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AN EXPERIMENTAL USE OF SISAL FIBER IN HOT MIXED PAVEMENT

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Abstract: The increase in traffic growth and maintenance expenditures demands the urgent need for building better, long-lasting, and more efficient roads preventing or minimizing bituminous pavement distresses. The Sisal fiber mixtures provide a durable surface course. In order to improve the performance for an pavement surface, the fiber additives in flexible pavement mixture were compared. Furthermore, certain groups of comparative experiments were conducted by adding the different length and different quantity of the sisal fiber toward the flexible pavement mixture by conducting various test and showing that the sisal fiber is good additive to improve performance for pavement. The best length and the best quantity of the sisal fiber in the flexible pavement mixture were determined. and its application is very limited mainly due to the lack of proper specifications. The concept of using natural fibers and waste materials to replace these energy intensive synthetic fibres or polymer additives is a recent development in this field. India, being an agricultural economy produces fairly huge quantity of natural fibres such as coconut, sisal, banana, sugar cane, jute etc. Now- a -days the disposal of waste plastics is a major concern for an eco- friendly sustainable environment. In line with these thoughts, this research focuses on the utilization of natural fibres and waste plastics as additives to improve the performance of pavement.

Keywords: Fibers, Naturalfiber, Sisal, Asphalt

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INTRODUCTION

Sisal Fiber is one of the most widely used natural fiber and is very easily cultivated. It is obtain from sisal plant. The plant, known formally as Agave sisalana. These plants produce rosettes of sword-shaped leaves which start out toothed, and gradually lose their teeth with maturity. Each leaf contains a number of long, straight fibers which can be removed in a process known as decortication. During decortication, the leaves are beaten to remove the pulp and plant material, leaving the tough fibers behind. The fibers can be spun into thread for twine and textile production, or pulped to make paper products. Sisal fiber is fully biodegradable, green composites were fabricated with soy protein resin modified with gelatin. Sisal fiber, modified soy protein resins, and composites were characterized for their mechanical and thermal properties. It is highly renewable resource of energy. Sisal fibre is exceptionally durable and a low maintenance with minimal wear and tear. Its fibre is too tough for textiles and fabrics. It is not suitable for a smooth wall finish and also not recommended for wet areas.

Review of literature

O.S.Abiola et al (2013) sisal fiber is one of the most widely used natural fibers and is very easily cultivated. Nearly 4.5 million tons of sisal fibers are produced every year throughout the world. Tanzania and Brazil are the two main producing countries. Sisal fiber is a hard fiber extracted from leaves of the sisal plant. A sisal plant produces between 200 and 250 leaves and each leaf contains between 1000 and 1200 fiber bundles, which are composed of: 4% fiber, 0.75% cuticle, 8% dry matter and 87.25% water. Therefore, a leaf which weighs about 600 g will yield about 3% by weight of fiber with each leaf containing 1000 fibers. The advantages of sisal fibers are: they have good resistance against moist, heat and short fibers delay restrained plastic shrinkage thereby controlling crack development at early ages. In developing countries, sisal fibers are used as reinforcement in houses.

Oda et al. evaluated the use of asphalt rubber binder and natural fibers (sisal and coconut) in discontinuous stone asphalt mixture (d-SMA). Comparison was done between the performances with: (i) mixture without fibers, (ii) polyester fibers and (iii) cellulose. The results of the mechanical tests (tensile strength and modulus of resilience) demonstrated that blends with natural fibers showed high resistance, while preventing the asphalt drain down. The result of fatigue analysis showed that the mixture with an asphalt modified rubber had the best behavior and the results obtained with cellulose fibers, sisal and coconut shells were not significantly different.

Delgado and Arnaud investigated the potential use of hemp fibers as reinforcement for asphalt paving materials. Four different lengths of fiber and three different proportions were investigated in order to assess the influence of fiber content and length on the fatigue behaviour of the composite. The results indicated that there is a reduction in the complex

modulus and phase angle (damping)of the fiber-modified asphalt mixtures in comparison with the control. Fatigue life was improved for fiber-modified asphalt mixtures with fibers of 5 cm length and percentage of 0.4%.
Coir fiber was reported to have improved fatigue life of bituminous mixes. Thulasirajan and Narasimha presented a study on stability, flow and volumetric properties of the coir fiber reinforced bituminous concrete by varying the binder content, fiber content and fiber length. The results indicated that the addition of coir increased the stability and voids with decrease in the flow rate. Fiber length of 15 mm with a fiber content of 0.52%and a binder content of 5.72% provided good stability and volumetric properties. It can be said that coir fiber has the potential to improve the structural resistance to distress occurring in flexible pavement due to traffic loads [1]

