Physical Properties of Aggregate and Tar in Designing of Elastic Highway

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Abstract - *The current plastic pavement is normally planned and erected in, numerous layers for effective stress distribution through pavement layers beneath the weighty traffic loads. Interlayer bonding of the multilayered pavement arrangement plays a vital role to attain long term performance of roadway. Suitable bond between the layers must be confirmed so that multiple layers makes as a monolithic structure. To attain good bond strength, a tack coat is usually scattered between the bituminous pavement layers. As a result, the applied stresses are consistently dispersed in the pavement system and reduce structural impairment to the pavements. One of the most common sufferings due to poor bonding between pavement layers is a Slippage failure, which naturally occurs where weighty vehicles often hurrying, braking, or whirling. The vehicle load generates dynamic normal and lateral stresses in the pavement boundaries from horizontal and vertical loads. With the vehicle load being relocated to each underlying bituminous layer, the boundary between the layers is vital to the pavements integrity. Slippage failure changes when the pavement layers start to slide on one another typically with the top layer untying from the lower layer. This is initiated by a lack of bond and a great enough horizontal force to cause the two layers begin to separate. Other pavement scrapes that have been related to poor bond strength between pavement layers cover early fatigue, top down cracking, ruts, and exterior layer delamination.*

Key Words: **Slippage failure, monolithic, whirling.**

1. INTRODUCTION

An elastic or Tarmac roadway usually comprises of three or four layers. For a four layer elastic pavement, there is a surface course, base course, and sub base course fabricated over a compacted, natural soil sub grade. When building a three layer flexible pavement, the sub base layer is not used and the base course is placed directly on the natural sub grade. A flexible pavement's surface layer is fabricated of hot-mix tarmac (HMA).Unstained masses are typically used for the base course; however, the base course could also be stabilized with asphalt, Foamed Bitumen, Road stone Recycling, Portland cement, or another stabilizing agent. The

Sub base is generally constructed from local aggregate material, while the superior subgrade is often soothed with cement or lime.

With flexible pavement, the maximum stress occurs at the surface and the stress decreases as the depth of the pavement increases. Consequently, the highest quality material needs to be used for the surface, while lower quality materials can be used as the depth of the pavement increases. The term "flexible" is used because of the asphalts ability to bend and deform slightly, then return to its original position as each traffic load is applied and removed. It is possible for these small deformations to become permanent, which can lead to rutting in the wheel path of an extended time. The service life of a plastic pavement is typically designed in the range of 20 to 30 years. Required thicknesses of each layer of a flexible pavement vary widely depending on the materials used, magnitude, and number of repetitions of traffic loads, ecological conditions, and the preferred service life of the pavement.

2. OBJECTIVES

To check Physical Properties of Aggregate using in construction of plastic pavement. To check Physical Properties of Bitumen using in construction of plastic pavement.

Subsequent Tests were led to explore the properties of the aggregate and tar.

1. Aggregate Impact Value Test

2. Flakiness & Elongation Index Test

 TEST FOR BITUMEN

1. Penetration Test

2. Softening Point Test

3. Ductility Test

4. Specific Gravity Test

 TEST ON AGGREGATE

Specific Gravity & Water Absorption Test.

1. About 2kg of the aggregate sample is washed thoroughly to remove fines, drained and then placed in the wire basket and immersed in distilled water at a temperature

between 22 to 320C with a cover of at least 50 mm of water above the top of the basket

2. Immediately after the immersion the entrapped air is removed from the sample by lifting the basket containing it 25 mm above the base of the tank and allowing it to drop 25 times at the rate of about one drop per second. The basket and the aggregate should remain completely immersed in water for a period of 24±0.5 hours afterwards.

3. The basket and the sample are then weighed while suspended in water at a temperature of 22 to 320C. The weight is noted while suspended in water (W1) g.

4. The basket and the aggregate are then removed from water and allowed to drain for a few minutes, after which the aggregates are transferred to one of the dry absorbent clothes.

5. The empty basket is then returned to the tank of water, jolted 25 times and weights in water (W2) g.

6. The aggregates placed in the dry absorbent clothes are surface dried till no further moisture could be removed by this clothe.

7. Then the aggregate is transferred to the second dry cloth spread in a single layer.

Impact Value Test

It is used to estimate the robustness of nugget or the resistance of the aggregate to rupture under repeated impacts. The aggregates were subjected to 15 blows with a hammer of weight 14kg and the crushed aggregates were sieved on 2.26mm sieve. The aggregate impact value is the percentage of fine (passing through the 2.36mm sieve size) to the total weight of the sample. The aggregate impact value should not exceed 30% for use in wearing course of pavements. Maximum permissible values are 35% for bituminous macadam and 40% for water bound macadam

Elongation index test.

