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PARTIAL REPLACEMENT OF BITUMEN BY USING PLASTIC WASTE IN BITUMEN CONCRETE

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ABSTRACT:- Disposal of waste materials including waste plastic bags has become a serious problem and waste plastics are burnt for apparent disposal which cause environmental pollution. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned is cut into a size such that it passes through 2-3mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The use of the innovative technology will not only strengthen the road construction but also increase the road life as well as will help to improve the environment. 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. This paper includes the results of the various laboratory tests conducted on bitumen, aggregate and bitumen-aggregate plastic mix.

Key words: Waste plastic, Aggregate, Bitumen, plastic-bitumen-aggregate mix, plastic modified bitumen and plastic modified aggregate.

1.0 INTRODUCTION

Now-a-days disposal of different wastes produced from different Industries is a great problem. These materials pose environmental pollution in the nearby locality because many of them are non-biodegradable. Traditionally soil, stone aggregates, sand, bitumen, cement etc. are used for road construction. Natural materials being exhaustible in nature, its quantity is declining gradually. Also, cost of extracting good quality of natural material is increasing. Concerned about this, the scientists are looking for alternative materials for highway construction, and industrial wastes product is one such category. If these materials can be suitably utilized in highway construction, the pollution and disposal problems may be partly reduced. In the absence of other outlets, these solid wastes have occupied several acres of land around plants throughout the country. Keeping in mind the need for bulk use of these solid wastes in India, it was thought expedient to test these materials and to develop specifications to enhance the use of these industrial wastes in road making, in which higher economic returns may be possible. The possible use of these materials should be developed for construction of low volume roads in different parts of our country. The necessary specifications should be formulated and attempts are to be made to maximize the use of solid wastes in different layers of the road pavement. Post construction pavement performance studies are to be done for these waste materials for construction of low volume roads with two-fold benefits: (a) it will help clear valuable land of huge dumps of wastes; (b) it will also help to preserve the natural reserves of aggregates, thus protecting the environment. Plastics are user friendly but not eco-friendly as they are non-biodegradable generally, it is disposed by way of land filling or incineration of materials which are hazardous. Plastic is versatile material and a friend to common man becomes a problem to the environment after its use. The better binding property of plastics in its molten state has helped in finding out a method of safe disposal of waste plastics. Road surface with neat bitumen can cause bleeding in hot climate, may develop cracks in cold climate, possess fewer loads bearing capacity and can cause serious damages because of higher axle load in present conditions due to rapid infrastructure development. Useful life of bituminous overlays has reportedly declined 7- 8 from average life of 5-6 years in the past to about 3-4 years at present as compared to average pavement life (5-6 years) in abroad. India has to raise transportation system to a higher level both in terms of length and quality. This study presents the use of waste in hot bituminous mixes to enhance pavement performance, protect environment and provide low cost roads. Polymer and plastic modified bitumen, often abbreviated as modified bitumen is obtained with the incorporation of selected thermoplastics and shredded plastic from discarded waste, natural plastic or any other suitable elastomers in bitumen.

1.1 OBJECTIVES OF THE STUDY

Basic intention is to efficiently utilize the waste plastic in constructive way so that it can be beneficial to society. Main objectives of current project work are:

1. To identify the optimum proportion of waste plastic to be added in the bitumen mix for getting the required strength.
2. To compare the experimented results with the conventional pavement details and perform the economic analysis.
3. To prepare statistical model for optimum utilization of plastic waste.
4. To improve the volumetric properties of BC mix design
5. To utilize waste plastic in bituminous mixes
6.

1.2 SCOPE OF STUDY

This study will be conducted to explore the idea about use of waste material in bituminous concrete with detailed laboratory Investigation will be carry out to find whether it is viable to use or not in terms of suitability, economically and environmentally. The present study will focus basically on these following points:

1. To study the basic physical and mechanical properties of waste plastic in order to contribute a better knowledge of its properties.
2. To study the effect on Marshall Stability of bituminous mix with the addition of waste plastic.
3. To reduce the bitumen content by the addition of Waste plastic in bituminous mix.

