Use of SISAL fiber as stabilizer in Stone Mix Asphalt and as an additive in Bitumen

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ABSTRACT

Generally a bituminous mixture is a mixture of coarse aggregate, fine aggregate, filler and binder. A Hot Mix Asphalt is a bituminous mixture where all constituents are mixed, placed and compacted at high temperature. HMA can be Dense Graded mixes (DGM) known as Bituminous Concrete (BC) or gap graded known as Stone Matrix Asphalt (SMA). SMA requires stabilizing additives composed of cellulose fibbers, mineral fibres or polymers to prevent drain down of the mix.

In the present study, an attempt has been made to study the effects of use of a naturally and locally available fibre called SISAL fibre is used as stabilizer in SMA and as an additive in BC. For preparation of the mixes aggregate gradation has been taken as per MORTH specification, binder content has been varied regularly from 4% to 7% and fibre content varied from 0% to maximum 0.5% of total mix. As a part of preliminary study, fly ash has been found to result satisfactory Marshall Properties and hence has been used for mixes in subsequent works. Using Marshall Procedure Optimum Fibre Content (OFC) for both BC and SMA mixes was found to be 0.3%. Similarly Optimum Binder Content (OBC) for BC and SMA were found to be 5% and 5.2% respectively. Then the BC and SMA mixes prepared at OBC and OFC are subjected to different performance tests like Drain down test, Static Indirect Tensile Strength Test and Static Creep Test to evaluate the effects of fibre addition on mix performance. It is concluded that addition of sisal fibre improve the mix properties like Marshall Stability, Drain down characteristics and indirect tensile strength in case of both BC and SMA mixes. It is observed that SMA is better than BC in respect of indirect tensile strength and creep characteristics.

INTRODUCTION

1.1 GENERAL

Construction of highway involves huge outlay of investment. A precise engineering design may save considerable investment as well a reliable performance of the in-service highway can be achieved. Two things are of major considerations in flexible pavement engineering–pavement design and the mix design. The present study is related to the mix design considerations.

A good design of bituminous mix is expected to result in a mix which is adequately (i) strong (ii) durable (iii) resistive to fatigue and permanent deformation (iv) environment friendly (v) economical and so on. A mix designer tries to achieve these requirements through a number of tests on the mix with varied proportions and finalizes with the best one. The present research work tries to identify some of the issues involved in this art of bituminous mix design and the direction of current research.

1.6 OBJECTIVE OF PRESENT INVESTIGATION:-

A comparative study has been made in this investigation between Bituminous Concrete (BC) and Stone Matrix Asphalt (SMA) mixes with varying binder contents (4% - 7%) and Fibre contents (0.3% - 0.5%). In the present study 60/70 penetration grade bitumen is used as binder and Sisal fibre is used as stabilizing additive.

The whole work is carried out in four different stages which is explained below.

- Study of Marshall Properties of BC mixes using three different types of fillers without fibre(fly-ash, cement, stone dust)
- Study of BC mixes with fly ash as filler and sisal fibre as stabilizer
- Study of SMA mixes with fly ash as filler and sisal fibre as stabilizer
- Evaluation of SMA and BC mixes using different test like Drain down test, Static Indirect tensile Strength test, Static Creep test

Literature review

Brown and Manglorkar (1993) has done a comparative study on SMA and DGM by using 2 type aggregate (granite and local siliceous gravel) and also used cellulose and mineral fibre in SMA and did different test like Marshall test, Drain down test , Indirect tensile strength test, resilient modulus. They found that in SMA mixture the high amount of coarse aggregate forms a skeleton type structure providing a better stone-on-stone contact between coarse aggregate particle , which offer high resistance to rutting.SMA has shown good resistance to plastic deformation under heavy traffic loads with high tire pressure , also show good low temperature properties. Further, SMA has a rough texture which provides good friction properties after surface film of the binder is removed by the traffic.

