iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** Issue II **Month of publication:** June 2015

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Utilization of Fibre as a Strength Modifier in Stone Matrix Asphalt

Vivek B. R[1], Dr. Sowmya N. J. [2]
IV Sem M. Tech, Prof. Dept. of Civil Engg, K.V.G.C.E. Sullia.

Abstract: 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.
Key words: shredded waste plastic, coconut fibre, 60/70 asphalt, Marshall Properties

I. INTRODUCTION

Aggregates bound with bitumen are conventionally used all over the world in construction and maintenance of flexible pavements. The close, well, uniform, or dense graded aggregates bound with normal bitumen normally perform well in heavily trafficked roads if designed and executed properly and hence very common in paving industry. However, it is not always possible to arrange dense graded aggregates available at the site, In such situations a bituminous mix called stone matrix asphalt (SMA) which basically is a gap graded mixture containing 70-80% coarse aggregate of total aggregate mass, 6-7% of binder, 8-12% of filler, and about 0.3-0.5% of fibre or modifier. The stabilizing additives composed of cellulose fibres, mineral fibres, or polymers are added to SMA mixtures to prevent drain down from the mix. The high amount of coarse aggregate in the mixture forms a skeleton-type structure providing a better stone-on-stone contact between the coarse aggregate particles, which offers high resistance to rutting. The higher binder content makes the mix durable. The fibres or modifier hold the binder in the mixture at high temperature; prevent drainage during production, transportation and laying. Mostly cellulose fibres have been tried by various investigators in SMA mixes to solve the draindown problem. These fibres are either costly or not readily available but the coconut fibre contains certain amount of cellulose. So utilize a naturally and abundantly available low cost material such as locally available coconut fibre, in preparation of SMA mixes and study the resilient properties of the SMA mixes. The threat of disposal of plastic will not solve until the practical steps are not initiated at the ground level. It is possible to improve the performance of bituminous mixed used in the surfacing course of roads.

II. LITERATURE REVIEW

Bindu et al. (2014) as conducted experimental on Influence of Additives on the Drain down Characteristics of Stone Matrix Asphalt Mixtures.This paper focuses on the influence of additives like 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. Based on the drain down characteristics of the various stabilized mixtures it is 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 are respectively 7% and 5% by weight of mixture. The drain values for the waste plastics mix is within the required specification range. The coir fibre additive is the best among the fibres investigated. Sisal and banana fibre mixtures showed almost the same characteristics on stabilization.

Arpita et al. (2011) studied, an attempt has been made to study the resilient properties of mixtures of stone matrix asphalt made with two types of conventional binders namely bitumen 80/100 and 60/70, with 0.3% by weight of a non –conventional natural fiber, namely coconut fiber. Addition of fibre results higher tensilestrength. It is also observed that for a particular binder, thetensile strength decreases with increase in temperature. Atlower temperature, the mixes with 60/70 bitumen has the higherindirect tensile strength than 80/100 bitumen. But at highertemperatures, the mixes with 60/70 binder have the highest tensile strength as compared to the mixes with other twobinders. The resilient modulus value does not change significantly with applied tensile stress. It is also observed that a mere 0.3% incorporation of binder results inconsiderable increase of the resilient moduli and fatigue life of the mixes.

Amit et al (2012) studied the use of modified bitumen with the addition of processed waste plastic (size 2-4mm) of about 5-10% by weight of bitumen helps in substantially improving the Marshall stability, strength, fatigue life and other desirable properties of bituminous concrete mix, resulting which improves the longevity and pavement performance with marginal saving in bitumen usage.

Rajmane et al (2013) studied the major polymers namely polyethylene, polypropylene, polystyrene show adhesion property in their molten state. Plastics will increase the melting point of the bitumen. The waste plastic bitumen mix forms better material for pavement construction as the mix shows higher Marshall Stability value and suitable Marshall Coefficient. Hence the use of waste plastics for pavement is one of the best method for easy disposal of waste plastics. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes.

