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Study on the Effect of RHA as Mineral Filler in Hot Mix Asphalts (HMA)

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Abstract*: *Rice husk is one of the main agricultural residues obtained from the outer covering of rice grains during the milling process. It constitutes 20% of the 500 million tons of paddy produced in the world. It's an agriculture waste and when waste are to be burned and to depose it in land filling, it's not a ecofriendly processes as they pollute the land and the air. Use of rice husk ash in embankments is also an important.

These days utilization of waste product in construction industry is going on rapidly. One such types of agro-industrial waste product is Rice Husk Ash (RHA), produced abundantly in rice mills from the burning of Rice Husk (RH).

RHA is using in preparation of semi dense bituminous concrete as a filler material in place of lime. The optimum bitumen content for 2 % lime and 2% RHA is calculated. The above OBC is calculated with the preparation of marshal stability mould with different percentage of bitumen (4.5%, 5.0%, 5.5%, and 6.0%). The optimum bitumen content (OBC) is found as 5.5% for both the cases.

The result of replacement of lime by RHA shows remarkable increases in stability with other specification (flow value, Vv%, VMA% & VFB%) remains in permissible limits as per MORTH specification (section 500-16)

Keywords*: *Rice husk ash, lime, flexible pavement, hot mix asphalts, marshal stability test, optimum bitumen content.

I. INTRODUCTION

In India, it is estimated that over 50 lakh kilometres of road exists. The road transport carries close to 85% of passenger traffic and 75% of freight transport.

In India two types of pavement are available i.e.; - Flexible Pavement & Rigid Pavement. Flexible pavement is the common type & economical than rigid pavement. Flexible Pavement consists of 3 layer of different materials on the top of soil sub grade. It transmits the load from top surface to the bottom through its inter-connecting layers. Flexible pavement distributes load over a relatively smaller area of the sub grade beneath. The initial construction cost of a flexible pavement is comparatively minimum that is why this type of pavement is more commonly seen universally. However, the flexible pavement requires maintenance & routine repairs every few years. Additionally flexible pavement deteriorates rapidly due to the occurrence of cracks & potholes are likely to appear due to poor drainage or heavy vehicular traffic.

Semi dense bituminous concrete shall be used as a wearing course & shall not be laid directly over WBM or any granular base. Bituminous concrete is a costlier material than semi dense bituminous concrete. They both mainly differ in the percentage of dust. SDBC product is a highly engineered but simple & effective solution for paving roads. Roads that require a durable all-weather surface measuring 25-40 mm in thickness over previously prepared CRRI-BitChem Cold BM structure, with closed graded aggregates.

Filler play important role in property of SDBC mix, Fillers increases the stiffness of the asphalt mortar matrix. Fillers also affect workability, moisture resistance, and aging characteristics of HMA mixtures. Different types of mineral fillers may be used in the HMA mixes such as stone dust, ordinary Portland cement (OPC), slag, fly Ash, hydrated lime and Rha etc.[3]

Rice husk ash (RHA), as a by-product of rice mill, has recently been used in highway construction. However, the use of RHA in asphalt mix is still in very.Rice husk is one of the main agricultural residues obtained from the outer covering of rice grains during the milling process. It constitutes 20% of the 500 million tons of paddy produced in the world. It's an agriculture waste and when waste are to be burned and to depose it in land filling, it's not a ecofriendly processes as they pollute the land and the air.

From total production of rice about 20% is rice husk, which is used to generate electricity in power plants, and that produces about 18% of rice husk ash (RHA) which is about 4.43 million tonnes. RHA is a highly pozzolanic material, contains silica and surface specific area. RHA, That's why many of the field in civil engineering it's being used in soil engineering and in highway

construction in flexible pavements as mineral filler. It is discovered that RHA is a highly pozzolanic material contains more % of silica, its rich in amorphous silica about 86% in RHA in this study **[4]**

(a) **(b)**

Fig. 1 RHA

II. LITERATURE REVIEW

Although many researchers have studied the effects of RHA in concrete mixtures but very little study has been a done to utilize RHA into SDBC mixtures.

During the last few decades the developments on the analysis of asphalt mixes with RHA is developed.

R. Tomar, et al (2013) [5] – studied the effect of fillers on bituminous paving mixes. Construction of highway involves huge outlay of investment. A precise engineering design may save considerable investment; as well as reliable performance of the in-service highway can be achieved. Two things are of major considerations in this regard pavement design & the mix design. A good design of bituminous mix is expected to result in a mix which is adequately strong, durable & resistive to fatigue and permanent deformation & at the same time environment friendly & economical.