Brown (1994) studied on SMA using different type of filler, stabilizer and concluded that Drain down in SMA is effected by type of filler, type of stabilizer , amount of stabilizer(higher the amount of stabilizer lower the drain down).Optimum binder content of SMA mixes is greater than DGM.

Bradely et al. (2004) studied Utilization of waste fibres in stone matrix asphalt mixtures. They used carpet fibre and polyester fibres and waste tires to improve the strength and stability of mixture compared to cellulose fibre. They found waste tire and carpet fibre are effective in preventing excessive drain down of SMA mixture also found that tensile strength ratio of mixes more than 100% , it means fibre don't weaken the mixture when expose to moisture. Addition of tire and carpet fibre increases toughness of SMA. They found no difference in permanent deformation in SMA mix containing waste fibres as compared to SMA mix containing cellulose or mineral fibre.

Kamaraj et al. (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.

Punith et al. (2004) did a comparative study of SMA with asphalt concrete mix utilizing reclaimed polythene in the form of LDPE carry bags as stabilizing agent (3 mm size and 0.4%) .The test results indicated that the mix properties of both SMA and AC mixture are getting enhanced by the addition of reclaimed polythene as stabilizer showing better rut resistance, resistance to moisture damage, rutting, creep and aging.

Reddy et al. (2004) used Crumb Rubber (CR) OBTAINED from discarded tire with 80/100

penetration grade bitumen in SMA and concluded that it improves fatigue and permanent deformation characteristics, greater resistance to moisture damage than normal mixes.

Ibrahim M.asi(2005) performed different test like Marshall stability test, loss of Marshall stability, tensile strength, loss tensile strength, resilient modulus, fatigue life, rutting resistance were conducted on both SMA and DGM . He concluded that though DGM have high compressive strength and tensile strength; SMA have higher durability, high resilience property, high rutting resistance as compare to DGM. Hence SMA is preferable in hot climate weather.

Muniandy and Huat (2006) used Cellulose oil palm fibre (COPF) and found fibre-modified binder showed improved rheological properties when cellulose fibres were pre blended in PG64-22 binder with fibre proportions of 0.2%,0.4%,0.6%,0.8 %and 1.0% by weight of aggregates. It showed that the PG64-22 binder can be modified and raised to PG70-22 grade. The Cellulose oil palm fibre (COPF) was found to improve the fatigue performance of SMA deign mix. The fatigue life increased to a maximum at a fibre content of about 0.6%, while the tensile stress and stiffness also showed a similar trend in performance. The initial strains of the mix were lowest at a fibre content of 0.6%.

Various tests to be conducted in study

- Test on Material Used
  - Aggregate
  - Filler
  - Binder
  - Fibre

  Preparation of Mixes
- Tests on Mixes
  - Marshall Test
  - Drain down Test
  - Static Indirect Tensile Strength Test
  - Static Creep Test

Concluding Remarks

The review of literature gives an overview of the researches were done on bituminous mixture like stone matrix asphalt (SMA) and Dense graded mixtures. Keeping the important points of the researches in mind, the materials of SMA and Bituminous concrete (BC) with its composition and the corresponding test methods for the present investigation have been chosen. Here an attempt has been made to compare the different properties of SMA and BC through different test like Marshall Test, Indirect Tensile stress Test, Static Creep Test where 60/70 penetration grade bitumen is taken as binder and fly ash as filler. . In this research work the MORTH gradation has been adopted. . Investigators mainly have focused on uses of cellulose fiber and other materials in the mixes to prevent drain down of binder mortar from the mix. Use of a non conventional fiber such as SISAL fiber

which primarily contain cellulose on its outer part and is widely and cheaply available all over the world, is not available in past literature, particularly in SMA mixes. Hence this material has been used as the stabilizing additive in the preparation of BC and SMA mixes. This would solve to good extent the problem of solid waste management and at the same time explore the possibility of using a non conventional waste material in a typically non conventional mix like SMA.

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