Rema et al (2013) carried out the modification of 60/70 grade bitumen which was obtained from Cochin refineries Ltd with polythene carry bags (less than 30microns) which was shredded in a shredding machine (particle size 2-3mm). To get 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 140-150°C and the shredded plastic was added to the hot aggregate with constant mixing to have a uniform distribution . Proportioning of aggregates were done by Rutherfoth method like taking Aggregate A-15%,Aggregate B- 32% Aggregate C- 51% and Cement- 2% (filler). The value of optimum bitumen content was obtained as 4.658% for Ordinary aggregate mix and 4.583% for Plastic coated aggregate mix aggregates which shows there is a decrease in optimum binder content by use of plastic coated aggregate. Considerable increase in Marshall Stability value from 1135.78 to 2091.59 by adding plastic of 4-5% by weight of bitumen was observed. Tests showed that the properties like water absorption, stripping value and soundness and the properties of aggregates which mainly cause rutting action were improved using plastic coated aggregate.

III. OBJECTIVES OF THE STUDY

In this a comparison is made between stone matrix asphalt mixes with varying binder contents and with different types of waste plastic mainly polyethylene packets.

The objectives of this study are as follows:

A. To determine the relevant index and engineering properties of plastic waste and polyethylene packets in stone matrix asphalt.
B. To study the effects of adding in varying percentages of coconuts fibre to stone matrix asphalts mix with stone dust as filler.
C. To study resistance to permanent deformation of mixes with and without the above mentioned admixtures.
D. To study the Marshall properties of the stone matrix asphalt mixes with plastic waste, polyethylene packets and coconuts fibre with cement filler materials to determine how they affect the properties of mixes.

IV. EXPERIMENTAL INVESTIGATIONS

A. Types of Materials used and there properties

1) Bitumen: The bitumen used in this study was tested in the laboratory. The physical properties such as Penetration, Ductility, Softening Point and Specific gravity were evaluated and the results are tabulated in Table 4.1.

Table 4.1 Physical Properties of (60/70) VG 30 Penetration Grade Bitumen

Property Tested	Results
Penetration (100 gram, 5 seconds at 25^0C) ($1/10^{th}$ of mm)	64
Softening Point , ^{0}C(Ring & Ball Apparatus)	44
Ductility at 27^0C (5 cm /minute pull), cm	63.4
Specific Gravity	1.01
Flash point, ^{O}C	310
Fire Point, ^{O}C	330

2) Aggregates: The aggregates present in BC should be highly durable, strong and tough to resist heavy loads. They undergo internal friction and high rubbing; hence the physical properties of these aggregates should be given high importance. Aggregates having sufficient strength, hardness, toughness, specific gravity and shape are chosen. The properties of aggregates used in the present study are tabulated in Table 4.2.

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Table 4.2 Properties of Aggregates

Property Tested	Results
Aggregate Impact Value	24%
Los Angeles Abrasion Value	14.2%
Water Absorption Value	0.84%
Specific Gravity	2.69
Combined Flakiness and Elongation Index	28.2 %

3) *Aggregate Gradation Adopted*: Aggregate grading that satisfied the requirement of the Ministry of Road Transport and Highways (MoRT&H, 2009) specification for midpoint gradation for Grading- II of stone matrix asphalt were selected.

B. Design Of Stone Matrix Asphalt Mix By Marshall Method Of Compaction

The properties of SMA mixes i.e. stability and bulk density depends on the gradation of aggregate, binder content, compaction temperature and types of methods used for testing. Marshall Method of mix design was adopted to find the OBC.

1) *Mix preparation:* The properties of any bituminous mix like stability, bulk density, air voids, are mainly dependent on the gradation of aggregates, binder content and its type, the type of compaction and compaction temperature. The Marshall Test specimens were prepared by adding 5.5, 6.0, and 6.5 per cent of bitumen by weight of mix.

Following procedure was adopted to prepare the samples,

a) The aggregates were proportioned and mixed as given in Table 3.4 (aggregate and filler contribute to 1200gm). The aggregates were heated to temperature of 155^0C-165^0C.
b) The bitumen heated to150^oC to 160^oC was added in required quantity i.e. 5.5, 6.0 and 6.5 per cent by weight of mix and was thoroughly mixed with the aggregates at a desired temperature of 160^oC.
c) The mix was placed in preheated mould of 10.16 cm diameter and 6.35 cm height with a base plate.
d) After levelling the top surface, the mix was compacted by a rammer of 4.54 kg weight and 45.7 cm height of fall with 50 blows on either side at temperature of 150^oC.
e) Three specimens were prepared for different bitumen content (5.5, 6 and 6.5 per cent) by weight of mix.
f) Compacted specimens were removed after 24 hours using specimen extractor.

V. RESULTS AND DISCUSSION

Table 5.1: Properties of Stone matrix asphalt control mix using Marshall Stability with stone dust as filler.

