Adhesion Promoters for Bitumen

This booklet gives an introduction to the problem of adhesion between bitumen (asphalt cement) and surfaces and how this adhesion can be improved by additives known variously as "adhesion promoters", "antistripping agents", "wetting agents", "antistrips" or "adhesion agents" in the different regions of the world. In this booklet we have used the term "adhesion promoters" to include all additives to bitumen designed to improve adhesion.

The largest use of bitumen (asphalt cement) is in road construction and the discussion is mainly directed to adhesion in road materials, but adhesion and wetting can also be an issue in bituminous coatings and filled bitumens as well as with related binders like tars and resins. Some examples are given in the "Applications" section.

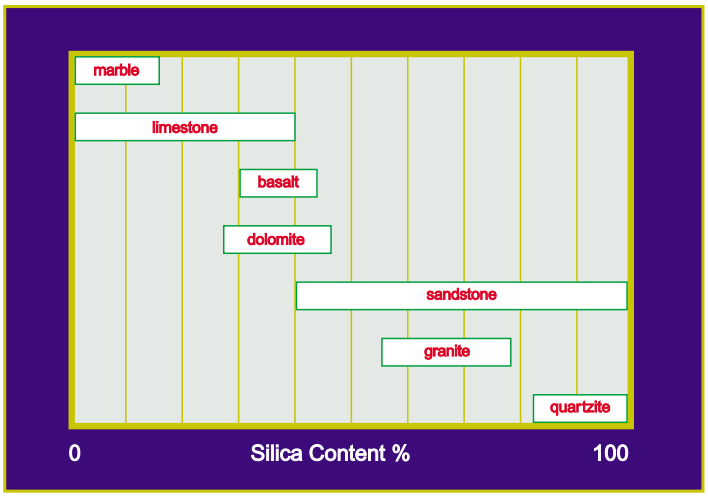
That roadways can suffer water damage is well established. The symptoms of water damage are various and include rutting and shoving, loss of chippings from surface dressings (chipseals), ravelling of surface layers leading to potholes, susceptibility to freeze-thaw damage, cracking and bleeding. But the underlying problem on a micro scale is loss of adhesion between the binder and the aggregate.

How Adhesion is Affected

Bitumen (asphalt cement) is an oily material of low polarity with little chemical affinity for aggregate, whereas the aggregate has a high affinity for water. This means bitumen is easily displaced by water. In practice the adhesion between bitumen and aggregate depends on the source of the bitumen and the chemistry of the aggregate surface.

Aggregates may be of an "acidic" type whose surfaces have a tendency to become negatively charged, or "basic" with surfaces which have a tendency to become positively charged. Acidic aggregates include those with high silica contents, while basic aggregates include carbonates.

Bitumens, especially those of high acid value, have a tendency to become negatively charged and thus adhesion problems occur particularly, but not exclusively, with acidic aggregates.



