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A REVIEW STUDY OF STONE MATRIX ASPHALT USING A NATURAL FIBRE

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Abstract: Stone Matrix Asphalt (SMA) was originally developed in Europe as an impervious/highly durable wearing surface for bridge decks. Based on its performance history, "split matrix asphalt" began to be used as a surface layer for roadways carrying heavy truck traffic throughout Germany and other European countries. Today, it is the "pavement surface of choice" where long term performance and durability is needed. There are two types of pavement, one is flexible pavement and second one is rigid pavement. If the initial cost is considered, than the rigid pavement is costly, but the maintenance cost of it is low. And country like INDIA, its not possible to provide rigid pavement everywhere, so flexible pavement is the option only. In flexible pavement, it is required to be maintained at some interval of time so the cost of maintenance is should be minimum. At present, the maintenance cost is higher so now the method of maintenance has to be modified for the flexible pavement. To avoid the maintenance cost, the proper quality of work and material is important. So to improve the quality, various material or chemicals are used to improve the quality or to improve the property of the raw material. The study is about to improve the properties of bitumen. In this Paper various applications and properties of SMA mixes are studied. Also the studies done by various authors are reviewed in this study.

1.0 INTRODUCTION

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.

1.1 DIFFERENCE BETWEEN SMA & CONVENTIONAL MIXES

SMA is successfully used by many countries in the world as highly rut resistant bituminous course, both for binder (intermediate) and wearing course. The major difference between conventional mixes and SMA is in its structural skeleton .The SMA has high percent about 70-80 percent of coarse aggregate in the mix .This increases the interlocking of the aggregates and provides better stone to stone contact which serves as load carrying mechanism in SMA and hence provides better rut resistance and durability. On the other hand, conventional mixes contain about 40-60 percent coarse aggregate. They does have stone to stone contact, but it often means the larger grains essentially float in a matrix composed of smaller particles, filler and asphalt content .The stability of the mix is primarily controlled by the cohesion and internal friction of the matrix which supports the coarse aggregates .It can be followed from diagram of the grain size distribution of the mixes given below.

The second difference lies in the binder content which lies between 5-6 percent for conventional mixes. Below this the mix becomes highly unstable. Above this percent will lead to abrupt drop of stability because the binder fills all the available voids and the extra binder makes the aggregates to float in binder matrix. The SMA uses very high percent of binder > 6.5 percent which is attributed to filling of more amount of voids present in it, due to high coarse aggregate skeleton. The high bitumen content contributes to the longevity of the pavements.

The third difference is the use of stabilizing additives in SMA which is attributed to the filling up of large no of voids in SMA so as to reduce the drain down due to presence of high bitumen content. On the contrary, there is no stabilizing agent in conventional mixes since the bitumen content is moderate, which only serves the purpose of filling the moderate amount of voids and binding the aggregates

2.0 LITERATURE REVIEW

Rosli Hainan et al studied the Importance of Stone Mastic Asphalt in Construction. The first aim of this study is to provide an updated systematic review of the evaluation of stone mastic asphalt in construction. The second aim is to develop knowledge readers and researchers for advantages and disadvantages of stone mastic asphalt to help focus future research in this area. This paper has reviewed on stone mastic asphalt that addressed these major elements through interviews with a number of respondents and through an investigation of previous researches used SMA. It is concluded that SMA is appropriate asphalt in construction. The use of SMA does not show any systemic safety issues. There are however institutional issues that influence the effective use.

TEJA TALLAM et al studied the assessment of stone mastic asphalt Performance with the inclusion of fiber Material on resilient characteristics. The main objective of this study is to compare the inclusion of polyester fibers in SMA Mix for understanding the behaviour of resilient characteristics. Optimum binder content (OBC) of SMA Mix is arrived 6.5% and the corresponding fiber content (OFC) was arrived as 0.4% when performed through drain down test. Polyester fibers have good drain down characteristics and provide good homogeneous mixture compared with conventional SMA. It is observed from test results that resilient modulus increased with the addition of polyester fibers by 18% and tensile strength ratio by 1.2%. This indicates that fiber inclusion provides better cracking resistance when compared with conventional SMA Mix.

Mohammad Altaf Bhat et al studied the Effect of Fillers on Bituminous Mixes. To satisfy the design requirements of stability and durability the bituminous mixes should be designed effectively. The ingredients of the mixture include dense grading of coarse aggregates, fine aggregates, fillers and bitumen binder. In this Study an attempt was made to find the effect of filler on the behavior of bituminous mixes. Fillers play an important role in the filling of voids and hence change the physical and chemical properties. Thus their effect is of utter importance. Bitumen in combination with filler forms mastic. This mastic can be seen as a constituent of mixture of asphalt that holds the aggregates together. An important role is played by the fillers that pass through 0.075mm sieve. With the increase in the amount of filler, Marshall Stability of the bitumen mix increases directly. Use of 4-8% filler in asphalt concrete is recommended by the Asphalt Institute. In India, waste concrete dust and brick dust are considered to be cheaper and are available in plenty. In this study an attempt was made to find the effect of fillers on the bitumen mixes. In this study, concrete dust and brick dust was used as filler. The properties of bituminous mixes containing these fillers were studied and compared with each other. For the purpose of comparison Marshall Method of mix design was used. In this study various tests were also conducted on aggregates and bitumen and the results were compared with the specifications. The study revealed that use of concrete dust and brick dust as filler improves the physical characteristics of bitumen. Marshall Stability and flow value of bitumen mix also improved.

