Study on Stone Matrix Asphalt Using Banana Fibre

[1]Chikkanagouda Choudhari, [2]Pratiksha Malviya

[1]*M. Tech. Scholar,* [2]*Professor Department of Civil Engineering*

Millennium Institute of Technology, Bhopal, India

Abstract-Stone Matrix Asphalt having good stability, strength and maintenance of smooth surface of roads & other structure is required. Stone Matrix Asphalt mix is prepared by blending of course and fine aggregates. Banana fibers improve service properties of SMA Mix by forming micromesh in the mix to prevent drain down flow of asphalt so as to increase its stability and durability of mix. Aggregate gradation was taken as per MoRTH specification for SMA mix. Binder content was 4, 4.5, 5, 5.5, 6, 6.5, & 7 percentages by weight of aggregate. Fiber was 0.35% by weight of aggregate. Cement was used as a filler material and 60/70 grade of bitumen is used as a binder. Study resulted that optimum bitumen content for samples prepared by mix of banana fiber is found to be 5.3%. Mixing of banana fiber in SMA was observed cost effective & economical. Study resulted higher stability, strength & durability of roads.

Keywords-Banana Fiber, Natural Aggregate, Binder content, SMA, HMA, Marshall Test.

I. INTRODUCTION

Stone Matrix Asphalt (SMA) is a gap-graded mixture, have a better stone to stone contact which gives better strength to the mixture.

In this research work aggregate used as per the MORTH specification which was taken from a same lot. The samples are made with aggregate with different gradation, filler (cement) and binder (bitumen 60/70). Fibers are used as stabilizer and are used to decrease the drain down and to increase the strength and stability of the SMA mix. The test of the SMA Mix samples is done in Marshall apparatus. Here the comparison of SMA Mix with and without banana fiber was done.

All the research work done before by using banana fibers. Banana fibers are extensively used in SMA in Europe and USA. These fibers are patented. The fibers improve the service properties of the mix by forming micromesh in the asphalt mix to prevent the drain down of the asphalt so as to increase the stability and durability of the mix. Here we have tried to use banana fiber which is more economic than cellulose fibers, doing same work as cellulose fiber.

Flexible pavements designing are preferred always over all other rigid pavements for road construction. Stone matrix asphalt mix sample were tested in Marshall Apparatus. SMA Mix is desired to have quality of resistance to wear & tear, greater strength for better performs during heavy loads.

Stone Matrix Asphalt (SMA)

Stone matrix asphalt (SMA), sometimes called stone mastic asphalt, is a gap-graded HMA originally developed in Europe to maximize rutting resistance and durability in heavy traffic road. SMA has a high coarse aggregate content that interlocks to form a stone skeleton that resists permanent deformation. The stone skeleton is filled with a mastic of bitumen and filler to which fibers are added to provide adequate stability of bitumen and to prevent drainage of binder during transport and placement. Typical SMA composition consists of 70−80% coarse aggregate, 8−12% filler, 6.0−7.0% binder, and 0.3 per cent fiber. The deformation resistant capacity of SMA stems from a coarse stone skeleton providing more stone-on-stone contact than with conventional dense graded asphalt (DGA) mixes. Improved binder durability is a result of higher bitumen content, a thicker bitumen film, and lower air voids content. This high bitumen content also improves flexibility. Addition of a small quantity of cellulose or mineral fiber prevents drainage of bitumen during transport and placement. There are no precise design guidelines for SMA mixes. The essential features, which are the coarse aggregate skeleton and mastic composition, and the consequent surface texture and mixture stability, are largely determined by the selection of aggregate grading and the type and proportion of filler and binder. SMA improved rut resistance and durability. It has good fatigue and tensile strength.SMA is almost exclusively used for surface courses on high volume roads. Materials used for SMA are Gap- graded aggregate, modified asphalt binder, fiber filler. Other SMA benefits include wet weather friction (due to a coarser surface texture), lower tire noise (due to a coarser surface texture) and less severe reflective cracking. Mineral fillers and additives are used to minimize asphalt binder drain-down during construction, increase the amount of asphalt binder used in the mix and to improve mix durability.

