SAW DUST ASH: AN ECO-FRIENDLY WASTE MATERIAL AND A STRENGTH BOOSTER TO BITUMINOUS CONCRETE MIXTURE

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ABSTRACT

In the Era of Technological Development, With growing demand and emerging Technologies, Large scale Industries manufacture various products of Wood in the form of wooden furnitures, wooden materials, doors, windows etc etc. Saw dust is a major waste product of wood working operations such as sawing, milling, planning, routing, drilling and sanding. It is composed of fine particles ***of*** *wood. Saw dust ash is the residue powder left after the combustion of wood, such as burning wood in fireplace or an industrial power plant. But, we observe that disposal of these large quantities of sawdust becomes a serious environmental concern and many a times it is dumped near river areas, big lands and other places. Therefore, an attempt has been made to utilize that waste material in bituminous concrete roads as a mineral filler so that it could fill up the voids and boost the stability and durability of the pavement instead of using conventional fillers. This paper presents the performance of eco-friendly waste material (saw dust ash) as an filler in bituminous concrete mixture. Marshall Stability test is conducted for the bituminous concrete mix where, saw dust ash is replaced as a filler material. The study shows that, the saw dust carbonized can be replaced as filler in bitumen mixture concrete up to 0%to10%. Proper utilization of such waste materials proves to bring both ecological and economic benefits.*

Keywords: *Bitumen, Saw dust ash, filler, Marshall Stability test, Marshall flow value test.*

INTRODUCTION

Bitumen is basically obtained by refinery processes from petroleum. Mostly the colour of bitumen is black or brown and it possesses waterproofing and adhesive properties .Continuous generation of industrial waste such as fly ash , solid waste such as saw dust has a negative impact on our environment .Many local government bodies worldwide are struggling with this issue. However proper utilization of this type of waste is beneficial. The Objective of this study is to know the effect of saw dust ash as substitute for conventional filler (e.g. cement, lime, crusher dust, fine aggregate dust etc) in bituminous concrete mixture and it is replaced in place of other conventional fillers .Saw dust is a waste material forming from the processing of wood into various shapes and sizes and generally used as domestic fuel .The focus of the study is to convert saw dust ash into a construction product .This will help to reduce the quantity of waste material into our environment.

LITERATURE REVIEW

1. **Surya Muthukumar et al. :–**The main aim of this research was to evaluate the effect of non-degradable and toxic waste material in pavement construction .He proves that use of waste material in pavement construction makes it both economical and eco-friendly .
2. **K.J.Osinubi et al.:-** This research paper gives an idea to evaluation of SAD stabilized RAP as highway construction material, In this Study, Insignificant expansion and water absorption were observed.
3. **Manish Chand Kumain et al. :-**He proves that the mixture can be partially replaced with waste material. He replaced cement with saw dust ash as filler.
4. **Afifa Rahman et al. :-**He gave a statement on effect of different types of filler on bituminous paving mixes and different types of filler materials such as brick dust , cement and stone dust .
5. **Ankita Dhiman et al**.:-She concluded that the use of filler in bitumen mixes results in better performance of bituminous mixture and also helps to utilize waste material .as an filler, fills up voids in mineral aggregates, Marshall stability value & flow value of asphalt increases too.
6. **Rillagoda G.N. Yasanthi et al. 6 :-** This paper gives an information about the behaviour of HMA concrete .
7. **Debasish kar et al. :-** He studied the effect of using fly ash as filler replacing the common filler in Bituminous mix .

From the above literature, it is found that very limited study has been done on bituminous concrete mixture to fill the air voids between coarse aggregate particles.

