



PERFORMANCE OF COCONUT SHELL CHARCOAL AS FILLER IN BITUMEN MIX

Aditya Sase¹, Aditya Mandavkar², Dinesh Tambe³, Ranjit Sable⁴, Navanath Khadake⁵

^{1,2,3}Research Scholar, JSPM's Imperial College of Engineering and Research Wagholi, Pune .

⁴Assistant Prof. JSPM's Imperial College of Engineering and Research Wagholi, Pune

⁵Prof.& Head of Civil Engineering Department JSPM's Imperial College of Engineering and Research Wagholi, Pune.

*Corresponding Author: Aditya Sase (adityasase3@gmail.com)

Article History: Received: 01.02.2023

Revised: 07.03.2023

Accepted: 10.04.2023

Abstract

Improvement in transportation system is today's need. It is not only done by providing roads to connect different cities or sectors but it is done by improving the quality of road pavement. A well designed Bituminous mix that has all the good properties like rutting resistance, resistance to temperature changes, must be strong and at the same time it should be economical and environment friendly. Different filler materials are added to the bitumen mixture to increase the strength and performance of the road pavement. The main aim of this project is to determine the suitability of coconut shell charcoal powder as a filler material in Bitumen Mix (which has significant characteristics such as resistance to freezing, rutting, crushing and surface moisture) and to analyze the results of other filler materials like Quarry Dust, M-Sand and to find the best economical and environment friendly filler material that improves the standard and imperishability of road. The Marshall Stability Method is the main test used for this project.

Keywords: Coconut Shell Charcoal Powder, Marshall Stability, Bitumen Mix, Aggregate, Bitumen, filler material Binder, Stability.

1.Introduction: In general for construction work and maintenance work aggregates mixed with bitumen are used. The well graded and dense aggregates are generally used as they give the best result and good life span [14]. But it is a difficult job to form dense aggregate at construction site because various sizes of aggregate are there on actual site. In such condition bituminous mix also known as Bituminous Concrete is used which consists of properly graded aggregates [8]. It has great resisting

properties against temperature, crushing under heavy traffic load and rutting. Bituminous Concrete is a mixture containing 55-60% coarse aggregate, 4-6% of binder and 10-12% of filler material [10].

Aim and Objective: To determine if coconut shell charcoal powder is used as filler material in bitumen mix and compare its results with other filler materials like M-Sand, quarry dust etc [3]

Objectives:

1. The main Objective is to check the relevancy of a Coconut shell charcoal powder as a filler material in bitumen mix,[1] and then analysing the obtained results with the other filler material and then analysis its effect on the different characteristics of a bitumen mix [12].

2. To perform Marshall Stability Test to check different properties with different filler material (Quarry Dust, M-Sand etc) and to differentiate the results with coconut shell charcoal powder [13].

2.RESEARCH WORK:**Materials Used**

- 1) Coarse aggregate
- 2) Fine aggregate
- 3) filler material – Coconut Shell Charcoal Powder, M-Sand, Quarry Sand [6].
- 4) Binder – VG30 grade bitumen

Coarse Aggregate – The coarse aggregate is in form of crush rock passing by 19mm size sieve and retained on 4.75mm size sieve. The rock should be in good condition i.e rough surface, cubical in shape and well graded for good compaction. It should have good hardness to counter the traffic load.

Fine Aggregate – Generally fine aggregates are dust from stone crusher which should pass over 4.75 mm size sieve and should be hold on 0.075 mm size sieve. The fine aggregate must be clean, hard, should have durability and cubical in shape

Mineral Filler – the aggregates which passes through the sieve size of 0.075 are called filler. They have considerable impact over SMA properties there are various types of filler material used in mixtures i.e M-Sand, Coconut Shell Charcoal [7].

Binder – The main aim of Bitumen is to act as a binding material for coarse and fine aggregate and work as a stabilizer in BC Mixtures [5]. The aging property of mix is increased by BC mixes which are rich in

mortar binder. The bitumen we are using for the project experiment is of VG30 grade.