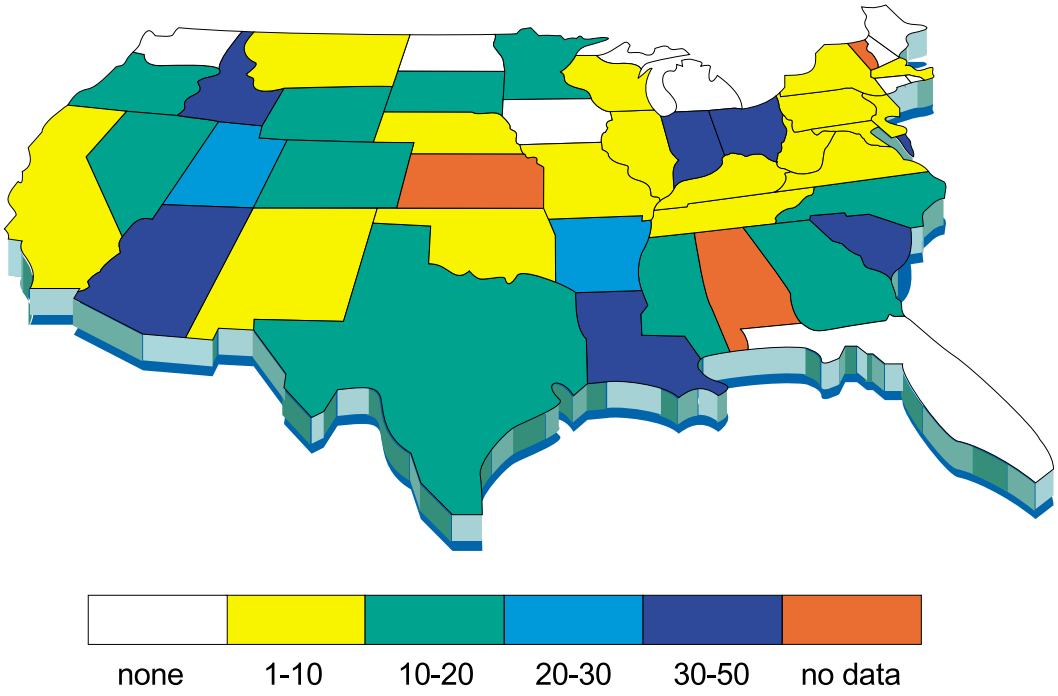
Silica content of road aggregates

All road materials can be damaged by water. Experience has shown that there are few aggregates which completely resist the action of water under all conditions. The water may enter the pavement structure in several ways:

- water inside or on improperly dried aggregate
- rainfall seeping through shoulders, cracks or porous pavements
- subsurface water from higher ground producing a hydrostatic head
- capillary water from the subgrade
- or water vapour from the subgrade

Some things make the pavement more susceptible to moisture damage, such as:

- mix designs low in binder and open in grading
- inadequate compaction so the material has high voids
- inadequate subsurface drainage
- a high content of clay fines and dusty aggregate surfaces
- and where water vapour can condense under impermeable layers



Effect of climate. Percentage of sites showing moisture damage in USA

Water damage is more likely in wet climates and highly trafficked roads are liable to show the effects of any damage most quickly. But water damage can occur in all climates as shown by a study of moisture damage in the USA.

The chemical affinity between bitumen and aggregate can be improved by the addition of small quantities of chemicals which change the nature of the aggregate surface or the nature of the bitumen.

These chemicals are known as "adhesion promoters". The use of adhesion promoters cannot eliminate all the moisture damage caused by poor design, bad construction techniques or poor materials, but it can reduce their effect in practice.

Effect of water on binder coating. Sample on the right contains adhesion promoter

Adhesion

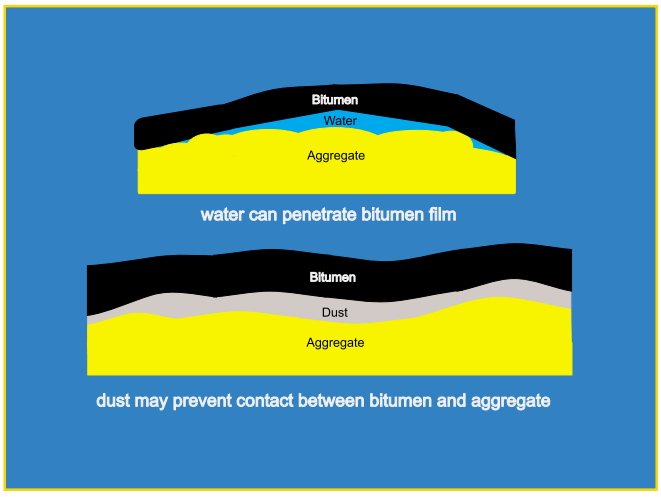
We can recognize two aspects of adhesion:

- taking hold (wetting): the binder comes in intimate contact with the aggregate
- keeping hold (resistance to stripping): the binder stays in contact with the aggregate during the lifetime of the road.

Wetting

Bitumen is highly viscous with little chemical affinity for the surface of aggregates so it spreads only with difficulty. To ensure good wetting it is necessary to reduce its viscosity and to modify the chemical nature of the bitumen or the aggregate.

Bitumen viscosity can be reduced by heating or adding solvents, and to some extent the high viscosity can be overcome by using lots of mechanical energy such as intensive mixing. Additives like polymers or fillers like lime which have the effect of increasing binder viscosity can impede wetting and may require the use of higher temperatures or longer mix times. For hot mix a maximum binder viscosity of 0.2Pa.s (2 poise) at the mix temperature is generally considered necessary for good coating.



Adhesion problems can occur beneath the binder film

A rough or dusty aggregate surface will make spreading more difficult. A damp or water-wet surface will in most cases make it impossible for an untreated binder to coat the aggregate. Bitumen has much less affinity for the aggregate surface than water and little ability to displace it. The ability of the binder to displace water from aggregate surfaces is known as "active" adhesion.

Poor wetting can be recognized by the presence of uncoated surfaces in mixes and early loss of chippings from surface dressings. But even when the aggregate is apparently well coated with bitumen, a dust or water layer may prevent intimate contact and the establishment of the adhesive bond.

How to ensure good wetting

Poor wetting can be avoided by the modification of the binder or by the modification of the aggregate surface. Chippings can be precoated with bitumen or kerosene or with a water solution of adhesion promoters. The idea is to make the surface more receptive to the bitumen.

