

## Utilization of Coconut Shell in Dense Bituminous Macadam with Hydrated Lime as a Filler Material

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### Abstract:

In this paper an attempt has been made to utilize the coconut shell, hydrated lime in dense bituminous macadam. The coconut shell is produced as waste from the coconut.. Coconut shell is used as a fine aggregate by varying the percentage from 10%, 20% and 30% with lime as a filler material. Marshall Test has been considered for the purpose of mix design as well as evaluation of paving mixes. The Marshall property such as stability, flow value, % of air voids, void filled in mineral aggregate (VMA), void filled in bitumen (VFB) and optimum bitumen content was found.

**Keywords**— coconut Shell, Hydrated Lime, Marshall Test.

### I. INTRODUCTION

The highway helps to cause economical, social and cultural development of any country. In the present frame work, the need for the construction material is perpetual increasing. The setting up of highway and evolution of high speed passage strive force on natural resource. The construction of highway brings in usage of huge amount of coarse aggregate. The exterior of the road should be firm, non yielding and to permit wheel loads. The highway construction requires massive outlay of investment. The vertical oscillation is caused by the unevenness and undulation of the surface course and it increases the vehicle operation cost and also increase the vehicle operation cost.

Dense Bituminous is a sort of development material used for parking lots, drive ways, paving roads. It is made from a blend of coarse aggregate, fine aggregate, filler and blend indissoluble together by a binding agent. This blending indissoluble agent is called as a "bitumen". It is a black, sticky substance used for roads it is a by-product of petroleum refining. Bitumen will form as a bulky, tenacious appearance like tar when it is warmed, and next it shapes like a opaque when it dries. Bitumen composed primarily of profoundly condensed polycyclic aromatic hydrocarbons. It contains of 95% C and H ( $\pm 87\%$  of carbon and  $\pm 8\%$  of hydrogen) and 1 percentage of Sulphur, 1 percentage of Nitrogen, 1 percentage of Oxygen and 2000 ppm metals. Substantial fragments of unrefined petroleum the one with reaching boiling point ( $525^{\circ}\text{C}$ ). For pavement various Grades of bitumen are used for the purpose: 30/40, 60/70 and 80/100. Bitumen is also known as

asphalt. A bituminous is a mixture of coarse and fine aggregate, bitumen and it is assorted in appropriate extent to come about solid and to tough blend to resist the ponderous traffic load. Ideal substance composition and reform bituminous binders have been found to prolonged life for tiring courses rely upon the type of filler material and percentage of filler. In India, the naturally accessible substances like soils and aggregates are used for the construction of roads. Gigantic scarcity of construction materials due to the speedy development of industries and vast infrastructural progress in India. Utilization of dumping material like zinc slag, lime sludge, copper slag, red mud, ashes of coal, lime sludge and coconut shell in the construction of road would lead to solve this problem to a certain limit and it would certainly allocate an different to regular materials. Restricted use of these materials generate enormous load of wastes dumps interior the plant premises causing contamination of environment.

### II. LITERATURE REVIEW

1. **Ludfi et al(2015)** investigated on the utilization of steel and pyrophyllite as a filler material in the porous asphalt mix. 180 specimens were prepared to know the Marshall characteristics using Marshall Stability test the Optimum asphalt content was determined. By varying the asphalt content as 4%, 5%, 6% and 7% optimum content was determined. Coarse aggregate were used namely pure crushed aggregate, combined crushed aggregate with pyrophyllite and combined crushed with steel slag were prepared for comparison. Based on the experimental investigation, the authors concluded that the stability depends on the hardness of the material.