The main aim of the experiment is differentiate the results obtained by using different filler materials in BC Mix and to find the most appropriate and economical filler for Bitumen Concrete Mix [11].

3.EXPERIMENTAL PROCEDURE:**Preparation of Mixes:**

As stated by the composition specified by MORTH-5th revision, the specimen of coarse and fine aggregate are prepared [2]. The total weight should not be less than 1200gm. 3 samples of coconut shell charcoal replaced with other material should be prepared [4]. The charcoal powder should be in proportion of 2%, 3%,4% and then the Marshall Stability Test, Flow Value Test and Air Voids Test should be performed [9].

Sieving:

The aggregates should be cleaned, and oven dried before the experimental procedure the aggregate which are to be used are well graded and properly sieved from 19mm sieve to 0.0075mm sieve.

Mixing: The aggregates are properly mixed to reduce the pores between the aggregates which also provide good compaction of aggregates. They are mixed 5 times and then oven dried at a temperature of 150^oC and then they are mixed with the bitumen.

Moulding: By using Marshall Compaction Mould the mixed bitumen sample is fully compacted. The hammer used for compaction has a weight of 4.54kg which falls from a height of 400mm. 50 blows of hammer are given to the sample and then it is kept for drying for 24 hours [15].

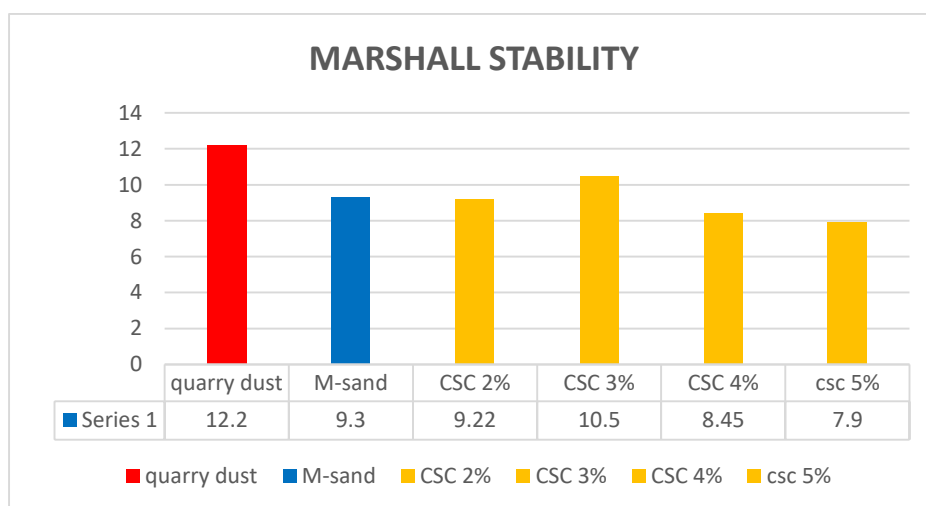
Weighing: The weight, height and radius of the sample is measured. The weight of sample in water also measured.

Water Bath: The hot water bath is given to the sample at 60^o C for a period of 30 minutes. Proper precaution should be taken the sample should not overheated or kept in water bath more than 30 minutes. If proper care is not taken and such condition occurs then the bitumen mix is useless and the test can't be carried out.

Marshall test: The Marshall Stability is nothing but the entire amount of load carried by a well compacted bitumen mixed specimen and a standard temperature of 60^oC. The maximum load carried by the specimen before its failure is taken as the Marshall Stability

4.RESULTS AND DISCUSSION

A. Marshall Stability: The Marshall Stability is obtained by multiplying the total load carried by the bitumen sample with the correlation ratio. This ratio is obtained by the height, weight, thickness, and volume of the specimen. Theoretically, as the bitumen content increases the strength of the specimen will also increase but up to a certain specific limit and then it starts gradually decreasing. This is because as bitumen content increases the bond between the bitumen and aggregate also increases but after specific limit there is decrease in strength due to immobilize of contact point between aggregate.

