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A Review on Enhancing the Properties of Stone Mastic Asphalt Using Bagasse and Coir Fiber as Additives

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***Abstract:** Stone mastic asphalt is recognized for its remarkable durability, making it a crucial component for constructing pavements on aerital roads, which must withstand heavy traffic. When road authorities choose asphalt for main roads under these conditions, they often prefer stone mastic asphalt. The most crucial aspect of this type of asphalt is ensuring that SMA is implemented correctly, as it has excellent performance characteristics. However, improper implementation can lead to changes in performance. European countries favor SMA for its outstanding performance. There have been recent advancements in SMA methods, including computation and artificial intelligent systems such as artificial neural network and fuzzy logic (ANN and FL) in various engineering fields. It is vital to consider the resilient module when discussing fuzzy logic and SMA performance characteristics. Air voids, bulk density, and permeability coefficient are some of the critical SMA features that should be evaluated when applying fuzzy logic. In the initial stages, fuzzy logic utilizes weighted average operations to input data, and the output undergoes assessment by a mathematical model. Through experimental study, applying fuzzy logic can enhance the accuracy of evaluation.*
***Keywords:** A Stone Mastic Ashphalt(SMA), Durability of Pavement, Aerital Roads etc.*

I. INTRODUCTION

Infrastructure development in India has identified the construction of new roads and strengthening of bridges as a major focus area. To create a strong and sustainable wearing course for bridge construction, mastic asphalt is the preferred material due to its desirable properties. This material is made up of a mixture of coarse aggregate, sand, limestone fine aggregate, filler, and bitumen. It has a low void content and the binder content is adjusted to completely fill the voids. Mastic asphalt is pourable and requires no compaction on site, making it an ideal surfacing material for bridges. However, the high percentage of bitumen content can cause drain down during mixture and transportation.

A. Stone Mastic Asphalt

Stone mastic asphalt (SMA) is a type of asphalt mixture used for road construction and surfacing. It is a high-quality mix that consists of large stones, sand, filler, and bitumen binder. The large stones in the mix provide a high level of durability and resistance to wear and tear, while the sand and filler help to create a smooth, even surface.

The use of SMA results in a pavement that is more resistant to deformation, cracking, and potholes compared to traditional asphalt mixes. It also has improved skid resistance and can reduce noise levels compared to conventional asphalt surfaces.

SMA is typically used for high-traffic roads and motorways, where a durable and long-lasting surface is essential. It can also be used in more demanding applications, such as airport runways, industrial estates, and heavy-duty truck parks.

B. Bagasse

Bagasse is the fibrous residue that remains after sugarcane or other plant materials have been crushed to extract their juice or sap. It is primarily composed of cellulose, hemicelluloses, and lignin and is used as a biofuel source for the production of energy, as well as for manufacturing paper, building materials, and animal feed.

In India, bagasse is a major agricultural waste generated by the sugarcane industry. According to the Ministry of New and Renewable Energy, the country produces about 27 million tonnes of bagasse every year. While some of it is used as a fuel in the sugar mills to generate electricity and steam, a significant portion of it remains unutilized and is either burned or disposed of in landfills, leading to environmental problems.

However, in recent years, there has been increasing interest in using bagasse for various purposes such as production of biofuels, animal feed, and paper pulp. Additionally, bagasse is being explored as a potential reinforcement material in composite materials, including in the construction of low-cost housing. The Indian government has also initiated various schemes and incentives to encourage the utilization of bagasse and other agricultural waste for renewable energy production and other applications.
Hence our aim is to use Bagasse as a reinforcing matial in SMA.

C. Coir Fiber

Coir fiber is a natural fiber extracted from the husk of coconut fruit. In Stone Matrix Asphalt (SMA), coir fibers are used as a reinforcement material to improve the mechanical properties and durability of the asphalt pavement. The addition of coir fibers to the SMA mix helps to increase the tensile strength, reduce the risk of cracking, and enhance the resistance to permanent deformation.
Coir fibers are particularly useful in hot and humid climates, as they have a high resistance to moisture absorption and are less likely to break down in such conditions. The use of coir fibers in SMA also has environmental benefits as it reduces the reliance on synthetic fibers, which can be harmful to the environment.
Overall, the addition of coir fibers to SMA has been found to result in improved pavement performance, particularly in terms of rutting resistance and cracking resistance, making it an attractive option for road construction and rehabilitation projects.

