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No. RW/NH-VI-50(8)/84-NH(Stds.)DII *Dated the 15th April, 1988*

To

All Chief Engineers of States and UTs dealing with NH & Centrally Aided Works; Director General (Works); Director General Border Roads.

Subject: Use of antistripping compounds in bituminous mixes — Guidelines Regarding

It has been observed that the performance of bituminous pavements is adversely affected in areas where the pavements are subjected to prolonged contact of water due to heavy monsoon, high water table, etc. Stripping in bituminous pavements is aggravated by the use of aggregates with high stripping values and high water absorption values. In such cases it may be possible to improve the performance of road pavements by the use of suitable antistripping compounds in the bituminous mixes, at specified dosages. However, in the absence of any standard for antistripping compound and guidelines on their use, besides high cost it is all the more necessary that they are used in the works after careful consideration.

2. Looking to the advantages in using antistripping compounds, it has been considered appropriate to work out some guidelines on its use till regular specifications are developed. The guidelines enclosed broadly envisage the function of antistripping compounds in bituminous mixes to minimise the adverse effects of stripping and prolonged service life of bituminous pavements.

3. Though some firms manufacturing the antistripping compounds have got their product tested by CRRI for their characteristics, the Bureau of Indian Standards is yet to evolve standards for manufacturing antistripping compounds. To start with, these products which have been evaluated and recommended for use by CRRI shall be used on the National Highways works with the approval of the Ministry.

4. For ensuring mixing of adequate quantity of antistripping compounds, it is preferable that the approved quality antistripping compounds are mixed with bitumen in desired proportions at the point of manufacturing of bitumen itself so that properly mixed product will be available at site in a ready to use condition. Mixing of antistripping compounds with bitumen at site of work is not desirable due to inherent drawback in proper quality control. However as no bitumen manufacturer in the country is adding antistripping compounds to bitumen at present, the mixing of these compounds with bitumen at site may have to be resorted to till such time the bitumen manufacturers start manufacturing bitumen with antistripping compounds.

Till the time site mixing is permitted suitable antistripping compounds (certified by CRRI/approved by competent authority) shall be mixed with bitumen at site in the presence of the Engineer who should certify that appropriate compound in suitable quantity as specified in the sanctioned work has been added.

Enclosure of letter No. RW/NH-VI-50(8)/84-NH(Stds.) DII dated the 15th April, 1988

Subject: Guidelines on Use of Anti-Stripping Compounds in Bituminous mixes.

1. General

In heavy rainfall areas or reaches prone to inundation the bituminous road pavement gets damaged under moving traffic much quicker than other conditions. One reason for damage of bituminous pavements due to presence of water is stripping of bitumen. Stripping is characterised by separation of bitumen adhering to the surface of aggregate particle under the influence of moisture. The stripping action depends upon the physical and chemical properties of the aggregate and the binder. Where the aggregate is hydrophillic the stripping will be faster and quicker.

2. Causes of Stripping

As stated above the main cause for stripping is the presence of water in any form. Water has the ability to penetrate into the gap between bitumen and aggregate and cause the two to separate. In addition, phenomenon of stripping can be attributed to one or more of the following reasons:

(i) Use of hydrophillic aggregate to which the binder does not adhere.

(ii) Inadequate mix composition. Insufficient binder for the size of aggregate being used.

(iii) Prolonged contact of water with the coated aggregate.

(iv) Cold or wet weather before, during and soon after laying the bituminous mix or spray for the binder.

(v) Initial over heating of the binder or aggregate or both.

(vi) Presence of dust or moisture on aggregates when it comes in contact with the bitumen.

(vii) Occurrence of rain or dust storm immediately after construction.

(viii) Concentration of soil salt, sodium chloride (Nacl) in rain water coming in contact with the aggregate.

(ix) In the case of surface dressing poor bond with the surface existing below, delay in spreading the cover aggregate over the sprayed bitumen or insufficient compaction.

(x) Use of improper grade of bitumen.

(xi) Use of improper cutter as also excess cutter in the binder.

(xii) Ageing and hardening of bitumen leading to the embrittlement of the binder filling.

(xiii) Opening the road to fast moving traffic before the binder has set.

(xiv) Insufficient rolling and compaction.

(xv) Aggregate size incompatible with the aggregate size of the lower layer.