S.Karahancer, et al (2013) [6] - reported on the use the rice husk ash (RHA) in the hot mix asphalt as mineral filler. For this purpose, four different serial asphalt concrete samples are produced using limestone (LS) in different proportions 2% - 5% as mineral filler. The amount of optimum bitumen & the value of Marshall Stability (MS) are determined with MS test for the samples. Choosing the series of asphalt having 5% filler which has given the highest stability RHA is changed with LS filler in the rate of 25%, 50%, 75%, & 100%. After that MS test is conducted on the produced samples & the results are evaluated.

Mistry,T et al (2015)[3] – studied the utilization of rice husk ash in hot mix asphalt concrete as mineral filler replacement. RHA (Rice Husk Ash) is a highly pozzolanic material & contains non crystalline silica & high specific surface. In their work the researcher tries to make an effort to evaluate the usefulness of RHA as filler instead of conventional filler in hot mix plant that may mitigate the problem of waste management. The researcher used OPC-43 grade cement & rice husk satisfying (MORTH) as an alternative of cement (confirming to IS 4031).

M.Jamil, et al (2013)[10] - studied the Rice husk ash (RHA) is an established supplementary cementitious material (SCM). Extensive research has been carried out to incorporate RHA as a SCM in casting concrete & mortar. RHA contributes in two fold of effects in concrete or mortar; i.e. filler effect and Pozzolanic effect. Replacement percentages of RHA used in various previous studies are chosen arbitrarily like 5%, 10%, & 20% & so on to determine the total effect of RHA. But the unique filler effect or Pozzolanic effect of RHA in cementitious system is yet to be investigated comprehensively by the scientific community.

This study is carried out to find the maximum Pozzolanic (chemical) contribution of RHA in cementitious system in terms of replacement percentage.

III.MATERIAL

A. Aggregates

Aggregates are the principal material in pavement construction. Conventional road aggregates in India are natural aggregates obtained by crushing rocks. The physical properties of coarse aggregate are more significant in bituminous mixtures. Shown in table-3.1.1,

Coarse aggregates: The coarse aggregates shall be generally as specified in Clause 507.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-14.MORTH[7]

Fine aggregates: The fine aggregates shall be all as specified in Clause 507.2.3 MORTH [7]

Aggregate characteristics such as particle size, shape, and texture influence the performance and serviceability of hot mix asphalt pavement.

B. Binder

Bitumen acts as a binding agent to the aggregates, fines and stabilizers in bituminous mixtures. Binder provides durability to the mix. The behaviour of bitumen depends on temperature as well as on the time of loading. It is stiffer at lower temperature and under shorter loading period

Physical property of Bitumen & their specifications as per IS: 73-2006[10]

C. Filler

Filler shall, be generally as specified in Clause 507.2.4. 2 per cent by total weight of aggregate, of hydrated lime shall be added without additional cost.[7]

Rice husk is an agricultural residue which accounts for 20% of the 649.7 million tons of rice produced annually worldwide. The chemical composition of rice husk is found to vary from one sample to another due to the differences in the type of paddy, crop year, climate and geographical conditions. See Table 1. The chemical composition of typical rise husk ash**.** Burning of RH in ambient atmosphere leaves a residue, called rice husk ash. The non-crystalline silica and high specific surface area of the RHA are responsible for its high Pozzolanic reactivity. [18]

Research has shown that RHA has been used in SDBC mix as mineral filler and could be a suitable Use in place of lime.

Table 1

The chemical composition of typical rise husk ash is as follows:-

Chemicals	%
Silicon dioxide (SIO_2)	86.66
Aluminium oxide(AL_2O_3)	2.48
Iron oxide (FE_2O_3)	1.10
Calcium oxide (CAO)	1.75
Magnesium oxide (MgO)	1.08
Carbon dioxide ($9CO_2$)	0.51
Loss on ignition	3.80
Potassium (K_2O)	1.4
Sodium (NA_2O)	0.1

IV. EXPERIMENTAL WORK

The semi dense bituminous concrete mix was prepared by using Marshal Method of bituminous mix design. The SDBC was prepared with conventional 60/70 grade bitumen & using RHA as filler by partial replacement of lime with varying percentages.

