

Study physical properties of Aggregate and Bitumen in construction of Flexible Pavement

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Abstract— Flexible pavements are the most commonly used type of pavements in India. Due to heavy traffic, by lack of maintenance because of insufficient funds, and deteriorating before their life span. So to decrease these damages several measures such as, use of cost effective materials, quality materials, raising sufficient funds for the maintenance and improving the roadway design. It is essential to constantly improve its quality, strength and durability of road. Due to some reason check of physical properties is needed. Conventionally bituminous roads have worked well for long time. The factors which effect the Flexible pavement are temperature, rainfall, traffic, land base, etc it cause cracks, Potholes, rutting in road surface. Now a days because of heavy traffic improper quality of material and environment factor the life of bitumen roads was become 3 to 5 years. In this study different physical properties of Aggregate and Bitumen had been find by carried various test and resulted are noted. All the properties are satisfactory with Indian standard code and produces good result.

Index Terms—Flexible Pavement, aggregate test, Bitumen test

I. INTRODUCTION

Flexible pavements are called "flexible" since the total pavement structure "bends" or "deflects" due to traffic loads. This pavement structure generally composed of several layers of materials which can accommodate this "flexing". In this type of pavements, material layers are usually arranged in the order of descending load bearing capacity with the highest load bearing capacity material (and most expensive) on the top and the lowest load bearing capacity material (and least expensive) on the bottom. The surface course is the stiffest and contributes the most to the pavement strength. The underlying layers are less stiff but are still important to pavement. The surface course is the top layer in contact with traffic loads. This layer provides the characteristics such as friction, smoothness, noise control, rut resistance and drainage. In addition, it serves to prevent the entrance of excess quantities of surface water into the underlying base, sub base and sub grade courses. The topmost layer of the surface course which is in direct contact with traffic loads is the wearing course. This can be removed and replaced as and when it becomes damaged or worn out. The wearing course can be rehabilitated before distress propagates into the underlying intermediate / binder course. This layer which constitutes the major portion of the surface course is meant to distribute the load coming over it. The base course is the layer directly below the surface course which helps in transmitting the load to the sub grade and generally consists of aggregate either stabilized or un stabilized. Bituminous mixes like Hot Mix Asphalt can also serve as a base course. Under the base course layer, a layer of less expensive / inferior quality material can be provided as sub base course material over the sub grade. The sub base course is optional in many cases. Bituminous materials or asphalts are extensively used for road way construction, primarily because of their excellent binding characteristics and water proofing properties and relatively low cost. Bituminous material consists of bitumen which is a black or dark colored solid or viscous cementitious substances consists chiefly high molecular weight hydrocarbons derived from distillation of petroleum or natural asphalt, has adhesive properties, and is soluble in carbon disulphide.

OBJECTIVES

- To check Physical Properties of Aggregate using in construction of flexible pavement
- To check Physical Properties of Bitumen using in construction of flexible pavement

PROPOSED METHODOLOGY

Following Tests were conducted to investigate the properties of the aggregate as well as bitumen.

TESTS FOR AGGREGATE

1. Specific Gravity & Water Absorption Test
2. Aggregate Impact Value Test
3. Flakiness & Elongation Index Test

TESTS FOR BITUMEN

1. Penetration Test
2. Softening Point Test
3. Ductility Test
4. Specific Gravity Test

II. TEST ON AGGREGATE

1. Specific Gravity & Water Absorption Test

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. Immediately after the immersion the entrapped air is removed from the sample. The basket and the sample are then weighed while suspended in water at a temperature of 22 to 32⁰C. 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. The empty basket is then returned to the tank of water, jolted 25 times the aggregates placed in the dry absorbent clothes are surface dried till no further moisture could be removed by these clothes. Then the aggregate is transferred to the second dry cloth spread in a single layer, covered and allowed to dry for at least 10 minutes until the aggregates are completely surface dry. 10 to 60 minutes drying may be needed. The aggregate is placed in a shallow tray and kept in an oven maintained at a temperature of 110⁰C for 24 hours. It is then removed from the oven, cooled in air tight container.

2. Aggregate Impact Value Test

It is used to evaluate the toughness of stone or the resistance of the aggregate to fracture 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

3. Elongation Index Test

A minimum of 200 pieces of each fraction is taken and weighed. In order to separate elongated materials, each fraction is then gauged individually for length in the length gauge. The pieces of aggregate from each fraction tested which could not pass through the specified gauge length with its long sides elongated are collected separately to find the total weight of aggregate retained on the length gauge from each fraction. The total amount of elongated material retained by the length gauge is weighed to an accuracy of 0.1% of the weight of sample.