METHODOLOGY ADOPTED:

The methodology is being divided in 3 phases as mentioned below:

1. Collection of material (saw dust Ash)
2. Tests on Physical properties of Bitumen and Aggregates (vg30 Bitumen used)
3. Marshall Stability Tests using saw dust ash as a filler

Materials used:-

1. **Bitumen:-**. VG 30 grade has been used .Bitumen percentage is been taken from 4-5%. Physical properties of bitumen are given in Table -1

Table – 1 Properties of Bitumen

Property	Test Method	Obtained Value	Standard Value (According to ASTM)
Penetration test at 25°C	IS:73 - 2006	90	80 - 100
Softening point ,°C	IS:73 - 2006	46.5	46.5 - 52
Specific gravity	IS:73 - 2006	1.05	1.03 – 0.6
Ductility at 25°C , cm	IS:73 - 2006	104	Minimum 100

2. Filler material:- The sample of saw dust was collected from nearby wood shop store . In a metal container, saw dust was carbonized or burnt into dust ashes and then ,it was grinded properly to make saw dust ash. Then sieve analysis is done .(Table-2)

Table – 2 Sieve test on saw dust ash.

Sieve size	Mass Retained in gm	Percentage retained	Percentage passing
150	0	0	100
75	20	20	80
pan	80	80	0
Total	100g	100%	

3. Aggregates:-

Aggregates were collected. The coarse aggregate and fine aggregates were separated into different sieve sizes (Table-3).

Table – 3 AGGREGATE GRADATION AS PER BITUMINOUS CONCRETE MIX.

Sieve size (mm)	Mass Retained (gm)	Percentage Retained	Percentage passing %
25mm	0	0	100%
12.5mm	250	25.0	75%
10mm	358	35.8	64.2%
4.75mm	109	10.9	89%
2.36mm	90	9.0	91%
1.18ppmm	25	2.5	98%
0.6mm	53	5.3	94.7%
0.3mm	15	1.5	98.5%
0.075mm	90	9.0	91%
Pan	10	1.0	99%
Total	1000gm	100%	

Mixture using saw dust ash as filler material and traditionally fillers have been used in bituminous concrete.

Table – 4 Physical Properties of Aggregate.

Properties	Test Method	Test result of Coarse Aggregates	Test result of Fine Aggregates	Standard values
Aggregate Crushing value (%)	IS: 2386 (Part IV)	27	-	<30
Aggregate Impact value (%)	IS: 2386 (Part IV)	25	-	<30
Specific gravity		2.70	2.78	2.60 – 2.90
Flakiness index (%)	IS: 2386 (Part I)	12	-	<25
Elongation index (%)	IS: 2386 (Part I)	16	-	<25

Marshall Method for Bituminous Mix Design:-

This test was carried out for determining the Marshall stability, flow value and optimum binder content. The test has been used to calculate the various mixture at different bitumen contents. The optimum bitumen content was selected having maximum unit weight, stability, and allowable limit of percentage air-voids. In this Mix Design following major methods were adopted:-

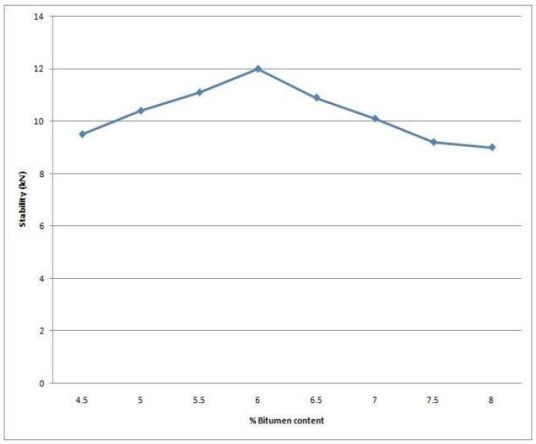
- Aggregates are mixed in suitable proportion.
- Surface coarse with 12.5mm aggregate
- Using optimum bitumen content, the mixture was prepared by replacing crushed dust with saw dust ashes fully and partially i.e 100%, 80%, 60%, 40%, 20%, 10%, 5% by the weight of filler material. For each percentage, value three samples were prepared.

  Table -5 Marshall Test result of bituminous concrete with variation of saw dust ash as filler.