3. Anti-Stripping Compound

3.1 Function of Anti-Stripping Compound

The anti-stripping compounds are surface active cationic chemicals. Each molecule of the chemical has two portions, one portion has affinity for road surface and the other has affinity for the binder. Therefore, when mixed with binder the anti-stripping compound arranges itself so that upon mixing with the aggregate at the end it is attached to the stone surface while at the other end it is attached to the binder to ensure complete coating of stone surface by the binder. This results in stronger bond between the binder and the aggregate. In short the function of an anti-stripping compound is to improve the adhesion between the bitumen binder and aggregate or the receiving bed surface. The anti-stripping compound is an organic material in which the polar hydrophillic group gets attached to the hydrophillic aggregate surface and the hydrophobic group is solubilised in the bitumen establishing a firm bond between bitumen binder and aggregate, thereby preventing stripping action in the presence of water. Considering these characteristics the anti-stripping compound

could be made use of for effective economic consumption of binder, consistent with strength and stability.

3.2. Types of Anti-Stripping Compounds

Anti-stripping compounds in liquid, or solid state under various brand names are manufactured and available in India. Any of these products found suitable to discharge the function expected of it can be used in bituminous road pavement where stripping is anticipated.

3.3 Essential Characteristics of Anti-Stripping Compounds

Before use the anti-stripping compounds should be tested in laboratory for the following properties:

(i) **Miscibility:** The anti-stripping agent shall be 100%, miscible in the binder (as per Test CRB 155-01 of Country Road Board of Victoria — Appendix I).

(ii) **Test for stability of anti-stripping compound subject to storage in hot bitumen:** The anti-stripping compound should not lose its efficacy when heated to 163°C for 5 hours (Test per CRB — 155.02 of Country Roads Board of Victoria — Appendix II).

(iii) **Test for stability of anti-stripping compound subjected to exposure to air:** The anti-stripping compound should not lose its efficacy when exposed to atmosphere for two weeks (Test as per CRB — 155.04 of Country Roads Board of Victoria — Appendix III).

(iv) **Test for determination of Stripping value of Aggregates:** The stripping value of the aggregate when tested as per IS 6241-1971 should be nil when suitable quantity of anti-stripping agent is added.

(v) **Test for quantitative evaluation of loss in values of Marshall Stability and unconfined compressive strength after immersion in water:** The tests should be conducted as stipulated in ASTM 1971 Method of test "Effect of water on resistance to plastic flow of bituminous mixture using Marshall Apparatus" and ASTM 1075-76" "Effect of water on cohesion of compacted bituminous Mixtures". With the appropriate quantities of anti-stripping compound the retained value of marshall stability and unconfined compressive strength of 75% or more is generally acceptable.

3.4 Mixing

The anti-stripping compound can be mixed directly with the binder in mixer. The mechanical agitation helps in uniform distribution of the additives. Thereafter the binder can be used in the usual manner for bituminous works.

4. The Indian Roads Congress has recommended the use of suitable anti-stripping compound with bitumen at the time of construction as a precautionary measure. IRC has also stipulated in their standards pertaining to bitumen mixes, the maximum values of stripping of aggregate at 25% and water absorption at 1% to 2%.

5. There are a number of anti-stripping compounds under different brand names available in the country at present. The Central Road Research Institute, New Delhi has carried out various tests on some of these agents. There are no standards stipulated by the Bureau of Indian Standards on the subject as such so far. It is under consideration with them.

6. Suggestions for use of Anti-Stripping Compounds

6.1 The compound should be tested by an approved laboratory and fulfil the characteristics given below:

(i) It should be fully miscible.

(ii) The percentage of the compound required for effective coating of wet aggregates should be obtained from the lab. (Generally it is between 1% to 2%).

(iii) The presence of salt, sodium chloride (NaCl), in the water, wetting the aggregate and/or the surface to be overlaid, should be evaluated and the percentage of anti-stripping compound required to eliminate its stripping effect should be determined.

(iv) The efficacy and stability of anti-stripping agent when subjected to storage in hot bitumen at 160°C to 200°C, should be retained.

6.1 The retained values of Marshall stability and unconfined compressive strength of the bituminous mix, when immersed in water for 24 hours with 1% NaCl, should not generally be less than 75% of its strength value when tested without immer sion in water. Whenever it is found less than this value, the same can be made up by adding appropriate amount of anti-stripping compund.

