AN EXPERIMENTAL INVESTIGATION ON EFFECT OF FILLER TYPE ON STONEMIX ASPHALT

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ABSTRACT:

STONE MATRIX ASPHALT – SMA, a gap graded mix, is extremely rut resistant, tough, stable, skid resistant, with high quantity of coarse aggregates, relies on stone to stone contact, to supply strength & rich in binder, to produce durability.This study examines three forms of industrial and by-product waste fillers, namely Stone dust, fly ash and wooden charcoal.To decrease the price and increase its workability and strength waste materials are used as filler. It consists of gap- graded mix comprising of aggregate continuously graded from maximum size, typically lesser than 19 mm, through the fine filler which is smaller than 0.075 mm.The quantity of fiber that's used during experiment is about 0.3% to 0.5% of the entire weight.The STONE MIX ASPHALT design aims to figure out the proportion of bitumen, filler, fine aggregates, and coarse aggregates to supply a mix which is workable, strong, durable and economical.

Keywords: Recycled crumb rubber, low density polyethylene flakes, dry process, properties.

I.INTRODUCTION

Stone matrix asphalt (SMA) is a durable asphalt surfacing option for residential streets and highways.SMA incorporates a high coarse aggregate content that interlocks to make a stone skeleton that resist permanent deformation.

SMA, otherwise called Split Mastic Asphalt.The excellent performances include immune to mechanical and temperature deformation, cracking, and particularly rutting, proof against weathering actions like aging and low temperature cracking.SMA provides a deformation resistant, durable, surfacing material, suitable for heavily trafficked roads.

Typical SMA composition consists of 70−80% coarse mixture, 8−12% filler, 6.0−7.0% binder, and 0.3 % fibre.As a results of high content of bitumen the fillers fills the voids between the aggregates effectively and binds them on, thus adding to its durability from premature cracking.Thus

stabilizing additives like cellulose fibers, mineral fibers or polymers used to accustomed stiffen the matrix thereby reducing the drain down and bleeding significantly.

The different kinds of stabilising agents are usually utilized in SMA and are costly therefore there exist a necessity to get an alternate, lower-cost stabilizers for which we have used is cellulose fiber.The standard of SMA mixes affected by mineral filler therefore it's occupied by proper portion in SMA.Thus it's essential to check the impact of fillers in SMA. Numerous fillers like stone dust, fly ash and wooden charcoal are used as fillers and optimum proportion are determined during this study.

II.MATERIALS

Coarse Aggregate: The aggregates are crushed by using jaw pressure to induce different size of aggregates variable from 19 mm to 75 micron. The coarse aggregate should be hard, durable, and roughly cubical in shape once crushed. Qualities of aggregates were checked with tests like Impact value test, Abrasion value test, Flakiness and Elongation Index test.

Bitumen: Bitumen act as a binder in SMA mix.Totally different{completely different} grade of bitumen are employed in different mix like hot-mix or gap-graded mix or dense graded mix. For preparation of SMA mix we tend to use 60/70 bitumen.

Mineral Fillers: The function of a filler is to reduce the gaps i.e. voids so the compaction between coarse and fine aggregate will increase the stability.During this study,varied fillers like stone dust, wooden charcoal and fly ash are used to confirm the optimum filler.

Cellulose Fiber: Cellulose fiber is employed as a stabilizer in the present study. It is mixed with SMA in order that it will bind the bitumen with the coarse aggregate and fine aggregate properly.

III.MATERIAL TESTING

Coarse Aggregate: The following experiments were conducted on normal coarse aggregate to find out the properties of coarse aggregate as per IS:2386-1963.

Gradation of Aggregate: The gradation test is employed to determine aggregate particle size distribution. Size distribution is probably the one most significant aggregate quality associated with the control of HMA mixtures. 1200gm of aggregates are taken in the preparation of moulds

TABLE 1

IS SIEVE SIZE (mm)	% PASSING RANGE	CUMULATIVE % BY WEIGHT PASSING	% WT. RETAINED	WT. RETAINED (gms)
19	100	100	0	0
13.2	90-100	95	5	60
9.5	50-75	62.5	32.5	390
4.75	20-28	24	38.5	462
2.36	16-24	20	4	48
1.18	13-21	17	3	36
0.6	12-18	15	2	24
0.3	10-20	15	0	0
0.075	8-12	10	5	60
Pan			10	

Specific gravity of Coarse Aggregate: The specific gravity of coarse aggregate is determined by using pycnometer.