1) The objective is to ascertain the pertinent index and engineering properties of bagasse and coir fibers in stone matrix asphalt.
2) The aim is to investigate the impact of different percentages of bagasse and coir fibers added to stone matrix asphalt mixes with stone dust as filler.
3) The goal is to analyze the resistance to permanent deformation of mixes with and without the aforementioned admixtures.
4) The objective is to examine the Marshall properties of stone matrix asphalt mixes containing bagasse and coir fibers with filler materials to determine their impact on mix properties.

II. LITERATURE REVIEW

Rosli Hainan and colleagues conducted a study to explore the Importance of Stone Mastic Asphalt (SMA) in construction. The study had two primary objectives: first, to provide a comprehensive review of the evaluation of SMA in construction to provide an updated systematic review, and second, to provide knowledge to readers and researchers regarding the advantages and disadvantages of SMA to help them focus their future research in this area. The researchers conducted interviews with several respondents and investigated previous research on SMA to address major elements of SMA. The study concluded that SMA is an appropriate material for use in construction as it does not show any systemic safety issues. However, institutional issues can influence the effective use of SMA.
Teja Tallam et al.: conducted a study to assess the performance of SMA with the inclusion of fiber material on resilient characteristics. The primary objective of the study was to compare the inclusion of polyester fibers in SMA mix to understand the behavior of resilient characteristics. The optimal binder content of SMA mix was determined to be 6.5%, and the corresponding fiber content was 0.4% when performed through the drain-down test. Polyester fibers were found to have good drain-down characteristics and provided a good homogeneous mixture compared to conventional SMA. The study showed that the inclusion of polyester fibers improved the resilient modulus by 18% and the tensile strength ratio by 1.2%. This indicates that the fiber inclusion provides better cracking resistance compared to conventional SMA mix.
Mohammad Altaf Bhat et al.: conducted a study to investigate the effect of fillers on bituminous mixes. The study aimed to design bituminous mixes effectively to satisfy the design requirements of stability and durability. The ingredients of the mixture included dense grading of coarse aggregates, fine aggregates, fillers, and bitumen binder. The study aimed to find the effect of filler on the behavior of bituminous mixes, as fillers play an important role in filling voids and hence change the physical and chemical properties of bituminous mixes. The study showed that the use of concrete dust and brick dust as fillers improved the physical characteristics of bitumen. The Marshall Stability and flow value of bitumen mix also improved.
K. Karthik et al.: were conducted a study to investigate the effects of using carbon fiber as an additive in Dense Bituminous Macadam (DBM). The study used the Marshall Procedure to determine the Optimum Fiber Content and Optimum Binder Content for DBM. The researchers conducted laboratory investigations by preparing asphalt concrete mixtures by adding carbon fiber with dosages of 0.5% to 2.5% by weight of binder. The study showed that the addition of carbon fibers provided a uniform fiber distribution, improving the volumetric properties of the mixes and increasing the strength of the mixes.
Dr. P. Sravana et al.: were conducted a study to investigate the properties of Stone Matrix Asphalt (SMA) mixture by altering aggregate gradations and filler types. The study aimed to explore the effect of aggregate gradation and filler type on the properties of

SMA. The researchers used four different aggregate gradations with two types of fillers, hydrated lime and crushed stone dust, for the preparation of mixes. The study showed that the crushed stone dust improved the Marshall properties such as Marshall Stability and unit weight values more than hydrated lime.

Vivek B. R et al.: were conducted a study to explore the utilization of fiber as a strength modifier in Stone Matrix Asphalt (SMA). The study investigated the potential use of shredded waste plastic as a modifier for asphalt concrete and the addition of coconut fiber to stabilize the asphalt from SMA mixes. The researchers subjected conventional SMA mixes and stabilized SMA mixes 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 percentages.

Ms. P. Bakiya et al: conducted a study to investigate the effect of coir fibre on the properties of bituminous concrete mixes, which are widely used as the structural layer in flexible pavements. The study showed that the addition of coir fibres, at lengths of 10mm, 15mm, and 20mm and at rates of 0.3%, 0.5%, and 0.7% by weight of mix, enhanced the mechanical properties of the bituminous concrete mixes. These properties were investigated through tests such as the indirect tensile strength test (ITS), short and long-term ageing tests, and stiffness modulus test. The study concluded that the incorporation of coir fibre in the mix improved the properties of bituminous concrete, but there was a reduction in stiffness modulus values of coir of up to 10% and 40% after short-term and long-term ageing tests, respectively. However, this minimum reduction would not affect the performance of the pavement because, even after the long-term ageing process, the modified mix increased by up to 40% when compared to the IRC values.