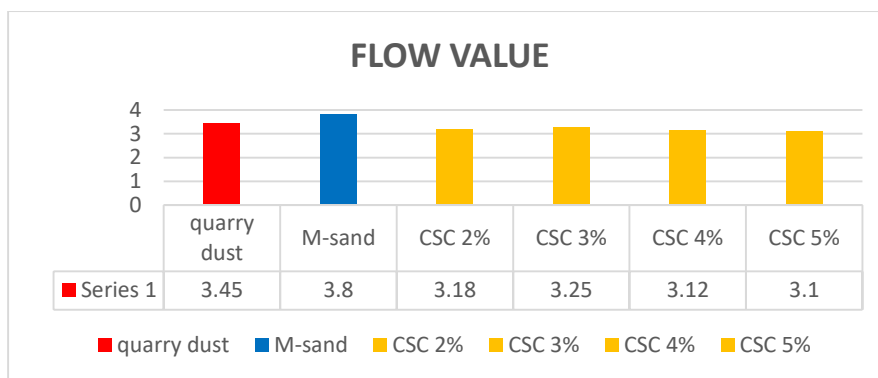


Marshall Stability Graph

Stability Value using different fillers

| Filler Material | | Marshall Stability Value (KN) |
|------------------------|----|-------------------------------|
| Quarry Dust | | 12.2 |
| M-Sand | | 9.3 |
| Coconut Shell Charcoal | 2% | 9.22 |
| | 3% | 10.5 |
| | 4% | 8.45 |
| | 5% | 7.9 |

B.Flow Value: The deformation caused by the maximum load applied where usually any failure occurs is called as flow value. As the amount bitumen increases the flow value also increases. If stabilizers are not used in sample the flow gradually decreases. At initial stage flow rate increases slowly but as the bitumen content increases the value also increases rapidly.

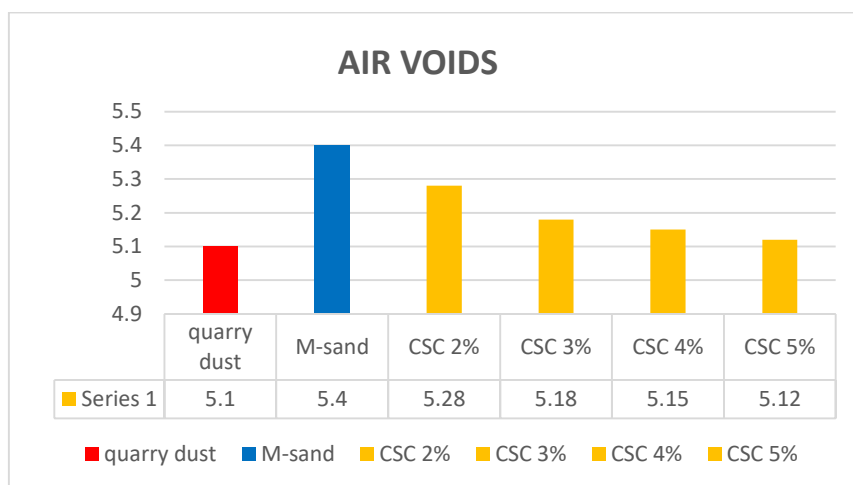


Flow Value Graph

Flow Value using different filler

| Filler Materials | | Flow Value(mm) |
|------------------------|----|----------------|
| Quarry Dust | | 3.45 |
| M-Sand | | 3.8 |
| Coconut Shell Charcoal | 2% | 3.18 |
| | 3% | 3.25 |
| | 4% | 3.12 |
| | 5% | 3.10 |

C.Air Voids: The gap in between the aggregates is called as Air Voids. As the amount of bitumen increases the voids decreases. Excess voids decrease the workability thus the voids should be as less as possible, this is done by increase in percentage of bitumen and some amount of stabilizers. Less Air voids also increases the compatibility.