	Property Tested	Bitumen content by weight of aggregate		
		5.5%	6%	6.5%
1	Marshall stability (kN)	15.56	17.87	15.34
2	Flow Value (mm)	3.10	3.50	3.90
3	Bulk Density (gm/cc)	2.3084	2.3116	2.3198
4	Volume of voids Vv (%)	4.84	4.09	3.14
5	Volume in Mineral Aggregate VMA (%)	16.39	16.81	17.05
6	Void filled with bitumen VFB (%)	70.84	75.64	81.62
7	Optimum Bitumen content (%)	6.2		

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering
Technology (IJRASET)

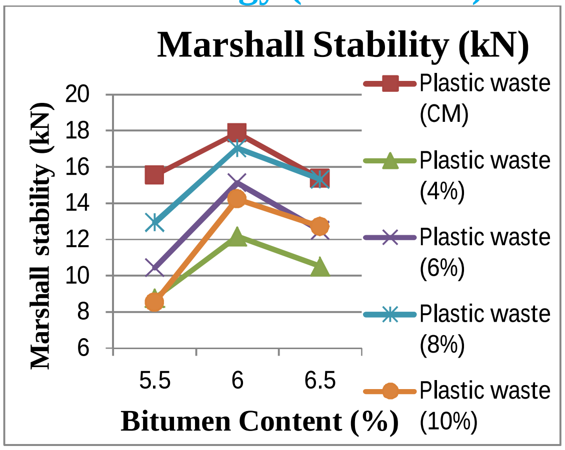

Fig. 5.1: Variation of stability with % of bitumen for plastic.

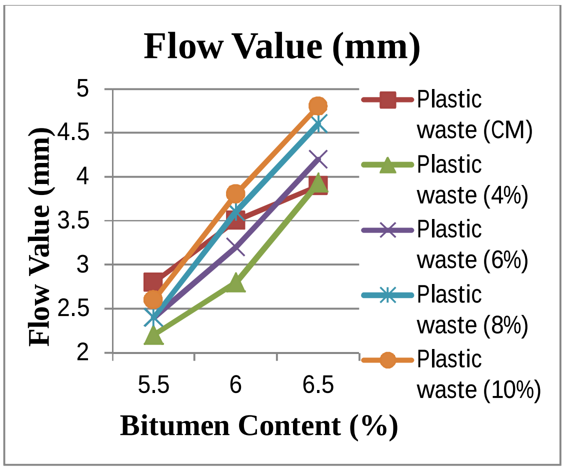

Fig. 5.2: Variation of flow value with % of bitumen for plastic.

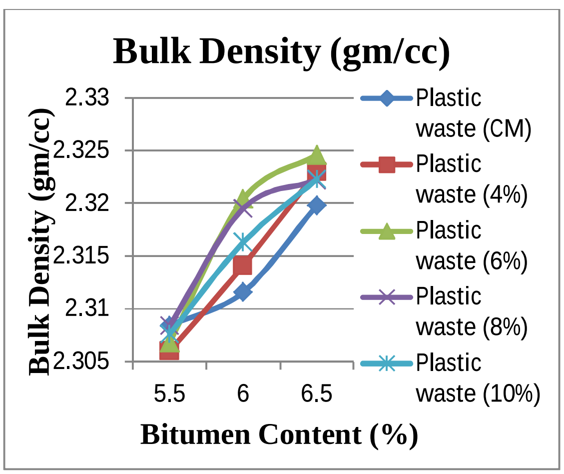

Fig. 5.3: Variation of bulk density with % of bitumen for plastic.

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

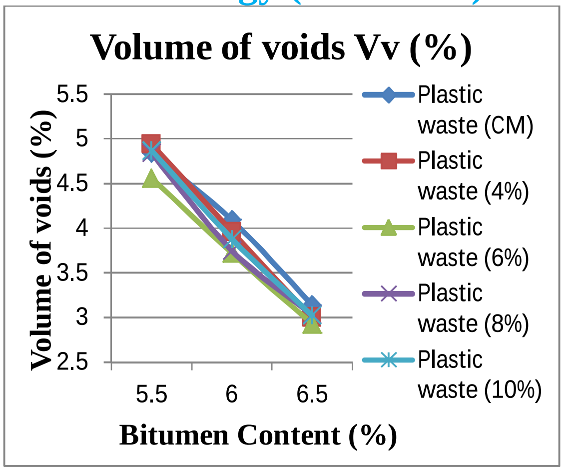

Fig. 5.4: Variation of volume of voids with % of bitumen for plastic.