7. Recommendations

To begin with, the use of anti-stripping compounds in bituminous mixes should be confined to the following cases:

(i) In case where the stripping value of aggregate is more than 25% and water absorption value is more than 2% and it is not possible to obtain* characteristics within economical leads;

(ii) In areas where prolonged contact of water either due to heavy monsoon, or high water table or snow melting, even if the values of stripping and water absorption for the aggregate are within specified limits.

*aggregates of desired....

APPENDIX-I

Laboratory Manual

Test Method CRB 155.01
dt. January, 1975
(1 page)

COUNTRY ROADS BOARD OF VICTORIA

Miscibility of Adhesion Agents with Light Diesel

Fuel Oil

Applicable to bitumen adhesion agents

APPARATUS AND MATERIAL

(a) Glass vessel with screw-cap or tight-fitting cork (not rubber).

PROCEDURE

(a) Disperse the adhesion agent in DF oil in the concentration of 15 g per kilogram of solution, in the glass vessel.

(b) Not any non-dispersible residue at this stage.

(c) Close the glass vessel, up-end it five times, and set it aside seven days.

(d) Examine the bottom and sides of the vessel for any sediment.

REPORTING

Report whether any sediment is present, whether it is soft, or hard, fluid or immobile, adherent to the glass or detached.

APPENDIX-II

LABORATORY MANUAL

Test Method CRB 155.02.
January, 1975

COUNTRY ROADS BOARD OF VICTORIA
STABILITY OF ADHESION AGENTS TO STORAGE IN HOT BITUMEN

APPLICABLE TO bitumen adhesion agents

APPARATUS AND MATERIALS

(a) A press-lid can of about 250 ml capacity.

(b) Oven capable of maintaining a temperature of 175°C-180°C.

PROCEDURE

(a) Dissolve the adhesion agent in bitumen in the press-lid can and stir thoroughly to give a homogeneous solution at a concentration of ½ part by mass of adhesion agent to 99½ parts by mass of bitumen.

(b) Tightly close the can and place in the oven at 175°C to 180°C.

(c) Remove the can from the oven and allow to cool to about 120°C.

(d) Add sufficient light Diesel fuel oil to produce a cutback containing 100 parts by volume of bitumen to 15 parts by volume of DFO.

(e) Test for adhesion to stone by *Method No. 112.03* (enclosed Annexure 'A')

REPORTING

Report the value of the expression $\frac{100\,(F-C)}{100-C}$ as required by Method No. 112.03

APPENDIX-III

LABORATORY MANUAL

TEST METHOD CRB 155.04
January 1975

COUNTRY ROADS BOARD OF VICTORIA
STABILITY OF ADHESION AGENT SOLUTIONS TO EXPOSURE TO AIR

APPLICABLE TO bitumen adhesion agents

APPARATUS

(a) A flat dish having an area of 150 ± 10 cm^2

PROCEDURE

(a) Make a solution of the adhesion agent in Diesel fuel oil, containing 1½ parts by mass of the agent in 98½ parts by mass of the DFO.

(b) Measure out 50 ± 1 ml of the solution and pour it into the flat dish.

(c) Allow the dish containing the test solution to stand horizontally for 14 days open to the air at temperatures between 20°C and 25°C.

(d) Pour the contents of the dish carefully into a measuring cylinder, allowing the dish to drain for 30 seconds.

(e) Make up the volume of the recovered solution to that it originally had by adding small amounts of light Diesel fuel used for rinsing the dish.

(f) Shape the cylinder to ensure uniformity of the solution.

(g) Test for adhesion promoting ability according to the relevant parts (Steps (b) to (e) of Procedure B. and all of Procedure AB) of *Method No. 112.03* (enclosed Annexure 'A').

REPORTING

Report the ratio of the after-exposure of the before-exposure value of the expression $\frac{100\,(F - C)}{100 - C}$ as a percentage

ANNEXURE-'A'

LABORATORY MANUAL TEST METHOD CRB 112.03 January 1975 (3 Pages)

COUNTRY ROADS BOARDS OF VICTORIA
ADHESION OF BINDER TO STONE

Ability of a binder to displace water from a wet stone surface.

APPLICABLE TO bitumen adhesion agents, sealing aggregates etc.

The method is based upon that described in RRL Road Note 14 (Appendix) under the title of Immersion Tray Test.

The test may be carried out in one of two ways according to requirements. (A) by using a treated binder or (B) by using a treated stone and either procedure may be used for evaluation of both adhesion agents and aggregates.