Vidhi Patel et al: studied the enhancement of bituminous properties using Fortafibre in SMA. The study aimed to improve the properties of bitumen, which is commonly used in flexible pavement construction, by adding fibres, chemicals, waste materials, etc. The study investigated the most suitable fibres to improve the properties of bitumen, such as Marshall Mix design, viscosity, ductility, and specific gravity. According to literature, Forta Fi-fibre is the most advantageous for improving bituminous properties. Therefore, the study checked its feasibility in their country to improve different bituminous properties. The study used 1%, 2%, and 3% of Forta Fi by weight of conventional bitumen mix. The results showed that mixing Forta Fi in various proportions, such as 1%, 2%, and 3% in bituminous mix, increased the penetration value up to 1% of plain bituminous mix to 5% in the case of binding containing Forta Fi. However, in the case of adding 3% fibre to the bituminous mix, the penetration value exceeded the limit, indicating that 3% fibre of binding containing is not suitable for bituminous mix. The viscosity value of the bituminous mix also increased in a wide range, from 17% of plain bituminous mix to 64% in the case of binding containing 1%, 2%, and 3% of Forta Fi.

Bindu et al. conducted an experiment on the influence of additives on the drain down characteristics of Stone Matrix Asphalt (SMA) mixtures. This paper focused on the influence of additives such as coir, sisal, banana fibres (natural fibres), 0.1, 0.2, 0.3, 0.4, respectively, and waste plastics (waste material) and polypropylene (polymer), 1, 3, 5, 7, 9, respectively, in the drain down characteristics of SMA mixtures. The study inferred that the optimum fibre content is 0.3% by weight of mixture for all fibre mixtures, irrespective of the type of fibre. For waste plastics and polypropylene stabilized SMA mixtures, the optimum additive contents were respectively 7% and 5% by weight of mixture. The drain values for the waste plastics mix were within the required specification range. Among the fibres investigated, the coir fibre additive was found to be the best. Sisal and banana fibre mixtures showed almost the same characteristics on stabilization.

Arpita et al.: conducted a study to examine the resilient properties of stone matrix asphalt mixtures made with two types of conventional binders, namely bitumen 80/100 and 60/70. The study also evaluated the effects of adding 0.3% by weight of a non-conventional natural fiber, specifically coconut fiber. The results showed that the addition of fiber resulted in higher tensile strength. However, for a particular binder, the tensile strength decreased as temperature increased. At lower temperatures, mixes with 60/70 bitumen had higher indirect tensile strength than 80/100 bitumen. Conversely, at higher temperatures, mixes with 60/70 binder had the highest tensile strength compared to the other two binders. The study also showed that the resilient modulus value did not change significantly with applied tensile stress. Finally, the addition of just 0.3% binder resulted in a considerable increase in the resilient moduli and fatigue life of the mixes.

Amit et al. (2012): examined the use of modified bitumen with the addition of processed waste plastic (size 2-4mm) at a rate of about 5-10% by weight of bitumen. The study revealed that this addition substantially improved the Marshall stability, strength, fatigue life, and other desirable properties of bituminous concrete mix. As a result, the pavement performance and longevity were improved with marginal savings in bitumen usage.

Rajmane et al. (2013): investigated the adhesion properties of major polymers, namely polyethylene, polypropylene, and polystyrene in their molten state. The study showed that waste plastic added to bitumen increases its melting point.

This mixture forms a better material for pavement construction, showing higher Marshall Stability value and suitable Marshall Coefficient. Thus, the use of waste plastics for pavement is an excellent method for easy disposal of waste plastics. Furthermore, plastic roads are highly beneficial for India's hot and extremely humid climate, where temperatures frequently exceed 50°C, and torrential rains create havoc, leaving most of the roads with significant potholes.