The more usual approach is to modify the binder by the addition of adhesion promoters (wetting agents) so that it has more affinity for the aggregate. Normally 0.5-1.0% of an adhesion promoter is sufficient to ensure active adhesion.

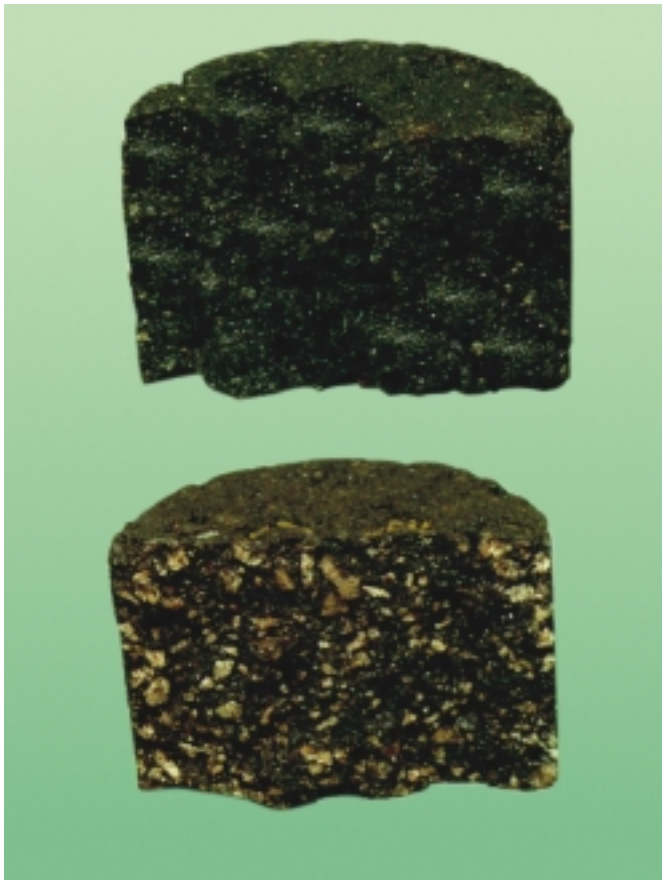
Stripping

There is only one cause of stripping: water getting between a bitumen film and an aggregate surface, replacing the bitumen as the coating of the aggregate. Stripping can show itself by cracking or deformation in a mix, a tendency for the bitumen to flush to the surface, loss of structural strength, ravelling, loss of chippings from surface dresssings and detachment of seals from the underlying surface. In many cases an examination of the materials will show uncoated aggregate surfaces (stripping).

Smooth-surfaced aggregates will not hold the binder film as well as rough-surfaced aggregates and so are more likely to strip.

In the most simple case stripping is the retraction of the bitumen film from the surface of the aggregate–a type of dewetting. But it can also show itself as a detachment of the bitumen film from the the stone or substrate caused by water penetrating the film or coming out of the stone itself.

The aggregate may appear coated but the binder can be easily removed. This may be associated with the formation of soluble salts at the interface. In favourable circumstances detached films may partially reattach on drying out.



Stripping in hot mix specimens. The sample on the top contains adhesion promoter

How to prevent stripping

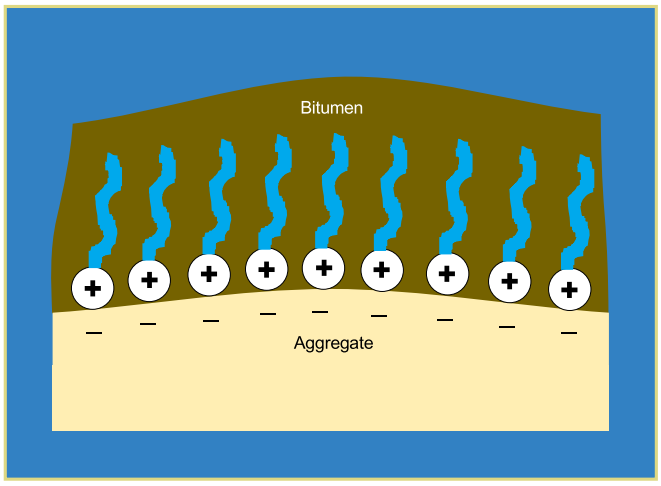
Resistance to stripping is sometimes called "passive" adhesion. Passive adhesion can be ensured by the addition of adhesion promoter (antistripping agent) to the binder. Typically 0.2-0.5% is sufficient to impart water resistance. The effect of the adhesion promoter is long-lasting and the resistance to stripping can be seen many years after the construction of the roadway.