The laboratory investigations on the bituminous mix have been carried out as per the Indian Standards used for the road construction. The field application is out of the scope of work.

2.0 LITERATURE ON WASTE PLASTICS

Sasane Neha et al studied about the application of waste plastic as an effective construction material in flexible pavement. The research methodology in this study has adopted various tests to investigate the results on aggregate, bitumen and plastic and aggregate-bitumen-plastic mix. The tests conducted were water absorption, aggregate impact, loss Angeles and aggregate crushing test [is: 2386 (part 4)-1963] for aggregates and softening point, penetration test and ductility test [is: 1203-1978] for bitumen. For mixing the ingredients of road mix, dry process was adopted. In this process, waste plastic is mixed with aggregates and blends of polymer modified aggregate are prepared by mixing bitumen in it. These blends are later tested in laboratory and required optimum results are obtained. This paper includes the results of the various laboratory tests conducted on bitumen, aggregate and bitumen-aggregate plastic mix. it shows that with the increase of waste plastic in bitumen increases the properties of aggregate and bitumen. And use of waste plastic in flexible pavements shows good result when compared with conventional flexible pavements.

Pankaj P.Shedame et al experimentally studied on the bituminous Concrete Containing Plastic Waste Material. This study deals with study on the various test performed on aggregates, bitumen and methodology of using plastic waste in bituminous mixes. This threat has emphasized the need to find appropriate solutions for effective plastic waste management. Rapid growth of infrastructure in road construction needs natural resources. In recent year escalation of prizes of natural resources, so that required reuse of waste material in road construction. Now-a-days disposal of different wastes (plastic waste) produced from different Industries is a great problem. In recent years, applications of industrial wastes have been considered in road construction with great interest in many industrialized and developing countries. Reuse of wastes material is a very simple but powerful concept.

Bhageerathy K. P studied the use of Biomedical Plastic Waste in Bituminous Road Construction. In this work, the use of medical plastic waste in the form of shredded syringes in road construction is tested. The main objective of the study was to investigate the performance of the bituminous mix modified with bio-medical plastic waste and to compare it with the normal mix. Medical plastic waste was collected from IMAGE (Indian Medical Association Goes Eco-friendly), Palakkad, Kerala, India. As part of the study, the properties of Plastic Coated Aggregates (PCA) were determined. The results showed improved properties for PCA when compared to normal aggregates. The properties of both the mixes were tested by conducting creep test and indirect tensile stiffness modulus test. On the basis of the experimental results obtained, it is found that mixes prepared with biomedical plastic waste has shown better properties compared to the conventional bituminous mixes. Hence, the biomedical plastic waste can be disposed off judiciously by incorporating it in bituminous mixes.

Devesh ojha et al proposed the design of Flexible Pavement using Waste Plastic. In the current era of economic development with such a hefty population, it is required to have a dense network of road for the smooth transportation of goods & passengers. India, despite having one of the largest railway network moves mostly on roads. Be it passenger or freight all move on roads. Nearly 65% of freight and 85% of passenger traffic use roads for their movement. Today India has 3.34 million km of road network out of which 65579km is the network of national highways. In this study the methodology & design of proposed plastic tar road.

3.0 RESEARCH METHODOLOGY

The research methodology for present study has adopted various tests to investigate the results on aggregate, bitumen and plastic and aggregate-bitumen-plastic mix. The tests conducted were Aggregate Impact, Ductility Test [IS: 1203-1978] and Marshall stability test for bitumen. For mixing the ingredients of road mix, dry process was adopted. In this

process, waste plastic is mixed with aggregates and blends of polymer modified aggregate are prepared by mixing bitumen in it. These blends are later tested in laboratory and required optimum results are obtained. The blends using aggregates and bitumen were prepared along with the use of different percentage of waste plastic in it separately and were kept for water bath at least 24 hrs. Later these blends were tested under marshal stability apparatus to check its stability for road pavements.

