

Investigation on Properties of SMA Using Sisal Fiber & Slag Aggregate on Road Construction

Waseem Ghani¹, Pratiksha Malviya², Bharti Tantaway³

¹M. Tech. Scholar, ^{2,3}Professor Department of Civil Engineering

Millennium Institute of Technology, Bhopal, India

Abstract-Stone matrix asphalt, was as a matter of first importance created in 1960 in Germany which now to a great extent helps in giving a more noteworthy changeless twisting protection, strength to surfacing materials, longer administration life, enhanced maturing, high protection in splitting, exhaustion, wear, better slide protection and like in diminishing commotion. A fiber that is promptly accessible in nature. Less savvy contrasting with other non-traditional filaments has been utilized as stabilizer. It is Sisal fiber, which is fiber. It has high quality in fiber course, more noteworthy malleable, flexural and affect quality. Slenderness level of fiber can undoubtedly be acquired from it. It is solid in nature, has steadiness and great security esteem. An endeavor has been made to discover its appropriateness in expanding the dependability and stream an incentive in the blend of Stone Framework Black-top Blends. For this task, we have arranged SMA blends utilizing stone as coarse aggregate, slag in fractional substitution of coarse aggregate and utilized distinctive stabilizers and have endeavored to think about the outcomes at a fluctuating bitumen substance of 4%, 4.5%, 5%, 5.5% and 6 % bitumen with stabilizers 0.4%.

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

I. INTRODUCTION

Stone Matrix asphalt which is a gap graded mixture widely varies in its result according to the varying methods, procedures, apparatus and Materials to be used for the Mix preparation and so the result also is valid only to the particular region and conditions. In this topic it mainly includes the selection of material types which includes Coarse and Fine Aggregate, Filler, Binder and Stabilizer. Here Coarse Aggregates are taken as Slag aggregate. Binder is Bitumen of grade 60-70 as it is the binder required and mostly preferred by the engineers due to its atmospheric condition of India. Sisal fibres are used as stabilizer to check their varying results.

II. LITERATURE SURVEY

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

Laith Tashman & Brian Pearson July 2011 This examination connected regular research facility tests and propelled imaging systems to tentatively confirm the voids

in coarse total (VCA) technique. Five stone network black-top (SMA) blends intended to have diverse coarse total skeletons were examined to build up connections between the VCA proportion, microstructure parameters and the mechanical reaction of SMA. X-beam CT and picture examination strategies were used to non-dangerously evaluate the microstructure of SMA blends. The air void size disseminations were evaluated with the Weibull total conveyance capacity to depict the pressing of the SMA blends and to consequently confirm the presence of a stone-on-stone coarse total skeleton. The dynamic modulus and static crawl tests were led to gauge the mechanical reaction of the blend, which portrays the basic amplex of the SMA blends. As a rule, the outcomes demonstrated that the VCA technique sensibly distinguished blends with a stone-on-stone coarse total skeleton. The connections created suggested that the VCA strategy be changed to incorporate a lower basic VCA proportion and mechanical testing to guarantee ideal execution of SMA.

Shuler, T. S., et al. (2012) considered the practicality of base fiery debris for HMA, that will be utilized as a part of the middle of the road courses of the adaptable asphalts specific in fastener course. The outcomes acquired from the examination clarify that the blend performed better when 15% of base fiery remains was added to the blend in substitution of compare measure of sand. It is additionally eyewitness that with increment in black-top substance, wearing protection of the blends increments likewise.

The test outcomes demonstrate that there is no breaking down in mechanical properties of the bituminous blend as opposed to the traditional blend. However the mechanical and synthetic normal for the tried bituminous blends support the conceivable utilization of base slag in the cover course.

Gunalaan Vasudevan (2013) led a test on Execution qualities of Base powder in HMA (Hot Blend Black-top). The goal of this examination is to utilize the Base fiery remains as totals in sub bases, bases, and asphalt layer. This examination is inspired with three sections destinations for assessing the dependability of bitumen blend which are readied shape certain level of base fiery debris utilizing Marshall Technique, deciding physical

attributes of base powder when it was blended with bitumen and assessed the change of building properties of the Marshall 3D square as far as surface and appearance.