Table 2

the details of the experimental programme are as follows:-

Filler	Filler % by weight of total weight	% Constituent of bitumen by total weight
Lime	2%	4.5%
		5.0%
		5.5%
		6.0%
RHA	2%	4.5%
		5.0%
		5.5%
		6.0%

Ministry of Road, Transport and Highways (MORTH)(section 500-16)[7] has provided specifications for road and bridge Works. The specifications for SDBC are as follows:

Table 3
Specifications for SDBC

Sr. No.	Parameter	Specified limit
1	Min. stability (in KG at 60°c)	820
2	Min. flow (mm)	2
3	Max. flow (mm)	4
4	Compaction level (no. of blows)	75 blows on each face/side
5	% Air voids Vv	3-5
6	% VFB	65-78

V. RESULT AND DISCUSSION

The SDBC was prepared by Marshal method using the 60/70 grade bitumen to obtain optimum bitumen content and the various mix design characteristics of the Marshal stability value, bulk density, air voids (Vv) %, void in mineral aggregates (VMA), Voids filled with bitumen were found out. The results are shown in table 4

Table 4
Result of Marshal Stability with 2% lime in various percentage of bitumen content

Lime%	B.C.%	Stability in kg	flow	Vv%	VMA%	VFB%	Unit wt. gm/cc
	4.5	868	2.2	6.96	16.78	58.40	2.194
2	5	930	2.8	5.22	16.19	67.75	2.201
	5.5	1178	4.0	5.00	16.87	70.36	2.290
	6	1023	5.2	4.89	17.64	72.28	2.245

The result shows that at 5.5% bitumen content higher value of Marshal Stability value and greater density was achieved & all other parameters were in permissible limit within the specification MORT&H.The results are shown in Table 5.

Table 5
Result of Marshal Stability with 2% RHA in various percentage of bitumen content

RHA %	B.C. %	Stability in kg	flow	Vv%	VMA%	VFB%	Unit wt. gm/cc
	4.5	961	2.9	6.30	16.11	60.91	2.150
2	5	1054	3.6	5.24	16.11	67.47	2.190
	5.5	2170	3.8	5.12	16.99	69.86	2.230
	6	1550	6.0	4.83	17.66	72.65	2.202

This result shows that by using RHA in place of Lime as a filler in SDBC mix at 5.5% bitumen content higher value of Marshal Stability and greater density was achieved .all other parameters were in permissible limit within the specification MORTH[7].