3.1 Collection of waste plastic

The waste plastics are collected from many sources like industries, commercial sector, agricultural sector, and municipal sector. The industrial plastic wastes are collected in one place than transported through trucks in used area. For collection of commercial plastic the big size dustbins are used than they are transported from the trucks. Similarly plastic waste are collected from the entire source and placed in a place. There are four basic ways in which communities can offer plastic recycling collection services for plastic bottle and containers – curbsides, drop-off, buy-back, or deposit/refund program.

3.2 Cleaning of waste plastic

The plastic which are collected for pavement construction is must to clean. If the impurities are present in the plastic they are decrease the binding property of the plastic. The dust and dirt are mix with plastic particle and they are creating the voids, and after sometimes they are filed with air or water. The water and air voids are decreasing the strength, hardness, shear capacity. So it must to clean the plastic pieces. But sometimes the chemical of the plastic are mix with water due to the cleaning process of the plastic and they are do harmful effect on the humans and animals so it is a negative point of this process. The cleaning process is done near the water bodies like lake or rivers. The cleaning mills are generally situated away from the cities. The water in which the plastics are washed is treated by treatment plant and cost is increase

3.3 Size reducing of plastic

After the cleaning of plastic, the size of plastics is reducing by the cutting mills. They are cut in small size between 2.36mm – 4.75mm using shredding machine. Small pieces are mix uniformly and give better result. To maintain the strength the size of plastic is uniform. The clean plastic fed in the shredding machine after that the shredded plastics are removed from the machine. Once sorted the raw plastics are reduced the size by shredding and granulating machinery. These machines are capable of processing any size of materials from ordinary domestic plastic waste to much larger lumps or spoils from industrial, commercial processes. To maintain our high standards of purity and quality all shredders and granulators have metal detectors fitted to their purpose built conveyor systems.

3.4 Clean plastic pieces

After the cutting of plastic they are in small and clean which is sent to continue the process. The clean plastic pieces are sent in the field to mix with aggregate. The clean plastic pieces are free from dust, dirt, clay, sand and other agents.

3.5 Heating the aggregate and mixing with clean plastic pieces

The aggregate is heated about temperature160oc. After the heating of aggregate, the hot aggregate is transfer into the mixing chamber. At the mixing chamber, the shredded plastics waste is to be added. It gets coated uniformly over the aggregate within 30 to 60 seconds, giving an oily look. From the heating the aggregates molecules are active and they are sufficiently bind with the clean plastic pieces. And from the heating the aggregate the clean plastic pieces are properly spread over hot aggregate. The heating process is done by air blast aggregate heaters. The aggregate is heated with hot air in the overhead bins, or in the receiving hoppers. A high pressure industrial fan distributes the heated air via pipes and diffusers into the material in the bins.

3.6 Adding bitumen and Mix

After the collection, cleaning and size reducing the plastic pieces are mix with the hot aggregate (temperature about 165oc) the bitumen is add in hot plastic coated aggregate (the bitumen is heated up to 160oc). The hot bitumen is mix uniformly on hot plastic coated aggregate. The bitumen is also as a binder they are bind all aggregate from each-other.

4.0 RESULTS AND DISCUSSIONS

IMPACT TEST

Toughness is the property of a material to resist impact. Due to traffic load and intensity, the road stones are subjected to various actions leading in formation of pounding impact or breaking into smaller pieces. Thus, road stones should therefore be tough enough to resist fracture under impact. Hence, a test is designed to evaluate the toughness of stone. The results of Impact test with various percentage of plastic in aggregates are shown in Table 1 and Figure 1.