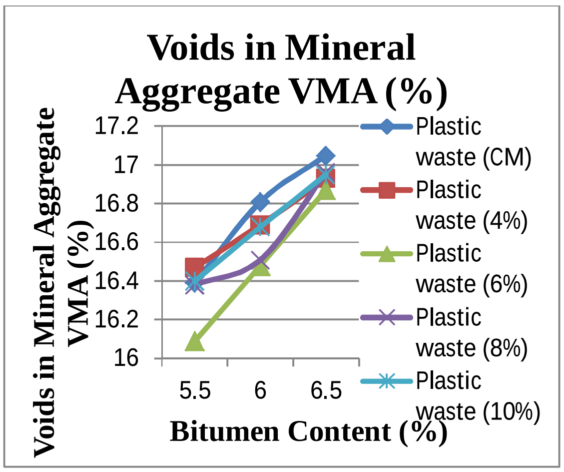

Fig. 5.5: Variation of voids in mineral aggregate with % of bitumen for plastic.

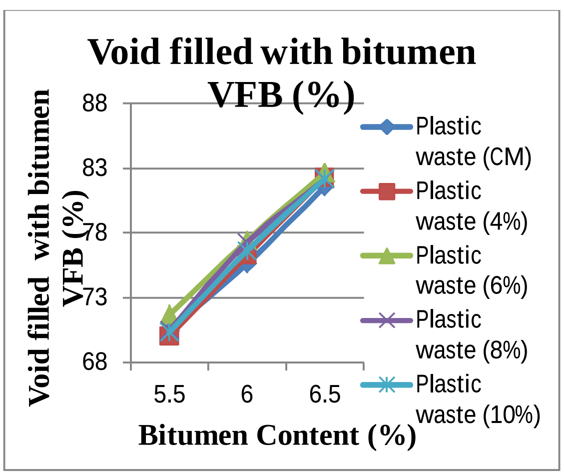

Fig. 5.6: Variation of voids filled with bitumen with % of bitumen for plastic.

Volume 3, Special Issue-I1, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

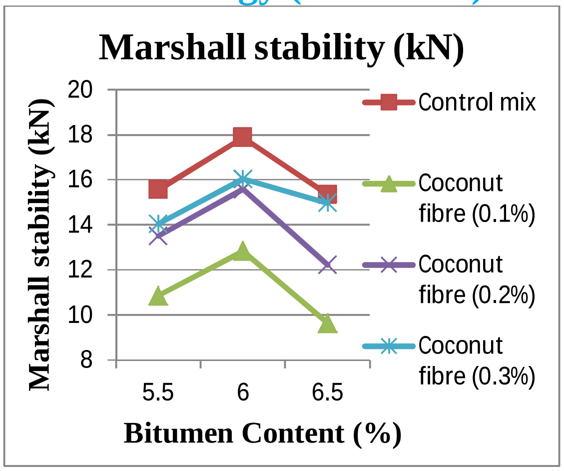

Fig. 5.7: Variation of stability with % of bitumen for coconut fibre.

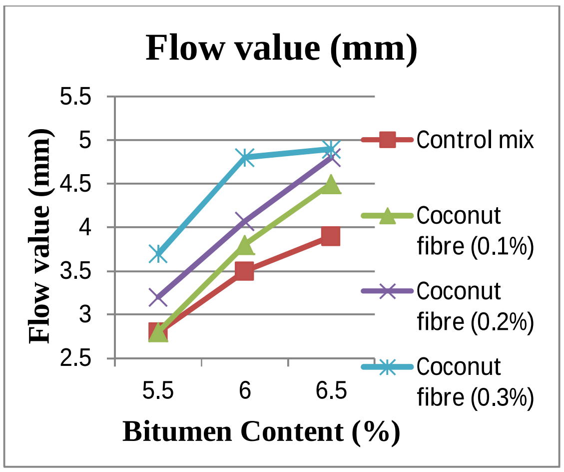

Fig. 5.8: Variation of flow value with % of bitumen for coconut fibre.

