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TO EXAMINE THE STRIPPING AND STABILITY CHARACTERISTICS OF AGGREGATES OF HARYANA

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ABSTRACT

Stripping is one of the main causes due to which distress in bituminous layers occur. Moisture presence results in weakening or eventual loss of adhesive bond of bitumen from aggregate. Now a days, the roads are lacking in respect of proper drainage facilities. which is one of the main reasons for road damage due to stripping. Stripping can cause complete or partial failure of the pavement. Inadequacy in quality of aggregates and adhesion property of bitumen affects the quality of life of road, and if stripping is prevented, it will lead to reduction in quantity of resources and increase in pavement design life which in turn will lead to sustainable development. A brief overview of the stripping phenomenon of bituminous mixtures and research in the field over the past years has been presented in this study. The main objective of the paper is to study on stripping and stability characteristics of aggregates of Haryana due to the variation in various environmental factors. The aggregates which are used in the study are taken from two places i.e. Tosham and Yamuna Nagar and then stripping value using these aggregates are studied. The field factors which are used to simulate the field conditions are temperature, contact period of water with bitumen and traffic effect. This work presents the lab test results which show the stripping value increases with increase in contact period, temperature and applied pressure on the aggregate at the time of test. After applying the pressure on aggregate with increase in temperature of water bath up to 60°C and contact period of water with bitumen for 5 days it has been observed that stripping value is increased with increase in immersion time. This study also shows that aggregates from Tosham shows more stripping value as compared to aggregates from Yamuna Nagar. The indirect tensile strength test results conducted on bituminous concrete samples indicated that tensile strength ratio increased with the use of modified bitumen that is CRMB-55 in place of VG-30.

Keywords: stripping, stability, bitumen, immersion time, tensile strength, de-bonding

1. INTRODUCTION

The stripping value of aggregate is defined as the ratio of uncovered area observed visually to the total area of aggregates, expressed as percentage. Proper adhesion between aggregate and bitumen is one of the principal fundamental properties for good performance of bituminous pavement. This adhesion can be reduced by presence of water which may be caused by de-bonding of bitumen from aggregate. The phenomenon is known as 'stripping". Bituminous roads are greatly susceptible to moisture damage. Nowadays proper drainage facilities are lacking on the roads which is one of the main reasons for road damage due to stripping. Adequate drainage must be provided for prevention of damage of roads due to stripping as complete failure of the pavement can take place. Stripping is a complex problem comprising many variables, including the type and use of mix, aggregate and bitumen characteristics, environment, traffic, construction practice and use of anti-stripping additives. Contact of water with bituminous pavement is one of the main factors for stripping. The moisture affects physical properties and mechanical behavior of bitumen paving mixtures as aggregates that have a dry surface adhere better to bitumen and have a higher stripping resistance than wet aggregate. The water can be in the form of ground water, surface water or rain water. Presence of water on the road, if not properly managed, may cause deterioration of road more rapidly as it reduce the potency of bond between bitumen and aggregate which provides strength to the mix and ultimately leads to failure of pavement. For prevention of such damage, adequate drainage must be provided. The physical and chemical characteristics of aggregates have a significant effect on the bonding between aggregate and bitumen. In addition, aggregate surface texture. aggregate porosity and pore pressure are also known to affect stripping. A deficiency in properties of aggregates reduced the strength of bond and leads bitumen-aggregate mixture towards stripping. Stripping may further cause rutting, raveling, bleeding, cracking and formation of potholes and culminate with complete failure of pavement.

2. OBJECTIVES

The study under consideration aims to identify the factors causing stripping and stability value of aggregate. It investigates the factors influencing stripping and stability of the mix including traffic and other environmental factors such as temperature, alternate wetting and drying and the pH value of water. The main objectives of the study are:

1. To evaluate the stripping and stability (indirect tensile strength) characteristics of aggregates of Haryana under standard test conditions.
2. To vary the standard test conditions of temperature and immersion time to simulate the field conditions and to evaluate the stripping under these varying conditions.
3. To evaluate stripping under the application of external pressure in the lab to simulate the effect of traffic load and tyre friction on the coated aggregate.