4. Flakiness Index Test

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

5. Aggregate Impact Value Test

The cylindrical steel cup is filled with 3 equal layers of aggregate and each layer is tamped 25 strokes by the rounded end of tamping rod and the surplus aggregate struck off, using the tamping rod as a straight edge. The net weight of aggregate in the cylindrical steel cup is determined to the nearest gram) and this weight of aggregate is used for the duplicate test on the same material. The cup is fixed firmly in position on the base of the machine and the whole of the test sample is added in thirds, each third being subjected to 25strokes from tamping rod. The surface is leveled and the plunger is inserted so that it rests horizontally on the surface. The whole assembly is then placed between the platens of testing machine and loaded at a uniform rate so as to reach a load of 40 tones in 10 minutes. The load is then released and all aggregate is removed from the cup and sieved on 2.36 mm. IS sieve until no further significant amount passes in one minute.

III. TEST ON BITUMEN

1 .Penetration Test

The bitumen is softened to a paving consistency between 75⁰ C and 100⁰C above the approximate temp at which bitumen softens. The sample containers are cooled in atmosphere of temperature not lower than 13⁰C for one hour. Then they are placed in temperature controlled water bath at a temperature of 25⁰C for a Period of one hour. Using the adjusting screw, the needle

assembly is lowered and the tip of the needle is made to just touch the top surface of the sample. The needle assembly is clamped in this position. The contact of the tip of the needle is checked using the mirror placed on the rear of the needle. Then the needle is released by pressing a button and a stop watch is started. The needle is released exactly for a period of 5.0 secs.

2 Softening Point Test

Sample 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 glycerin and dextrin. After cooling the rings in air for 30 minutes, the excess bitumen is trimmed and rings are placed in the support. At this time the temperature of distilled water is kept at 5°C. This temperature IS maintained for 15 minutes after which the balls are placed in position. 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.

3 Ductility Test

The bitumen sample is maintained to a pouring temperature (75°C to 100°C) and poured into the mould assembly and placed on a bras plate, where a solution of glycerin or soap solution is applied at all surfaces of briquette mould exposed to bitumen. After the sample is poured to the mould, thirty to forty minutes the entire assembly is placed in a water bath at 27°C. Then the sample is removed from the water bath maintained at 27°C and excess bitumen material is cutoff by leveling the surface using hot knife. After trimming the specimen, the mould assembly containing sample is replaced in water bath maintained at 27°C for 85 to 95 minutes. The pointer is set to read zero. The machine is started and the two clips are thus pulled apart horizontally.

4 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°C. 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°C and then weighed. The remaining space in the specific gravity bottle is filled with distilled water at 27°C, stopper placed and is placed in water container at 27°C. The bottle containing bituminous material and containing water is removed, cleaned from outside and is again weighed.

IV. EXPERIMENT RESULTS

Properties	Normal Aggregate	IS CODE	Specification Requirement	Remarks
Flakiness Index	20.95 %	IS 2386 part 1 1963	30 % max	Satisfactory
Elongation Index	18.45%	IS 2386 part 1 1963	30 % max	Satisfactory
Specific Gravity	2.62%	IS 2386 part 3 1963	2-3	Satisfactory
Impact value test	11.06%	Is 2386 part 4 1963	30 % max	Satisfactory
Water Absorption	1.01%	IS 2386 part 1 1963	2 % max	Satisfactory
Crushing strength	12.36 %	Is 2386 part 4 1963	30 % max	Satisfactory

Table 1 Summary of test results of Aggregate

Properties	Results	IS Code	Specification Requirement	Remarks
Specific Gravity	1.02 %	IS :1202 - 1978	1%	Satisfactory
Penetration Test	95.1mm	IS: 1203 - 1978	80 to 100	Satisfactory
Ductility Test	72 cm	IS: 1208 - 1978	75 cm	Satisfactory
Softening Test	44.3°C	IS: 1205 - 1978	40 to 60	Satisfactory

Table 2 Summary of test results of Bitumen

V. CONCLUSION

- Flakiness index of aggregate was 20.95 % which is less than 30% and elongation index of a aggregate is 18.45% which is less than 30%.All the results are satisfactory as per Indian standard . Specific Gravity of the aggregate was 2.62 which is between 2 to 3 as per Indian standard .Aggregate Impact value was 11.01% 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 12.36 % which is satisfactory as per Indian standard
- The specific gravity of bitumen is 1.02 % which is nearly to 1 % so it is satisfactory result; the penetration value of bitumen was 94.1 mm which is between is 80 – 100. It indicate the grade of bitumen, softening point of bitumen is 44.3 degree which is between 40 to 60, The ductility of bitumen is 72 cm. All the results are satisfactory as per Indian Standard.

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