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Application of Cenosphere Fillers in Bituminous Concrete for Tensile Strength Quality Improvement

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ABSTRACT

Present era Bituminous concrete used as main ingredients for the manufacturing of high strength roads and highways. But due to high heat in atmosphere, roads are severely affected due to water surpass into the pavement. Regular maintenance and high traffic can cause damage to the road. Hence this paper highlights to use of better quality material to enhance the strength of the bituminous concrete for roads. Cenosphere materials are part of the fly ash, due to its structural appearance it is named as cenosphere. The cenosphere materials can be effectively utilized into the concrete material to develop its quality and helps in reducing stresses due to water and heats, rutting and cracking. The modification in ingredients of the material mix of bituminous and cenosphere can effectively improve the quality of road. In this paper experimental testing on the material mix studied and validated. The evaluations are carried using Marshall Stability Test (MST). Both modified and conventional tests are done for validation in these experiments. This experimental study with proper laboratory validation can effectively helps the researchers to get the idea about the tensile strength and stability of the density in coal based fly ash type bituminous mixture concrete material for roads.

KEYWORDS: *Bituminous concrete, Cenosphere, Coal Fly ash, Marshall Test, Tensile Strength*

I. INTRODUCTION

A highway pavement is usually a design that has prepared materials on top of a healthy soil sub-grade. The primary purpose of which is to transfer the loads of the used vehicle to the sub-grade. Pavement is a real travel surface, specially made long-lasting as well as practical to withstand the traffic load commuting on it. Pavement offers friction for vehicles, thereby providing an acceptable operating quality surface, adequate skid resistance, optimal reflective lighting and lower noise pollution. The essential objective is to ensure that the stresses transmitted due to the load of the wheel are sufficiently minimized so that they do not exceed the load capacity of the sub-grade.

II. BITUMINOUS MIX DESIGN

The design of the bituminous mixture is intended to decide the proportion of bitumen, filler, fine aggregates and coarse aggregates to produce a mixture that is workable, solid, durable and economical. Generally, the construction of the highway pavement required a large cost of money. Reasonable architecture, therefore, saves detailed speculation. Appropriate pavement design includes structural design and mixing design. Objective of structural intent is the thickness design of the paving material and the mixing design consists of a dry mix design and a wet mix design.

A. *Coarse aggregate*

The aggregates retained on a 4.75 mm sieve are calla coarse aggregates. Coarse aggregates of crushed rock, angular in form, free from dust particles, mud, vegetation and organic matter, offering compressive and shear strength and strong interlocking properties, should be screened. For the preparation of bituminous mixtures (SMA, DBM, BC) aggregates as per MORTH grade of a specific form of binder in the appropriate quantity is mixed as per Marshall procedure. The coarse aggregate is chosen on the basis of the necessity and suitability of the mixing design and should be as defined. Specifications shall include physical specifications as set out in the MORTH standards.

B. *Fine aggregate*

Clean sifted quarry dusts should be fine aggregate and free from clay, loam, vegetation or organic matter. A local crustor with fractions of 4.75 mm has been collected and retained on 0.075 mm IS sieve, which consists of fine aggregates consisting of stone crushing material. The vacuum is filled in the grower and the binder is steeped.

C. *Filler*

The IS sieve is called a filler machine that passes through 0.075 mm. The vacuum is completed, the bond is reinforced and permitting. The mineral filler must consist of finely divided materials such as rock dust, broken slag, cement, ash-flying content, hydrated lime, etc. Stone dust for preparing the control mix is used as standard filler for this analysis, while stone dust and cenosphere are used for substitution purposes as fillers both. In below figure 1 and figure 2 cenospheric materials are shown.