How Adhesion Promoters Work

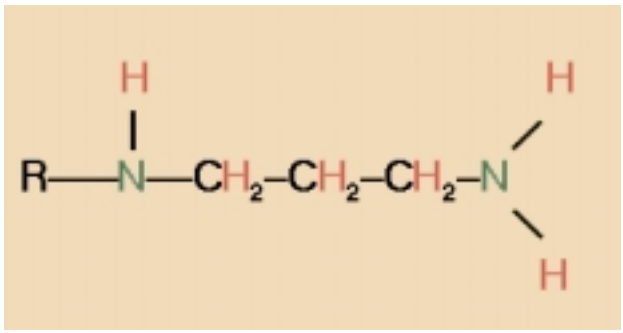
Adhesion promoters are surface active materials which concentrate at the interface between bitumen and the aggregate surface. They displace most of the weakly adsorbed components of the bitumen to form strong chemical bonds to the aggregate surface.

While the head groups on the surface active agents bind strongly to the aggregate surface, the hydrocarbon "tails" of the molecules are compatible with the bitumen. The adhesion promoter thus acts as a bridge between the bitumen and the surface which resists the action of water.

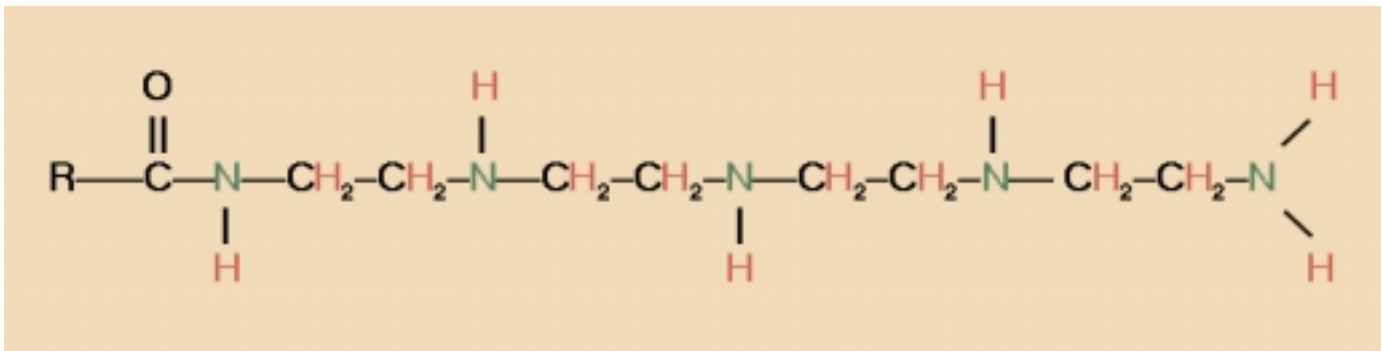
The adhesion promoters can be introduced into the system by addition to the binder. Although added to the binder, the molecules of the adhesion promoter quickly find their way to the interface where they bind so strongly to the aggregate surface that the binder film can push away any water present (active adhesion).



Adhesion promoter molecules act as bridge between aggregate and bitumen



Typical adhesion promoter molecules
Left: Diamine type
Below: Amidoamine type



Other Benefits of Adhesion Promoters

Age-hardening

Adhesion promoters not only improve the adhesion between the binder and aggregate. Because of their chemical nature they can slow down the age-hardening of the binder.

Bitumen oxidizes both during the mixing process itself, during the storage of the mix and more slowly during the lifetime of the roadway. The effect of this oxidation is a hardening of the bitumen and a loss in flexibility of the roadway which can lead to cracking.

The hardening during mixing is simulated in the laboratory by the Rolling Thin Film Oven Test (RTFOT) where hot binder is exposed to a stream of air. The viscosity of the binder is then compared to an untreated sample.

The slower age-hardening during the life of the road can be simulated by the so-called pressure ageing vessel (PAV) test developed as part of the Superpave protocols developed in the USA. In this test the bitumen is exposed to air in an autoclave and then its rheology is compared to that of an untreated sample.

The increase in stiffness of binders before and after RTFOT and PAV tests, as measured by the Dynamic Shear Rheometer, shows the tendency to age during mixing and service.

Adhesion promoter reduces the age-hardening of bitumen

The results show reduced age-hardening with treated binder which should lead to less tendency for fatigue cracking during the service life of the pavement.

As roads are designed for longer lifetimes, oxidative hardening and stripping become significant factors contributing to early failure. The combined effect of improved adhesion and slower hardening on the lifetime of the roadway makes the use of adhesion promoters even more cost-effective.

Mixing and Compacting

Adhesion promoters ease the spreading of binder over the aggregate surface and help to disperse fillers in asphalt mixes. The result is fewer uncoated particles and a more consistent mixture which compacts easier.

