International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN: 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)
doi : https://doi.org/10.32628/IJSRSET

Study ON DBM Mixes with Coal Ash by Using Natural Fiber

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Article Info
Volume 8, Issue 6
Page Number : 191-195

Publication Issue :
November-December-2021

Article History
Accepted : 01 Dec 2021
Published: 18 Dec 2021

ABSTRACT

Coal-based thermal power plants have been a key source of power generation in India. The prime waste product of a coal thermal power plant is fly ash and bottom ash. Heavy dumping of these waste products causes fatal environment pollution to air, water, and land, besides impairing human health. This research work is done to deliver the optimum use of ash, namely bottom ash as fine aggregate and fly ash as mineral filler with natural fibber (such as sisal fiber) used to improvise the engineering properties of bituminous paving mixes. For national interest these waste products, which are available easily and abundantly can be used economically for bituminous paving purpose, which ultimately helps in saving the natural aggregate resources of the nation.

In the present study, dense graded bituminous mix specimens are prepared using natural aggregate as coarse aggregates, bottom ash as fine aggregates, fly ash as filler and sisal fiber as additive. Proportion of aggregate for dense graded bituminous macadam (DBM) grading has been considered as per MORTH (2013) having nominal maximum aggregates size (NMAS) 26.5 mm. To strengthen the mix, slow setting emulsion (SS1) coated sisal fiber is added in varying percentage of 0, 0.25%, 0.5%, 0.75%, and 1% by weight of the mix, with different length variations such as 5mm, 10 mm, 15 mm and 20 mm. At the initial stage of the research, specimens were prepared with two types of paving bitumen i.e. VG30 and VG10, out of which the initial trials resulted better Marshall characteristics with VG30 bitumen and hence was considered for subsequent study. Detailed study with Marshall test results were used to determine the marshal characteristics, optimum binder content and also optimum fiber content including the optimum length of fiber. Marshall stability as high as 15kN was obtained with optimum bitumen content of 5.57%, with optimum fiber content of 0.5% with optimum fiber length of 10 mm. Further, for delivering the performances of the pavement, various performance tests were also conducted such as moisture susceptibility test, indirect tensile strength (ITS), creep test and tensile strength ratio of

bitumen mixes. It is finally observed that not only satisfactory, but also much improved engineering properties result with coal ash as fine aggregate and filler, stabilized with natural sisal fiber duly coated with SS-1 emulsion in advance.

Utilization of non-conventional aggregate like coal ash and natural fiber together thus may help to find a new way of bituminous pavement construction. The coal ash dumping which is a serious concern to everyone in respect of its disposal and environmental pollution, can find one way for its reuse in an economical way by substituting natural resources of sand and stone dust.

Keywords : Bottom ash, Fly ash, Sisal fiber, Emulsion, Indirect tensile strength, Static creep test, Tensile strength ratio.

I. INTRODUCTION

Pavements or highways or roads are regarded as country's backbone, upon which its upswing and progress depend on. All countries normally have a series of programs for building a new road infrastructures or emerging the existing one. Construction of both flexible and rigid pavement include a gross amount of investment to reach better performance oriented and smooth quality of pavement that will endure for long time. In India, where highways are considered as the primary function of transportation, Government of India have been investing a huge amount of money for developing the pavement construction and maintenance. A detailed engineering study may retain significant amount of investment and pavement materials, which in turn achieve a reliable performance of the in-service highway. Regarding flexible pavement, two major facts are taken into considerations i.e. pavement design and mix design. The present research study is focused on engineering property of bituminous mixes prepared from alternate or nonconventional materials.

II. OBJECTIVES

This experimental study has done to enable the most appropriate use of coal ash as nonconventional aggregate along with natural fiber (Sisal fiber) as an additive by ensuring the adequate performance result in the field of fatigue, moisture susceptibility, and creep value. Again the possible effects of fiber on bitumen mixes are also taken into consideration, and comprehensive study was done to find the optimum fiber content and fiber length that will increase the engineering property of bituminous mix.

