iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3736

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

Effect of Rise Husk Ash as Mineral Filler in Mastic Asphalt

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Abstract: Here in the study, were looking forward to use the Rise Husk Ash (RHA) as filler in Mastic Asphalt (MA). For such study different Mastic Asphalt samples were made with Limestone (LS) as filler in different proportion (i.e. 8%, 9%, 10%, and 11%) with varying percentages of binder content (i.e. 14%, 15%, 16% and 17%). These samples were tested with Marshall Stability test and Marshall Stability value (kg) is find out. By looking towards the test results it is observed that the sample with 8% limestone filler gives the highest MS value. Now again this LS filler is replaced by RHA with different percentages (25%, 50%, 75%, and 100%) with respect to LS. The MS test is again performed on the samples made by adding RHA and find out the Marshall Stability value (kg), it was clearly observed that RHA can be used as filler in Mastic Asphalt.
***Keywords*: Mastic Asphalt, Rice Husk Ash (RHA), Marshall Stability Test, Marshall Stability.**

I. INTRODUCTION

The quality of roads dictates the economy of a country and hence the quality of our lives. Roads are vital for the transport of the goods and passengers. In India, road transport carries approximately 85% of passenger traffic and 70% of freight transport. But the construction of highways involves huge amount of the investment and mainly sixty percent of the highway project cost is associated with the pavement construction. Pavement is a durable surfacing of a road, airstrip, or similar area and the primary function is to transmit loads to the sub-base and underlying soil sub grade. Around ninety percent of the Indian Highways have a covered surface with bituminous layers which are constructed and maintained by using naturally available road aggregates and bitumen, a petroleum product, which being mixed at high temperatures to produce hot mix asphalt.

Mastic asphalt is an ideal material for a whole range of construction applications, both new build and refurbishment, where a smooth, seamless, durable surface is required. It offers total waterproofing integrity for roofing and tanking and acts as a tough working surface in flooring and paving. This standard covers the requirement for bitumen mastic for use as wearing course in different situations of heavy duty road pavements. However, use of this material is not recommended in place where abundant fuel oil dripping is expected on the pavement surface like bus depots, fuel filling and service stations etc [MORTH 515.1].

The bitumen mastic asphalt is an intimate homogeneous mixture of mineral fillers and well graded fine and coarse aggregate with a hard grade bitumen, cooked and laid hot, trowelled and floated by means of a wooden float. The mixture settles to a coherent, voidless and impermeable solid mass under normal temperature conditions. The bitumen mastic is normally used as a wearing course over the mastic laid surface, hard stone chips precoated with bitumen are grafted or spread and rolled to provide a skid resistant surface.

Rice Husk Ash (RHA) is formed by the rice husk, which is the by product of rice crop. It is formed by burning the rice husk at a certain temperature [3]. Since India is one of the world's largest rice producing country, the amount of rice husk is produced in very huge amount also hence this will lead to large amount of RHA .

Every year approximately 100 million tonnes of paddy are produced in India. This gives around 24 million tonnes of rice husk and 4.4 million ton of RHA[13]. So every 1000 kgs of paddy milled, about 220 kgs(22%) of rice husk is produced, and when this husk is burnt in the boilers, about 55 kgs (25%) of RHA is generated. This RHA contains around 80-90 % silica.

II. PRESENT SCENARIO AND SCOPE

In our current scenario pollution is our major problem and keeping our environment clean and free pollution is our main motive. Since rice is very important crop and we always focusing on increasing the growth rate of crop, this leads to increase in rice husk also, this rice husk sometimes dump in the form of husk but mostly it is dumped by converting into RHA. There were many works are conducted by using RHA in many work area**[6], [7].** But there is not any work about using of RHA in Mastic Asphalt. The purpose of this work is to use of RHA in Mastic Asphalt. Since MA is generally used for covering purpose over flexible pavement, hence RHA has high amount of silica (80-90%), then it's use in MA increase it's binding nature and increase the load capacity and

durability of the flexible pavement. . For this purpose Marshall Stability test is carried out by preparing different MA samples with different RHA content and lime content with different binder content.

