THE EXPERIMENTAL STUDY ON THE CONSTRUCTION OF STONE MATRIX ASPHALT USING RECRON FIBRE

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Abstract: Stone matrix asphalt was designed as a wearing course with especially high resistance to studded tires in the mid sixties Stone mastic asphalt is also known as stone matrix asphalt. It is analogous mixture of selected well graded aggregate, filler and bitumen in proper grading. It was developed in Germany in the 1960s to provide maximum resistance to rutting and cracks. It also has anti skid property. It provides Provide stone-on-stone contact through the selection of a proper gradation. In the stone mastic asphalt, 100 % crushed aggregates are used. Stone mastic asphalt has a comparable good durability and stability like asphalt but can be transported and paved like asphalt concrete. In this study, Recron fibre is added to various percentage of bitumen i.e 4 %, 5 %, 6 %, 7 % and Marshall Stability test is conducted by adding recron fibre at the percentage of 0.3, 0.6, 0.9, 1.2 and 1.5.

Keywords: Stone Matrix Asphalt, Recron Fibre, Optimum Bitumen content, Marshall Stability, Wearing course.

1.0 INTRODUCTION

SMA is successfully used by many countries in the world as highly rut resistant bituminous course, both for binder (intermediate) and wearing course. Stone-Matrix Asphalt (SMA), also called Stone Mastic Asphalt, was developed in Germany in the 1960s, it has also been used to successfully minimize rutting and lower maintenance costs in high traffic areas throughout Europe. The use of stone matrix asphalt (SMA) has steadily increased since its introduction in the United States in 1991. SMA consists of gap graded aggregates this kind of gradation has high amount of coarse aggregate in the mixture forms a skeleton-type structure providing a stone-on-stone contact between the coarse aggregate particles, which give the pavement resistance to rutting and low amount of fine aggregate (fine aggregate that pass of 4.75 sieve analysis) . Also the higher binder content makes the mix durable, the fibres or modifier hold the binder in the mixture at high temperature and prevents drainage during production, transportation and laying, as SMA being a gap graded mix has more air void content and thus has a greater tendency of drain down. SMA has shown high resistance to permanent deformation due to having a high coarse aggregate content which interlocks to form a stone skeleton