This is in contrast to the addition of lime and cement fillers, occasionally used to improve the water resistance of mixes, which tend to stiffen the binder and so impede spreading.

Applications

Surface Dressing (Chip Seal)

Surface dressing (chip sealing) involves spreading chippings over a sprayed seal of binder and rolling in. The binder cools rapidly on the road surface leading to high viscosity and wetting problems which can be made worse by wet and dusty aggregate.

This is an application where "active" adhesion is essential and typically 0.5-1.0 % adhesion promoter is added to the binder. Alternative techniques include precoating the chippings with a mix of diluted binder and adhesion promoter or the spraying of a diluted water solution of adhesion promoter before spreading the chippings, so-called interfacial dope.

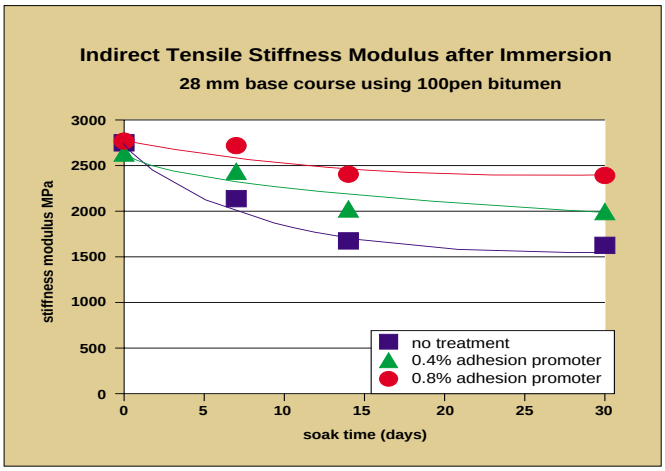
There have been several field studies which demonstrate beyond doubt that the use of adhesion promoters in surface dressing leads to resistance to early rain, an ability to cope with more dusty aggregate and less loss of chippings in the long term. Not surprising that one author concluded: “Although the cost of adding a small amount of adhesion promoters is small, the savings to be made are incredible”. The use of adhesion promoters in surface dressing is specified by many national authorities.

Chip spreading

Hot Mixes

Most asphalt mixes are made hot with dry aggregate. The use of adhesion promoters ensures complete coating of aggregates that are difficult to coat and also improves the durability of the roadway. Typical use levels range from 0.2-1.0% on the binder.

In contrast to treatment with lime or lime slurry adhesion promoters are required at much lower levels. They do not form dust and the treated binder coats more easily. There is also evidence that mixes containing adhesion promoters compact more easily.



Compacted mixes containing adhesion promoters resist the effect of water.

Tests on specimens using the Nottingham Asphalt Tester show that mixes containing treated bitumen maintain their load bearing capacity (stiffness modulus) even when immersed in water.

Cold Mixes

Asphalt mixes can be made without heating if the binder is of sufficiently low viscosity. Typical applications include road oil mixes, common in Scandinavia, and reinstatement and repair materials made with fluxed or cutback binders.

Because the process is carried out cold, the aggregate is usually not dried or heated so the binder may have to displace water from the surface. In these cases an active adhesion promoter is essential.

Typical use levels range from 0.5-1.5%. The adhesion promoter also ensures that stripping does not occur during the stockpiling of the mixes.

Precoated Chippings

Chippings are lightly coated with bitumen or oil to ensure adhesion in surface dressing or when rolled into hot rolled asphalt surfaces to improve skid resistance. Adhesion promoters are added to the coating material to ensure good adhesion.

Prime Coats

In some countries cutbacks or road oils are used for priming and to control dust on road bases during construction. Because the road base is cold and damp, adhesion promoters should be added to the prime coat to ensure active adhesion and rainfastness.

Hot Recycling

If partly coated surfaces are obvious in the reclaimed asphalt, adhesion promoters should be used.

Bituminous Coatings

Bitumen is used for waterproofing, sealing and corrosion protective coatings. Many of the same problems with coating and water resistance seen in road construction materials also apply to these coatings. Where the substrate is cold and could be damp, then it is necessary to ensure active adhesion by the use of adhesion promoters at a level of 0.5-2% on the binder.

Emulsions

The use of cationic bitumen emulsions usually ensures good adhesion in both road and industrial applications. There may be cases where additional water resistance is required. Adhesion promoters can be added to the binder before emulsification and usually at a level of 0.2-0.5%.

Anionic emulsions generally provide poor adhesion to siliceous (acidic) aggregates and to metallic or stone substrates. Adhesion of anionic emulsions is improved by adding adhesion promoters to the binder before emulsification, typically at a level of 0.2-0.5%, or to the finished emulsion.