In view of the test comes about, the example with base slag is better than ordinary examples as far as solidness, quality and the example stream. Accordingly, the asphalt will end up more grounded and can withstand if stacked high activity stack. Nonetheless, there are downsides with the uses of coal base fiery debris as mineral filler where the air void substance expanded which cause in diminishment of thickness in the blend.

Goutham Sarang, B.M. Lekha, G. Krishna & A.U. Ravi Shankar Dec 2015

Stone Grid Black-top (SMA) is a hole reviewed bituminous blend described with its enhanced trench protection and strength. It has nearly higher extent of coarse totals and folio mastic with bituminous cover and mineral filler. Deplete down of mastic content at different phases of development is a typical issue with SMA, and by and large, some fiber added substances are utilized to balance out the blend or an altered bitumen is utilized as the cover material. In this examination, destroyed waste plastics (SWP) are utilized rather than other balancing out added substances, to get ready SMA blends with traditional consistency evaluated (VG) 30 bitumen. Blends were set up with four distinct levels of SWP content, and another blend with no stabilizers was additionally arranged utilizing polymer-changed bitumen (PMB). Examples were set up in superpave gyratory compactor (SGC) for all blends at various bitumen substance to decide volumetric and Marshall properties, and ideal bitumen content (OBC) was ascertained for every blend. Rigidity, dampness vulnerability, rutting protection and exhaustion conduct were likewise decided for all blends at comparing OBC. From the accessible outcomes, the ideal level of SWP in SMA blend was resolved as 8% by weight of bitumen. The investigation demonstrated that despite the fact that blend with PMB played out the best, SMA with 8% SWP gave tantamount outcomes. In view of the present examination, squander plastic in reasonable measurements can be prescribed in SMA, rather than a settling added substance.

Sara Fernandes, Hugo M. R. D. Silva & Joel R. M. Oliveira Oct 2017

The reuse of waste materials in black-top blends has been as of late explored, keeping in mind the end goal to grow new manageable answers for the street clearing industry. Such materials ought to enhance the mechanical execution and give safe/agreeable asphalt surface courses for street clients, without trading off their ecological execution. In this manner, the point of this examination is to assess the mechanical, surface and natural properties of stone mastic black-top (SMA) blends delivered with forward-looking

black-top folios consolidating waste materials. These folios were intended to boost the waste material substance utilizing engine oil, high-thickness polyethylene, styrene-butadiene-styrene and morsel elastic, while performing so well as a business changed bitumen. At long last, the general execution of the SMA blends created with the chose fasteners was assessed. It was inferred that these blends enhance the water affectability, weakness breaking and changeless disfigurement execution. The necessities for macrotexture, slip protection and nearness of substantial metals in leachates of these blends were comparatively satisfied. In this manner, this work demonstrates that new black-top blends with squander materials can be utilized as a part of street clearing attempts to enhance the execution without trading off human and natural wellbeing.

Elham H. Fini, Shahrzad Hosseinnazha Nov 2017 The use of scrap elastic in the black-top industry has shown numerous favorable circumstances in asphalt, yet the difficulties related with its application in asphalt development have restricted its use. In this investigation, Bio-Cover was utilized as an added substance for scrap elastic altered (CRM) black-top folio to upgrade its rheological properties while enhancing workability and lessening isolation. The item created by adding Bio-Folio to CRM cover is called Bio-Changed Elastic (BMR) fastener. Rheological investigations demonstrated a diminishment in the blending and compacting temperatures of BMR folio in contrast with CRM cover, which subsequently prompts change in the workability and pumpability of the subsequent black-top blend. The isolation which was measured utilizing a stage division file, lessened from 58% in CRM fastener to 33% in BMR folio. Also, BMR folio demonstrated preferable exhaustion breaking protection over both CRM and perfect fasteners. Assessing low-temperature properties of examples molded at -12°C for 12 h demonstrated that BMR fastener had enhanced low-temperature properties contrasted with CRM folio. Likewise, blend thinks about were directed on the fine total grid (FAM). It was demonstrated that low-temperature properties of FAM blends improved with BMR were essentially than those of CRM blends.