Air Voids Graph

Air Voids Value using different fillers

| Filler Materials | | Air Voids (%) |
|------------------|----|---------------|
| Quarry Dust | | 5.1 |
| M-Sand | | 5.4 |
| | 2% | 5.28 |

| | | |
|------------------------|----|------|
| Coconut Shell Charcoal | 3% | 5.18 |
| | 4% | 5.15 |
| | 5% | 5.12 |

Results using coconut shell charcoal as filler material

| Sample No | Bitumen Content | Measured Stability kg | Corrected Stability kg | Flow Value |
|-----------|-----------------|-----------------------|------------------------|------------|
| 1 | 4 | 730 | 860.7 | 2.8 |
| 2 | 4 | 715 | 825.6 | 3.2 |
| Average | 4 | | | |
| 1 | 5 | 860 | 920.3 | 3.2 |
| 2 | 5 | 830 | 960.5 | 3.4 |
| Average | 5 | | | |

5.CONCLUSIONS

From all the experimental work, research and results obtained it is observed that the addition of coconut shell charcoal powder in Bitumen mix increases the performance of Bitumen asphalt over a long period of time (service). Addition of coconut shell charcoal in different percentage shows very good effect on the flow, stiffness and stability of the Bitumen asphalt over long term ageing. Approximately 3% to 4% of coconut shell charcoal powder in mixture of asphalt will enhance higher stability in comparison with other amount.

REFERENCES:

1. Case Study on Assessment of Coconut Shell Charcoal as Filler in Stone Matrix Asphalt.
2. Kumar Pawan, Chandra Satish and Bose Sunil, 'Laboratory investigations on SMA mixes with different additives', International Journal of Pavement Engineering, Volume 8, Issue 1, March 2007, Pages 11-18.
3. T. Subramain, (2012), "Experimental investigations on coir fiber reinforced bituminous mixes", International Journal of Engineering Research and Applications, Vol. 2, Issue 3, May-June 2012, pp. 1794- 1804.
4. "Laboratory evaluation of SMA mixtures containing different additives", Journal of Applied Science, March 2018.
5. "Use of natural fibre and binder quality in stone matrix asphalt mixture", International Journal of Latest Research in Engineering and Computin, January 2020. [11] "Principles of Transportation Engineering", PHI learning private limited, 2017.
6. Rijwan Ahamed, Mukesh Choudhary, Bharat Nagar, "Experimental study on effect of fly ash by partially replacing with conventional fillers on bitumen on BC mix", International Research Journal of Engineering and Technology, July 2020.
7. Nagappan.B.A, Bheema Shankar, Amarnath. M.S, "Comparative study in bituminous concrete mix using different fillers and zycotherm as additive", Transportation System Engineering and Management, May 2015.
8. Study by J K Patil, Ankit Biradar, Roshni Upare, Gaurav kudale, Sushant Shelar
9. Case study on Assessment of suitability of Coconut Shell charcoal as a Filler in Stone Mastic Asphalt.
10. Study by Aswathy A, Soumya S, Akhil K P, Rakesh R, Adheena Bai G, Arya C A
11. Case study on Performance of Charcoal Coconut Shell Ash in the Asphalt Mixture under Long Term Aging.

12. Case study on flexible Pavement using coconut shell and coir fiber
13. Case study on an Experimental Study on M-Sand and Coconut Shell Charcoal as Filler Material in Bituminous Concrete Mix
14. Chakraborty Partha, Das Animesh, Principles of transportation engineering, PHI 2003, page no 294-299.
15. MoRTH, Specifications for Road and Bridge Works, Upgradation of Third Revision, Ministry of Road Transport and Highways.