Rema et al. (2013): conducted a study to modify 60/70 grade bitumen obtained from Cochin Refineries Ltd with polythene carry bags (less than 30microns) that were shredded in a shredding machine (particle size 2-3mm). To achieve the required gradation, three grades (A, B, C) of aggregates were used, and Ordinary Portland cement was used as the filler material. The aggregate was heated to a temperature of 140-150°C, and the shredded plastic was added to the hot aggregate with constant mixing to achieve a uniform distribution. The proportioning of aggregates was done by the Rutherfoth method, with Aggregate A at 15%, Aggregate B at 32%, Aggregate C at 51%, and Cement at 2% (filler). The study found that the optimum bitumen content was 4.658% for Ordinary aggregate mix and 4.583% for Plastic coated aggregate mix aggregates, indicating a decrease in optimum binder content by using plastic-coated aggregate. The study also observed a considerable increase in Marshall Stability value from 1135.78 to 2091.59 by adding plastic at a rate of 4-5% by weight of bitumen. Tests showed that the properties like water absorption, stripping value, soundness, and the properties of aggregates, which mainly cause rutting action, were improved using plastic-coated aggregate.

HAMID et al.: In this study is based on the most important aspect of stone mastic asphalt is SMA in proper way to give excellent performance characteristics but in some condition SMA is improper because of lack of enough evaluation. And thus as a result there is a change in performance could be seen in SMA.European countries mostly preferably SMA for its excellent performance. This paper conclude that for the requirement of improvement characteristics of SMA it is important to understand the fact of resilient module while discussing about fuzzy logic . because main aim is to understand all the evaluation aspects related to the characyeristics of SMA.and to improve better . he main aim to understand all this is the evaluation of fuzzy logic in the performance characteristics of stone mastic asphalt is also known to be resilient modulet will precisely conclude in the best solution for technical repairs because of detecting the reason of these damages over them by adding additives, filers and reconstructing layers for bearing heavy traffic. Thus in the summary portion we can say it is durable for basically overall roads and highly permanent age. sean jamleson:while considering the flexible pavement all over the world the airports should have been firstly consider in flexible pavement and in most of the countries such as in Australia the flexible pavement . SMA is also known for its resistance aspect And that is the reason that behind that stone mastic asphalt fulfil or satisfy all the criteria of airports pavements related to basically durability and fracture. .this paper totally discuss aboiut the flexible pavement not only on airports .its is essentialto have that kind of pavement surface in most of the heavy loaded roads for better resistance and durability . and this overall paper summarise the alternate runway surfacing , subsequent field trial , and ;laboratory performance testing , and may provide reacherch for all over that .

Marta Wasilewska: As the comparision of skid resistance form wearing course made of SMA (Stone Mastic Asphalt) mixtures which differ in resistance to polishing of coarse aggregate.And while considering about the mixtures in SMA and for that different values has been decided for agreegate and minerals such as for agreegate the same nominal size as 11mm .All the specimen in this tests is overally made up of each coarse agreegate . and containing these agreegate is also an important factor and stone mastic asphalt (SMA11) mixtures may contain these agreegates. All the specimen in this tests is overally made up of each coarse agreegate . and containing these agreegate is also an important factor and stone mastic asphalt (SMA11) mixtures may contain these agreegates.

A. K. Arshad et al.: this paper is basically based on the cellulose fiber because cellulose fiber is the aspect of stone mastic asphalt which may be considerd as in the form of additives in SMA in which the size and nature of cellulose fiber is most important and that is the reason behind that investigation in the structure if stabilizing additives for SMA concrete , as well as on the basis on the geometric paramaters the retention capacity of fiber has been determined . Thus by using nanosilica as a bitumen modifier it improves the performance of pavement . the increased value of resilient molulus obtained from the nanosilica addition in bitumen . . but by using of nanosilica it may impact on the resiatance as improve the resistance to moisture damage of SMA20 mix . The TSR value for SMA20 using nanosilica modified bitumen increased by 13.08% compared to the SMA20 using unmodified bitumen.

Zhen Leng, Imad L. Al-Qadi & Ruijun Cao: the construction of road under environment area in which climate suddenly changes as increased more. So its important to have durable and resilient pavement system. In this study, integrated life-cycle cost analysis (LCCA) and lifecycle assessment (LCA) is introduced to quantify the lifwhen applied to stone mastic asphalt (SMA) in comparison with conventional hot SMA. ecycle economic and environmental potential impact of WMA . The longer the asphalt mixture is maintained at high temperature, the better the effect of CR in the mixture will be. Ageing has a specific effect on the mechanical properties of asphalt concrete. However, the effect is still insignificant compared to the effect of CR modification.