Midhila V S, Veena G Raj stated that Reinforcement with natural fibers has been shown to possess certain advantages over such as: their ease availability, low density, acceptable specific properties enhanced energy recovery and biodegradability other fibers. the results of the addition of a large variety of fibers to bituminous mixes. The result shows that fiber improves the fatigue life by increasing the resistance to cracking and permanent deformation. The fiber reinforcement thus provided additional tensile integrity in the mixes and hence increasing the strain energy absorption thereby inhibiting the formation and propagation of cracks. Researchers on natural fibers agreed that uniform distribution, fiber length, percentage and orientation are the keys to mixture performance. In order to understand the mechanical properties of fiber reinforced bituminous mixes.[2]

Labib and Maher (1999) stated that the use of recycled fibers in asphalt mixtures was considered advantageous when using fishing nets. As a result, fibers could be uniformly and consistently incorporated into the asphalt mixture without segregation or introduction of excessive air voids. However, the same authors refer that fibers typically obtained from recycling operations such as those from carpets and car seats were difficult to be utilized with the dry mixing process used in laboratory. Thus, a first stage to study these fibers should comprehend the use of virgin fibers to clearly understand how fibers affect the mechanical properties of the mixture, and then apply the results to the use of recycled fibers. [2]

Vivek B. R, Dr. Sowmya N. J. stated that as plastic content increases, the stability increases up to 8% plastic content and then goes on decreases. The Marshall stability value of SMA with 8% shredded waste plastic is 17.04 kN, which has been considered as the optimum value. The Marshall Stability value of stabilized SMA with 0.3% coconut fibre is found to be 16.35 kN, which is lesser than the stability value of SMA with 8% shredded waste plastic. The flow value of SMA with 8% and 10% plastic content is 4.6mm and 4.8mm respectively. This shows that the flow value increases with increase in the bitumen content. It is observed that with increase in the bitumen content the volume of voids decreases. The voids filled with mineral aggregate and the voids filled with bitumen both increases with increase in the bitumen content. The above results indicates that the flexible pavement with high performance and durability can be obtained with 8% shredded waste plastic and 0.3% coconut fibre.[3]

Bindu C.S, Beena K.S Presence of fibres in SMA mixture enhances the stone to stone contact of aggregates in the gap graded mixture by strengthening the bonding between them. These fibres also enhance the adhesion between aggregate and bitumen, which results in less stripping of SMA mixture. All these give rise to a stiffer and tougher mix with considerable improvement in compressive strength. fibres do not cause the SMA mixture to weaken when exposed to moisture. Actually they are enhancing the resistance to moisture susceptibility of the mixture. The indices of retained strength for all stabilized mixtures satisfy the limiting value of 75%. But for control mixture, it is only about 60%, which substantiate the necessity of additives in SMA mixtures. Although all the fibres significantly improve the performance of the SMA mixtures in terms of compressive strength, coir fibre gives the best result[4]

H.p.singh and M.Bagra stated that present investigation it is concluded that CBR value of soil increases with the inclusion of Jute fiber.When the Jute fiber content is Increases the CBR value of soil is further increases and this increase is substantial at fiber content of 1%.It was also found that preparation of identical soil samples for CBR test beyond 1 % of fiber content is not possible and optimum *fiber* content was found to be 1 % by dry weight of soil.It Is also concluded that there is significant effects of length and diameter of fiber on the CBR value of soil.The CBR value of soil increases with the increase in length and diameter of fiber.The maximum increase in CBR value was found to be more than 200 % over that of plain soil at fiber content of 1 % for fiber having diameter 2mm and length 90 mm.[5]

Jaime Preciado, Gilberto Martínez Arguelles, Margareth Dugarte,Alessandra Bonicelli, Julio Cantero, Daniela Vega, Yennis Barros stated that it indicates that the effect of additive in Marshall Stability HMA depends on mix design characteristics (e.g, aggregate type and grading, and bitumen grade and amount). Then, it is believed that in some way, the additive modify of some intrinsic property of the mix that in conjunction with different aggregate source and grading, causes a different effect in Marshall Stability for each mix. [9]

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