

A STUDY ON USAGE OF CEMENT, GGBS, HOSPITAL WASTE ASH AND BRICK DUST IN BITUMINOUS MIX

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Abstract- Bituminous materials are extensively used for pavement construction, primarily because of their excellent binding characteristics, water proofing properties and relatively low cost. But in bitumen concrete mix the strength of bitumen concrete depends on all the constituent materials that are used in the mix design i.e. bitumen, coarse aggregate, fine aggregate and filler. Above all the bitumen concrete are prepared by bitumen and mineral aggregates. Therefore, there is a need to explore the use of various types of waste materials like Slag, fly ash, stone dust, brick dust, GGBS, HWA and steel slag etc. Hospital waste generated from hospitals, medical research activities and the other medical sources are causing a major problem in India. The waste generated affects adversely environment as well as the human world. Some studies revealed scope of utilization of biomedical waste ash as partial replacement of cement in concrete. Cement, Brick dust, HWA and GGBS is used in bituminous concrete mix due to its physical properties i.e. gradation, specific gravity, durability, moisture content, very hard and abrasion resistant. Therefore, there is an increase in the values of Marshall Stability, Flow value and Bulk density in bituminous concrete mixes by using fillers Cement, GGBS and Brick Dust.

I. INTRODUCTION

As the traffic demand is growing at a rapid rate along with the increase in the axle loads, it is necessary to improve the highway paving materials. The main objective of highway authorities is to provide safe, smooth, imperishable, and economical pavements that are capable of carrying the anticipated loads. To achieve this select objective, many specialists, engineers and researchers are anxious and dedicated to the paving material that can curtail pavement distress and upgrade the performance of asphalt pavements.

Filler, as one of the constituent in an asphalt mixture, plays a major part in and determining the properties and performance of the mixture, especially its binding interlocking effects. Mineral fillers on adding to asphalt mixtures serve dual purpose. Asphalt cement binder mixes

with mineral filler (finer than thickness of asphalt film) forms mortar that leads to improved stiffening of the mix. Particles larger than the thickness of the asphalt film act as mineral aggregate and hence contribute to the contact points between distinctive aggregate particles (Puzinauskas 1969). Also, they affect the moisture sensitivity, workability stiffness asphalt (HMA) (Mogawer 1996). and ageing features of hot mix.

Due to variation in gradation, particle shape, surface area, voids content, physico- chemical properties and mineral composition of fillers their influence on the properties of HMA mixtures varies. For various types of fillers, the maximum allowable amount should be different. By increasing the surface area of mineral particles the filler also influences the optimum asphalt content (OAC) in bituminous mixtures and, simultaneously, the surface properties of the filler particles modify significantly the properties of asphalt such as penetration, ductility, and also of the mixture, such as resistance to rutting. The pavement performance is improved by ensuring that sufficient behavior of the bituminous mixtures is achieved, which essentially depends on their composition. Therefore, selecting the proper type of filler in asphalt mixtures would upgrade the filler's properties and, thus, enhance the mixture's performance (Kandhal 1981).

II. LITERATURE REVIEW

Antonio José Tenza-Abril et al (2014) focuses on "Using Sewage-Sludge Ash as Filler in Bituminous Mixes". In this study, the behaviour of bituminous mixes made with sewage sludge ash (SSA) as mineral filler was investigated. The behaviour of these mixes was evaluated with the Cantabro, indirect tensile strength, water sensitivity, permanent deformation, and resilient modulus tests. The results show that SSA waste may be used in bituminous mixes at approximately 2–3% weight percent, maintaining adequate levels of cohesion and adhesion in the mixtures,

which is comparable to mixtures made with active fillers such as hydrated lime and cement. Moreover, its use does not increase permanent deformations.

Satish Kumar ahirwar and Prof Rajesh Jain(2018) paper on Use of RHA as mineral filler in hot mix has presented a Review SDBC. This paper summarizes the ongoing researches about Use of RHA as mineral filler in hot mix asphalts (SDBC). Many researches regarding the addition of filler have been laid down by different scholars. Many studies regarding the addition of OPC and waste materials like cement kiln dust, lime and rice husk ash were studied and then their effects were also analyzed and laid down to a proper conclusion. It was concluded that by use of different types of fillers increase the life of pavement, increased marshal stability values, lowered pavement deformation, increase fatigue resistance, provide better adhesion between asphalt and aggregates and increase in durability of flexible pavement.

R. Mistry et al (2016) has studied the effect of using fly ash (FA) in asphalt mixture as replacement of common filler. In view of the same, samples were prepared for different bitumen content (3.5–6.5% at 0.5% increments) by using 2% hydrated lime (HL) in control mix as well as varying percentage of FA ranging from 2 to 8% as alternative filler in modified mixes. The optimum bitumen content (OBC) was then determined for all the mix by Marshall Mix design. Experimental results indicate higher stability value with lower OBC for the mix having 4% FA as optimum filler content in comparison with conventional mix & standard specification.