Table 1: Result for aggregate impact test

Stone aggregate	% of plastic	Aggregate impact values
Without plastic coating	0	10.85 %
With plastic coating	6	10.67 %
	12	10. 14 %
	18	9.84 %

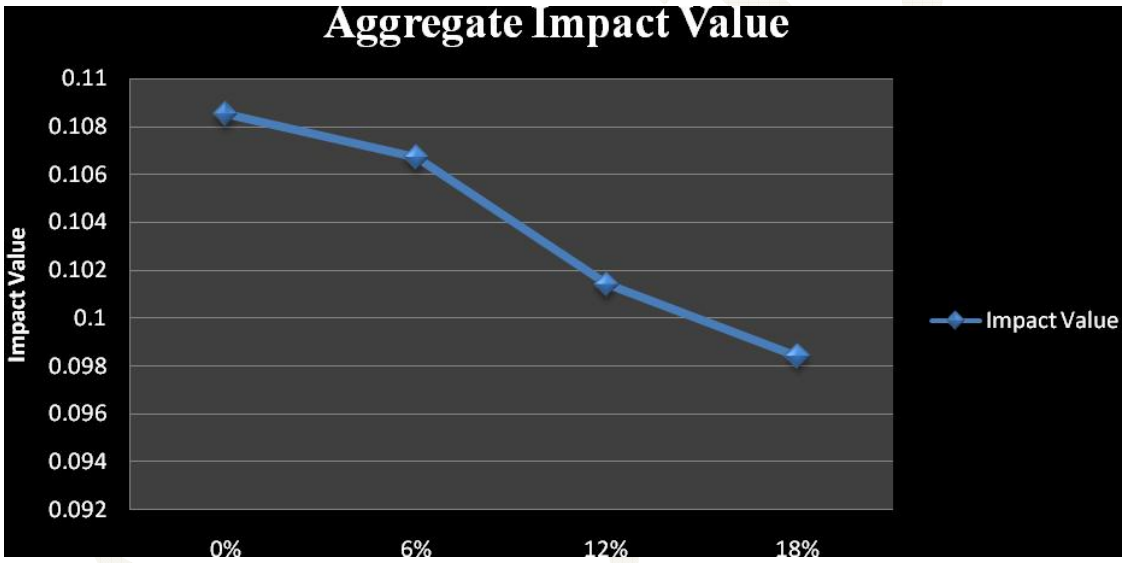

Figure 1: Aggregate Impact Values of various percentage of replacement of waste plastic.

DUCTILITY TEST

This test is done to determine the ductility of bitumen. The principle of this test is that: the ductility of a bituminous material is measured by distance in cm to which it will elongate before breaking. The following results of ductility test are shown in Table 2 and Figure 2.

Table 2: Ductility test of Bitumen

Bitumen	% of plastic	Ductility value
Pure Bitumen	0	87
With plastic coating	6	74
	12	58
	18	51