TABLE 2

S.NO	WEIGHT IN (gms)	TRAIL 1	TRAIL 2
1	Weight of empty pycnometer(m1)	682	682
2	Weight of pyconometer+ weight of half filled aggregates(m2)	1210	1264
3	Weight of pyconometer + weight of half filled aggregates + weight of water(m3)	1894	1880
4	Weight of pyconometer + weight of water(m4)	1524	1548
5	Specific gravity	2.84	2.86

G = (M2-M1)/((M2-M1)-(M3-M4))

= (1210- 682)/((1210-682)-(1894-1524)) = 2.84

Water absorption of Coarse Aggregate: To determine the water absorption of coarse aggregates as per IS:2386 (Part III) 1963,to measure the strength or quality of the material also determine the absorption of coarse aggregates

Water absorption = (A-B)/B X 100

Water absorption = ((1.005 – 0.990)/0.990) x 100 = 1.6%

III. TEST OF BITUMEN

Bitumen: The bitumen for fibre stabilised SMA shall be viscosity grade VG30 yielding with Indian standard Specification for paving bitumen IS:73 or polymer modified bitumen (PMB) Grade 40 yielding with the Indian Roads Congress Specification IRC:SP:53.

Specific Gravity of bitumen: The specific gravity of semi-solid bituminous material, asphalt cements, and soft tar pitches shall be expressed as the ratio of the mass of a given volume of the material at 25 °C to that of an equal volume of water at the same temperature

TABLE 4

S.NO	WEIGHTS				SPECIFIC GRAVITY
	Pycnometer(M1) (gms)	Pycnometer + water(M2) (gms)	Pycnometer +asphalt (M3)	Pycnometer+asphalt+water (M4)	
1	22.277	74.151	55.445	74.628	1.015
2	23.187	75.163	56.62	75.112	1.03
3	22.56	74.567	55.864	74.929	1.01

TABLE 3

S.NO	DESCRIPTION	TRAIL 1	TRAIL 2
1	Weight of given sample	1.00	1.00
2	Weight of saturated surface dry sample(A)	1.005	1.002
3	Weight of oven dry sample(B)	0.990	0.989
4	Water absorption	1.6%	1.8%
5	AVERAGE WATER ABORPTION	1.7%	

G = (M2-M1/((M2-M1)-(M3-M4))
=(74.151-22.277)/((74.151-22.277)-(55.4474.628))
=1.015

Penetration Test of Bitumen: Penetration of a bituminous material is that the distance in tenths of millimeter that standard needle can penetrate vertically into a sample underneath standard conditions of temperature, load and time.

Actual test temperature = 25 °c

TABLE 5

PENETRATION DIAL READING	PENETRATION VALUE
Test 1	63.2
Test 2	65.5
Average	64.35

Softening Point Of Bitumen: Softening point is the temperature at which the substance attains a particular degree of softening under specified conditions of test.

TABLE 6

TEMPERATURE WHEN THE BALL TOUCHES THE BOTTOM	1	2
	56	54

Softening point of bitumen / tar = 55°C

IV. MIX DESIGN CALCULATION

Based on gradation of aggregates, the quantity of aggregates for Preparing specimens are calculated.

TABLE 7

SIEVE SIZE(mm)	MATERIAL	AMOUNT OF AGGREGATES TAKEN ON THEPREPARATION OF MOULDS	
		1200	1200
19	COARSE AGGREGATES	0	0
13.2		60	60
9.5		390	390
4.75		462	462
2.36	FINE AGGREGATES	48	48
1.18		36	36

0.6		24	24
0.3		0	0
0.075		60	60
	FILLER	120	120
	BITUMEN%	5.5%	6%
FIBER		0.3%	0.3%
TOTAL WEIGHT OF INGREDIENT		1266	1272

Quantity Of Materials:

TABLE 8

DESCRIPTION	SAMPLE 1(g)	SAMPLE 2(g)	SAMPLE 3(g)	SAMPLE 4(g)	SAMPLE 5(g)	SAMPLE 6(g)
Weight of aggregate	1080	1080	1080	1080	1080	1080
Weight of bitumen	66	66	66	72	72	72
Weight of stone dust	120	-	-	120		
Weight of fly ash	-	120	-	-	120	-
Weight of wooden charcoal	-	-	120	-	-	120
Weight of cellulose fibre	3.8	3.8	3.8	3.8	3.8	3.8

V.MARSHALL TEST:

The marshall stability of mixture is said as as a most load carried by a compacted specimen at a typical check temperature of 60ºC. The flow value is deformation the marshall check specimen under goes throughout the loading upto the utmost load, 0.25 millimetre units.

