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Review paper on Use of Rise Husk Ash as mineral filler in Mastic Asphalt

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Abstract - *Bituminous materials are extensively used for pavement construction, primarily because of their excellent binding characteristics, water proofing properties and relatively low cost. But In bitumen concrete mix the strength of bitumen concrete depends on all the constituent materials that are used in the mix design i.e. bitumen, coarse aggregate, fine aggregate and filler. Above all the bitumen concrete are prepared by bitumen and mineral aggregates . Therefore, there is a need to explore the use of various types of waste materials like Slag, fly ash, stone dust, brick dust and Rise Husk Ash, steel slag etc. We will use Rise Husk Ash in Mastic Asphalt due to its various properties i.e. specific gravity, high silica content. Therefore there is an increase in the values of Marshall Stability, Flow value and Bulk density in.*

Key Words: **Rice husk ash, lime, marshal stability test, marshall stability value and mastic asphalt.**

1. 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 Mastic Asphalt 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.[1]

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 so pollution level of this waste is quietly very low in compare to other wastes. Every year approximately 100 million tones of paddy are produced in India. This gives around 24 million tones of rice husk and 4.4 million ton of Rise Husk Ash (RHA) [17] . 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 generally contains around 80-90 % silica.

RHA is a highly pozzolanic material, contains silica and surface specific area. 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 85% in RHA in this study.

2. MATERIALS TO BE USED IN THE STUDY

2.1 Coarse Aggregates

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 [5]-[8] given in Table below.

GRADE AND THICKNESS OF MASTIC ASPHALT PAVING, AND GRADING OF COARSE AGGREGATE

Application	Thickness range (mm)	Nominal size of coarse aggregate (mm)	Coarse aggregate content % by mass of total mix
Roads and carriageways	25 -50	13	40 ± 10
Heavily stressed areas i.e. junctions and toll plazas	40 – 50	13	45 ± 10

Nominal size of coarse aggregate IS Sieve (mm)	13 mm
	Cumulative % passing by weight
19	100
13.2	88 – 96
2.36	0 – 5

PHYSICAL PROPERTIES OF COARSE AGGREGATE

Description test	Allowable (max in %)	Test method	Test result
Loss Angeles abrasion test %	30	IS: 2386	16.20
Water absorption test %	2	IS:2386	0.188
Stripping	25	IS:6241	8
Flakiness index %	35	IS:2386	14

2.2 Fine Aggregates

The fine aggregate should consist of crushed hard rock and natural sand or a mixture of bwoth. The grading of fine aggregate inclusive of filler material passing 75 micron shall be given below.

2.3 Filler

The conventional filler is using is limestone powder passing 75 micron and shall have calcium carbonate mot less than 80 % when determined in accordance with 1195-1978.

GRADING OF FINE AGGREGATE INCLUDING FILLER

Passing IS sieve	Retained on IS sieve	Percentage by weight
2.36 mm	600 micron	0-25
600 micron	212 micron	5-25
212 micron	75 micron	10-20
75 micron		30-50

TESTED VALUES OF SPECIFIC GRAVITY OF MATERIALS

Content	Specific gravity
Aggregate	2.68
Sand	2.55
Bitumen	1.025
Lime	3.044

2.4 Bitumen

The bitumen shall be straight run bitumen considering to IS: 73-1961 or industrial bitumen as per IS: 702-1961 of suitable consistency satisfying the requirement of physical properties [4]as per given in Table.

PHYSICAL PROPERTIES OF BITUMEN

PROPERTY	METHOD OF TEST	REQUIREMT	TEST RESULTS
Penetration at 25%	IS: 1203-1978	20-40	35
Softening point	IS: 1205-1978	50 to 90	60
Ductility at 27*C (min in cm)	IS: 1208-1978	3	1.2
Loss of heating (% max)	IS: 1212-1978	1	.6
Specific Gravity	IS 1202		1.025

3. Role of filler in Mastic Asphalt

Fillers have plays a significant and important role on the properties of HMA mixtures particularly in terms of air voids, voids in mineral aggregate. Fillers increase 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.

Utilization of Rice Husk Ash :-

- Fillers for concrete and board production.
- Economical substitute for micro silica/silica fumes.
- Absorbents for soil and chemicals.
- Soil ameliorants (An ameliorant is something that helps improve soil drainage, slow drainage, breaks up soil or binds soil, feeds and improve structure etc).
- As a source of silicon.
- As insulation powder in steel mills.
- As repellents in the form of "Vinegar Tar".
- As a release agent in the ceramic industry.
- As an insulation material for homes and refrigerants.

(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%

4. Status of ongoing researches

Although a lot of works were conducted about using RHA in many work area[10,[14],[15],but there is not any work in the literature about use of RHA in the Mastic Asphalt. In this study, the usability of RHA in Mastic asphalt was investigated in order to bear the load and stresses occurring due to traffic loading. For this aim, Marshall Stability mixtures were prepared and evaluated by using these materials with different RHA contents and different bitumen contents with respect to different filler ratio.

RHA in Asphalt Concrete

During the last few decades the developments on the analysis of asphalt mixes with RHA is developed. Some of them are mention below.

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.

