Type: - B (standard paving grade to BS EN 12591)

P (containing added polymer)

F (containing more than 2% added flux)

Class for breaking value (from 0-7)

e.g. a K1-70 could be classified as C70B3 (cationic 70% paving grade bitumen with a class 3 breaking value).

A proprietary polymer modified bitumen emulsion could be classified as C70BP3 (cationic 70% bitumen modified with a polymer with a class3 breaking value)

It must be remembered that BS EN 13808 is a FRAMEWORK for characterising the properties of cationic emulsions and is not a means for specifying the performance of such emulsions.

Bitumen emulsions have the benefit of:

- enabling a binder of higher viscosity (once the emulsion has broken) to be applied to the road at a lower temperature than cut-back binders
- can be used on damp (but not wet) roads using damp chippings. The bond is achieved once the emulsion is “broken”.

The process by which the bitumen emulsion reverts to its original water and bitumen components is known as “breaking”. The break of an emulsion is often indicated by a progressive change in colour from brown to black. This break is a complex process in which, initially, bitumen separates from the water in the emulsion onto the road and onto the applied chippings. The final stage of break involves the loss of water by evaporation so that a continuous adhesive film of binder is produced. The loss of water from an emulsion will be delayed if the road surface is very wet or if there is a high level of moisture in the air (i.e. if it is very humid). These conditions will unduly prolong the breaking period. Because emulsions contain water, they must be protected from frost whilst in storage.

3.2 Properties associated with modified bitumen binders

The majority of materials sprayed today contain modification in many forms, chiefly of synthetic elastomers, plastomers or natural elastomers.

The benefits of such modification can be seen in the fact that they exhibit:

- higher resistance to shear
- increased tenacity of bond
- reduced susceptibility to extremes of temperature

In simple terms, this increases the performance of the binder in service particularly in the following areas:

- a) increasing the temperature at which the binder begins to soften, reducing the occurrence of bleeding and fatting at stress areas
- b) improves the low temperature adhesion and elasticity during the serviceable life of the binder (reduced embrittlement)
- c) improved elasticity to bridge hairline cracks
- d) improved early stability in the dressing
- e) improved long term adhesion of the dressing

- f) improved longer term durability of the dressings as thicker binder films can be applied
- g) extends the life of the dressing, particularly when high quality aggregate is used

3.3 Modified Emulsion Binders

In addition to the benefits listed in 4.3, modified emulsion binders also:

- a) initially perform better in damp conditions
- b) perform better in high humidity
- c) perform better in areas of higher annual rainfall

4. SELECTION OF BINDERS TO MEET SITE REQUIREMENTS

Good results can be achieved with all binders given proper preparation, design, execution and after-care. However, the matching of binders to sites representing different degrees of difficulty requires care.

4.1 SPECIFICATION

Cationic emulsions are specified in the UK to the European Standard BS EN 13808 which is a framework for identifying or specifying the characteristics of cationic emulsions and not a specification for the performance of these emulsions.

However under the Mandate M/124 "Road Construction products", directive (89/106) "EU construction products directive"; the reporting of certain properties will become mandatory and the declared value or class should be quoted.

These are:

Emulsions

On the emulsion

- 1) viscosity
- 2) Adhesivity
- 3) Breaking behaviour

On the binder after recovery

- 1) Penetration (consistency at intermediate service temperature).
- 2) Softening Point (consistency at elevated service temperature).
- 3) Cohesion (for modified binders only).

On the aged recovered binder

- 1) Penetration (Durability of consistency at intermediate service temperature).
- 2) Softening point (Durability of consistency at elevated service temperature).

3) Cohesion (Durability of cohesion modified binders only)

Note: if the properties of the recovered binder from the emulsion have the consistency of a cutback then the following tests apply for the binder after recovery.

- 1) Viscosity S.T.V (consistency at intermediate service temperature).
- 2) Dynamic Viscosity (consistency at elevated service temperature).
- 3) Cohesion (for modified binders only).

An advice note regarding BS EN13808 is available from The Road Emulsion Association (REA). - www.rea.org.uk/

The British Board of Agrément runs a HAPAS scheme (Highway Authority Product Approval Scheme) under SG4 for modified binders for surface dressing, bond coats and microsurfacing. This scheme is a five stage assessment of the binder covering lab performance to specific tests, Quality Assurance of the supplier and monitored test site trials.