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Composition of SMA

- Coarse Aggregate
- Fine Aggregate
- Binder
- Filler
- Fibre

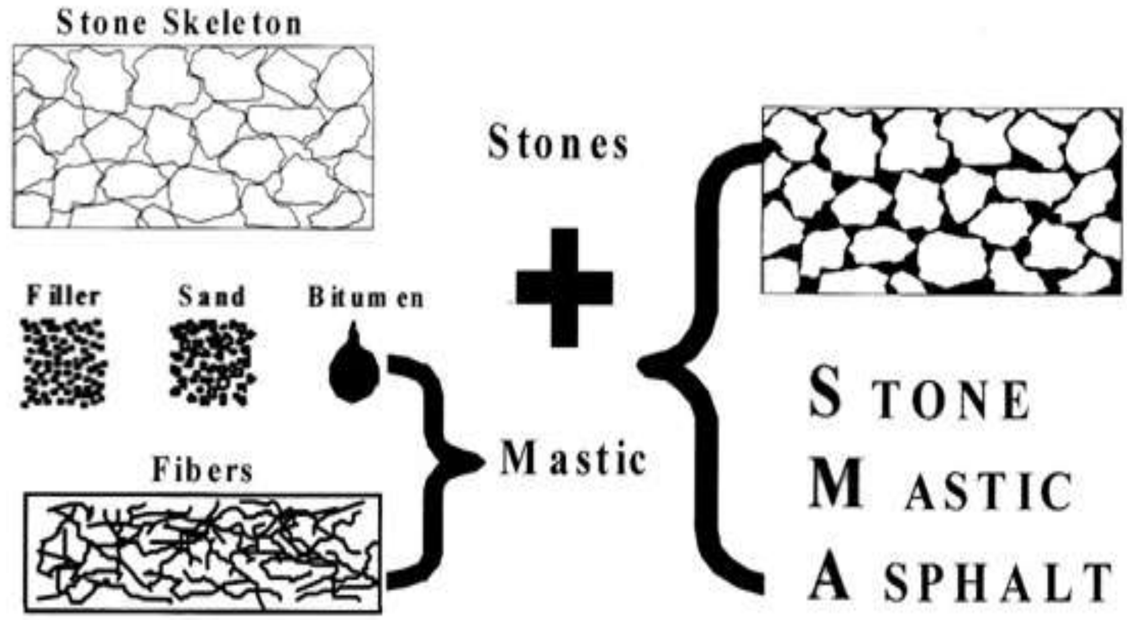

Figure 1.1: Components of Stone Mastic Asphalt

1.2 LITERATURE REVIEW

Pawan Kumar et al conducted the study on the use of various additives in stone matrix asphalt. Use of crumb rubber modified binder (CRMB) is also investigated as stabilizer in SMA mixes. The performance of these mix were evaluated by conducting draindown by two different methods, moisture susceptibility test, durability test, rutting test and fatigue life tests. German draindown test is not suitable for modified binder. NCAT basket test is better in evaluating mixes prepared with both stabilizers. The results of mix prepared with indigenously available fibers are comparable to the patented fibers. Mix prepared with modified binder alone provides encouraging results.

Tapase A.B. et al conducted the study on Performance evaluation of polymer modified bitumen in flexible pavement. The objectives of the study was to find out the use of waste plastic in bitumen roads by wet mix process, and to find a suitable alternative over conventional materials with cost reduction and improvement in strength and other parameters in flexible pavements. The work consists of an experimental approach towards waste management and finding alternative to conventional materials in flexible pavements. To simulate with the field conditions Marshall Stability method is considered to carryout experimental work. Based on the experimental study following important conclusions are drawn. From the study, it is observed that the 7.5 percent of bitumen can be replaced by plastic waste in bituminous layer having 5.5 percent optimum bitumen content. The basic test properties indicate that the replacement of bitumen by waste plastic reduces the penetration and ductility values, whereas increases in softening point and specific gravity values, when about 7.5 percent by weight of bitumen having 5.5 percent optimum bitumen content, is replaced by waste plastic.

Vaishakhi Talati deals with the use of SMA layer as a Surface layer. The study has been carried out in Indian conditions where there is enormous difference in the maximum and minimum loading of the vehicle. The temperature in some parts of the country is very high, this leads to increase in pavement temperature to a greater extent. With this increase in the loading and temperature there is formation of various distresses in the pavement. Draindown tests work done to determine the drainage of the bitumen when modified bitumen was used. In this study attempt was made to study the Rutting characteristics of the SMA using CRMB-55 as a binder in the mix. The results indicated the SMA had good stone-on-stone contact, use of modified binder enhanced the rutting resistance and repeated load test indicated higher fatigue life of the mix.

Dr A Ramesh carried works on the behavior of the SMA layer in addition with the fibers. The fibers used in the study were cellulose and polyester fibers, the optimum fiber was found out to be 0.4% when performed through the draindown test. Polyester fibers showed good draindown characteristics and provided good homogeneous mixture when compared to the normal conventional mix. The results showed that there is increase in Marshall Properties as well as in the tensile strength ration of the mix.

1.3 PREPARATION OF MARSHALL SAMPLES

Marshall Test procedure is used -, evaluating and optimizing the bituminous paving mixes and has become a normal procedure for the design of paving mixes. This test gives two major features which are stability-flow and density-void analysis. Strength of the specimen is measured in terms of „Marshall Stability Value‟, which is defined as the maximum load carried by a compacted specimen at a standard test temperature of 60°C. The loading rate is 50.8mm/min till the specimen fails. Flexibility is measured in terms „Flow Value‟, which is change in the diameter of the sample on the application of the load. The density-void analysis is done on the basis of the volumetric properties of the mix.