Fig. 1. Different Size of Aggregates

Fig. 2. Different Size of Aggregates of cenosphere materials

III. Cenosphere

The division of carbon fly powder with an empty circular structure is one of the most critical considerations. Cenosphere. Because of its specific characteristics, for example low mass thickness, high warm opposition, high workability and high efficiency, it can be related in many applications. During the carbon combustion process, general cenosphere and other particles are produced. A cenosphere has a lightweight, idle, hollow sphere of vast quantities of silica and alumina, filled with air or inactive gas, which is normally processed in warm power plants as a result of coal burning. The cenosphere varies from almost black to nearly white and its real gravity is between 0.4–0.8 g / cm3, offering exceptional lightness. Cenosphere components: SiO_2 (Quartz), Al_2O_3 (Alumina), Fe_2O_3 (Haematite), CaO(Calcium Oxide), TiO_2, MgO (Periclase) and H3PO4(Phosphoric Acid). The cenosphere's spherical nature allows for a low volume surface area that needs less resin, binder and water, and is therefore an adjustable tool for polymers and various polymer composites. Cenosphere is the only part of the surface. Cenosphers can be used as lightweight concrete filler with a decreased water release for building applications. This is ideal for sturdy bridge desks, paves and highways.

IV. Marshall Test Experimental Program

Marshall Test is a standard laboratory method that is used worldwide to define bitumen coating paving mixtures' strength and flow characteristics. The way to describe bituminous mixes is very common in India. Because of its ease and low cost this test method is well know. Since the Marshall method shown in figure 3 has numerous benefits, the Best Binder Content (OBC) method has been determined to use this method.

Fig. 3. Marshal Test of Material Mix

V. Experimental Results

Experimental analysis categorized into

four contents:

- Initial deals with characteristics and parameters
- Second deals with control mix and calculation using Marshal Test
- Third deals with result analysis and compositional contents
- Fourth deals with strength of tensile test

Result analysis of control mix results

shown in table 1.

Table.1 Characteristics of control mix for Bituminous concrete BC

Bitumen mix content (%)	Strength Stability (KN) at 60^0 C	Content Flow (mm)	Mix Bulk density(gm/cc)	Mix Air voids (%)	VMA Content (%)	VFB content (%)
6	10.87	2.8	2.85	5.2	15.62	72.6
6.5	12.58	3.0	2.65	4.2	15.34	80.6
7	13.21	3.5	2.64	3.25	15.55	81.6
7.5	11.07	4.0	2.52	3.05	15.20	82.2

The changes are occurring that the mixture's stability is closely correlated to the mix's density and versatility. That is if the mix's consistency is longer, either the mix's density should be greater or the mix versatility should be greater or both. With excess filler, consistency also improves, but the combination gets unstable and sudden cracking. In cases of filler failure, but the mixture is soft, stability decreases. The stability of the mix and the volume density are identical in nature here. Here it is found. Stability decreases from the combination of 60 to 100 percent cenosphere. The decrease in density can be induced. Density is a compaction and material type feature. Compaction depends on the active effort, the form of material and the quality of bitumen.

- Bituminous Concrete (BC)
- Flow Content (FC)
- Voids in Mixed Aggregate (VMA)
- Voids Filled with Bitumen (VFB)

In below table no. 2 the Marshal Test results are illustrated.

Table.2 Result analysis of Mix

SL No.	Bitumen Mix Content (%)	FC (% by vol.)	Strength Stability (KN) at 60^0	Content Flow (mm)	Mix Bulk density(gm/cc)	Mix Air voids (%)	VMA Content (%)
1	6.012	95 SD + 10 C	12.20	2.64	3.463	4.64	70.20
2	6.012	85 SD + 20 C	12.01	2.74	3.464	4.54	71.18
3	6.012	75 SD + 30 C	13.12	2.72	3.465	4.12	71.56
4	6.012	65 SD + 40 C	13.46	2.92	3.469	4.24	72.12
5	6.012	55 SD + 50 C	14.10	2.95	3.566	4.46	74.46

VI. Conclusion

Hence from the above experimental study it is found that cenosphere mix content enhance the filler by 70%. Furthermore it is become more breakable. Hence using the bitumen mix reduces the brittleness and increase the tensile strength of the material mix. This research helps the other researcher to use the material percentage with use of advanced testing techniques to get better material for roads and pavements. The tensile strength increase by 94.2% with optimum analysis and satisfy the minimum necessary of 80% of strength and stability.

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