APPARATUS AND MATERIALS

(a) Flat-bottomed, shallow trays of any convenient shape and suitable material, large enough to hold twenty stones of 10 mm nominal size.

(b) Binder — being an intimate mixture of 90 penetration bitumen with Diesel Fuel Oil in the Proportions by volume of 100 parts bitumen to 15 parts DFO for use in Procedure A and 100 parts bitumen to 5 parts DFO for use in Procedure B.

(c) Adhesion agent (if testing aggregates).

(d) Washed and still wet aggregate of 10 mm nominal size (if testing adhesion agents).

Note: Washing is to be done with distilled or filtered and deionized water.

(e) Magnifier — Lamp (Maggylamp, made by Newbound & Co. Balmain, NSW is suitable).

(f) Low Speed mechanical stirrer with a broad, hinged-blade paddle.

(g) Belt Broad-head, round-bottom flask (1000 ml).

(h) Controllable heater — a glass-cloth, nest type, electric heater with variable transformer control is recommended.

PROCEDURE A (for an agent in the binder)

(a) Add the required quantity of adhesion agent to the binder and mix for ½ h at a temperature between 150° and 180°C. Except where otherwise specified, the concentration shall be ½ part by mass of adhesion agent to 99½ parts by mass of bitumen.

(b) Pour enough of the doped binder into the tray to make a layer about 2 mm deep.

PROCEDURE B (for a treated aggregate)

(a) Disperse the adhesion agent in Diesel Fuel Oil or other specified solvent at the required concentration. Unless otherwise specified, this shall be 15 g per 100 g of solution.

(b) Place 0.25 g of this solution in a press-lid 500 ml can.

(c) Take 20 stones, freshly washed with water and dried with a cloth or paper towel, and place them in the can with the adhesion agent solution.

(d) Shake for three minutes to coat the aggregate.

(e) Pour enough of the untreated binder into the tray to make a layer about 2 mm deep.

FOLLOWING PROCEDURE A B

(a) Place the tray in an oven at 105°C for 5 minutes.

(b) Remove the tray from the oven and tilt it appropriately to cover the whole bottom with binder.

(c) Place the tray on a non-metallic horizontal bench and allow it to cool to room temperature.

(d) Examine the cold binder film for uniformity of thickness. If seriously imperfect, briefly reheat and allow to cool on a horizontal bench.

(e) Place the tray of binder in a trough of filtered and deionized water between 20°C and 25°C so that the bitumen is submerged to about 3 cm.

(f) Push 20 pieces of the appropriate aggregate into the surface of the bitumen and leave them submerged for 10 minutes.

(g) Remove the tray from the water.

(h) Pull off all stones vertically taking great care to avoid any sideways movement and examine them for adhering bitumen.

(i) Assess as a percentage the proportion of the contact area covered with bitumen and average the values for all stones on the surface.

(j) Note this value as the percentage adhesion (F)

CONTROL: Parallel with all that after by Procedure A or Proceudre B a control test shall be carried out. This shall be identical for all aspects to the others except that no adhesion agent shall be present. The percentage adhesion assessed shall be recorded (C).

COUNTRY ROADS BOARD

MATERIALS RESEARCH DIVISION

ADHESION OF BINDER TO STONE

ABILITY OF A PHOTO TO DISPLACE WATER FROM A WET STONE SURFACE

Adhesion Agent :
Date Tested :
Lab.No :
Batch No :

Standard Aggregates — Test Method 112.03A

	1	2	3	4	5	6	7	8	9	10	
T.											
F.											
C.											
$\frac{100(F-C)}{100-C}$	00	00	00	00	00	00	00	00	00	00	Total

Decrease in non adhesion brought about by treatment of binder with adhesion agent : .....%..

Test Method : 112.03B

	1	2	3	4	5	6	7	8	9	10	
T.											
F.											
C.											
$\frac{100(F-C)}{100-C}$	00	00	00	00	00	00	00	00	00	00	Total

Decrease in non adhesion brought about by treatment of aggregate with adhesion agent :.....%

Total % contact area of 20 stones covered with bitumen : T.
Average bitumen coated area of T/20 : F.
Percentage adhesion of control blank : C.

(The value $\frac{100(F-C)}{100-C}$ gives the percent decrease in non adhesion brought about by treatment with adhesion agent.)