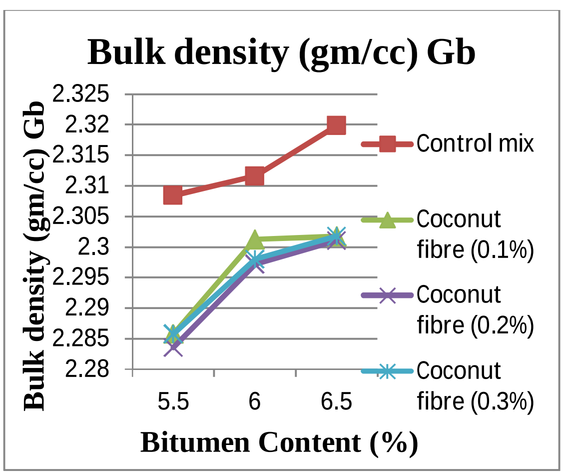

Fig. 5.9: Variation of bulk density with % of bitumen for coconut fibre.

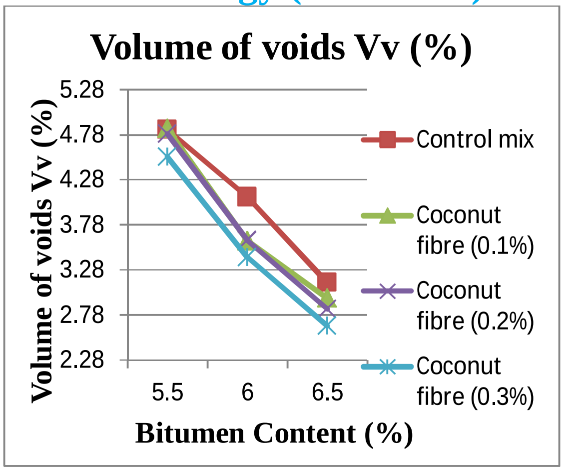

Fig. 5.10: Variation of volume of voids with % of bitumen for coconut fibre.

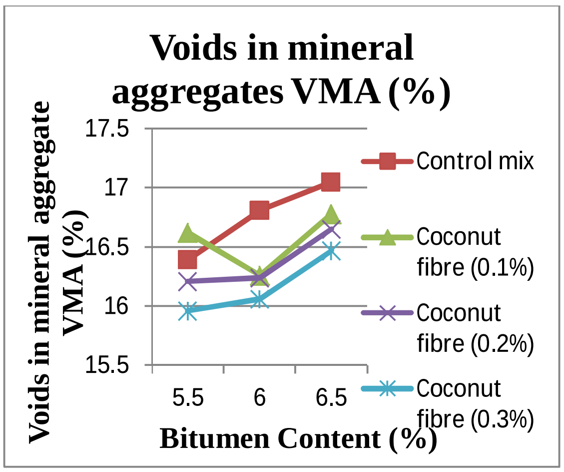

Fig. 5.11: Variation of voids in mineral aggregate with % of bitumen for coconut fibre.

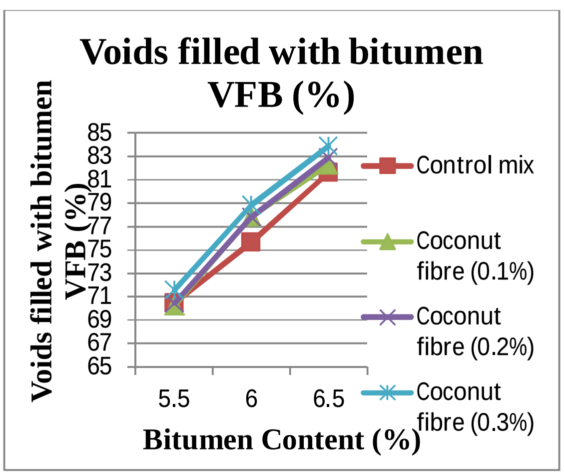

Fig. 5.12: Variation of voids filled with bitumen with % of bitumen for coconut fibre.

VI. CONCLUSION

A. The above results and graphs indicates 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.

B. 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.

C. 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.

D. The bulk density increases with increase in the bitumen content. It is found that the bulk density of SMA with 6% plastic content is higher than the control mix.

E. It is observed that with increase in the bitumen content the volume of voids decreases.

F. The voids filled with mineral aggregate and the voids filled with bitumen both increases with increase in the bitumen content.