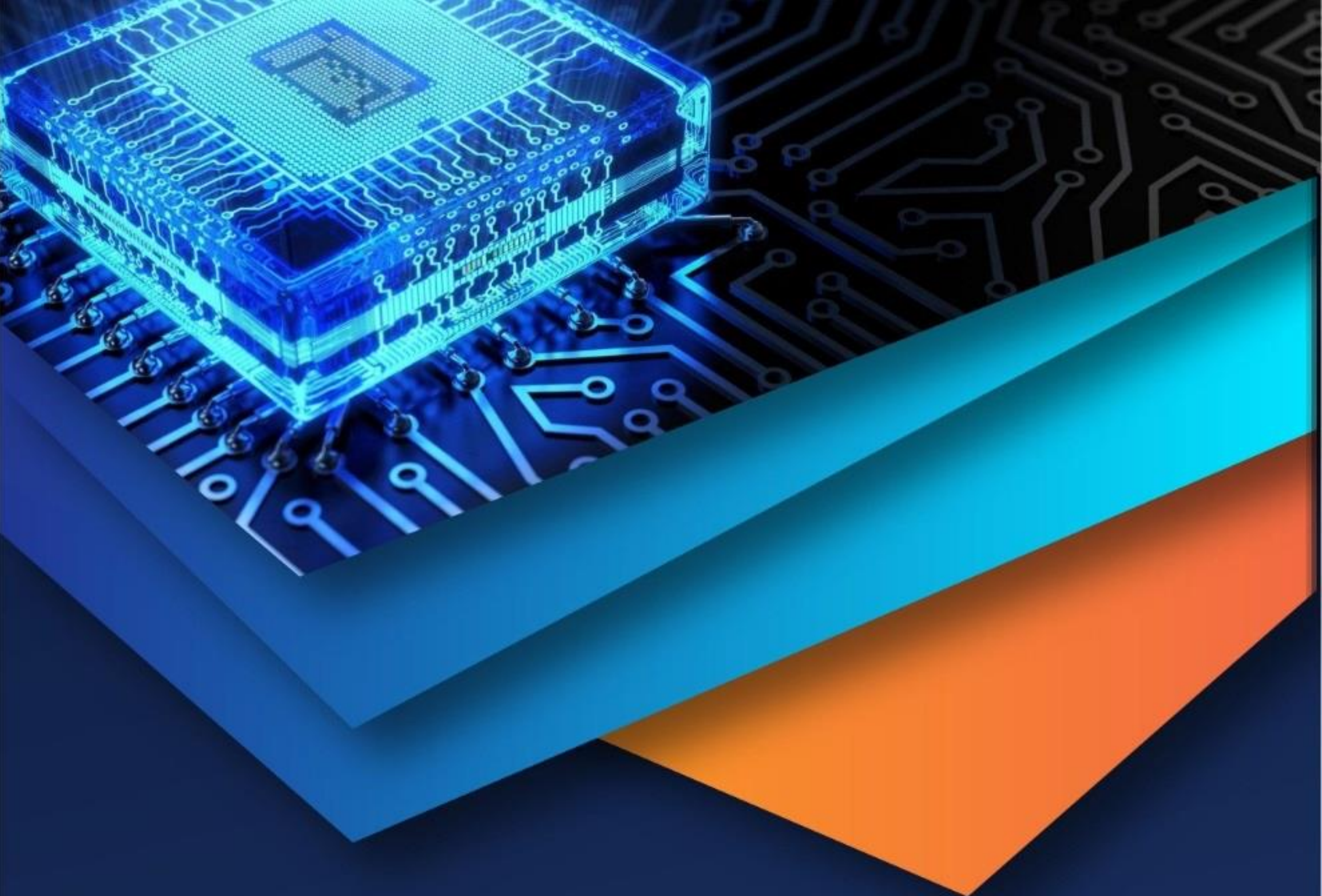
 At the optimal content of CR, the rutting resistance of dry process asphalt mixtures is as good as that of SBS and CR modified asphalt mixtures using wet process . From the various results in the earlier Section, a variety of effects of CR on the mechanical properties of dense-graded AC and SMA were recognized, including short-term ageing and an interaction between CR and bitumen.