Sl No.	Saw Dust Ash %	Crushed dust	Stability At 60°C In KN >9	Flow value In mm 2 - 4	Density In g/cc	Air voids % 3 - 5	VFB % 65 - 75	Remarks
(As per the MORT&H Specification)								
1	0	100	10.1	2.58	2.49	3.6	70	Satisfied
2	5	95	10.76	2.45	2.406	4.03	72.21	Satisfied
3	10	90	10.79	2.3	2.0	4.25	74.37	Satisfied
4	20	80	11.29	2.69	2.48	4.17	71.01	Satisfied
5	40	60	10.66	2.0	2.11	4.66	71.6	Satisfied
6	60	40	11.0	2.1	2.36	4.9	76.1	Not satisfied
7	80	20	10.99	2.0	2.09	5.1	75.3	Not satisfied

RESULTS AND DISCUSSION

The Marshall test results has been presented in figures 1 to 8 , in which variation of properties with respect to bitumen content and filler content were shown. Marshall Mix Design properties using fine aggregate or crushed dust and replacing crushed, using Saw Dust Ash as filler, graphical representations are as shown in figures 1 to 8.



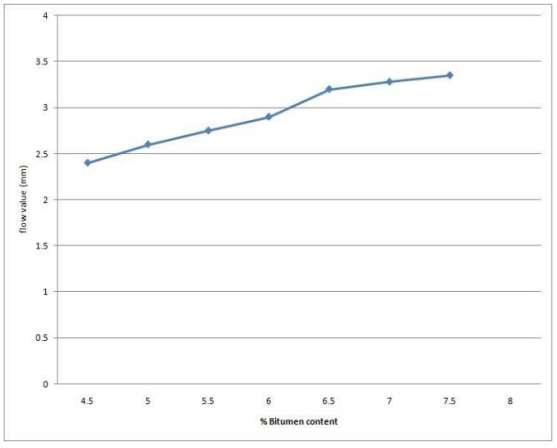


Figure 1 Stability variation with bitumen content **Figure-2** Flow value variation with bitumen content

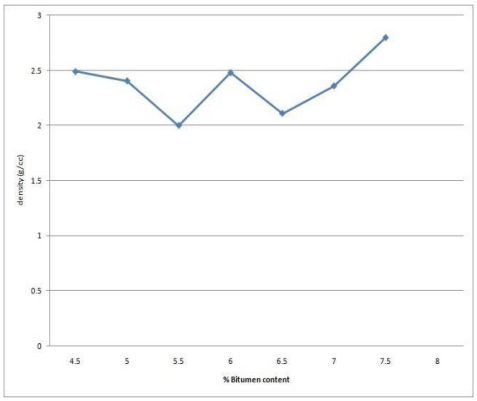


Figure-3 Density variation with bitumen content

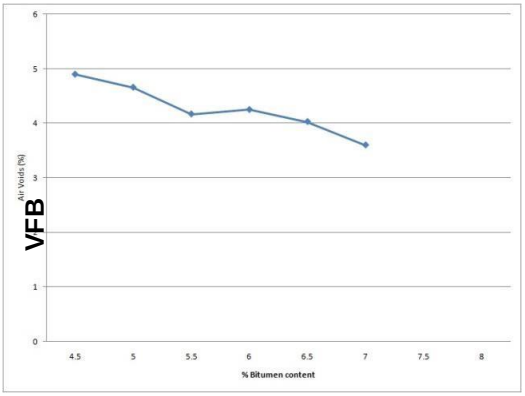


Figure-4 Air voids variation with bitumen content.