Use of Adhesion Promoters

Dosage equipment for adhesion promoters

Dosage

Dosing of adhesion promoters can be done at different stages in the mixing and application process.

Akzo Nobel Asphalt Applications can supply custom-built equipment for the dosing of adhesion promoters for either batch or continuous hot mix plants or provide information to assist the installation of a suitable system.

At refineries and bitumen distributor centres similar equipment can be used to add adhesion promoters inline when the bitumen is loaded into the distribution tanker.

Surface Dressing

In some applications, mainly surface dressing (chip seal), the bitumen is treated with a passive adhesion promoter at the refinery or the depot to ensure the long term adhesion performance of the seal. Adhesion promoters can be dosed into the bitumen line as the spray tanker is filled.

To enable surface dressing to continue during wet weather conditions, additional active adhesion promoters can be added on-site direct to the spray tanker as necessary. A solid pelletised form of adhesion promoter is most convenient to add by hand under these circumstances.

Heat Stability

Adhesion promoters are quite stable in cold bitumen and maintain their antistripping effect over many years.

Adhesion promoters slowly lose activity in hot bitumen. This loss in activity depends on the source of the bitumen and mainly due to the reaction of the alkaline amine with the acidic components in the bitumen. Activity is lost more quickly in bitumens with higher acid values such as those from Venezuelan crudes and particularly at higher temperatures.

Treated binders should not be overheated and should be stored for as short a time as possible before use. If extended storage of treated binder is unavoidable, then a special "heat stable" product should be selected.

Wherever possible the adhesion promoter should be added to the binder just before it gets into contact with the aggregate.

Hot Mix Plants

To minimize this loss of activity it is better to inject the product in-line via a metering system into the bitumen delivery line just before mixing.

Storage

Adhesion promoters are generally liquid products which can be stored in carbon steel tanks. Some products may require heating in cold weather conditions. Consult the product data sheet.

Industrial Applications

Bitumen (asphalt cement) is used as a binder and waterproofing agent in many industrial applications such as sealants, mastics, roofing compounds, pipe coatings etc.

Adhesion promoters are used in many of these products to ensure a good water resistant bond or to displace water in cold applied systems. Akzo Nobel Asphalt Applications can give advice on suitable products.

Survey of Laboratory Tests for Adhesion and Adhesion Promoters

Compatibility Tests

Total Water Immersion Test (TWIT)

Dry chippings are fully coated with binder, at a temperature related to the binder viscosity, allowed to cool, then covered with water. When applied to emulsion or cutback binders, the coated chippings may be allowed to cure before being covered with water. After storage for a time and at a temperature specified by the method, the coverage/stripping is estimated visually. When the water temperature is at 100°C, the method is known as "The Boiling Stripping Test".

In modified tests the aggregate may be covered with a solution of salt to simulate the effect of deicing chemicals. For binders of low viscosity the method may be modified to measure active adhesion by wetting the chippings before adding the binder.

References to typical procedures:

a) **Germany**: DIN52006 Effect of Water on Binder Coatings
Part 1 (Emulsions)
Part 2 (Active Adhesion)
Part 3 (Cutback Binders)
b) **France**: NFT 66-018 Test for Adhesivity for a Cationic Emulsion
c) **Austria**: O Norm B3682 (1984) Testing of Adhesion Properties between Bitumen and Aggregates by Stripping
d) **Canada**: Ontario Modified Static Immersion Test (uses salt solution)
e) **Norway**: VTI Method 262 Active Adhesion Laboratory Method

Rolling Bottle Test

f) **USA**: ASTM D3625-91 Effect of Water on Bituminous Coated Aggregate Using Boiling Water
g) **USA**: ISSA Method TB149 Test Method for Boiling Compatibility of Slurry Seal Mixes
h) **Akzo Nobel**: AA2 Passive Adhesion
i) **Akzo Nobel**: AA3 Active and Passive Adhesion of Soft or Cutback Binders
j) **Akzo Nobel**: AAE1 (Emulsions)

Rolling Bottle Test

Chippings are coated with binder and covered with water in glass jars. The jars are rotated so that the contents are agitated. Periodically the coating of the stones is estimated visually.

References to typical procedures:

a) **Akzo Nobel**: AA1 Rolling Bottle Test

Wet Mix Method

The method is primarily designed to evaluate cold mixed materials. Wet aggregate is mixed with binder and the coating is estimated visually.

References to typical procedures:

a) **Akzo Nobel**: AA4 Wet Mix Method

Tests Methods for Surface Dressing (Chip Sealing)

Immersion Tray Test

A film of binder in a shallow tray is covered with water and chippings pressed into its surface. The chippings are removed after a specified time period and the coverage of the face in contact with the binder is estimated visually.