III. CONCLUSION

Findings of the above studies basically deals with the comparision of pavement wearing coat with SMA mix . with conventional fiber . The previous studies gives a brief idea about how to evaluate the viability of natural fibres as a stabilizing agent in the mixture and thereby obtain the optimum bitumen content for the fibres by laboratory tests in which the flow parameter and the mechanical properties of the mixture was analyzed. - Considering all the properties and parameters of the mix we can consider using coir as fibre as it provides a considerable amount of stability for a non-conventional fibre. Examining the flow value the least being 2.9mm of bagasse, coir gives a flow of 3.05mm for 7% bitumen content. Overall this study considers the importance of additives in SMA . And it is essential to make stabilized SMA mix for that cost is one of the most important factor bacause by using synthetic fiber that may lead to higher cost and may not easily available for that. So the further scope of study on SMA mix with natural coire fiber and baggase is praposed.

REFERENCES

[1] Dr. R. Vasudevan, S.K. Nigam, R. Velkennedy, A. Ramalinga Chandra Sekar, B. SundarakannanìUtilization of Waste Polymers coated Aggregate for Flexible Pavement And easy Disposal of Waste Polymersî Proceedings of the International Conference on Sustainable Solid waste Management, Chennai, India. pp. 105-111, 5-7September (2007)
[2] D S V Prasad, M.Anjan Kumar, G V R Prasada Raju, V. KondayyaìA Study on Flexible Pavement Performance with Reinforced Fly ash Sub baseî International Journal of Earth Sciences and Engineering 4ISSN 0974-5904, Volume 04, No 06 SPL, October, pp. 403- 408(2011)
[3] Henning, N. E. (1974). ìEvaluation of lignite fly ash as mineral filler in asphaltic concrete.î Report No. Item (2)-73, Twin City Testing and Engineering Laboratory, St. Paul, Minn.
[4] JianhongDia, Zhanliang Liu, ìInfluence of Fly Ash Substitution for Mineral Powder on High Temperature Stability of Bituminous Mixtureî International Conference on Future Energy, Environment,andMaterials2012.
[5] J. Mater. ìCoal Ash Utilization In Asphalt Concrete Mixturesî Civ.Eng.11, 295(1999)
[6] Meor O. Hamzah , and Teoh C. Yi ì effects of Temperature on Resilient Modulus of Dense Asphalt Mixtures Incorporating Steel Slag Subjected to Short Term Oven Ageingî World Academy of Science, engineering and Technology 46, 008
[7] P Sreejith ìUse of plastic waste in Bitumen Roadsî Powered by WordPress.com (2010) Pada Sabtu, Utilisation Of Waste Plastic In Bituminous Mixes For Road construction,(2010).
[8] K.Karthik, ìCarbon fiber modified bitumen in bituminous macadamî, International Journal of Advance Engineering and Research Development Volume 2, Issue 12, December -2015.
[9] Anderson, D.A., and Goetz, W.H. (1973), "Mechanical Behaviour and Reinforcement of Mineral Filler-Asphalt Mixtures", Proceedings of Association of Asphalt Paving Technologists, Volume 42, No. 1, pp. 37-66, USA.
[10] Bindu, C.S. and Beena, K.S. (2014) "Influence of additives on the drain down characteristics of stone matrix asphalt mixtures" volume:03 issue:07, available @http://www.ijret.org
[11] Arpita, S., Mahabir, P. and Ujjal, C.R. (2010) "Characteristics of Stone Matrix Asphalt Mixes "DOI: 02.ACEE.
[12] Amit, G., Zamre, G.S., Renge, V.C., Bharsakalea, G.R. and Saurabh, T. (2012) "Utilization of Waste Plastic in Asphalting of Roads" Sci. Revs. Chem. Commun:vol 2(2), pag 147-157.
[13] Rajmane P.B., Gupta, A.K., Desai, D.B. (2013) "Effective Utilization of Waste Plastic in Construction of Flexible Pavement for Improving their
[14] Performance", IOSR Journal of Mechanical and Civil Engineering ,PP: 27-30http://www.iosrjournals.org/iosr-jmce/papers/sicete(civil)-volume2/17.pdf.



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