MARSHALL TEST RESULTS: The results of the Marshall test of individual specimens and average Marshall properties of specimens prepared with stone dust as filler for varying bitumen contents have presented below

Average Marshall Properties of samples with Stone dust as filler

TABLE 9

BITUMEN	5.5%	6%
FLOW VALUE(mm)	2.4	2.8
STABILITY VALUE (KN)	22.07	23.53

The results of the Marshall test of individual specimens and average Marshall properties of specimens prepared with fly ash as filler for varying bitumen contents have been presented below

Average Marshall Properties of samples with FlyAsh as filler

TABLE 10

BITUMEN	5.5%	6%
FLOW VALUE(mm)	2.4	3.2
STABILITY VALUE(KN)	19.67	22.35

The results of the Marshall test of individual specimens and average Marshall Properties of specimens prepared with wooden charcoal as filler for varying bitumen contents have been presented below

Average Marshall Properties of samples with wooden charcoal as filler

TABLE 11

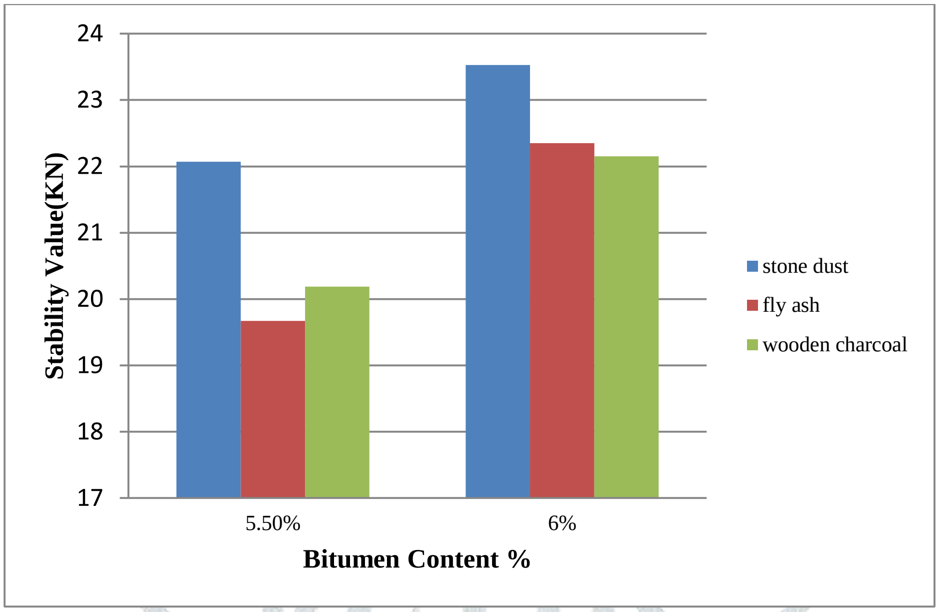
BITUMEN	5.5%	6%
FLOW VALUE(mm)	2.6	2.96
STABILITY VALUE(KN)	20.19	22.15

VI. MARSHALL STABILITY GRAPH

The results of Marshall Tests of specimens prepared with stone dust, fly ash and wooden charcoal as filler given in above table and have been presented graphically for comparison in following figure.

GRAPH 1

MARSHAL STABILITY GRAPH



Marshall Stability graph: Maximum stability value of 23.53 KN is observed at 6% bitumen content in case of stone dust as a filler.

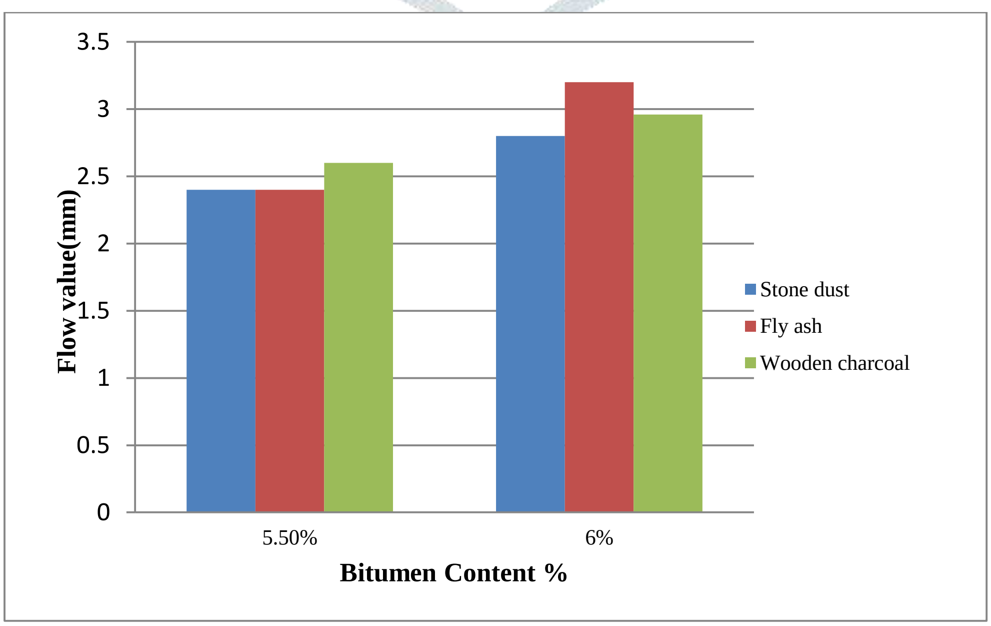
VII. MARSHALL FLOW VALUE GRAPH

The results of Marshall Tests flow value for specimens are prepared with stone dust, fly ash and wooden charcoal as filler given in above table and have been presented graphically for comparison in following figure.