III. 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 MASTIC ASPHALT.

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

1) *Sebnem Sargin, et al (2013)* - In the study, it was investigated to use the rice husk ash (RHA) in the hot mix asphalt as mineral filler. For this purpose, four different serial asphalt concrete samples were produced using limestone (LS) in different proportions (4%, 5%, 6%, and 7%) as mineral filler. The amount of optimum bitumen and the value of Marshall Stability (MS) were determined with MS test for the samples. Choosing the series of asphalt having 5% filler which has given the highest stability RHA was changed with LS filler in the rate of 25%, 50%, 75%, and 100%. After that MS test was conducted on the produced samples and the results were evaluated. As a result, it has come in view that RHA can be used as mineral filler in the asphalt concrete
2) *R. Tomar, et al (2013)* – 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.
3) *S.Karahancer, et al (2013)* - 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.
4) *Mistry,T et al (2015)* – 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).

IV.METHEDOLOGY

Preparation of mastic asphalt consist of two stages. The first stage shall be mixing of filler and fine aggregate and then heating the mixture to a temperature of 170*C to 210*C. Required quantity of bitumen shall be heated to 170*C TO 180*C and added to the heated aggregate. They shall be mixed and cooked in an approved type of mechanically agitated mastic cooker for some time till the material are thoroughly mixed. Initially the filler alone is to be heated in the cooker for an hour and then half the quantity of binder is added[MORTH 515.4.4].

After heating and mixing for sometime, the fine aggregate and the balance of binder are to be added and further cooked for about one hour. The second stage is incorporation of coarse aggregate and cooking and mixing, care shall be taken to ensure that the contents in thecooker are at no time heated to a temperature exceeding 210^0C.

V. MATERIALS USED IN THE STUDY

A. Coarse Aggregate:

The coarse aggregate shall consist of clean, hard, durable, crushed rock free of disintegrated pieces, organic and other deleterious matter and adherent coating. They shall be hydrophobic of low porosity and satisfy the physical requirement.

The percentage and the grading of the coarse aggregate to be incorporated in the mastic asphalt depending upon thethickness of the finished course. The minimum and maximum thickness of the mastic asphalt for wearing course shall be 25 mm and50 mm respectively except for footpath of bridges where it shall be20mm and 25 mm respectively **[512.2.2]**.

B. Binder

The bitumen shall be straight run bitumen considering **to IS: 73-1961** or industrial bitumen as per **IS: 702-1961** of suitable consistency. We use VG 40 grade bitumen for this study.

C. Filler

The conventional filler is using is limestone powder passing 75micron and shall have calcium carbonate not less than 80% when determined in accordance with 1195-1978.

D. Fine Aggregate

The fine aggregate should consist of crushed hard rock and natural sand or mixture of both. The grading of fine aggregate inclusive of filler material passing 75 micron.

E. Rice Husk Ash

The RHA is made by burning the rice husk at certain temperature. The grading of RHA is similar to the fine aggregate.

(a) **(b)**

Rice Husk (a) and Rise Husk Ash (b)

Chemical Properties Of Rise Husk Ash

Silica	lime	Alumina	Iron Oxide	Magnesia
85.14%	3.08%	2.07%	1.43%	4.03%

VI. PREPARATION OF MARSHALL SPECIMEN FOR MASTIC ASPHALT MIX

Mastic Asphalt samples were prepared for four different filler proportion (8%, 9%, 10% and 11%) and four different bitumen content (14%, 15%, 16% and 17%) and these samples were tested for determining the Marshall Stability. Four samples were prepared for each of fractions. Sixteen samples were totally prepared and MS, flow value, bulk specific gravity, volume of voids (Vv), voids in bitumen (Vb) , voids in mineral aggregate (VMA) and voids filled with bitumen (VFB) values were determined.