2. **Dipu et al (2015)** conducted an experimental investigation to determine the effect of waste material like concrete dust and brick dust as filler in the bituminous mixes. Control mix with fine sand and stone dust mixture was also cast to compare the results and to determine the mix design the Marshall Stability test was done. By the Marshall Stability, the exact content of bitumen was found by the Marshall Stability for various bitumen contents. Marshall Stability for fine sand and stone dust as filler was found to be 9.8 KN and 11KN.
3. **Lunagaria and gatesi (2015)** investigated to determine the utilization of high calcium fly ash as filler material in bituminous mix. The control, mix with cement as filler material was also prepared for comparison. The bitumen content was varied from 4 to 7.5% with an increment of 0.5% the result obtained showed the Marshall stability and unit weight increase with increases in bituminous concrete up to 5% and then decrease, the flow value of bituminous concrete with cement as filler was found to be lower compared to high calcium fly ash as filler.
4. **Palas and chirag (2015)** investigated an experimental study to determine the behavior of bituminous mix with steel slag as filler material. The bitumen content was varied from 4.5 to 6.5% with an increment of 0.5%. Total mixture of the steel slag was varied as 10%, 20% and 30% by weight. Marshall stability test was done to determine the mixture design.

### III. MATERIAL AND METHODOLOGY

#### A. Materials Used

1) **AGGREGATES:** The aggregates are important material in the road construction. The aggregates present in Dense Bituminous Macadam should be highly durable, strong and tough to resist heavy loads. The physical properties of aggregates should be given high importance because these aggregate undergo internal friction and high rubbing. While choosing aggregates it should have enough strength, specific gravity, hardness, toughness, and shape. Reviewing of total that ought to fulfill the necessity to the Ministry Of Road Transports and Highways specification particular were chosen.

2) **BITUMEN:** The bitumen sample was tested in the laboratory and the various physical properties such as Ductility, Penetration, Softening Point and Specific Gravity were obtained. The grade of bitumen is 60/70.

3) **COCONUT SHELL:** Coconut shell is an agricultural waste which is abundant to environment. Shell crushed in a crusher and used as a partial substitution material for fine aggregate of bituminous mix. The specific gravity of the coconut shell is found to be 1.07. The properties coconut shells were investigated in an experimental study. When Dense Bituminous Macadam mixtures are mixed with coconut shell it will improves the engineering properties.

4) **HYDRATED LIME:** Lime is used in the stabilization of road surfaces. Lime is used as filler in Dense Bituminous Macadam to improve resistance to high temperature rutting.

#### AGGREGATE GRADATION

Aggregate gradation adopted as per Ministry Of Road Transport and Highway Specification for Dense Bituminous Macadam grade II nominal size of aggregate is 26.5mm.

#### B. Methodology

##### DESIGN OF DBM MIX

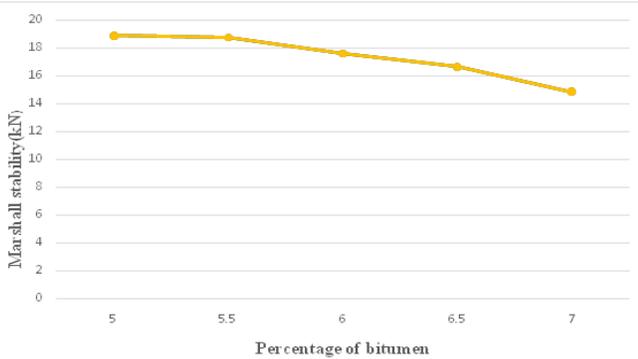
##### Mix preparation

- AS per the MORTH Specification the given sample are weighed as per gradation. The total weight of aggregate and filler is about 1200gm of aggregate from different size the selected mix proportion heated up to 165°C to 175°C .
- Bitumen Sample is heated to 150°C to 170°C temperature. Samples are prepared with different percentages such as 5%, 5.5%, 6.6%, 5% and 7% by weight of aggregate .
- After mixing the mix should be poured in to marshal sample mould.
- By using the rammer the top surface is compacted by giving 75 blows on either side of specimen. Rammer has 4.5kg weight and 7cm height.
- Each Dense Bituminous Macadam Sample is prepared using filler material as lime. The DBM samples are also prepared with coconut shell (10%, 20%, 30%) as replacement to fine aggregate with lime as filler material.
- By using the specimen extractor remoulding is done after 24hours. Weight in air and weight in water of the specimen will be noted.
- Marshall Stability, bulk density, the flow void in the mix voids in mineral aggregate and voids filled in bitumen are determined.