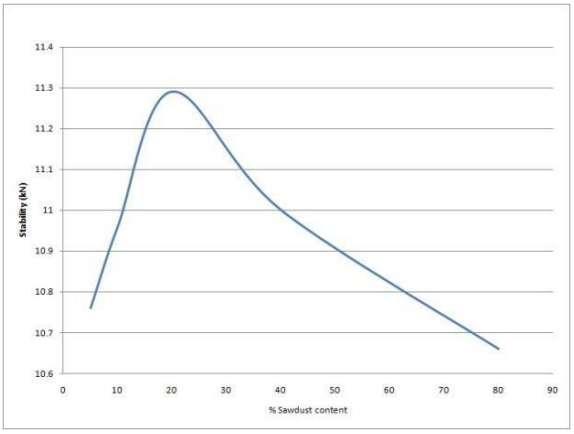


Figure-5 Variation stability with sawdust ash content

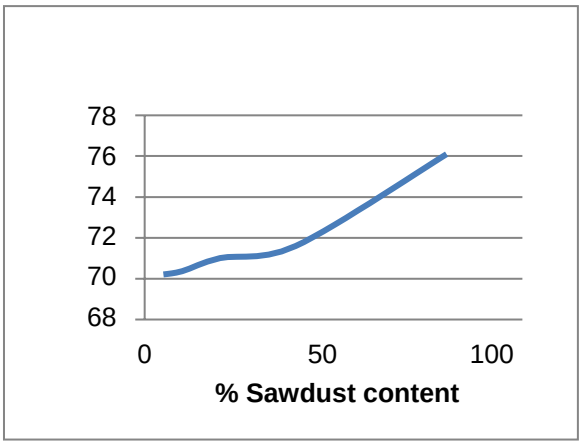


Figure-6 variation of VFB with saw dust ash

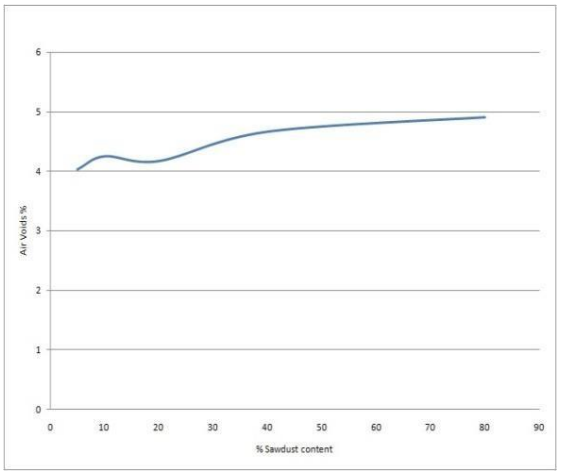


Figure-7 Air voids variation with saw dust content

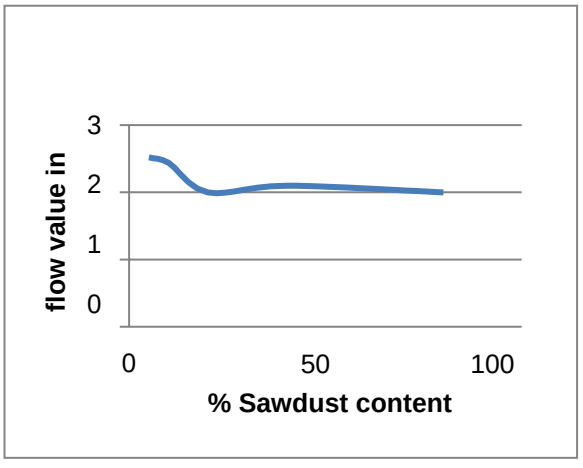


Figure-8 Flow value with saw dust content

CONCLUSION

It was found that the replacement of crush dust into saw dust ash can be possible and economical too . With 80% addition of crush dust and 20% addition of saw dush ash at 4.5% bitumen content, Marshall stability values are increasing but As the quantity of saw dust ash content increases beyond 50% filler, the mixture becomes sudden cracking prone and more brittle. Hence, saw dust ash as filler material in bitumen mix is recommended. The use of such waste material will helps to reduce the quantity of waste in our environment and also acts as an strength booster to bitumen.

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