VII. ANALYSIS OF TEST RESULTS

TABLE 1- Samples were prepared by filler proportion of 8 %.

OBC %	Bitumen CONTENT,%	HEIGHT OF SAMPLE mm	% VOIDS		VMA %	VFB %	STABILITY VALUE, KG	FLOW VALUE mm
			Vv	Vb				
14%	14%	74	2.71	27.75	30.46	91.10	1057.4	4
	15%	77.33	4.11	30.86	34.97	88.25	746.4	5
	16%	76.33	4.15	28.65	32.80	87.35	684.2	7.2
	17%	79	2.79	31.70	34.49	91.91	622	7.7

TABLE 2- Samples were prepared by filler proportion of 9%.

OBC %	Bitumen CONTENT,%	HEIGHT OF SAMPLE mm	% VOIDS		VMA %	VFB %	STABILITY VALUE, KG	FLOW VALUE mm
			Vv	Vb				
14%	14%	74.33	1.81	25.96	27.77	93.48	995.2	4.5
	15%	75.33	1.37	28.96	30.33	95.48	684.2	6.5
	16%	75	3.69	28.99	32.68	88.71	808.6	5.5
	17%	75.66	1.86	31.34	33.20	94.40	497.6	7.4

TABLE 3- Samples were prepared by filler proportion of 10%.

OBC %	Bitumen CONTENT,%	HEIGHT OF SAMPLE mm	% VOIDS		VMA %	VFB %	STABILITY VALUE, KG	FLOW VALUE mm
			Vv	Vb				
14%	14%	75.66	5.80	26.91	32.71	82.27	933	3
	15%	78	1.37	28.10	29.47	95.35	870.8	5
	16%	77.66	3.69	28.37	32.06	88.49	622	6.5
	17%	78.33	1.86	31.11	32.97	94.36	684.2	7.5

TABLE 4- Samples were prepared by filler proportion of 11%.

OBC %	BITUMEN CONTENT,%	HEIGHT OF SAMPLE mm	% VOIDS		VMA %	VFB %	STABILITY VALUE, KG	FLOW VALUE mm
			Vv	Vb				
14%	14%	73.66	5.28	25.22	30.5	82.69	890.50	3
	15%	75.66	3.65	28.07	31.72	88.49	720.50	3.5
	16%	74	4.60	28.62	33.22	86.15	648.80	4.5
	17%	76	3.26	30.89	34.15	90.45	635.90	6