G. 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.

REFERENCES

[1] 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
[2] Arpita, S., Mahabir, P. and Ujjal, C.R. (2010) “Characteristics of Stone Matrix Asphalt Mixes ”DOI: 02.ACEE.
[3] 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.
[4] Rajmane P.B., Gupta, A.K., Desai, D.B. (2013) "Effective Utilization of Waste Plastic in Construction of Flexible Pavement for Improving their Performance", IOSR Journal of Mechanical and Civil Engineering ,PP: 27-30http://www.iosrjournals.org/iosr-jmce/papers/sicete(civil)-volume2/17.pdf
[5] Remadevi, M., Leni, S., Mini, M. I., (2013) “Reduction of optimum bitumen content in bituminous mixes using plastic coated aggregates” International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 3.http://www.ijirset.com/upload/march/28_Reduction%20of%20optimum.pdf
[6] Bindu, C.S. & Beena, K.S. (2010) “Waste plastic as a stabilizing additive in Stone Mastic Asphalt” International Journal of Engineering and Technology Vol.2 (6), 2010, 379-387, ISSN : 0975-4024
[7] Afroz, S. and Prasad, B. (2012) “utilization of waste plastic as a strength modifier in surface course of flexible and rigid pavements” vol. 2, Issue 4, pp.1185-1191 (IJERA) ISSN: 2248-9622 www.ijera.com
[8] Mahabir, P., Biswanath, P. and Ujjal, C. (2013) “A Laboratory Study on Use of Waste Polyethylene in a Bituminous Concrete Mix”
[9] Vidula, S., Abhijeet, J., Karan, P., Suhas, P., Sushil, P. and Karan, S. (2012) “Use of waste plastic in construction of bituminous road” (IJEST) Vol. 4 No.05, ISSN : 0975-5462
[10] Harith, A. (2013) “Utilization of shredded tetra-pak in hot mix asphalt” AL-Qadisiya Journal For Engineering Sciences ,Vol. 6.No 3
[11] Ratnasamy, M., Eltaher, E.A., Hussain, B.H. and Robiah, Y. (2009) “An Initial Investigation of the Use of Local Industrial Wastes and by-Products as Mineral Fillers in Stone Mastic Asphalt Pavements” Vol. 4, No. 3, May 2009 Issn 1819-6608. Www.Arpnjournals.Com
[12] Rema, D., Leni, S. and Mini, M.I. (2013) “Reduction of optimum bitumen content in bituminous mixes using plastic coated aggregates” International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET) Vol. 2, Issue 3, ISSN: 2319-8753 www.ijirset.com
[13] Taher, B.M., Mohamed, R.K. and Mehrtash, S. (2013) “Utilization of waste plastic bottles in asphalt mixture” vol. 8, no. 3, pege-264 – 271.
[14] Abiola, A., Kupolati, A., Sadiku, B. and Ndambuki, A. (2014) “Utilization of natural fibre as modifier in bituminous mixes: A review” Science Direct, Construction and Building Materials 54, 305–312 journal homepage: www.elsevier.com/locate/conbuildmat
[15] Raghuram, K.B and Venkaiah, C. (2013) “Performance evaluation of stone matrix asphalt (sma) using low cost fibers” paper no. 595 journal of the indian roads congress
[16] Brijesh, K., Yadav, R.K. and Jain, R. (2013) “cellulose fiber as a stabilizing additive in bituminous concrete” IJESR/ Vol-3/Issue-8/448-458, e-ISSN 2277-2685, p-ISSN 2320-976, www.ijesr.org
[17] Punith, V.S., Suresha, S.N., Sridhar, R., Sunil, B. and Veeraragavan, A. (2012) “Laboratory Investigation of Open-Graded Friction-Course Mixtures Containing Polymers and Cellulose Fibers” journal of transportation engineering © asce .138:67-74.
[18] Dang, V. T. and Cheng, P. (2013) “Influence of different fibers on high temperature and water stability of stone matrix asphalt” International Journal of Applied Engineering and Technology ISSN: 2277-212X http://www.cibtech.org/jet.htm, Vol. 3, pp.1-10
[19] Ramez, A., Amiruddin, I., Mohammed, A., Mohammad, H., H. & Mojtaba, S., B. (2013) “ Comparison between Mixtures of Asphalt with Palm Oil Shells and Coconut Shells as Additives” Jurnal Kejuruteraan 25: 25-31
[20] Rasel, H. M., Rahman, M. N and Ahmed, T.U. (2011) “ Study of Effects of Waste PVC on the Properties of Bituminous Mixes” S-JPSET : ISSN : 2229-7111, Vol. 2, Issue 2