II. LITERATURE SURVEY

This chapter presents the characteristics of SMA with fibers to justify research aim and sets the background for the proposed work.

Bradely et.al. (2004) studied Utilization of waste fibres in stone matrix asphalt mixtures. They used carpet, tire and

polyester fibres to improve the strength and stability of mixture compared to cellulose fibre. They found no difference in moisture susceptibility and permanent deformation in SMA mix containing waste fibres as compared to SMA mix containing cellulose or mineral fibre.

Kamaraj C., G. Kumar, G. Sharma, P.K. Jain and K.V. Babu (2004) carried laboratory study using natural rubber powder with 80/100 bitumen in SMA by wet process as well as dense graded bituminous mix with cellulose fibre and stone dust and lime stone as filler and found its suitability as SMA mix through various tests.

Daniel and La (2005) has explained on mechanistic and volumetric properties of asphalt mixtures with recycled asphalt pavement. His research examines how the addition of RAP its changes in volumetric and mechanistic properties of asphalt mixtures. A superior asphalt performance pavement (SUPERPAVE) 19 mm mixture containing 0% RAP was used in his study to evaluating properties of mixes containing 15%, 25%, and 40% RAP. The VMA and VFB of the RAP mixtures

Shaopeng Wu et al. (2007) used slag after 3 year of ageing with PG76-22 modified binder, lime stone filler, short chopped polyester fiber (3%) for the SMA mix in Marshall method and found it to be suitable for use.

Kumar Pawan, Chandra Satish and Bose Sunil (2007) tried to use an indigenous fiber in SMA Mix by taking low viscosity binder coated jute fiber instead of the traditionally used fibers and compared the result with the imported cellulose fiber, using 60/70 grade bitumen and found optimum fiber percentage as 0.3% of the mixture. Jute fiber showed equivalent results to imported patented fibers as indicated by Marshall stability test, permanent deformation test and fatigue life test. Aging index of the mix prepared with jute fiber showed better result than patented fiber.

Chui-Te Chiu, Li-Cheng Lu, (2007) used asphalt rubber (AR),produced by blending ground tire rubber (GTR) (i) 30% of a coarse GTR with a maximum size of #20 sieve and (ii)20% of a fine with a maximum size of #30 sieve with an asphalt, as a binder for SMA and found AR-SMA mixtures were not significantly different from conventional SMA in terms of moisture susceptibility and showed better rutting resistance than that of conventional dense graded mixture.[11]

Yongjie Xue, Haobo Hou, Shujing Zhu, Jin Zha (2008) used municipal solid waste incinerator (MSWI) fly ash as a partial replacement of fine aggregate or mineral filler and BOF Slag as part of coarse aggregate with polyester fiber of 6.35 mm in length obtained from recycled raw materials, PG76-22 binder in the SMA mix and performed Marshall and super pave method of design and found it's suitability for use in the SMA mix.[15]

Vasudevanet. al [2014], exhibited an investigation on the readiness of plastics squander – bitumen mix and its properties to discover the appropriateness of the mix for street development, was completed. A changed procedure was produced and the stone total was covered with liquid plastics and the plastics squander covered total (PCA) was utilized as the crude material for adaptable development. PCA demonstrated better restricting property. It had less wetting property. Its voids were substantially less. The example demonstrated higher Marshall Solidness esteem. The streets laid utilizing PCA are performing admirably. A point by point considered is exhibited.