Marshall Flow Value graph: On comparing fly ash, stone dust and wooden charcoal results graphically it can be seen that specimens other than stone dust are found to display a higher flow value. The optimum material should show low flow value for high stability.

GRAPH 2

MARSHAL FLOW VALUE GRAPH



VIII. DRAINDOWN TEST

The amount of drain down in an uncompacted asphalt mixture when the sample is held at elevated temperatures is determined.

Calculations
Drainage = ((A-B)/C) X 100

Where:

A = Final weight of plate or container, g

B = Initial weight of plate or container, g

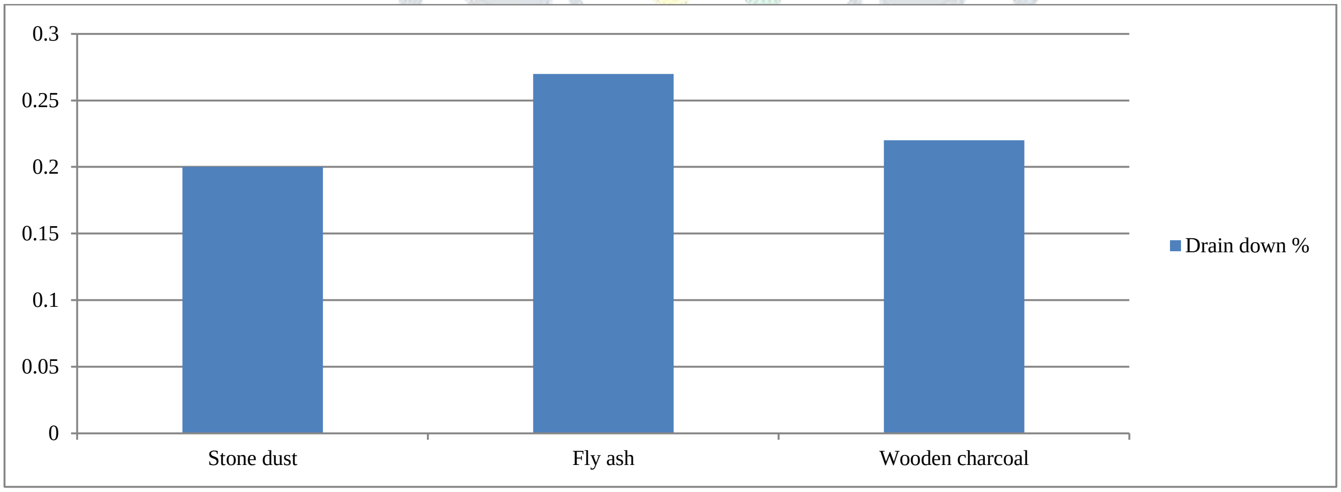
C = Initial total sample weight, g

TABLE 12

DESCRIPTION	DRAIN DOWN
STONE DUST	0.2
FLY ASH	0.27
WOODEN CHARCOAL	0.22

GRAPH 3

DRAIN DOWN PERCENTAGE



IX. CONCLUSION

1.The maximum stability obtained is 23.53KN in case of stone dust as filler with optimum bitumen content of 6%.
2. The flow value increases with increase in bitumen content in case of all fillers used in the sample.
3. As the stability value is high in case of stone dust as filler ,it can be used as filler in SMA mix for pavement of roads.
4. From the experiment, it can be concluded that stone dust can be used as a substitute for filler as it satisfies all the criteria to be used as filler.

X. REFERENCE

1. Laboratory Evaluation of the Performance of Stone Mastic Asphalt as an Ungrooved Runway Surface. Authors: Sean Jamieson,Greg white, Published - 2021.Refered for Performance of Stone Mastic Asphalt

2. Usage of Reclaimed Asphalt Material in Stone Mastic Asphalt .Authors :PetrHyzl, OndrejDasek, Iva Coufalikova, Michal Varaus, and Dusanstehlik

,Published-2019.Refered for Properties of SMA with different mixes .

3. A laboratory study on stone matrix asphalt using ground tire rubber .Authors: Chui-Te Chiu, Li-Cheng Lu,Published-2017.Refered for Lab tests on stone matrix asphalt .