Ishai et al. (1980) investigated six types of fillers possessing a wide range of properties, and two types of mixtures; sand asphalt and bituminous concrete. They performed rheological tests on filler-bitumen mastic samples, and mechanical tests on different sets of bituminous concrete samples. A basic model was adopted in which the bituminous mixture is composed of two components: an aggregate- bitumen system and a filler bitumen system (mastic). The model was analyzed through weight-volume relationship and the optimum mastic needed to obtain the optimal mechanical behavior of the mixture was determined.

Satish Chandra, Rajan Choudhary (2012) has studied the performance characteristics of bituminous concrete with industrial wastes as filler. Granite dust and marble dust

from stone industry and fly ash from thermal power plants are waste products which are produced in large quantities in India. Physical properties of these materials meet the requirements laid for fillers in Indian specifications. This study explores the possible use of these three industrial wastes along with hydrated lime and conventional stone dust from quartzite as filler in bituminous construction. Different test procedures are used to examine the void content and clay content in the five fillers. Bituminous concrete (BC) mixes were designed as per Marshall Method at four different percentages of the five types of fillers.

E. Remisova (2015) has focuses on the study of mineral filler effect on asphalt mixtures properties. The mineral filler in asphalt mixture is an important component of the mixture as it plays an important role in stiffening and toughening an asphalt binder. In addition to affecting the mechanical properties of asphalts, mineral fillers are also important with respect to stripping or moisture damage. The paper presents mechanical properties of asphalt concrete AC11 with paving grade bitumen 50/70 and polymer modified bitumen Seal flex with two mineral limestone fillers according to empirical requirements. The produced and compacted mixtures were tested to determine voids characteristics (Vm, VFB), water sensitivity (ITSR) deformation (WTSAIR, PRDAIR).

III. EXPERIMENTAAL STUDY

To study the properties of materials various laboratory investigations are carried out as per the IS code of practice. The materials used in the study are Aggregates, Bituminous Binder, Filler (Brick dust, Hospital waste ash(HWA), Cement, GGBS).

The following experimental investigations are carried out on the materials.

Tests on Aggregates:

- Specific Gravity Test
- Water Absorption Test
- Shape Test
- Impact Value Test
- Loss Angles Abrasion Test

Tests on Bitumen:

- Ductility Test
- Softing Point Test
- Penetration Test
- Flash and Fire Point Test

Tests on Filler Materials

- Density
- Specific Gravity
- Water Absorption Capacity
- Compaction Characteristics
- Shear Characteristics
- CBR test

IV. RESULTS

The following test results were obtained from the laboratory investigations.

Table 1 Physical Properties of filler

Filler	Specific Gravity
Brick dust	2.81
GGBS	2.86
HWA	1.096
cement	3.15

Table 2 Physical properties of aggregates

Property	Specification	Test Result
Aggregate Impact Value (%)	Max 24%	17.13%
Crushing Value (%)	Max 35%	18.80%
Abrasion Value (%)	Max 30%	24.31%
Combined Flakiness and Elongation Indices (%)	Max 35%	16.18%
Coating And Stripping of Bitumen Aggregate Mix	Minimum Retained Coating 95%	98%
Water Absorption (%)	Max 2%	0.15%

Table 3 Physical properties of Binder

Property	Test Result
Specific gravity	1.01
Penetration at 25°C(cm)	12
Softening Point (°C)	48
Ductility (cm)	68
Flash Point (°C)	180
Fire Point (°C)	188

Table 4 Marshall properties at OBC

Filler	OBC (%)	Marshall Stability (KN)	Flow (mm)	Va (%)	VFB (%)	VMA(%)
Cement	5.64	14.78	2.3	4.96	16.58	72.51
GGBS	6.13	14.23	4.57	3.9	19.5	80
HWA	6.22	14.38	2.8	4.5	17.6	74.43
Brick Dust	5.48	13.9	2.8	4.48	15.69	74.96

V. CONCLUSIONS

The following conclusions are drawn based on the experimental investigation.

- Ultimately, all the waste materials tested can be reused as either an aggregate or an additive to asphalt concrete. Based on the results, in consequence of increased awareness of environmental issues and natural resources constraints, the studied waste materials can be advantageously utilised in road construction.
- It is found that bituminous mixes containing HWA, GGBS and brick dust as fillers have almost same Marshall Properties as those of conventional filler(cement).
- It is observed that with the increase of bitumen content, the Marshall Stability of the mixture also increased. Bituminous mixes containing Hospital waste ash as filler showed maximum stability of 14.38KN at 6.22 % bitumen content with minimum flow value, maximum unit weight, maximum air voids and minimum VMA and VFB % values.
- The maximum stability value obtained for the mixes containing HWA, GGBS, brick dust and cement as filler were 14.38KN, 14.23KN, 13.9 and 14.78KN with a respective bitumen percentages was 6.22%, 6.13%, 5.48% and 5.64%.
- From the considerations of economy and availability Hospital waste ash is suitable as filler as compared with conventional filler generally used in bituminous mix.

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