Take the aggregate sample which contains minimum 200 pieces of any fraction. Sieve the sample through mentioned sieves i.e., from 63mm to 6.3mm sieves. The aggregate retained on 63mm and passed through 6.3mm should not be considered. The aggregate passed through 63mm and retained on 6.3mm and its above sieves is taken along with sieves. Now we have specified size range for every particle. Now weigh aggregate retained on different sieve and note down the total weight as "W1"The aggregate particles from each of the size range is taken and passed through corresponding gauge of length gauge or elongation gauge with its longest side. Each gauge length is 1.8 times the mean dimension of aggregate size range. If particle retained on 10mm and passed through 16mm size is taken, then it should pass through 23.4mm length gauge which is 1.8 times the

mean of 10mm and 16mm. To keep accuracy and eliminate testing bias, the particle should be passed multiple times with different facings. The particles which are not passed or retained on the length gauge are weighed which is "W2".Now calculate the elongation index which is the ratio of weight of particle retained on length gauge to the total weight of the sample gauged and it is expressed in percentage

Flakiness Index Test

In order to separate flaky materials, each fraction is then gauged independently for width on a thickness gauge. The total amount of flaky A least of 200 pieces of each segment is taken and weighed material passing the thickness gauge is evaluated to an accuracy of 0.1% of the weight of taster.

Aggregate Impact Value Test

The test sample shall consist of aggregate the whole of which passes a 12.5 mm IS Sieve and is retained on a 10 mm IS Sieve. The aggregate comprising the test sample shall be dried in an oven for a period of four hours at a temperature of 100 to 110°C and cooled. The measure shall be filled about one-third full with the aggregate and tamped with 25 strokes of the rounded end of the tamping rod. Further similar quantity of aggregate shall be added and a further tamping of 25 strokes given. The measure shall finally be filled to overflowing, tamped 25 times and the surplus aggregate struck off, using the tamping rod as a straight edge. The net weight of aggregate in the measure shall be determined to the nearest gram (Weight A).The impact machine shall rest without wedging or packing upon the level plate, block or floor, so that it is rigid and the hammer guide columns are vertical. The cup shall be fixed firmly in position on the base of the machine and the whole of the test sample placed in it and compacted by a single tamping of 25 strokes of the tamping rod. The hammer shall be raised until its lower face is 380 mm above the upper surface of the aggregate in the cup, and allowed to fall freely on to the aggregate. The test sample shall be subjected to a total of 15 such blows each being delivered at an interval of not less than one second. The crushed aggregate shall then be removed from the cup and the whole of it sieved on the 2.36 mm IS Sieve until no further significant amount passes in one minute. The fraction passing the sieve shall be weighed to an accuracy of 0.1 g (Weight. B).The fraction retained on the sieve shall also be weighed (Weight C) and, if the total weight (C+B) is less than the initial weight (Weight A) by more than one gram, the result shall be discarded and a fresh test made. Two tests shall be made

Test on Bitumen

- Heat the sample until it becomes fluid.

- Pour it in a container to a depth such that when cooled, the depth of sample is at least 10mm greater than the expected penetration.

- Allow it to cool in an atmospheric temperature.

- Clean the needle and place a weight above the needle.

- Use the water bath to maintain the temperature of specimen.

- Mount the needle on bitumen, such that it should just touch the surface of bitumen.

- Take at least three reading

Softening Point Test

Taster glycerin and dextrin. After chilling the rings in air for 30 minutes, the excess tar is trimmed and rings are placed in the support. At this time the temperature of purified water is kept at 5°C. This temperature IS maintained for 15 minutes after which the balls are placed in position material is heated to a temperature between 75° and 100°C above the approximate softening point until it is completely fluid and is poured in heated rings placed on the metal plate. To avoid sticking of the bitumen to metal plate, coating is done to this with a solution of. For material whose softening point is above 80°C, glycerin is used for heating medium and the starting temperature is 35°C instead of 5°C.

Ductility Test

Melt the bituminous test material completely at a temperature of 75°C to 100° C above the approximate softening point until it becomes thoroughly fluid. Strain the fluid through IS sieve 30. After stirring the fluid,   pour it in the mould assembly and place it on a brass plate. In order to prevent the material under test from sticking, coat the surface of the plate and interior surfaces of the sides of the mould with mercury or by a mixture of equal parts of glycerin and dextrin. After about 30-40 minutes, keep the plate assembly along with the sample in a water bath. Maintain the temperature of the water bath at 27° C for half an hour. Remove the sample and mould assembly from the water bath and trim the specimen by levelling the surface using a hot knife. Replace the mould assembly in water bath for 80 to 90 minutes. Remove the sides of the mould. Hook the clips carefully on the machine without causing any initial strain. Adjust the pointer to read zero. Start the machine and pull clips horizontally at a speed of 50 mm per minute. Note the distance at which the bitumen thread of specimen breaks is filled up to the half taking care to prevent entry of air bubbles. To permit an escape of air bubbles, the sample bottle is allowed to stand for half an hour at suitable temperature cooled to 27^0C and then weighed. The remaining space in the specific gravity bottle is filled with distilled water at 27^0C , stopper placed and is placed in water The bottle containing bituminous material and containing water is removed, cleaned from outside and is again weighed. From the weights taken, the specific gravity of bitumen can be found out.