The laboratory testing involves additional performance type testing and reporting to that required for BS EN 13808. Key tests are:

- a) Vialit Pendulum Cohesion test – measures of the cohesivity (bitumen to bitumen strength) of the recovered bituminous material (recovered from the emulsion) over a range of temperatures. Typically report peak cohesion strength, temperature at which peak cohesion is achieved, and the range of temperature over which a cohesion threshold is reached.
- b) Determination of the complex shear modulus and phase angle by the DSR method. This method determines the stiffness characteristics of the recovered bitumen binder over a range of temperatures and oscillation frequencies. It also provides indications of the visco elastic behaviour of the bitumen at different temperatures and oscillation frequencies.

Typically quoted are equi-stiffness temperatures at 2MPa and 2kPa (to provide a feel for temperature susceptibility) the complex moduli and phase angle at 0.4Hz and 0.1Hz frequency at various temperatures.

- c) Penetration at 5°C and 25°C again to provide information regarding temperature susceptibility.

To complement the information on these binders, there is a requirement to assess the durability of the material. This is “assessed” by means of artificially aging the binder. Whilst there is no definitive test correlated to site aging, the HiPAT test is often currently referenced.

This is a process whereby the recovered binder is subjected to above ambient pressure and elevated temperature (circa 80°C) for a prolonged period of time. Tests such as DSR/pen and softening point are referenced before and after aging.

BS EN 12271 “Surface Dressing Requirements”,
Road Note 39 and SHW clause 919 & 922

Indicate performance categories for binder types based on the binder’s cohesion.

Table 1 in PD6689:2009 “Surface Treatments-Guidance on the use of BS EN12271and BS EN12273” provides details for the pendulum cohesion classification of traditional binders under the new BS EN 13808 standard.

5. HANDLING OF SURFACE DRESSING BINDERS

All surface dressing binders, are hot at spraying temperatures. The exception is C60B type emulsion which is sometimes used for footway dressing. They must, therefore, be handled with care. Advice on the handling of binders is contained in the RSDA “Operators’ Guide to the Safe Use of Surface Dressing Sprayers” which forms Section 7 of this Code of Practice.

6. CHANGING THE TYPE OF BINDER USED IN A SPRAYING MACHINE

Emulsion binders are proprietary in nature and are formulated by the producer to give the required properties. The targeted properties will be related to:

- 1) Stability to Shear and Storage.
- 2) Viscosity for application.
- 3) Breaking performance on application.
- 4) End performance binder properties.

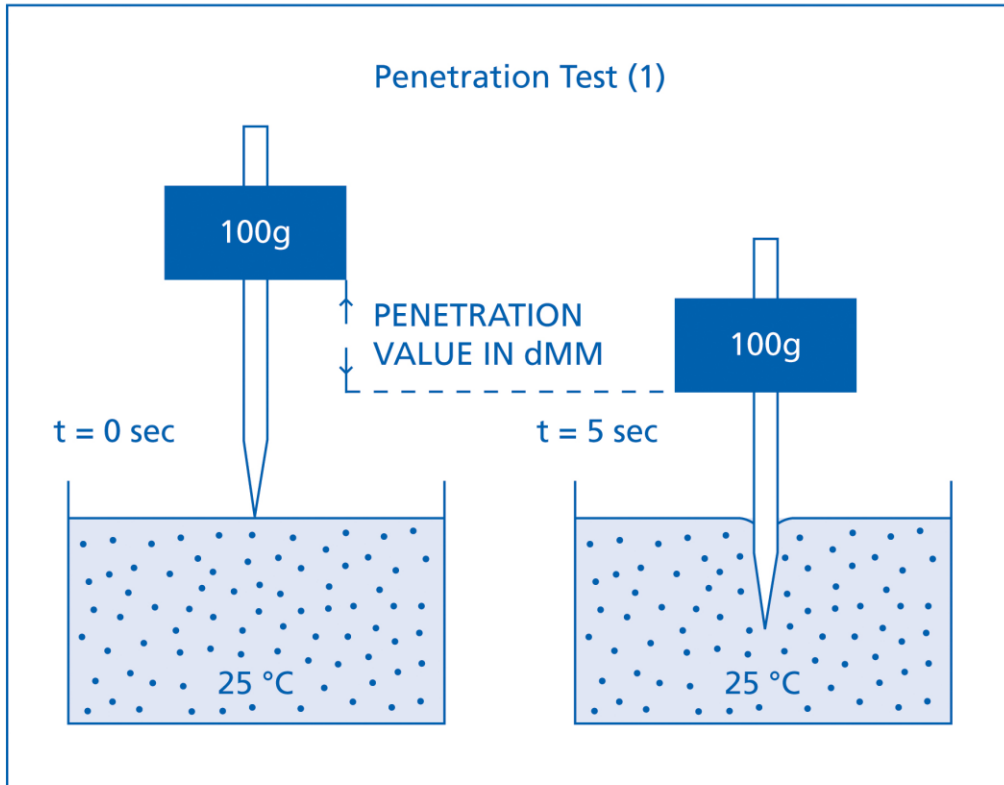
Different classes of emulsion from the same or different producer may vary chemically and therefore may not be compatible on mixing. Prior to changing binder types in spraying machines the contractor should check compatibility with the supplier to avoid unnecessary changes to the emulsion properties.