A review of the utilization of nanoclay changed bitumen in black-top blends for improved adaptable asphalt exhibitions

Fernando C. G. Martinho & José Paulo May 2017 Bitumens are unpredictable materials, delivered fundamentally from unrefined petroleum as a side-effect of oil refineries, yet may likewise be gotten from bio-oils or strong hydrocarbons. Bitumen particulars have turned out to be stringent, for the most part since they are utilized as covers in black-top blends that bring to the table great protection from climate and activity disintegration. There

are a wide range of kinds of added substances that can be utilized to enhance bitumen properties and, subsequently, black-top blends execution. Nanoclays are one of the most up to date added substances being utilized as a part of clearing grade bitumens to expand their in-benefit execution. This paper covers the fundamental parts of black-top blends with nanoclays, including constituent materials, blend plan and mechanical execution issues, and additionally specialized particulars.

Peiwen Hao, Ruixin Zhai, Zhenxing feb 2018 With the point of enhancing the black-top and black-top blend execution at high and low temperatures, polyphosphoric corrosive (PPA) and styrene butadiene elastic (SBR) were added to accomplish a change in this investigation. The impacts of PPA and SBR compound modifiers on the rheological and mechanical properties of black-top and black-top blend were portrayed by ordinary and curiosity tests. It was shown that PPA can drastically enhance the counter rutting execution of base and SBR-altered black-top and blend. What's more, protection against low-temperature breaking of PPA/SBR compound-changed black-top and blend was likewise attractive. Besides, the execution markers were positioned and broke down. As an outcome, 0.75%PPA/2.5%SBR is useful to accomplish the coveted properties extensively. The novel tests specified in the paper are legitimate and suggested. Successful pointers have been proposed for their capability to describe the execution of black-top and blend.

Jizhe Zhang, Zhanyong Yao, Tenghai Yu, Shengjie Liu & Hongguang Jiang feb 2018 Because of the sensational increment in rush hour gridlock volume, black-top asphalts break down step by step with the high-temperature rutting and low-temperature warm splitting as two primary disappointment modes. This paper centers around the incorporated adjustment of bituminous covers and black-top blends with the part of enhancing the execution of black-top asphalt at both high and low in-benefit temperatures. The reused scrap elastic (CR) and polyethylene (PE) were picked as polymer specialists keeping in mind the end goal to change the bitumen property. Investigation on the rheological execution of adjusted bitumen demonstrated the expansion of CR diminished the bitumen crawl solidness at low-temperature which thusly decreased the weakness and splitting danger. Then, the expansion of PE expanded the bitumen solidness at high-temperature which brought about enhanced rutting protection. Regarding the incorporated altered bitumen, the expansion of CR and PE helpfully enhanced the bitumen properties at both high and low temperatures. As far as the black-top blend. Again the use of fiber is limited to SMA and BC due to its comparatively high air voids content. Hence in many research work fibers are used as an additive or as a stabilizing agent in SMA or BC.

III. OBJECTIVES

The main objective of this project is to check the suitability of preparing SMA mixes using sisal fiber and slag.

IV. RESULTS

Marshall Stability:-

Stability value increases with increase in bitumen content up to some point theoretically and then decreases. The reason is due to increase in bitumen content there will be high bonding with aggregate and gets strong, but with further increase in bitumen, the applied load is transmitted and hydrostatic pressure keeps the aggregates immobilized. By this it makes weak against plastic deformation and stability decreases. Stability value increases with fiber than without fiber. Here fiber acts as stabilizer in mix, fiber not only fill the voids but also reduces the drain down and hold with binder and gives good result.

Flow Value

Flow value defined as deformation of sample where failure occurs. Flow value increases with increase in bitumen content using with fiber or without fiber. Generally increase is slow, but later with increase in bitumen content flow value increases. Flow value prepared with fiber show low when compare to without fiber. But in some situations, flow value increases with fiber due to formation of lumps of bitumen and fiber.