### IV. RESULTS AND DISCUSSIONS

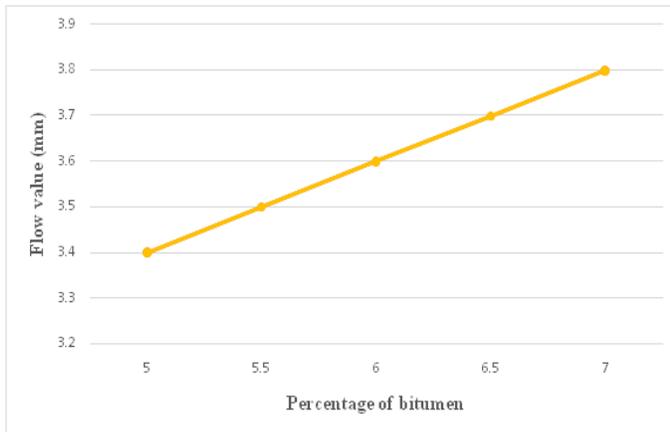
The Following Graphs shows the result the Marshall properties such as Marshall stability, Flow, Bulk

Density, volume of voids, voids in mineral aggregate, voids filled with bitumen.



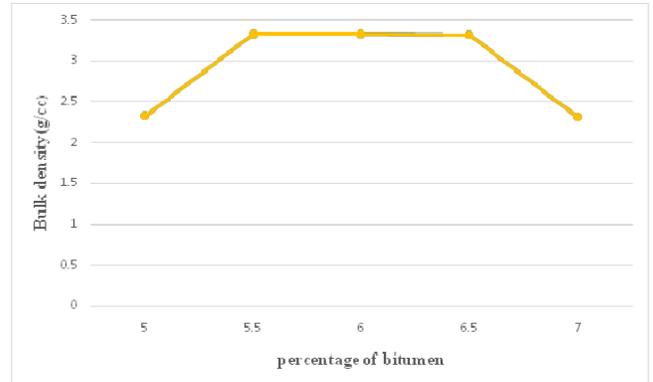
**Figure No 4.1: Marshall stability v/s bitumen content**

From fig 4.1, For dense bituminous macadam mix, the marshall stability value is higher with lime. The maximum stability occurs in 5% of bitumen content bitumen , it means the content of bitumen increases whereas the marshall stability value decreases.



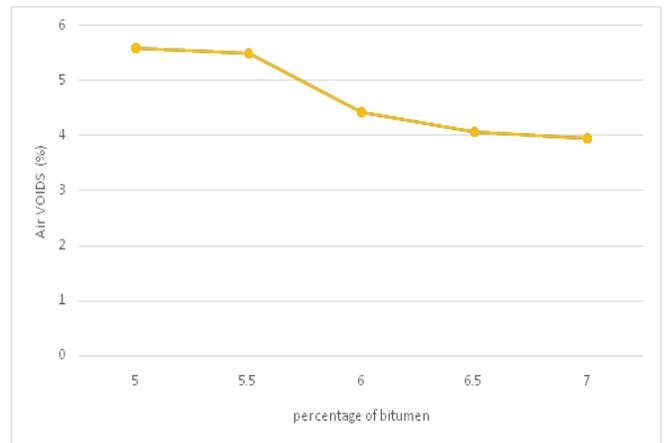
**Figure No:4.2:Flow value v/s bitumen content**

In fig 4.2 it indicates that as bitumen content increases as the flow value increases because the rate of increases is being higher for higher proportions of bitumen .Flow value obtained in Dense Bituminous Macadam with lime are within the Ministry Of Road Transports and Highway limits.