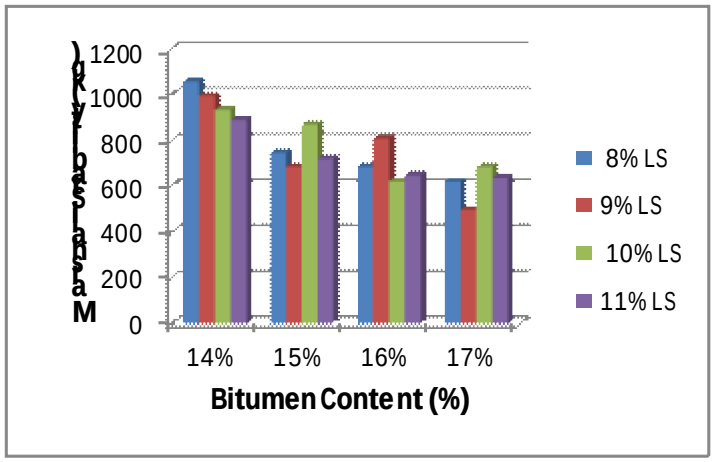

Fig. 1; Marshall Stability Vs Bitumen content

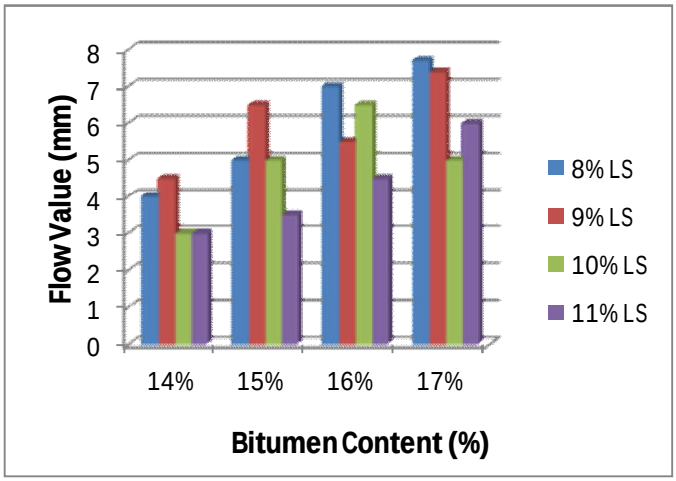

Fig. 2; Flow value Vs Bitumen content

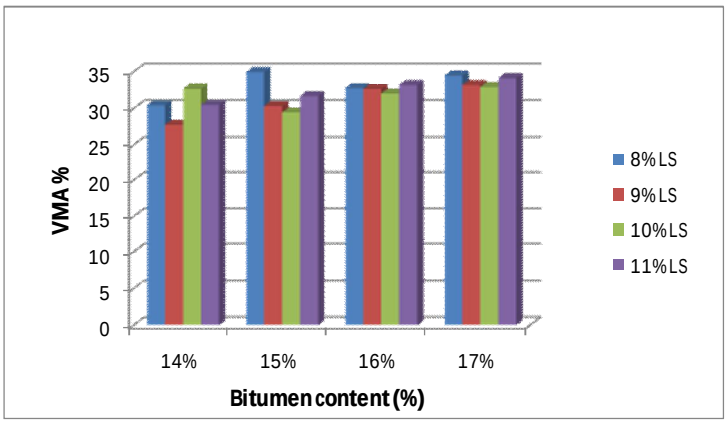

Fig. 4; VMA Vs Bitumen content

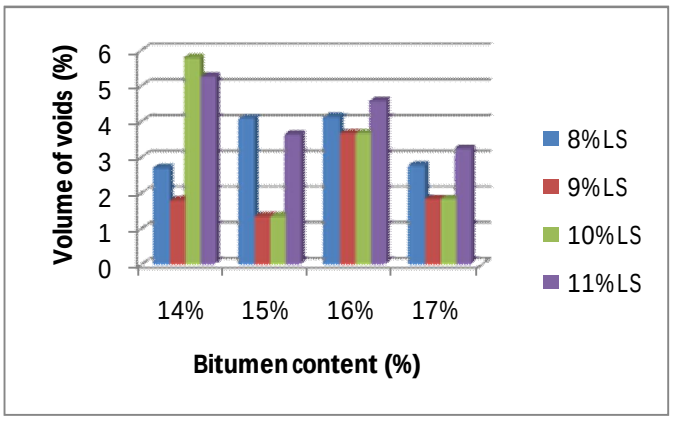

Fig. 3; Volume of voids Vs Bitumen content

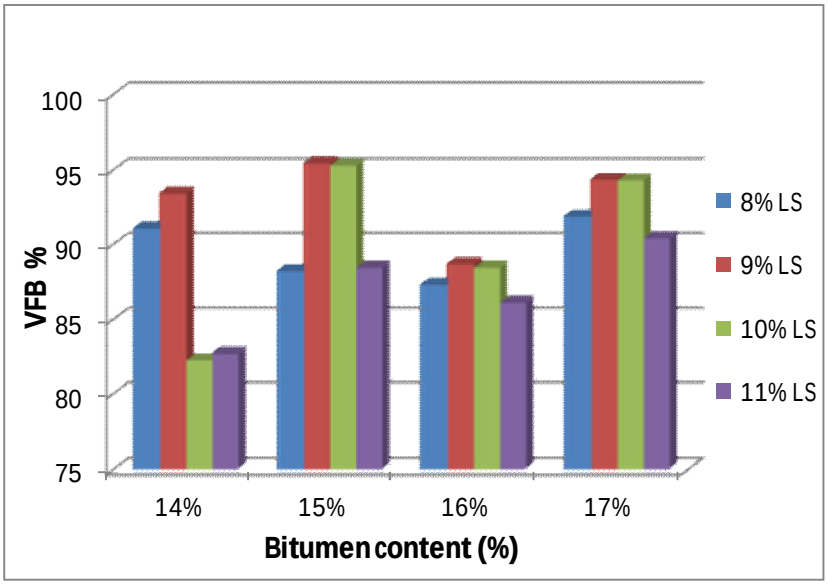

Fig. 5; VFB Vs Bitumen content

TABLE 5- Samples were prepared by filler proportion of 8% with Optimum Bitumen Content 14% for different proportion of RHA.

OBC %	FILLER RATE, %	MIX PROPORTION	MARSHALL STABILITY, KG	FLOW VALUE, mm	Vv	Vb	VMA	VFB
14 %	8%	100 % LS	1057	4	2.71	27.75	30.46	91.10
		75% LS- 25% RHA	1010	5	2.68	27.22	28.12	92.87
		50 % LS-50% RHA	1070	3.5	2.01	26.68	26.44	94.08
		25% LS-75% RHA	1150	3.5	1.66	26.20	24.86	95.77
		0% LS-100% RHA	1230	3	1.28	25.87	20.65	97.86