APPENDIX A

TEST METHODS FOR BITUMEN AND SURFACE DRESSING BINDERS

A number of test methods for bitumen and surface dressing binders are referred to in the test. A broad outline of each of those tests is given in the following pages. Fuller details are given in the appropriate British Standard

Penetration of Bitumen	BS EN 1426:2007
Ring and Ball Softening Point	BS EN 1427:2007
Viscosity by Standard Tar Viscometer (emulsions)	BSEN12846:2002
Dynamic Viscosity by Vacuum capillary Viscometer	BS EN 12596:2007



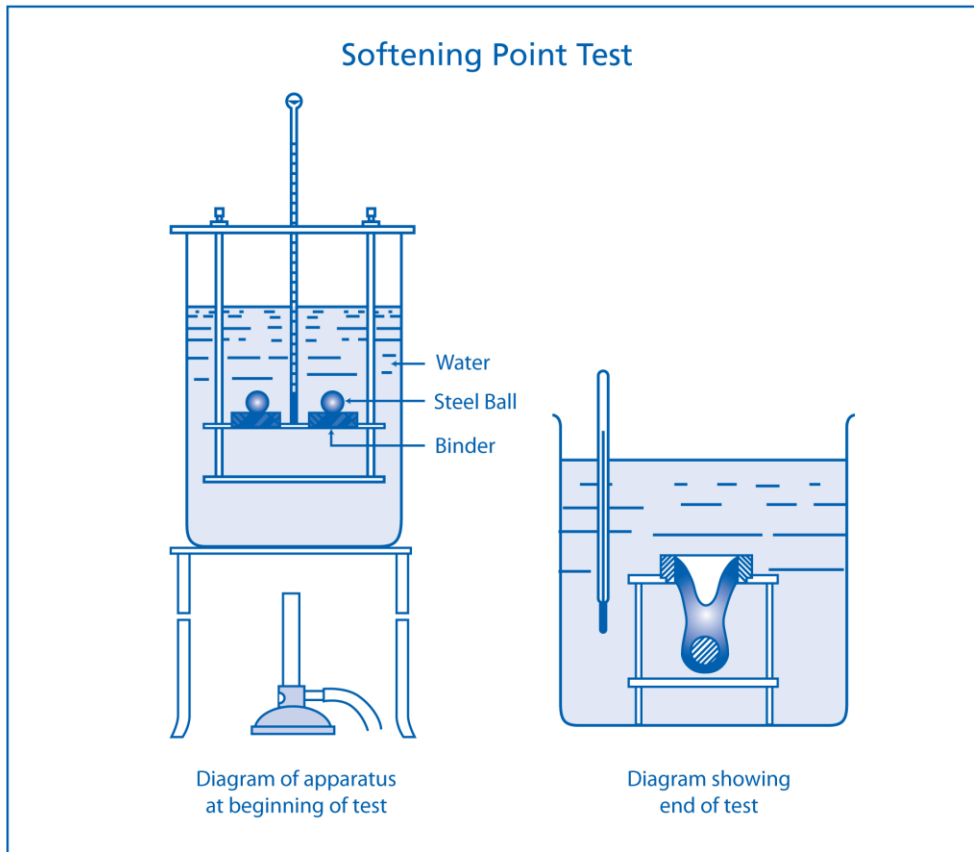
Penetration Test

In the penetration test the distance (measured in 10th of a mm) that a standard needle will penetrate into a sample of bitumen under specified conditions is measured.

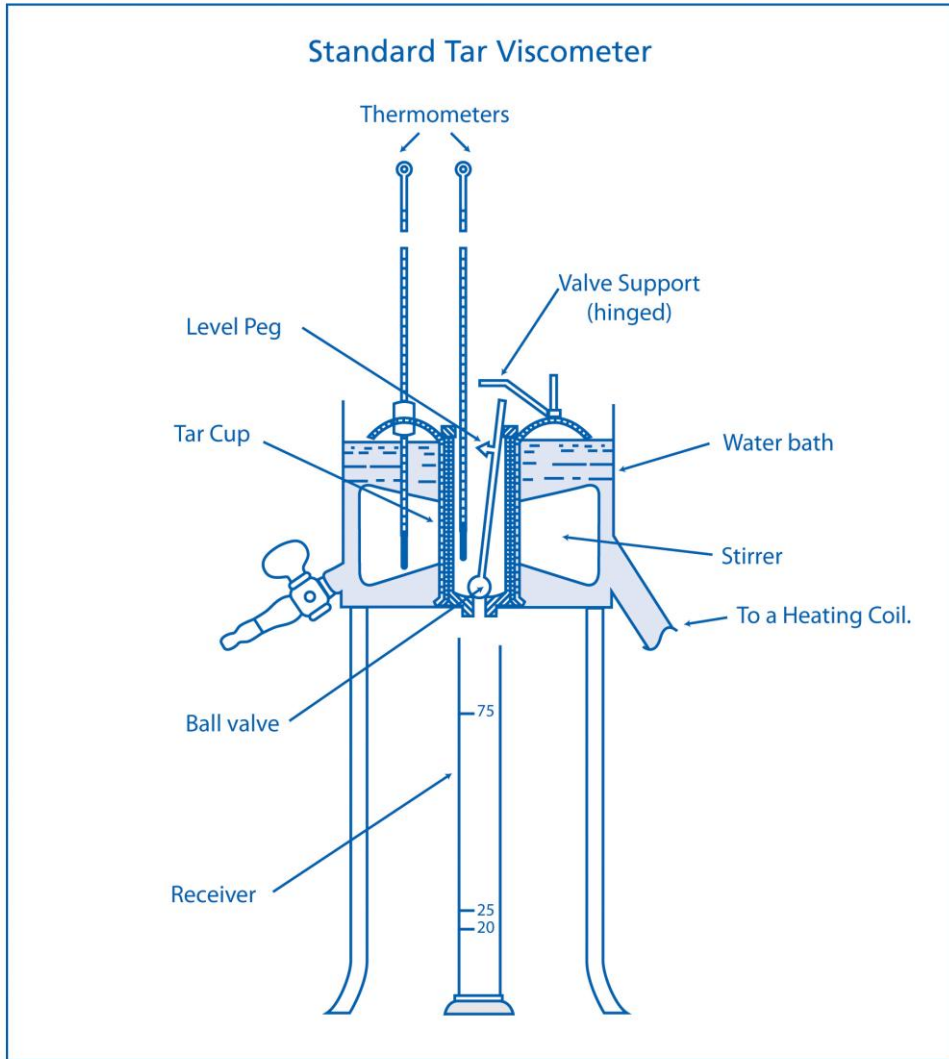
The conditions normally specified are:

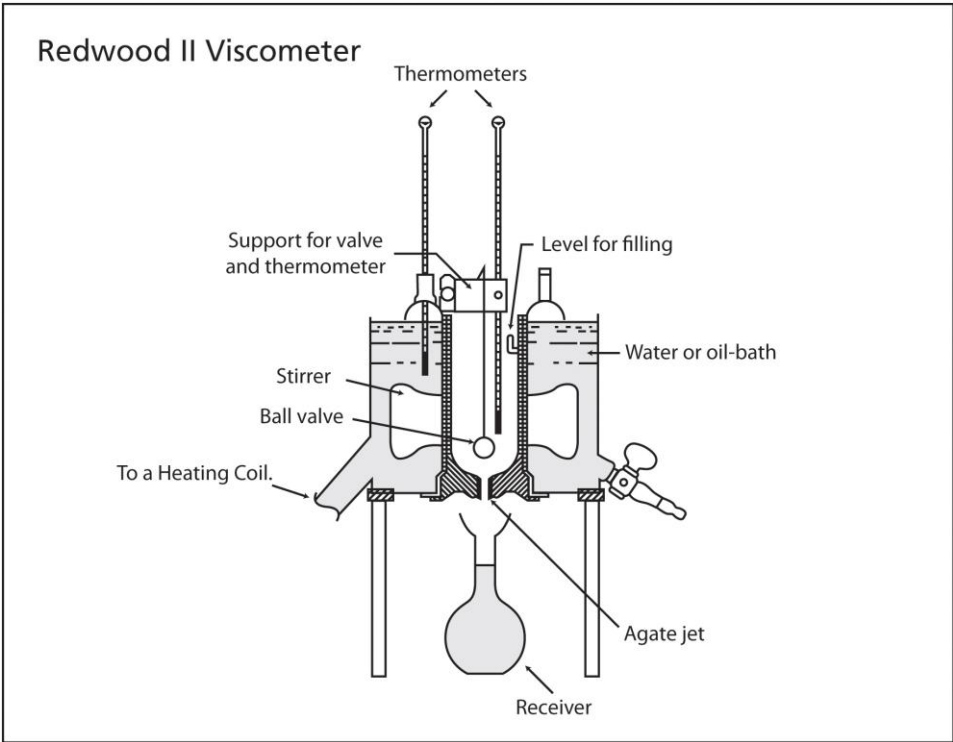
needle and weight	= 100g
temperature	= 25 °C
time	= 5 seconds

The timing of the test and the measurement of penetration are done using a Penetrometer.



The softening point test (sometimes called the rig and ball) measures the temperature in °C at which a disc of bitumen which is being heated at a fixed rate (5°C per minute) softens to such an extent that it allows a standard steel ball, placed on the disc of bitumen at the start of the test, to pass through it.





APPENDIX B

GLOSSARY

ADHESION

The property by means of which a binder sticks to the surface of a solid body, e.g. the road or chippings.

ADHESION AGENT

A material added to a binder which enhances the binder's adhesion to the surface of the road or aggregate, particularly when these surfaces are damp.

AGROCHEMICAL FLUXED BITUMEN

Bitumen whose viscosity has been reduced by the addition of flux oil derived from agrochemical based products.

ANIONIC BITUMEN EMULSION

An emulsion in which the emulsifier imparts negative charges to the dispersed bitumen droplets.

BAFFLE

A deflecting device fitted at the end of a spraybar to produce a concentration of binder on the road surface.

BAR

An abbreviation for spraybar (see Spraybar)

BINDER

Material serving to coat the particles of an aggregate and to assure its cohesion.

BINDER DISTRIBUTOR

A tanker fitted with a spraybar through which the binder is applied to the road surface.

BITUMEN

A viscous liquid, or a solid, consisting of hydrocarbons and their derivatives which are soluble in trichloroethylene, is substantially non-volatile and softens gradually when heated. It is black or brown in colour and possesses waterproofing and adhesive properties. It is obtained by refinery processes from crude oil.

BLEEDING

The exudation of bituminous binder from a road surface.

BITUMINOUS

Adjective applicable to binders and any material containing bitumen

BITUMINOUS BINDER

Adhesive material containing bitumen

BOND

The adhesion between the binder and the road surface and the binder and the applied chippings.

BITUMEN – EMULSION

Emulsion in which the dispersed phase is bitumen or a bituminous binder.