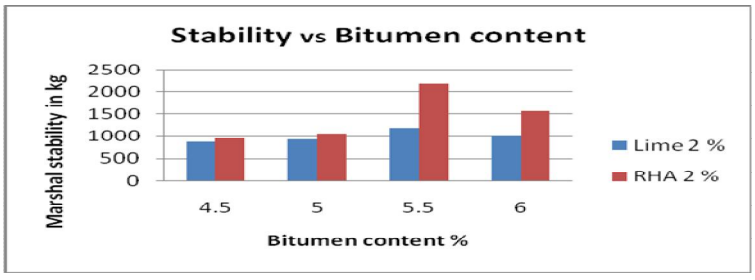

Figure2.Variation of Marshal stability V/S Bitumen content

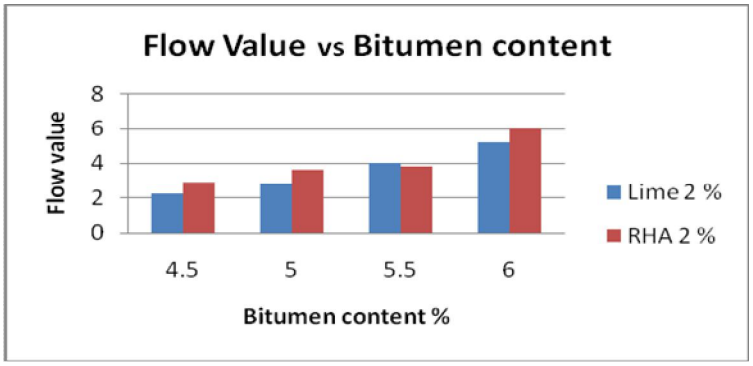

Figure3.Variation of flow value V/S Bitumen content

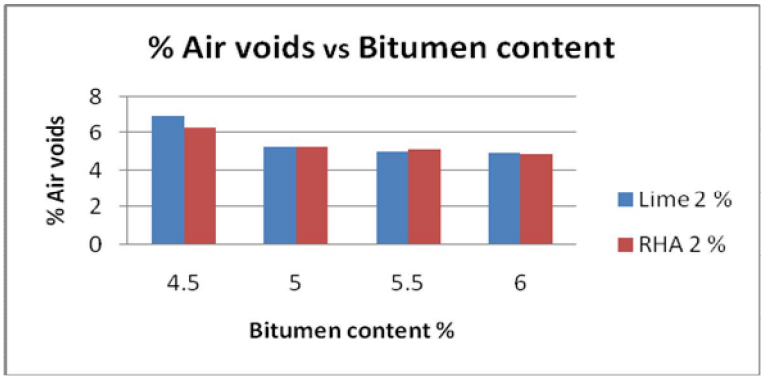

Figure4.Variation of % Air voids V/S Bitumen content

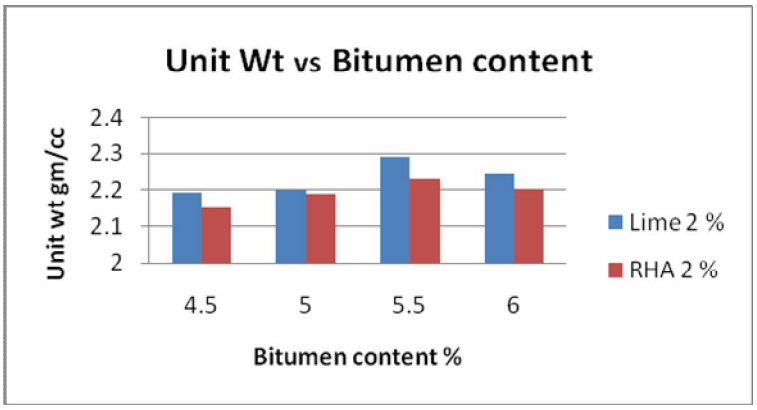

Figure5.Variation of unit wt. V/S Bitumen content

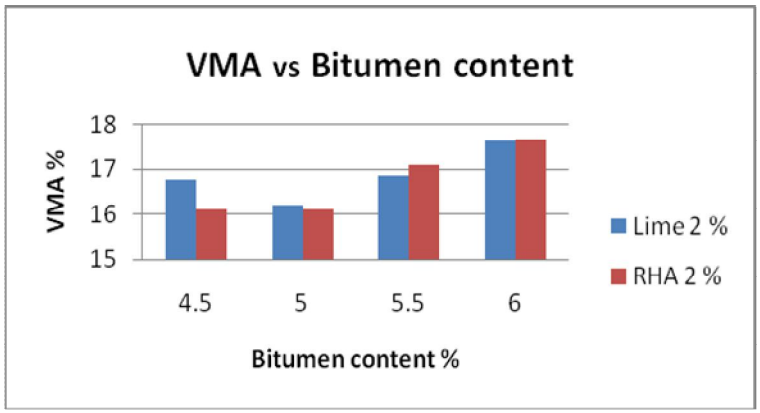

Figure6.Variation of %VMA V/S Bitumen content

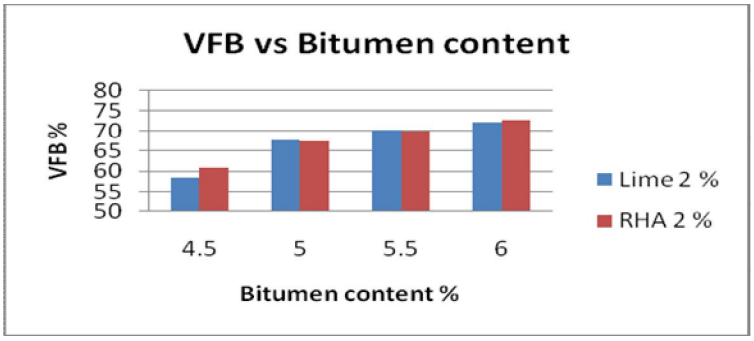

Figure7.Variation of VFB% V/S Bitumen content

Optimum bitumen for this mix is obtained from graph is 5.5% and Above optimum bitumen content higher value of marshal stability is obtained.