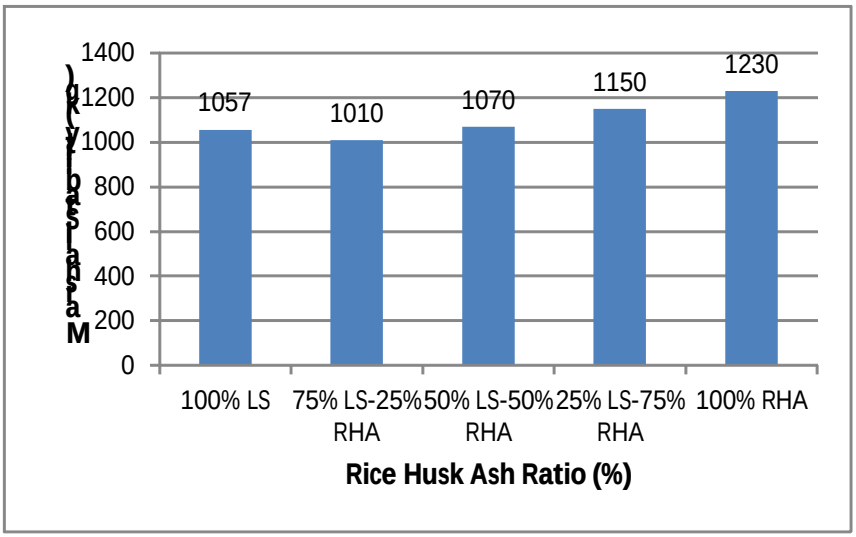

Fig. 6; Comparison of MS values for different filler proportion of RHA

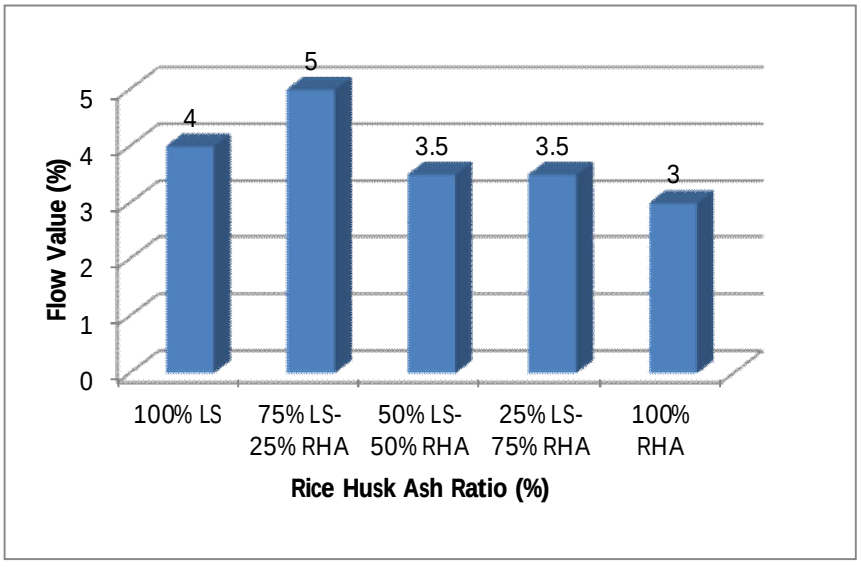

Fig. 7; Flow value Vs Rice Husk Ash Ratio (%)

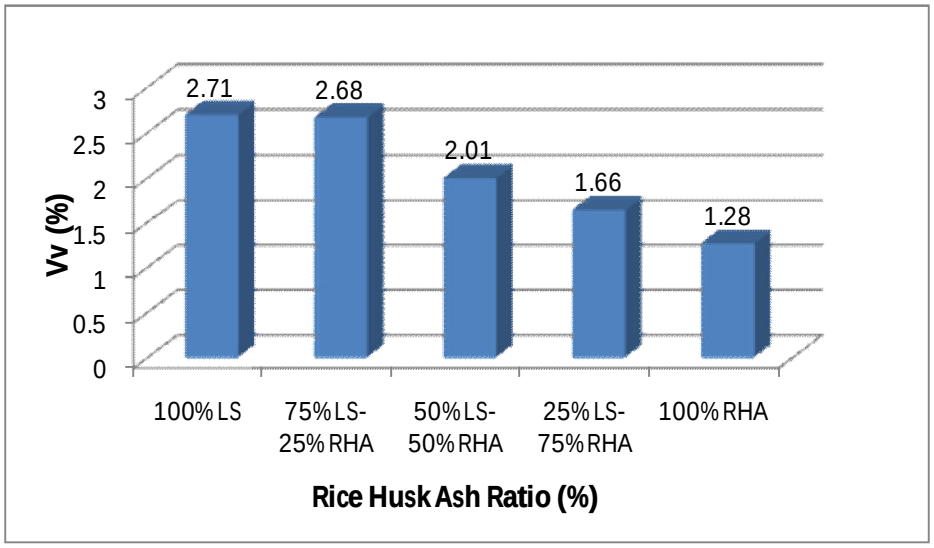

Fig. 8; Volume of voids Vs Rice Husk Ash Ratio (%)

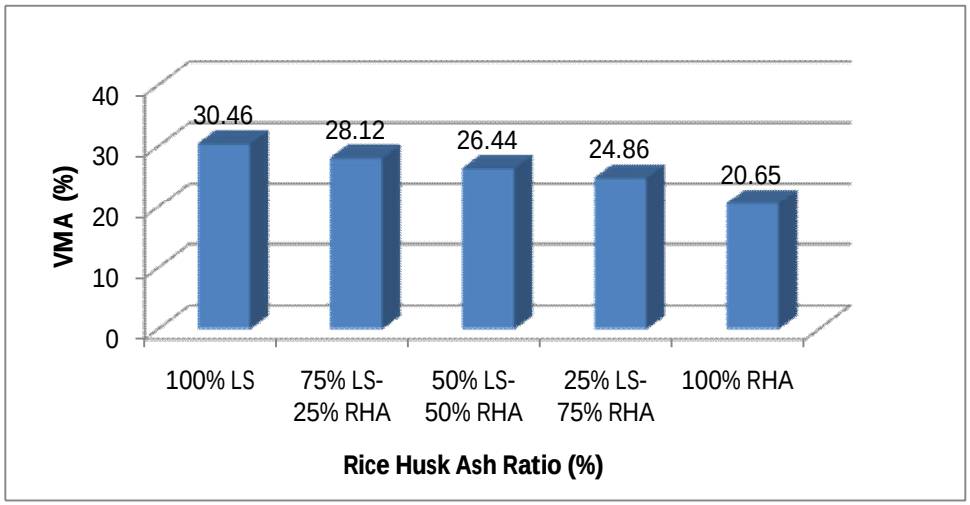

Fig. 9; VMA Vs Rice Husk Ash Ratio (%)