Vasudevan, et al. [2015] likewise watched that the polymer mixed bitumen has better properties with respect to Softening point, Entrance point, Flexibility, Stripping Quality and Marshall Security esteem. Thus the mix can be utilized for laying adaptable asphalt. In this investigation both dry and wet procedures were utilized to get ready adjusted bituminous blends. In the wet procedure, the mixing was done by straightforwardly blending the destroyed polymer with hot bitumen at 160 deg. C. In the dry procedure, a novel system was utilized to utilize higher level of waste plastics in street development and utilizing this strategy a substitute technique was utilized. In this technique, the waste polymer was included the hot total (170deg.C). The polymer was covered over the total. Here the spreading was simple. The hot total was covered with polymer consistently. At that point the Bitumen was included. The blending of bitumen with polymer was occurring at the surface of the total. The temperature was around 155 – 163 C. Both the polymer and bitumen were in the fluid state.

Vasudevan et al [2016] displayed that plastic waste comprising of convey sacks, containers and thermocoles can be utilized as a covering over total and this covered stone can be utilized for street development. By this procedure a street of 1 Km length and 3.375M width of single path can expends 10, 00000 convey sacks and the street quality is expanded by 100% and there is no pot opening arrangement. Infiltration was diminished to a low esteem and correspondingly the pliability. It has been construed that the utilization of higher rate (over 3%) of plastics in polymer altered bitumen isn't good. The paper additionally contemplates utilization of scrap elastic waste as bitumen modifier. Squander tires are powdered and the powder is mixed with bitumen (80/100) warmed to 100-120oC and blended at speed of 3000 rpm for 2-3 hours. This mix is utilized alongside plastic covered total. The blend polymer covered total and tire altered bitumen have indicated higher quality. The level of scrap elastic modifier in the blend changes from 1% to 5%.

Yadav et al [2017] manages the improvement of changed fastener definitions from plastomer and elastomer write squander with a mean to limit non-biodegradable the post customer polymer squander and also ecological peril, to meet this target ten unique examples have been grabbed from a few sorts of waste to cover distinctive classifications of polymeric waste from the household, mechanical and in addition therapeutic waste. Changed cover definitions were at first portrayed according to the pertinent gauges (code of training) to determining their appropriateness for above said application. The physical properties of altered covers are inside as far as possible. Marshall Soundness, backhanded rigidity and crawl modulus conduct have been assessed and talked about in this examination to demonstrate their double advantages like waste minimization and appropriateness of such fasteners to be utilized for sturdy street.

III. PROBLEM IDENTIFICATION

The growth in various types of industries together with population growth has resulted in enormous increase in economic activities world-wide.

- Various developments have caused tremendous increase in the movement of people and goods, causing much stress on roads.
- Road gets damaged frequently.
- Industrial developments & growth of population have resulted increase in economic activities.

Objectives

- Study of properties of SMA mix with banana fiber.
- Study of properties of materials like course, fine aggregates, filler and bitumen along with banana fiber.
- Comparison of SMA mix along with banana fiber with conventional mix.

Methodology Adopted

Research facility tests were directed on the regular bitumen (60/70) and changed bitumen tests. Singular properties (Infiltration, Softening Point, Flexibility, Flash and fire, and Specific Gravity) of the example were resolved. Utilizing the Marshal Blend outline portrayal of customary bituminous blend (60/70) for thick bituminous blend (DBC) were completed and examination was made for traditional bitumen blend properties with changed bitumen. Subsequent to deciding elements to be considered for demonstrating adjusted bitumen in bituminous blend, a point by point anticipates the exploratory program (test arrangement and arrangements of tests) was created.

IV. RESULTS

Determination of Mix Design Parameter

	With banana fiber
Asphalt content (%)	5.3
Stability (N)	13.87
Flow (mm)	2.4
VMA (%)	16
VFA (%)	74

V. CONCLUSION

- It is found that by addition of banana fiber of 0.35% to SMA mix, the OBC value is decreased to 5.3%
- By addition of 0.35% fiber to SMA, Stability value increases significantly, further addition to it stability decreases.
- Main advantage of using fiber is that air voids in mix decreased due to addition of banana fiber.

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