Specific Gravity Test

The specific gravity bottle is cleaned, dried and weighed along with the stopper. It is filled with fresh distilled water, stopper placed and the same is kept in water container for at least half an hour at temperature 27^0C.The bottle is then removed and cleaned from outside. The specific gravity bottle containing distilled water is now weighed. The bituminous material is heated to a pouring temperature and is poured in the above empty bottle taking all the precautions that it is clean and dry before filling sample materials. The material is filled up to the half taking care to prevent entry of air bubbles. To permit an escape of air bubbles, the sample bottle is allowed to stand for half an hour at suitable temperature cooled to 27^0C and then weighed. The remaining space in the specific gravity bottle is filled with distilled water at 27^0C , stopper placed and is placed in water The bottle containing bituminous material and containing water is removed, cleaned from outside and is again weighed. From the weights taken, the specific gravity of bitumen can be found out. The density of a bitumen binder is a fundamental property frequently used as an aid in classifying the binders for use in paving jobs. In most applications, the bitumen is weighed, but finally in use with aggregate system, the bitumen content is converted on volume basis. Thus an accurate density value is required for conversion of weight to volume. The specific gravity is greatly influenced by the chemical composition of binder. Increased amount of aromatic type compounds cause an increase in the specific gravity. The specific gravity is defined by ISI as the ratio of the mass of a given volume of the bituminous material to the mass of an equal volume of water, the temperature of both being specified at 27ºC±0.1ºC.The code of practice used to determine the specific gravity is IS: 1202.Procedure The clean, dried specific gravity bottle is weighed let that be W1 g. Then it is filled with fresh distilled water and then kept in water bath for at least half an hour at temperature 27ºC±0.1ºC. The bottle is then removed and cleaned from outside. The specific gravity bottle containing distilled water is now weighed. Let this be W2 g. Then the specific gravity bottle is emptied and cleaned. The bituminous material is heated to a pouring temperature and the material is poured half the bottle, by taking care to prevent entry of air bubbles. Then it is weighed. Let this be W3 g. The remaining space in specific gravity bottle is filled with distilled water at 27ºC and is weighed. Let this be W4 g. Then specific gravity of bituminous material is given by

formula, specific gravity= (W3-W1)/(W2-W1)-(W4-W3)

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3. EXPERIMENT RESULTS

Properties	Normal Aggregate	IS CODE	Specification Requirement	Remarks
Flakiness Index	22.95 %	IS 2386 part 1 1963	40 % max	Satisfactory
Elongation Index	16.75%	IS 2386 part 1 1963	30 % max	Satisfactory
Specific Gravity	2.65%	IS 2386 part 3 1963	2-3	Satisfactory
Impact value test	10.06%	Is 2386 part 4 1963	30 % max	Satisfactory
Water Absorption	1.01%	IS 2386 part 1 1963	2 % max	Satisfactory
Crushing strength	11.36 %	Is 2386 part 4 1963	30 % max	Satisfactory

Summary of test results of Aggregate

Properties	Results	IS Code	Specification Requirement	Remarks
Specific Gravity	1.02 %	IS :1202 - 1978	2%	Satisfactory
Penetration Test	92.1mm	IS: 1203 - 1978	90 to 100	Satisfactory
Ductility Test	70 cm	IS: 1208 - 1978	76 cm	Satisfactory
Softening Test	45.3°C	IS: 1205 - 1978	50 to 60	Satisfactory

Summary of test results of Bitumen

4. CONCLUSIONS

- Flakiness index of aggregate was 22.95 % which is less than 30% and elongation index of aggregate is 16.75% which is less than 30%.All the results are satisfactory as per Indian standard . Specific Gravity of the aggregate was 2.65 which is between 2 to 3 as per Indian standard .Aggregate Impact value was 10.06% which is less than 30% this shows that the toughness of the aggregate to face the impacts. Water absorption of aggregates 1.01 % which is less than 2 %. Crushing value of aggregates 11.36 % which is satisfactory as per Indian standard

- The specific gravity of bitumen is 1.02 % which is nearly to 2 % so it is satisfactory result; the penetration value of bitumen was 92.1 mm which is between is 90 – 100. It indicate the grade of bitumen, softening point of bitumen is 45.3 degree which is between 50 to 60, the ductility of bitumen is 76 cm. All the results are satisfactory as per Indian Standard.

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