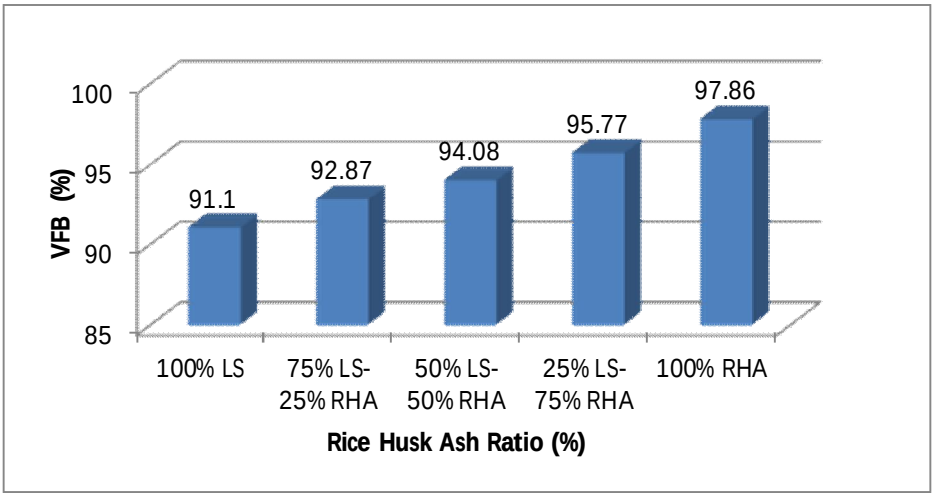

Fig. 10; VFB Vs Rice Husk Ash Ratio (%)

VIII. DISCUSSION

A. The constituent materials i.e. RHA conform to the specified requirement therefore RHA can be used in Mastic Asphalt in this study.

B. Fig. 1 shows that Optimum Bitumen Content (14%) with Lime Stone as Filler (8%), gives us the value of Marshall Stability which is 1057 kg (without adding RHA).

C. In above (fig. 2) shows the flow value with different proportion of Bitumen Content and Filler. In which least value of flow is 3 mm of 14% Bitumen Content with the 11% Filler.

D. Marshall Stability test conducted on Mastic Asphalt mix at OBC (fig.6) shows a gradual increase in Marshall Stability value when we gradually replace Lime by RHA as filler.

E. Maximum value of Marshall Stability determined when Lime Stone is fully replaced by the RHA is 1230 kg, which is approximately 17% greater than the Lime Stone as filler.

F. It has been noticed that in figure 7, the Marshall Flow value deceases with increasing amount of RHA.As also the RHA added sample shows the least value of flow which is 3 mm.

IX. CONCLUSION

Initially in the study, four different proportion of FR (i.e. 8%, 9%, 10%, and 11%) mixed with the different bitumen content(i.e. 14%, 15%, 16% and 17%) one by one for different samples of each FR with each bitumen content. The whole study and work is mainly divided into two sections which are mention below.

In first section we first prepare samples with different proportions of bitumen and FR and test these samples with Marshall Stability test and get the values of MS, Vv, Vb, VMA and VFB. From above samples, sample with 8% FR with 14% bitumen content gives the most suitable result.

In the second section of the study RHA which is obtained by burning the rice husk, replaces the 8% LS filler in proportion of 25%, 50%, 75% and 100% and further Marshall Stability test were performed and compare the result. Test results have showed that mixtures that used 100% RHA have had the best MS when evaluated in terms of MS.

In area or country like India where large amount of rice is produced and by which large amount of rice husk is formed, this rice husk ash can be widely used as a valuable product and it can be used as mineral filler instead of limestone in Mastic Asphalt.