3. LITERATURE REVIEW

Covington et al (1977) demonstrated that asphalt-aggregate adhesion is strongly influence by the PH of water, which changes with the temperature. The pH cause shift in angle of contact and significantly affect the wetting properties of bitumen. Weak acids affect some aggregate mineral like alkali feldspars. Adhesion affects capillarity while cohesion affects surface tension. Since most aggregate surface have electrostatic charges, water molecule attach to them with stronger forces than bitumen polar to satisfied unbalance surface charges. Calcareous aggregate give free calcium ions forming strong water resistant bonds with bitumen. Siliceous aggregates (with SiO2) form weak bonds with bitumen, which are hydrolytically unstable. Kennedy et al (1983) explained that stripping is the loss of adhesion between the asphalt binder and aggregate due to the action of the water. Loss of integrity of the hot mix asphalt through weakening of the bond between the aggregate and bitumen is known as stripping. When a weakening of the bond occurs, loss of strength of the hot mix asphalt can be sudden. Stripping usually begins at the bottom of the bituminous layer, then travel upward. A typical situation is a gradual loss of strength over a period of years, which causes rutting and showing to develop in the wheel path. Many times, stripping is difficult to identify because surface indicators may take years to show. Also many surface indicators are possible and may include: rutting, showing, corrugations and cracking. There are many ways in which moisture can inter the asphalt pavement layers: capillary action from the water table, run off from the road surface and seepage from surrounding areas. Ensley et al (1984) suggested that stripping is the displacement of the asphalt binder film from the aggregate surface, which is explained using the chemical reaction of adhesion. It mentioned adhesion as being poorly understood due to bitumen internal complexity and the variety of aggregate surface. Initially, interaction between the bitumen polar and active aggregates surface takes place. Several mechanisms have been used to explain the adhesion between the component materials. Hicks, G. R. (1991) reported in their study that Rheological properties of a bitumen binder have a major influence on bonding between bitumen and aggregate. During mixing, placing and compacting the mix, the viscosity of the bitumen is the key issues of concern. During mixing of asphalt and aggregates, an asphalt binder with high viscosity may not effectively wet the aggregate surface. But during the service period, high viscosity can be beneficial against stripping because high viscosity bitumen usually carry high concentration of polar functionalities that provide more resistance against stripping. The viscosity of bitumen is the most common factor affecting a bitumen stripping properties. High viscosity bitumen resist pulling along an air-water interface and pulling of the bitumen film increases with decreased viscosity. Low viscosity bitumen has higher "wetting power" and is therefore more desirable from stand point of coating

4. EXPERIMENTAL INVESTIGATION

In this study, testing is performed on the aggregate-bitumen sample by undertaking various field conditions in to consideration. Most of the time it is envisioned that the laboratory test condition and field condition vary a large extent leads to stripping of aggregates on the road even when laboratory tests indicates nil stripping value. It is mainly because of difference of temperature, contact time of water with coated aggregates, pH value of water, alternate wetting and drying conditions, traffic, vehicle load and tyre friction in the field which are different from the lab conditions. To determine the effect of these variables on stripping, experiment have been carried out in the highway engineering lab national institute of technology Kurukshetra. The effect of traffic load and tyre friction has been simulated by applying light pressure with small tyres by the observer.

5. INDIRECT TENSILE STRENGTH TEST

The IDT strength of bituminous mixtures is conducted by loading a cylindrical specimen across its vertical diametric Plane at a specified rate of deformation and test temperature The peak load at failure is recorded and used to calculate the IDT strength of the specimen. The values of IDT strength may be used to evaluate the relative quality of bituminous mixtures in conjunction with laboratory mix design testing and for estimating the potential for rutting or cracking. The results can also be used to determine the potential for field pavement moisture damage when results are obtained on both moisture- conditioned and unconditioned specimens. The tensile characteristics of bitumen mixture are evaluated by loading the Marshall specimen along a diametric plane with a compressive load at a constant rate acting parallel to and along the vertical diametrical plane of the specimen through two opposite loading strips. This loading configuration develops a relatively uniform tensile stress perpendicular to the direction of applied load and along the vertical diametrical plane, ultimately causing the specimen tested to fail by splitting along the vertical diameter. A13 mm wide strip loading is used for 101 mm diameter specimen to provide a uniform loading with which produce a nearly uniform stress distribution. A loading rate of 51mm/minute is adopted. Tensile failure occurs in the

sample rather than the compressive failure. The compressive load indirectly creates a tensile load in the horizontal direction of the sample. The peak load is recorded and is divided by appropriate geometrical factors to obtain the split tensile strength using the following equation:

$St= 2000p/\pi Dt$

St-indirect tensile strength, kPa

P= maximum load, N

T-specimen height immediately before test, mm

D= specimen diameter, mm

Equation is used to calculate indirect tensile strength and is used extensively in the section.

Bituminous mix made from certain materials may be sensitive to the presence of water in the finished pavement. Water will cause the binder to not adhere to the aggregate. Since the binder is the "glue" that holds the pavement together, rapid failure of the pavement can be expected if the Binder cannot adhere to the aggregate. This is often referred to as stripping. To help prevent stripping, additives such as hydrated lime or liquid anti- stripping chemicals may be required AASHTO T 283 is a test method that can be used to determine if the materials may be subject to stripping and also to measure the effectiveness of additives. The test is performed by compacting specimens to an air void level of six to eight percent. Three specimen are selected as a control and tested without moisture conditioning, and three more specimens are selected to be conditioned by saturating with water undergoing a freeze cycle, and Subsequently having a warm-water soaking cycle. The specimens are then tested for indirect Tensile strength by loading the specimens at a constant rate and measuring the force required to break the specimen. The tensile strength of the conditioned specimens is compared to the control specimen to determine the Tensile Strength Ratio (TSR)

6. TENSILE STRENGTH RATIO (TSR)

Moisture damage in bituminous mixes refers to the loss of serviceability due to the presence of moisture. The extent of moisture damage is called the moisture susceptibility. The ITS test is a performance test which is often used to evaluate the moisture susceptibility of a bituminous mixture. Tensile strength ratio (TSR) is measure of water sensitivity. It is the ratio of the tensile strength of water conditioned specimen, (ITS wet, 60°C, and 24 h) to the tensile strength of unconditioned specimen (ITS dry) which is expressed as a percentage. A higher TSR value typically indicates that the mixture will perform well with a good resistance to moisture damage. The higher the TSR value, the lesser will be the strength reduction by the water soaking condition, or the more water- resistant it will be.

7. CONCLUSION

The present study on the topic "A Study on stripping and stability characteristics of aggregates of Haryana" has been carried out with a view to determining and analyzing various factors influencing stripping and stability of bituminous mix of aggregates. Tests have been carried out on two types of aggregates obtained from Yamuna Nagar and Tosham quarries with three types of bitumen VG10, VG30 and CRMB55 under varying condition of temperature, effect of traffic load and tyre friction, contact time with water. wet dry cycles, altered temperature cycle and alkaline and acidic water. Lime as an additive is used to determine its effect on stripping. It is observed that the stripping of aggregates get affected by all these varying conditions. It is recommended that the standard stripping test conducted in lab to evaluate striping of aggregates needs to simulate the field conditions better to predict more accurately the actual stripping likely to take place under field conditions.

The main conclusions drawn from the study are:

1. Stripping of aggregates is caused on the roads when they are subjected to inundated conditions due to poor drainage of roads. The test conditions to determine stripping value in the Lab do not properly simulate the field conditions. The difference in the lab and field conditions leads to stripping in the field many a times whereas lab test results indicate no stripping.

2. Two types of aggregate are considered for the purpose of stripping test of aggregates, Yamuna Nagar and Tosham quarry of Haryana. It is observed that the aggregates from Tosham quarry show more stripping as compared to aggregates of Yamuna Nagar. The aggregates of Yamuna Nagar quarry are considered for the purpose of indirect tensile strength test. The lab tests indicate that stripping increases with increase in contact time of water with coated aggregate and test temperature. CRMB-55 grade bitumen shows higher resistance to stripping than VG-10 grade bitumen.

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