**Figure No:4.3 Bulk density v/s bitumen content**

Fig 4.3 shows that with increasing in the bitumen content the bulk density also decreases. The bulk density increases up to the 6.5% of the bitumen content after that the bulk density decreases by increases of the bitumen content. Bulk density is known by the weight of air, weight of water of the compacted specimen.



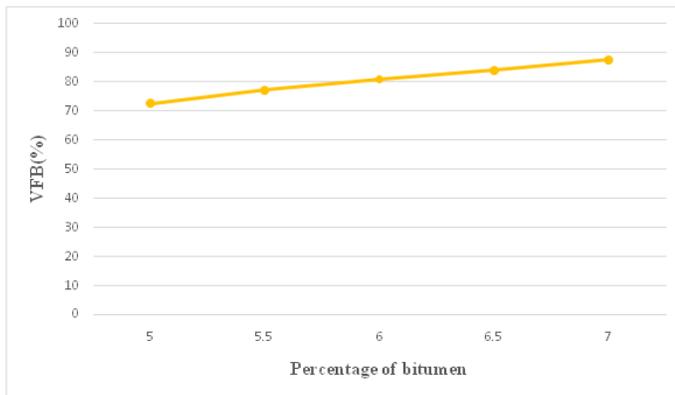
**Figure No:4.4 Air voids v/s bitumen content**

Fig 4.4 shows that the content of bitumen increases whereas the volume of voids decreases. It observed that lime is less reduction in air voids .Because of lime as too fines may fills the voids more effectively



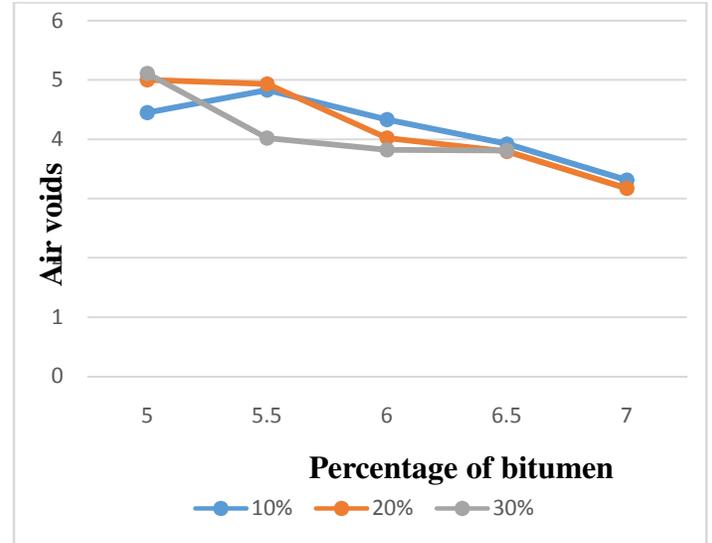
**Figure No:4.5 Voids in Mineral Aggregate v/s bitumen content**

Fig 4.5 shows that the increasing in the bitumen content the VMA also increase.



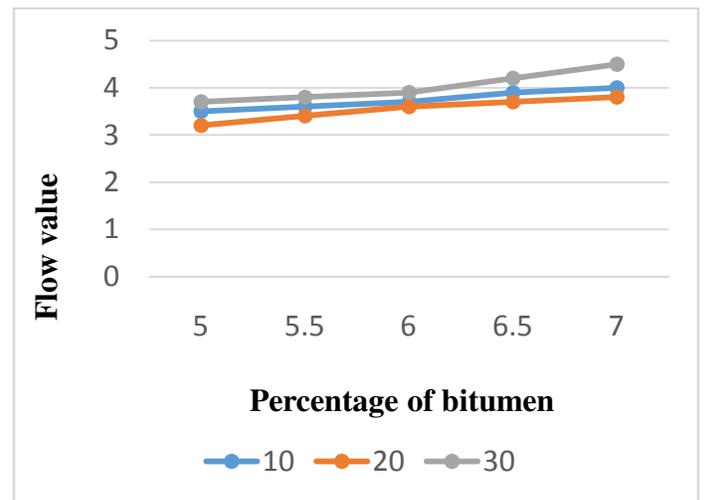
**Figure No:4.6 bVoids in Filled in Bitumen V/S Bitumen content**