K.Karthik et al studied the carbon fiber modified bitumen in bituminous macadam. In the present study, an attempt has been made to study the effects of use of a mineral fiber called Carbon fiber is used as an additive in Dense Bituminous Macadam (DBM). An experimental study is carried out on conventional bitumen and fiber modified binder. Using Marshall Procedure, Optimum Fiber Content (OFC) and Optimum Binder Content (OBC) for DBM are found respectively. Detailed laboratory investigations will be carried out by preparing asphalt concrete mixtures by adding carbon fiber with dosages of 0.5%to 2.5% by weight of binder. Volumetric properties of the mixes will be determined and various strength tests such as marshal stability will be conducted. In the present paper, an approach was developed to mix carbon fibers and bitumen which guarantees the uniform fiber distribution.

DR.P.SRAVANA et al studied the properties of Stone Matrix Asphalt Mixture by Altering Aggregate Gradations and Filler Types. In this present work, an attempt has been made to study the effect of aggregate gradation and filler type in properties of SMA. Four of different aggregate gradations with two types of fillers, such as Hydrated Lime and Crushed Stone Dust have been tried for preparation of mixes. First three gradations; upper, middle, and lower curves, middle gradation curve had better Marshall Properties of them. For fourth gradation that modified curve, crushed Stone has been improves the Marshall properties such as Marshall Stability and unit weight values more than Hydrated Lime. Hydrated Lime of SMA mixes has been improves air voids and Moisture Susceptibility in the same gradations of samples with Crushed Stone.

Vivek B. R et al studied the Utilization of Fibre as a Strength Modifier in Stone Matrix Asphalt. The present study investigates the potential use of shredded waste plastic as a modifier for asphalt concrete and with the addition of coconut fibre to stabilize the asphalt from SMA mixes. Conventional (without plastic) and the stabilized SMA mixtures were subjected to performance tests including Marshall properties such as Marshall stability, flow value, air voids,

voids filled with mineral aggregates and voids filled with bitumen tests, with varying percentage of shredded waste plastic (4%, 6%, 8% and 10%) by weight of the 60/70 grade of bitumen and 0.1%, 0.2% and 0.3% of coconut fibre by weight of total aggregate. It is observed that the stability value increases with increase in shredded waste plastic content up to certain value and then the stability value decreases, also stability value increases with increase in fibre content and with further addition of fibre content it decreases. This study evaluates the viability of shredded waste plastic and fibre as stabilizing agent in stone matrix asphalt.

Ms. P. Bakiya et al studied the Effect of Coir Fibre in the Bituminous Concrete Mix. Bituminous concrete mixes are the structural layer used widely in Flexible pavements. The property of bituminous mixes can be enhanced by addition of fibres such as coirfibres. Fibre lengths were kept i.e. 10mm, 15mm and 20mm and used at the rate of 0.3%, 0.5% and 0.7% by weight of mix. The mechanical properties such as indirect tensile strength test (ITS), short and long term ageing test and stiffness modulus test were investigated. It is concluded that the incorporation of coir fibre in the mix enhance the properties of bituminous concrete. After this study it is concluded that in ageing test, stiffness modulus values of coir have been reduced upto 10% and 40% after subjecting to short term and long term ageing test. This minimum reduction will not affect the performance of pavement because by comparing with IRC values the modified mix is increases upto 40% even after long term ageing process.

Vidhi Patel et al studied the enhancement into bituminous properties using Forta fibre in SMA. The study is about to improve the properties of bitumen. In Flexible pavement construction, modified bitumen can be used with fibres, Chemicals, Waste materials etc. for improving its properties. The most suitable fibres are used to improve its properties, i.e. Marshall Mix design, Viscosity, Ductility, and Specific Gravity. According to literature, Forta Fi- fibre is most advantageous for improving bituminous properties so here it is checked for its feasibility in our country to improve different bituminous property. 1%, 2 %, and 3 % of Forta Fi by its weight of Conventional bitumen mix is studied. Mixing Forta fi in various proportion like 1%, 2% and 3% in bituminous mix , the penetration value is increasing up to 1% of plain bituminous mix to 5% in case of binding containing of Forta fi. But in case of adding 3% fibre in bituminous mix, penetration value is exceed, so 3% fibre of binding containing is not suitable for bituminous mix. The viscosity value of bituminous mix increases in wide range up to 17% of plain bituminous mix to 64% in case of binding containing 1%,2% and 3% of Forta fi.

CONCLUSION

1. It was observed that the addition of fiber favourably affects the properties of bituminous mixtures by increasing its stability and voids and decreasing the flow value.
2. In addition to filling the voids, the fillers' components interact with the binder present in the mix, potentially making it stiff and brittle. The change in mix properties is strongly related to the properties of the filler.
3. It is observed that with increase in the bitumen content the volume of voids decreases.
4. The voids filled with mineral aggregate and the voids filled with bitumen both increases with increase in the bitumen Content.
5. Filler type and particle size directly affect the engineering properties of the asphalt mixtures.
6. It is concluded that, the fibre reinforced bituminous concrete pavement will sustain on various climatic condition in India.
7. These mixes were seen to display higher air voids than required for normal mixes.
8. Higher bitumen content is required in order to satisfy the design criteria and to get usual trends.

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