References to typical procedures:

a) **UK**: Road Note 39 (3rd Ed) Appendix D The Immersion Tray Test
b) **Australia**: Victoria CRB 112.03 (1975) Adhesion of Binder to Stone

Plate Methods

A film of binder is placed on a metal plate. Wet or dry chippings are pressed or rolled into the surface. The plate may be immersed in water. The adhesion of the chippings is determined by blows to the back of the plate. Chippings which fall off are weighed or counted or the chippings are removed by pliers and the coating determined. The use of wet chippings gives a measure of active adhesion.

References to typical procedures:

a) **France**: NF P98-274-1 Vialit Adhesiveness Test for Anhydrous Binders
b) **Australia**: HDSA 305.01 (1988) Determination of Aggregate Stripping Value by the One Day Plate Stripping Test
c) **Australia**: NSW T230 Resistance to Stripping of Cover Aggregates and Binders
d) **New Zealand**: MWD B301-83 Method of Measuring the Active Adhesion between a Bituminous Binder and a Roading Aggregate Material

Sand Mix Method

Wet sand is mixed or shaken with a solution of binder in solvent. The colour and cohesion of the sand are determined. A black agglomerated sand is a positive result.

Test Methods for Compacted Mixtures

Immersion Methods

Mixes are made and compacted, sometimes to a specified voids content. After curing the mixes are immersed in water for a specified time and at a specified temperature. The specimens may be vacuum saturated to ensure water penetration. The stability, compressive strengths, or tensile strengths of the specimens are compared with specimens which have not been immersed. The methods can also be applied to field cores.

References to typical procedures:

a) **France**: NF P98-251-1 Duriez Test for Hot Mixes
b) **France**: NF P 98-251-4 Duriez Test for Bitumen Emulsion-aggregate Mixtures
c) **USA**: ASTM D 4867-92 Effect of Moisture on Asphalt Concrete Paving Mixtures
d) **USA**: ASTM D 1075-94 Effect of Water on Compressive Strength of Compacted Bituminous Mixtures.

Modified Lottman Test

Mixes are made and compacted sometimes to a specified voids content. After curing the specimens may be vacuum saturated with water and subjected to one or more freeze-thaw cycles. The tensile strength or stability of the specimens is compared with specimens which have not been subjected to freeze-thaw.

References to typical procedures:

a) **USA**: ASTM D4867-92 Effect of Moisture on Asphalt Concrete Paving Mixtures
b) **USA**: AASHTO T238 Resistance to Moisture Induced Damage

Exposure to Moisture Vapour

Mixes are made and exposed to a moist atmosphere. The stability of the mix is determined after exposure.

References to typical procedures:

a) **USA**: California CT307 Moisture Vapour Susceptibility

Other Tests

Abrasion Tests

Compacted mix specimens are shaken in water and the weight loss of the compacted specimens measured. Metal balls may be included to increase the abrasion effect. In wheel tracking tests the surface of compacted specimens is abraded by a moving wheel.

References to typical procedures:

a) **USA**: ISSA Method TB144 Aggregate-Filler-Bitumen Compatibility by the Schultze Breuer Ruck Procedure (has been applied to cured slurry seals and hot mixed materials).
b) **USA**: California CT360 Surface Abrasion
c) **USA**: Nevada DOT Durability of Compacted Bituminous Mixtures by the Dynamic Strip Method
d) **UK**: TRL Immersion Wheel Tracking Test

Test to estimate Coating of Hot Mixes

Adhesion promoters may improve the coating of aggregates. The coating in hot mixes can be expressed in terms of the coating of the coarse aggregate and the time required for good coating can be determined.

References to typical procedures:

a) **USA**: ASTM D2489 Degree of Particle Coating of Bituminous Aggregate Mixtures

Sealants

A sample seal is made between two concrete blocks. The bond strength and other performance requirements are measured after immersion of the specimen in water.

References to typical procedures:

a) USA: ASTM D5329-92 Sealants and Fillers, Hot Applied for Joints and Cracks in Asphaltic and Portland Cement Pavements.

Joints in Roofing Layers

A specimen joint is immersed in water. The leakage and tensile strength of the joint is determined.

References to typical procedures:

a) Europe: UEAtc MOAT No 27:1983 General Directive for the Assessment of Roof Waterproofing Systems Section 5.2

Asphalt Roof Cements

The coverage of a wet surface placed in contact with asphalt cement is determined.

References to typical procedures:

a) USA: ASTM D3409-93 Adhesion of Asphalt-Roof Cement to Damp, Wet or Underwater Surfaces.