Fig 4.6 shows that increases the bitumen content and also increase the voids in mineral aggregate gradually. At 5.8% bitumen content the VFB IS 73.36 which is within the MORTH Specification.



**Figure No 4.8 marshall stability V/S percentage of bitumen**

Fig 4.8 shows that Marshall stability value for the mix rises up to the bitumen content 5.5% and later addition of bitumen the stability decreases. By adding of coconut shell to the DBM, stability value is higher than the control mix. when compared to conventional the 30% percentage of coconut shell with DBM Mix gives the high Marshall stability.



**Figure No: 4.9:Flow value V/S Percentage of bitumen**

Fig no.4.9 shows that the content of bitumen increases the flow value increase. The flow value for Dense Bituminous Macadam mix with coconut shell is slightly same as control mix.

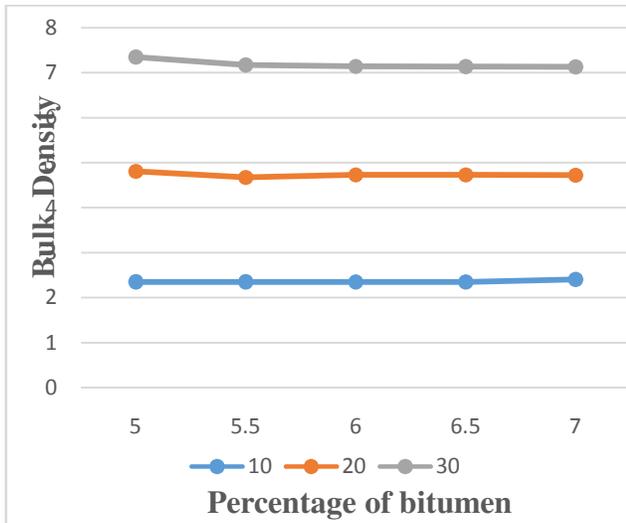
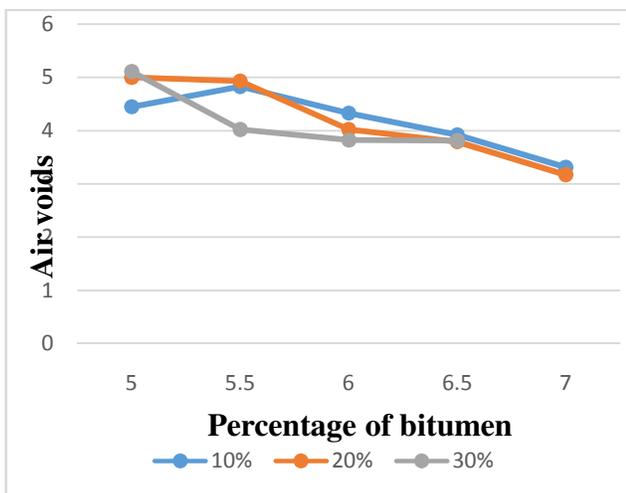