Approximately 1200gm of Aggregates combination and the filler are heated to a temperature of around 170°C-180°C for the preparation of the specimen. The bitumen is heated up to flowing state of around 125°C with the first trial percentage of bitumen. The heated aggregates and the bitumen are mixed in the mixer at a temperature of around 165°C-185°C. The mix is removed and placed in a pre-heated mould and compacted with the help of the rammer weighing 4.5kg with the fall of 45.7cm, giving 50blows on each face of the specimen at a temperature of around 130°C-150°C. Different concentration of the bitumen and various other materials to be used are predetermined and the Marshall Test is carried out on these specimens to obtain optimized values of the bitumen and the materials used. For SMA Conventional mix to know the optimum binder content and stability, the Marshall Stability test was conducted in the laboratory. Varying the percentage of bitumen with an increment of 1 % starting from a minimum value and progressing further 4 %, 5 %, 6 % and 7 %. After finding out the optimum bitumen content, Further the Marshall stability test is conducted again by adding the recron Fiber 0.3 %, 0.6 %, 0.9 %, 1.2 % and 1.5 % in optimum Bitumen content. The comparison of result between the various percentages of Recron fiber is discussed in Table 1.1

Table 1.1: Marshall Stability test

Sr. No	Mix	Binder Content	Recron Fibre (%)	Marshall Stability (KN)	Flow (mm)	Marshall Density (g/cc)	Percentage Air Voids (%)	Percentage voids filled with Bitumen, VFB (%)
1.	Mix 1	4 %	0 %	11.25	3.22	2.147	5.87	62.21
2.	Mix 2	5 %		12.12	3.47	2.214	4.92	65.47
3.	Mix 3	6 %		12.89	3.54	2.512	4.32	66.85
4.	Mix 4	7 %		12.02	3.72	2.121	3.56	72.54
5.	Mix 5	4 %	0.3 %	12.29	3.28	2.242	5.65	60.85
6.	Mix 6	5 %		12.89	3.52	2.34	4.62	62.87
7.	Mix 7	6 %		13.84	3.75	2.375	4.23	64.95
8.	Mix 8	7 %		12.32	3.81	2.016	3.54	70.24
9.	Mix 9	4 %	0.6 %	12.75	3.34	2.124	5.48	58.74
10.	Mix 10	5 %		13.02	3.56	2.254	4.54	60.32
11.	Mix 11	6 %		14.52	3.84	2.415	4.21	62.96
12.	Mix 12	7 %		12.41	3.91	2.354	3.48	64.54
13.	Mix 13	4 %	0.9 %	13.64	3.42	2.221	5.21	52.85
14.	Mix 14	5 %		13.92	3.74	2.421	4.52	55.96
15.	Mix 15	6 %		15.84	3.84	2.754	3.7	56.57
16.	Mix 16	7 %		14.75	3.99	2.564	3.47	60.22
17.	Mix 17	4 %	1.2 %	12.75	3.14	2.326	3.25	49.85
18.	Mix 18	5 %		12.94	3.42	2.421	4.25	51.65

19.	**Mix 19**	**6 %**		13.74	3.54	2.567	4.21	52.95
20.	**Mix 20**	**7 %**		13.01	3.65	2.521	3.54	54.7
21.	**Mix 21**	**4 %**	**1.5 %**	10.24	2.87	2.286	4.74	48.51
22.	**Mix 22**	**5 %**		10.98	3.02	2.354	4.32	49.72
23.	**Mix 23**	**6 %**		12.85	3.12	2.452	3.84	51.23
24.	**Mix 24**	**7 %**		11.54	3.34	2.245	3.64	52.64

CONCLUSION

Based on the results and discussion of experimental investigation carried out on mixes, Following conclusions are drawn:

1. The optimum bitumen content for the mix design is found by taking the average value of the following three bitumen contents from the graphs of test results.
   i) Bitumen content corresponding to maximum stability.
   ii) Bitumen content corresponding to maximum unit weight.
   iii) Bitumen content corresponding to the median of designed limits of percent air voids in the total mix.
   The optimum Binder content at various fibre content is shown in Table 5.1.

Sr. No	**Fibre Content (%)**	**Optimum Binder Content**
1.	0	6.16
2.	0.3	6.10
3.	0.6	6.16
4.	0.9	5.86
5.	1.2	6.16
6.	1.5	5.95

   Hence by calculating OBC for all percentages of fibre it is seen that maximum density and maximum stability is present in the mix having OBC 5.86 AND OFC 0.9 %.
2. The SMA has been found to be an excellent and durable surface course for high speed highways, heavy trucks lanes, near signalized intersections and in stopping areas.
3. The resistant to rutting and high skid resistance will increase with the use of SMA.
4. The percentage of air voids is decreased as the fibre content increased.
5. It can be concluded that utilization of industrial wastes and byproducts in SMA results in the improvement of the engineering properties

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