Air Voids

While preparing the samples, due to improper compaction and heating air voids are formed between the samples. Here air voids goes on decreasing on increasing the bitumen content. This is due to increase in bitumen content air voids get filled up. The air voids with fiber shows less than without fiber due to fibers fill up some voids in sample.

Voids in Mineral Aggregates

With increase in bitumen content, VMA goes on slowly decreasing and then it remains constant, and then finally increases with increase in bitumen. The slowly decreasing in VMA is due to reorientation of aggregates in bitumen. Whereas at high bitumen content, due to a thick bitumen film repels the aggregates and increases the VMA value theoretically.

V. CONCLUSIONS

Marshall Stability:-

SMA samples prepared with stone and slag as coarse aggregate. In this project work, slag aggregate shows better stability value when compare to stone aggregate.

The maximum stability value is obtained for slag as coarse aggregate i.e. 17.25 KN at 5.5% bitumen content when compare to stone as coarse aggregate.

Optimum Binder Content:-

The optimum binder content of the SMA mix, based on the results of Marshall test taking 4% air voids as the main criteria are observed to be increasing with the increase in stiffness of the binder. Slag shows optimum binder content of 5.5% which is same as that of SMA samples with slag where as SMA mix with only stone aggregates gives optimum binder content of 5.2%.

Future scope of work

In future performance of sisal fibre with other grades of bitumen can also be tested and seen whether it can be used successfully or not.

Use of sisal fibre may also be tested not only for SMA but also for different other HMA.

Indirect tensile test of bituminous mixes can give us an idea about tensile strength of bituminous mixes.

Optimum Binder Content:-

The optimum binder content of the SMA mix, based on the results of Marshall test taking 4% air voids as the main criteria are observed to be increasing with the increase in stiffness of the binder. Slag shows optimum binder content of 5.5% which is same as that of SMA samples with slag where as SMA mix with only stone aggregates gives optimum binder content of 5%.

Future scope of work

In future performance of sisal fibre with other grades of bitumen can also be tested and seen whether it can be used successfully or not.

Use of sisal fibre may also be tested not only for SMA but also for different other HMA.

Indirect tensile test of bituminous mixes can give us an idea about tensile strength of bituminous mixes.

REFERENCES

[1] Bindu C.S. et. al., "Waste plastic as a stabilizing additive in Stone Mastic Asphalt", International Journal of Engineering and Technology Voume-2 (6), 2010, 379-387.
[2] Brown E.R. and Mallick R.B. (1994), "Stone Matrix Asphalt Properties Related to Mixture Design", NCAT Report 94-02.
[3] Chakraborty Partha, Das Animesh ,Principals of transportation engineering, PHI 2003, page no 294-309.
[4] Chui-Te Chiu, Li-Cheng Lu,"A Laboratory study on stone matrix asphalt using ground rubber", Construction and Building Materials, Volume 21, Issue 5, May 2007, Pages 1027-1033
[5] D-6927-06, Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures.

[6] IRC: SP: 79-2008-Tentative specifications for stone matrix asphalt, Published by Indian Roads Congress.
[7] Kumar Pawan, Chandra Satish and Bose Sunil, 'Laboratory investigations on SMA mixes with different additives', International Journal of Pavement Engineering, Volume 8, Issue1, March 2007, Pages11-18.
[8] Manual for construction and supervision of bituminous works, MoRTH, IRC, New Delhi, 2001.
[9] MORTH, Specifications for Road and Bridge Works, up gradation of Third Revision, Ministry Of Road Transport and Highways.
[10] Putman B.J. and Amirhanian S.N. (2004), "Utilization of Waste Fibers in Stone Matrix Asphalt Mixtures", Resources, Conservation and Recycling, Volume 42, Issue 3, pp 265-274.
[11] Y. Xue, S. Wu, H. Hou, J. Zha "Experimental investigation of basic oxygen furnace slag used as aggregate in asphalt mixture"- J. Hazard. Mater. 138 (16) (2006), pp. 261-268.