VI. CONCLUSION

The paper presents a laboratory based study that was conducted to evaluate the performance SDBC mix design with RHA as a filler .that meets the standard specification for hot mix asphalt design.
Based on the number of test conducted the following conclusions were made as the outcome of the study:-

A. The constituent's materials conform to the specified requirement therefore RHA can be used in HMA.
B. The value for the required properties of bitumen as a binder as regards its penetration, viscosity, flash and fire point, durability and solubility all conform to those specified in IS standard specification of the design of asphalt concrete
C. Result of marshal stability test with 2% lime shows that that stability increases up to 5.5% bitumen content and decreases further addition of bitumen content.
D. While replacing 2% lime with 2% RHA result of marshal stability test with increases up to 5.5% bitumen content and decreases further addition of bitumen content
E. On comparing in both the cases with 2% filler RHA has much higher value of marshal stability at 5.5 % bitumen content.
F. The results of this investigation indicate that rice husk ash can successfully be used as filler in the semi dense bituminous mixes. For the particular type of grading used for this investigation 2% rice husk ash is considered with 5.5% bitumen content. Thus, it was concluded that Rice husk ash can effectively used in place of lime (filler).

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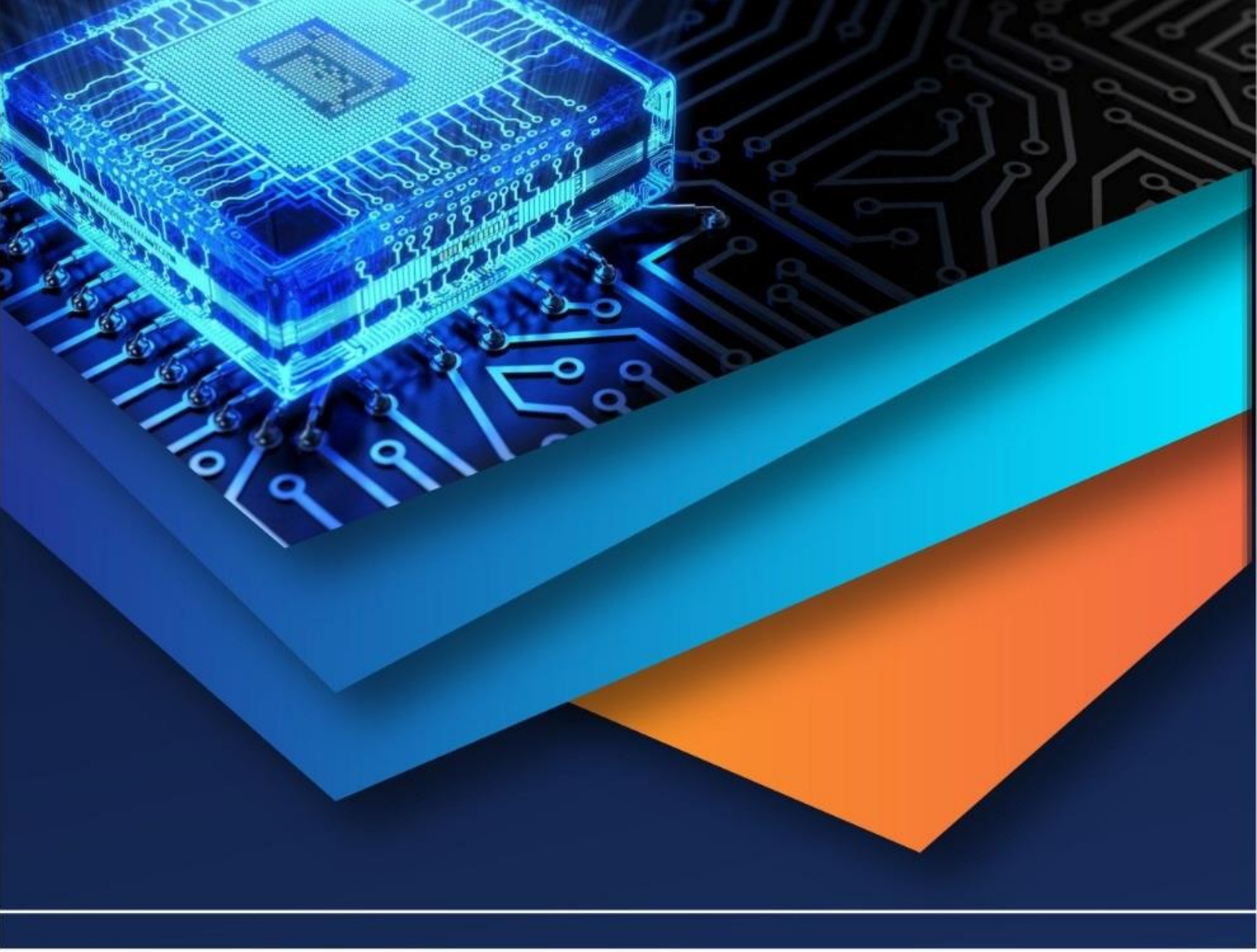

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