R. Mistry et al (2016) – studied the effect of using fly ash (FA) in asphalt mixture as replacement of common filler. In view of the same, samples were prepared for different bitumen content (3.5–6.5% at 0.5% increments) by using 2% hydrated lime (HL) in control mix as well as varying percentage of FA ranging from 2 to 8% as alternative filler in modified mixes. The optimum bitumen content (OBC) was then determined for all the mix by Marshall Mix design. Experimental results indicate higher stability value with lower OBC for the mix having 4% FA as optimum filler content in comparison with conventional mix & standard specification. So this study discusses the feasibility of using FA as alternative filler instead of HL in asphalt concrete mix by satisfying the standard specification.

Abdulfatai Adinoyi Murana, et al (2014) – investigated the partial replacement of cement with rice husk ash (RHA) as filler in asphalt concrete design. This work focused on the use of Rice Husk Ash (RHA) as filler in Hot Mix Asphalt (HMA). HMA design is carried out using Marshall Stability method. Several trial mixes with bitumen contents of 4.5% to 7.5% are produced to obtain the Optimum Bitumen Content (OBC). The investigation focuses on the partial replacement of cement with RHA using the obtained OBC in the following order 0%, 5%, 7.5%, 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, & 25%. A total of forty-two (42) mix specimens are prepared, twelve (12) of these are compacted at each percentage of bitumen content to determine the OBC & 30 specimens are used to determine the optimum RHA content in terms of the HMA strength. From the Marshall Stability-flow test analysis, the sample prepared with 10% RHA as filler with an OBC of 5.5% satisfied the provision of the Standard Specification requirement by Asphalt Institute.

Mahyar Arabani, et al (2017) – Using rice husk ash (RHA), as a waste byproduct of rice milling, in bituminous roadways provides valuable advantages such as reduction of environmental degradation, lowering construction costs and saving natural resources. However, there are limited numbers of studies on application of this material in asphalt mixture. The objective of this study was to investigate the effects of RHA as an asphalt modifier on hot mix asphalt. Bitumen blends with 5%, 10%, 15% and 20% RHA modifier. For evaluation of the rheological properties of asphalt

binders, various tests including penetration grade, ductility, softening point, rotational viscosity and dynamic shear rheometer were conducted. Also, the mechanical properties of asphalt mixtures including Marshall stability, stiffness modulus, rutting resistance and fatigue behavior were assessed. The results showed that the rheological properties of bitumen were enhanced by adding RHA. Furthermore, RHA modification had positive impacts on the Marshall stability, stiffness modulus, rutting strength and fatigue performance of asphalt mixtures.

Raissa Romastarika, Ramadhansyah Putra Jaya et al (2017) – rice husk ash waste product is inexpensive and can be obtained from rice mills. Reuse of waste product is ideal to reduce pollution, because disposal is decreased or eliminated. The commercial value of BRHA has increased, and it is suitable for use in road construction. In this study, BRHA waste was ground using a grinding ball mill for 120 min to form fine powder. BRHA was then sieved to less than 75 µm. At the laboratory, BRHA was mixed with bitumen to replace 2%, 4%, and 6% of the total weight, whereas 0% represented the control sample. The penetration, softening point, dynamic shear rheometer (DSR) and rolling thin film oven (RTFO) were investigated in this study.

Results showed that bitumen became harder, whereas the rate of penetration decreased when the replacement amount of RHA increased.

Rocksan Akter, et al (2017) – Filler is an important ingredient of asphalt concrete mixture. Cement, lime and stone dust are used as conventional fillers. In this study, an attempt has been made to assess the influence of non-conventional fillers such as rice husk ash and slag in bitumen paving mixes and also compared with traditional filler stone dust. From the experimental data, it is seen that specimen made with non-conventional fillers (e.g. slag, rice husk ash) are found to have satisfactory Marshall Properties, which are almost same as conventional filler (e.g. stone dust). The optimum asphalt content (5.5%) in case of slag and stone dust are same while for rice husk ash (5.83%), the same is slightly higher. It is seen that maximum stability is observed by rice husk ash followed by stone dust and slag as filler materials. The value of retained stability of the asphalt concrete mixture using stone dust, rice husk ash and slag are 112.2%, 111.52% and 95.68% respectively which satisfies the limiting value 75%. In addition, it has been recommended to use rice husk ash and slag wherever available, not only reducing the cost of execution, but also partly solve the solid waste disposal problem of the environment**.**

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. As a result, it has come in view that RHA can be used as mineral filler in the asphalt concrete. From the test the observed the highest MS value has seen on samples prepared with 2.5% RHA & 2.5% LS. MS value also increased by percentage of 2.26 in samples prepared with 1.25% RHA & 3.75 LS.

5. CONCLUSIONS

After going through no. of researches. I conclude that use of RHA as mineral filler in Mastic Asphalt not only improves the quality of Mastic Asphalt but also help in usage of waste material called RHA.

The number of case studies supplied though out for this research was sufficient to help readers to be familiar with the different technology applied of producing and incorporating fillers in Mastic Asphalt that are important in construction of roads with very qualified pavements , improved longevity and pavement performance.

By using RHA as mineral filler in place of conventional filler increased the stability of roads thus the road can be withstand heavy traffic load and shows better service life .

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