Glossary of Terms

Adhesion Promoter
Cationic surface active agent which ensures a thorough, irreversible water resistant bond between bitumen binder and aggregate.

Adhesion Promoter, Heat Stable
Adhesion promoter which maintains its performance after storage of treated binder at high temperature.

Adhesion Agent
Adhesion Promoter.

Adhesion, Active
Bitumen treated with active adhesion promoter displaces moisture from an aggregate surface and establishes a bond between the mineral surface and the bitumen.

Adhesion, Dynamic
Adhesion between mineral aggregate and bitumen is resistant to the pumping effect of vehicles on wet surface layers.

Adhesion, Passive
The ability of an established bond between mineral surface and bitumen to resist the effect of water.

Aggregate Mix, Dense Graded
A mix containing aggregate which is graded from the maximum size down to filler with the object of obtaining a bitumen mix with a relatively low void content.

Aggregate Mix, Open Graded
A mix containing little or no filler giving relatively large void spaces in the compacted mix.

Antistripping Agent
Adhesion promoter providing passive adhesion.

Binder
General term for asphalt cement which includes bitumen, coal tar or polymer-modified bitumens.

Bitumen
Dark viscous liquid, residue of the vacuum distillation of petroleum. Predominantly aliphatic and cycloaliphatic. Known as asphalt in the U.S.A.

Bitumen, Acid Value
Measurement of the acidity of bitumen expressed in milligrammes of potassium hydroxide required to neutralise one gram bitumen.

Bitumen, Blown and Oxidized
Asphalt that is treated by blowing air through it at an elevated temperature to give it characteristics desired for certain special uses, such as roofing, pipe coating etc.

Bitumen, Cutback
Bitumen containing 10-15% volatile solvent, e.g. kerosene, boiling range 150-200 °C.

Bitumen Emulsion
An emulsion of bitumen in water which contains a small amount of an emulsifying agent.

Bitumen Emulsion, Anionic
Bitumen emulsion in which the droplets of bitumen carry a negative charge.

Bitumen Emulsion, Cationic
Bitumen emulsion in which the droplets of bitumen carry a positive charge.

Bond Coat
New European terminology for tack coat.

Chip Seal
U.S. terminology for surface dressing.

Coal Tar
Dark viscous liquid obtained from the carbonisation of coal. Predominantly aromatic in character.

Deferred Set Macadam
Repair material based on fluxed or cutback binder.

Flux, Flux Oil
Thick, low-volatile petroleum fraction which may be used to soften bitumen.

Gradation
A general term used to describe the aggregate composition of a bituminous mix. When the exact percentages of all aggregate essential to a good mix are controlled through the percentage of each size aggregate used.

Hot Mix
Road material prepared from a hot mixture of bitumen and graded aggregate.

Hot Rolled Asphalt (HRA)
Type of gap-graded dense mix with a smooth surface texture, predominantly used in the UK, in which the fines and the binder form a load bearing mortar.

Impervious
Resistant to penetration by water.

Interfacial Dope
Adhesion promoter applied as an aqueous solution to the surface of freshly sprayed bitumen or to the aggregate surface before surface dressing.

Penetration
Measurement of the hardness of bitumen by the distance of needle penetration. High penetration refers to soft bitumen.

Penetration Macadam
Technique in which bitumen emulsion or cutback bitumen is sprayed on to an open graded aggregate mix, then compacted.

Porous Asphalt
Open graded wearing course material with good drainage and sound-deadening properties.

Precoats
Chippings coated with a small amount of bitumen or kerosene used in surface dressing or rolled into the surface of Hot Rolled Asphalt.

Prime Coat
Liquid binder sprayed on an unbound layer to provide a good bond with hot mix.

Ravelling
Loss of material from the wearing course of a roadway under the influence of traffic.

Road Oil
Heavy petroleum fractions used as binder in Northern Europe.

Soft Bitumen
Fluxed bitumen, viscosity 2000-20000 mPa.s at 60 ˚C, popular in Northern Europe.

Stripping
Process whereby water displaces bitumen binder from the aggregate surface. Includes processes where water penetrates the film of harder bitumens causing debonding.

Surface Dressing
Surface sealing technique in which chippings are spread on a sprayed film of hot bitumen, cutback bitumen or emulsion.

Tack Coat
An application of low viscosity liquid bitumen or emulsion between layers of bituminous materials to prevent slippage.

Warm Mix
Road material produced from a mix of aggregate and soft bitumen at relatively low temperatures, 100-120˚C, popular in Scandinavia.

Wearing Course
Top layer of the road pavement which is exposed to traffic.

Wetting Agent
Alternative term for adhesion promoter reflecting the ability of treated binder to coat aggregates.

References

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