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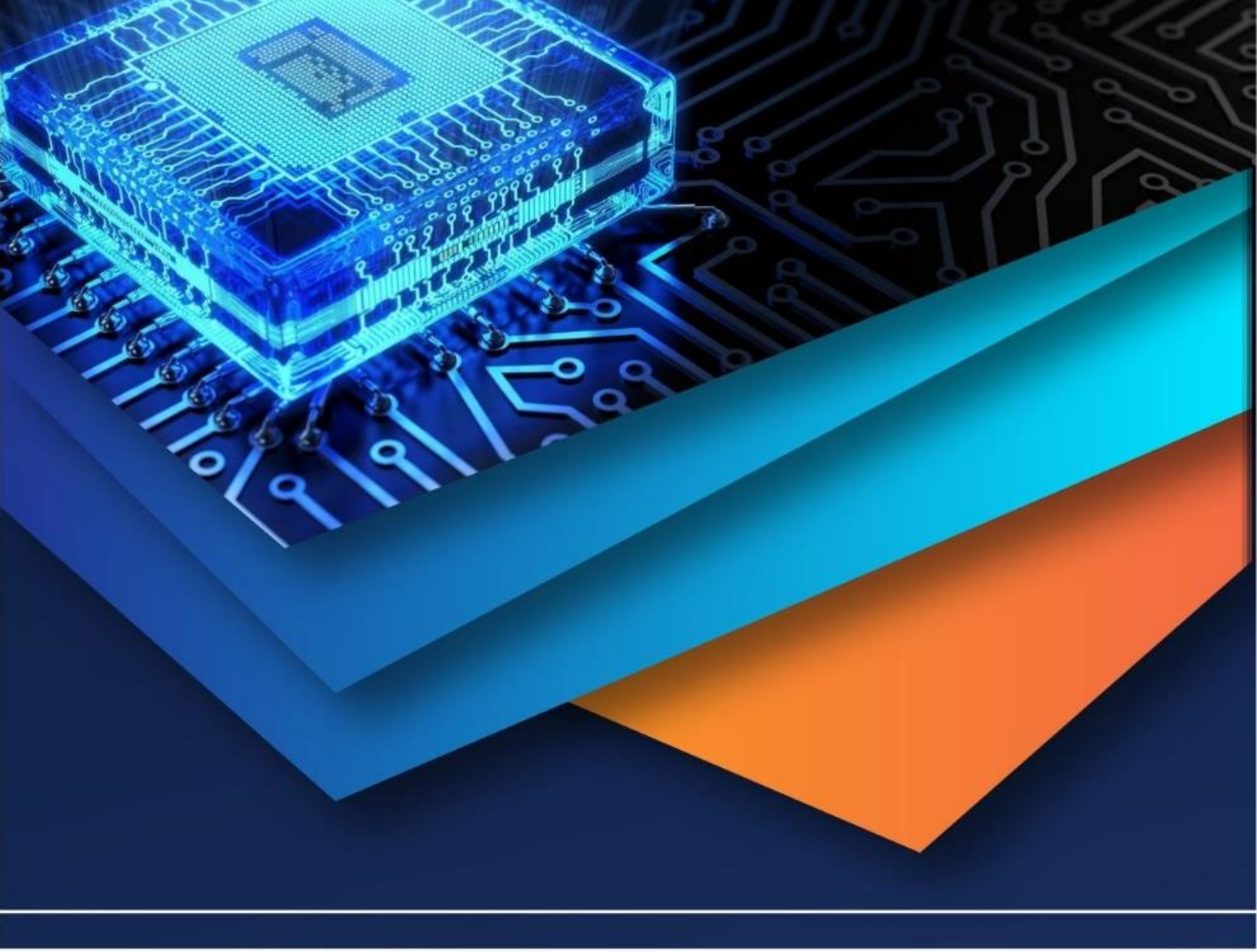

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