BITUMEN – PENETRATION GRADE

A grade of bitumen which complies with the requirements set out in Table 1 of BS EN 12591:2000 Part 1 when tested by the methods shown in that Table.

BLACKING UP

The discolouration of a dressing caused by the binder migrating to the surface under traffic loading.

BREAK

The coagulation of the dispersed bituminous phase of an emulsion.

BREAKING

The separation of binder from the aqueous phase in such a way that the binder forms a continuous medium with substantially similar properties to those of the binder before emulsification.

BREEDS

The width as sprayed by the bar, irrespective of the maximum spray width of which the bar is capable.

BSI

British Standards Institution

BUTT JOINT

A type of joint where the spray between adjacent “breeds” does not overlap significantly.

BOXED-IN

The creation of an even start and finish of adjacent breeds.

CARPET TILE TEST

A test used as a means of checking the amount of binder applied to a road surface. Sections of carpet tile of known area, normally about 200 mm square which have been pre-weighed, are placed on the road in front of the spraybar. Once the bar has passed over the tile, the tile is re-weighed. The quantity of binder delivered to the road surface is calculated and compared with the rate of spread specified for that section of road.

CATIONIC BITUMEN EMULSION

Emulsion in which the emulsifier imparts positive charges to the dispersed bitumen droplets

C E N

European Standards Organisation.

CHIPPINGS

Coarse, crushed aggregate practically free of fines with a narrow grading range.

CHIPPING SPREADER

A machine used to apply chippings to the road surface as part of a surface dressing.

CHIPPING STORAGE AREA

A suitable hardstanding for storing chippings

CLOSED-TEXTURED

A description of the density of macadam.

CONES

An abbreviation for traffic cones.

COSHH

Control of Substances Hazardous to Health.

COSHH ASSESSMENT

An assessment relating to the hazards to health represented by the use of materials or equipment.

COST LIFE INDEX

The cost (in this case of a surface dressing) expressed as the cost per square metre per annum of satisfactory life.

CUT BACK BITUMEN

Bitumen whose viscosity has been reduced by the addition of a cutback solvent.

CURTAINS

The canvas or other material surrounding a spraybar to minimise the gap between the bar and the road surface.

DENSE

See Close-Textured

DELAYED-SET

Freshly-mixed macadams to which volatile oils have been added to enhance the workability and compactability of the macadam after cooling.

DISTRIBUTOR

An abbreviation for binder distributor.

DRESSING

A surface treatment consisting of the successive laying of at least one layer of binder and at least one layer of chippings.

DUSTING

The application of 3 mm to dust crushed rock onto a road surface to counteract bleeding.

DUMPS

A politically incorrect term for chipping storage areas.

ECHELON WORK

The running of two binder distributors or chipping spreaders, one behind the other, in such a way as to produce an application of binder or chippings over a width equivalent to their combined widths.

EMULSION

Dispersion of a liquid in another with which it is immiscible with the aid of emulsifier.

EMULSIFIER

Material which assists formation and stabilisation of an emulsion.

EMULSION – ROAD

A 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.

FATTING-UP

The result of almost total embedment of chippings in the binder.

FLUX

Fluid added to another to reduce viscosity

FLUXED BITUMEN

Bitumen whose viscosity has been reduced by the addition of a flux oil.

FLUX OIL

Relatively involatile oil used in the manufacture of fluxed bitumen.

FLUSHING-UP

See Fatting-Up.

FUMING

The vapours given off by some binders when first sprayed on the road surface.

HAPAS

Highways Agency Product Approval Scheme which is overseen by the British Board of Agrément

HUNGRY

The description of a road surface which has become deficient in binder to the extent that when new binder is applied to it, some will soak into the surface.

JET

An orifice through which binder passes from the tanker spraybar to the road surface.

JOINTS

The point at which binder or chippings from adjacent breeds meet or overlap.

LANDING

A chipping storage area

LEAN

See Hungry

MASK

An adhesive tape or other similar material used to cover cat's eyes, road ironwork, etc, in such a way that, after removal, they are free from binder or chippings.

MODIFIED BITUMEN

Bituminous binder whose rheological properties have been modified during manufacture by the use of one or more chemical agents.