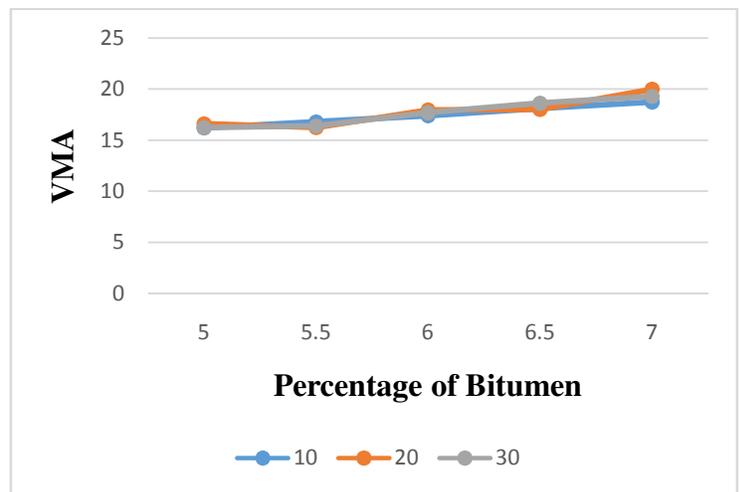
Fig no 4.9 shows that the increase in the percentage of coconut shell in the DBM the value of bulk density goes on increases. The DBM mix of 30% has high bulk density compared to Conventional and 10% , 20% DBM Mix.



**Fig 4.10 Air voids v/s percentage of bitumen**

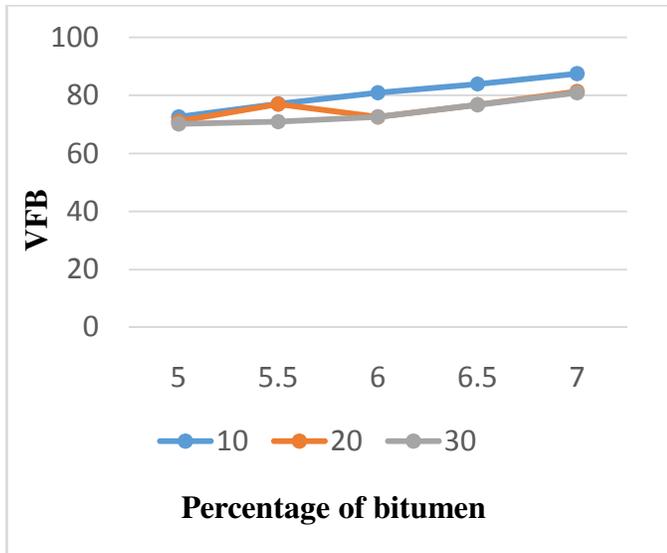
Fig no 4.9 shows that the increases in the bitumen content increases the void.

It shows that the content of bitumen increases whereas the volume of voids decreases. It observed that lime is less reduction in air voids .Because of lime as too fines may fills the voids more effectively.



**Figure No: 4.11: Voids Filled in Bitumen v/s Percentage of bitumen**

Fig no:4:11 shows that the increasing the bitumen content the voids filled in the bitumen increase. The 10% of coconut shell shows a maximum volume of voids. It shows that increases the bitumen content and also increases the voids in bitumen gradually.



**Fig 4.12 Voids filled in Mineral Aggregate v/s percentage of bitumen**

Fig 4.1.2 shows the void filled with bitumen decreases with increasing the bitumen content are lesser than the control mix. The mix with 20% of coconut shell shows a maximum void filled in the bitumen e than control mix, 10%, 30% Dense Bituminous Macadam.

#### V. CONCLUSION

1. The basic tests carried out on aggregate and bitumen are within the IS code specification.
2. Dense Bituminous Macadam mix with lime as filler material shows higher Marshall Stability value compared.
3. The maximum stability for lime mix found at 5% bitumen content.
4. In Dense Bituminous Macadam 30% of coconut shell with lime as filler material, the Marshall stability value increases when compared to Dense Bituminous Macadam of control mix lime 20% and 10% coconut shell with lime mix.
4. The maximum stability of Dense Bituminous Macadam with coconut shell and lime is at the bitumen content of 5.3% and Dense Bituminous Macadam with coconut shell is at bitumen content of 5.7%.
5. Based on the stability, volume of voids, bulk density, it clear the coconut shell can be used for the replacement of fine aggregate because it satisfy the

Ministry Of Road Transports and Highways specification.

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