III.SCOPE OF PROJECT WORK

1)The significant scope of this study is to use coal ash as a fine material in HMA mix design and thus producing a good quality and smooth surface road which may be commercially acclaimed and can with stand in any possible environment condition

2) Again Utilization of non-conventional materials like coal ash and natural fibers together thus may help to find a new way of bituminous pavement construction. The coal ash dumping which is a serious concern to everyone in respect of its disposal

and environmental pollution, can find one way for its reuse in an economical way by substituting natural resources of sand and stone dust.

Fly Ash

Bottom Ash

Stone chips

IV.METHODOLOGY

The adopted gradation for DBM sample has been considered as specified in MORTH (2013) Throughout the experimental study the aggregate gradation given in Table4 was followed, and the following tests were performed. The aggregate gradation curve

↓

After adopting the above aggregate gradation the subsequent test were made to ensure the performance characteristics.

↓

Design Mixes Then Following Test Given

- analysis
- Static indirect tensile test
- Resistance to moisture damage (Tensile strength ratio)
- Retained stability test
- Static creep test
-

↓

Coating of emulsion on fiber.

↓

Oven dry coated fiber.

↓

Cutting of coated fiber.

↓

Addition and mixing of fiber

↓

Pouring of mixture in mould then

Compaction of mixture in progress then DBM samples and Marshall test in progress

V. RESULT

1) TSR of DBM mixes with and without fiber and coal ash.

Tensile strength ratio			Design requirement
Type of Mixes	DBM With coal ash	DBM Without coal ash	
DBM With fiber	84.77 %	82.04 %	Minimum 80% (as per MORTH specification)
DBM Without fiber	82.35 %	80.26 %	

VI.CONCLUSION

Based on experimental study the following conclusions were drawn,

1) From the results of the Marshall tests it was observed that the DBM mixes prepared with bottom ash and fly ash used respectively in 300-75 micron sizes and passing 75 micron resulted

best mixes satisfying the Marshall criteria when bitumen content, fiber content and fiber length were 5.6%, 0.5% and 10mm respectively.

2) It is also observed that Marshall stability and flow values are quite acceptable when the coal ash content is within 15%.
3) It is also observed that with increase in fiber content and fiber length, air-void and flow decreases and Marshall Quotient increases which in turn is due to higher stability value.
4) An increase in fiber content and fiber length resulted in higher requirement of optimum bitumen content and emulsion for coating of the fibers.
5) From the indirect tensile strength test it is perceived that the indirect tensile strength of sample increased due to the addition of emulsion coated fiber and coal ash, which gives an excellent engineering property for DBM sample to endure thermal cracking.
6) It is also observed the use of emulsion coated fiber, coal ash or both in DBM mix increases the resistance to moisture induced damages determined in terms of tensile strength ratio and retained stability values.

VII. FUTURE SCOPE

1) As a natural fiber, sisal fiber has shown satisfactory results when used in bituminous mixes. Therefore to utilize the full extent of fibers, other natural fibers such as jute, coconut fiber etc. are also taken in to consideration and their effects on DBM bituminous mix should be tested and studied.
2) In this study only SS-1 emulsion was considered as a coating medium for sisal fiber, therefore the effect of other types of emulsion such as rapid setting emulsion (RS) and medium setting (MS) emulsion are taken in to account and subsequent tests should be performed for future study.
3) Furthermore the effect of different mineral fillers such as cement and lime cannot be overlooked. Lime as an anti-stripping agent and cement as a stabilizing agent can be used as potential mineral filler for DBM mix, and subsequent tests may be performed as a part of future scope.

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Cite this article as :

Akash N. Sangale, Dr. Sachin S. Saraf, Prof. Ashish R. Bijwe, "Study ON DBM Mixes with Coal Ash by Using Natural Fiber", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 8 Issue 6, pp. 191-195, November-December 2021.

Journal URL : https://ijsrset.com/IJSRSET218644