OPEN TEXTURED

A road surface consisting of aggregate of various sizes and proportions which, after compaction, contains a high proportion of air voids.

PETROLEUM FLUXED BITUMEN

Bitumen whose viscosity has been reduced by the addition of flux oil derived from petroleum.

POLISHED STONE VALUE (PSV)

A relative measure of the extent to which different types of aggregate in the wearing surface will polish under traffic.

POLYMER

A substance formed, either naturally or artificially, from chemically simpler substances called monomers, which are joined together by chemical (covalent) bonds to produce very large molecules.

POLYMER MODIFIED BITUMEN

Modified bitumen in which the modifier used is one or more organic polymers.

POLYMER MODIFIED BITUMEN EMULSIONS

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

PRE-PATCHING

The remedial measures carried out to make good defective areas of surfacing in advance of surface dressing.

PTR

An abbreviation for pneumatic-tyred roller.

QA

An abbreviation for Quality Assurance.

QUALITY ASSURANCE

A registration given to a contractor or to a product, under a scheme administered by the Department of Trade and Industry, through its agencies.

QUARTERING

A term used to describe the method of laying adjacent breeds of surface dressing. These are usually considerably less than the full width of the spray bar. They are laid to make up the difference between full (or approximately full) bar widths and the total (sometimes variable) width of a road.

RACKED-IN

The term used to describe the successive laying of one layer of binder and two layers of chippings, the second layer being of a smaller size.

REACH

Registration Evaluation and Authorisation of Chemicals is a new European system for regulating chemical safety.

SECTOR SCHEME

A Quality Assurance Scheme document used in highways construction and maintenance.

SET

A description of the state of a binder which has cooled to road temperature or, in the case of an emulsion, has 'broken'.

SKIDDING RESISTANCE

The frictional forces between tyre and road, which are available to oppose skidding.

SLAG

A manufactured aggregate from steel production or from the ore-refining industries.

SLOTTED JET

A jet nozzle fitted to a spraybar and formed in such a way that binder passing through it onto the road surface is in the shape of a fan.

SPRAYER

An abbreviation for binder distributor.

SPRAYBAR

The bar, carrying jets, which is fitted to the tanker and through which the binder is applied to the surface.

SPREADER

An abbreviation for chipping spreader.

STABILISED

A term used to describe a dressing where the binder has hardened or, in the case of emulsions, the emulsion has completely 'broken' and, in both cases where the aggregate applied to the surface has settled into a close mosaic.

STRIPPING (BINDER)

The displacement of binder from the surface of aggregate, usually by the action of water.

STRIPPING (CHIPPING)

The loss of chippings from a completed dressing.

SWEATING

The early stages of bleeding

SWIRL JET

A jet nozzle formed in such a way that binder passing through it swirls and forms a curtain in the shape of a cone.

TANDEM ROLLER

A roller with two drums.

TANKER

An abbreviation for binder distributor.

TEXTURE DEPTH

A term used to denote the measure of projection of aggregates in a wearing surface.

THERMOPLASTIC

The property of material by which their viscosity changes in relation to temperature change.

THERMOSETTING

A material formed by an irreversible chemical reaction, which renders it resistant to temperature variations.

TRAIN

A term used to describe all the vehicles required for the surface dressing operation, assembled in the order in which they play their part in that operation.

TRAY TEST

A test previously used, where a shallow metal tray, usually between 200 and 300 mm square and about 10 mm deep, was placed on the road surface ahead of the binder or chipping spreader. The tray collected binder or chippings, as appropriate, for the purpose of calculating the rate of spread.

This test has now been superseded by the carpet tile test.

UKAS

United Kingdom Accreditation Service is the sole national accreditation body recognised by government to assess, against internationally agreed standards, organisations that provide certification, testing, inspection and calibration services.

WET EDGE

The edge of a width of sprayed binder to which chippings have not been applied and which is incorporated in the joint-forming process.

“WET TAR”

The wording used on warning signs to describe any freshly-applied binder. Although it very rarely describes the binder accurately it is, nevertheless, the mandatory sign under “The Traffic Signs Regulations and General Directions of 1981”.