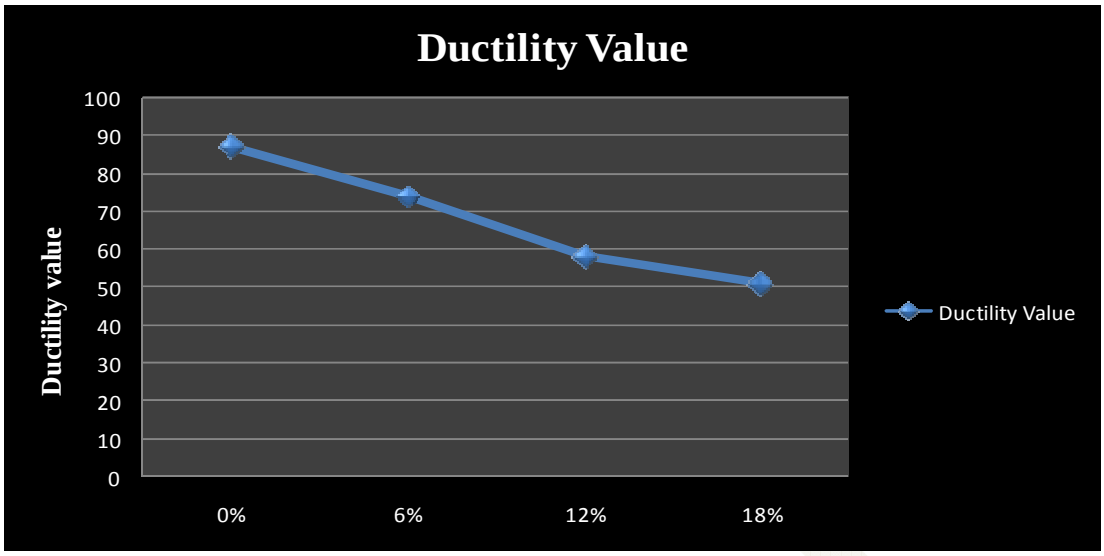

Figure 2: Variation in Ductility of Bitumen with increase in percentage of plastic

MARSHAL STABILITY TEST

In marshal stability test, the deformation of specimen of bituminous mixture is measured when the same load is applied. This test procedure is used in designing and evaluating bituminous paving mixes. The marshal stability of mix is defined as a maximum load carried by a compacted specimen. The following results of Marshal Stability test are shown in Table 3 and Figure 3.

Table 3: Marshal Stability of Bitumen

Bitumen	% of plastic	Stability (kg)
Pure Bitumen	0	1067
With plastic coating	6	1725
	12	2021
	18	1274

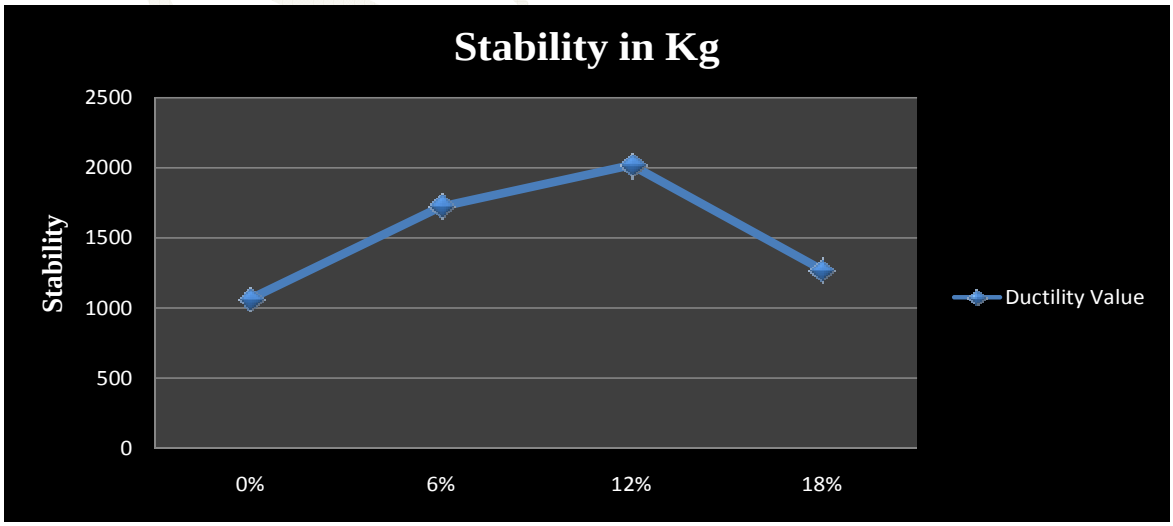

Figure 3: Variation in Stability of Bitumen with increase in percentage of plastic

6.0 CONCLUSION

The results of this research together with that of previous researches are found to be encouraging for the future researchers who are interested to work in this field. In consideration of frequent submergence problems, high summer temperature and poor pavement construction practice and above all environmental hazards due to waste plastic, the use of waste plastic in road construction may bring economical benefits in the many ways. After conducting laboratory tests on bitumen binder and mixtures with different polymer content and after analyzing the data and comparing the results, the following conclusions are drawn:-

1. The result shows that with increase of waste plastic in bitumen increases the properties of aggregate and bitumen.
2. The optimum use of plastic can be 12 % of bitumen based on Marshal Stability test.
3. The modified bitumen shows good result when compared to standard results.
4. For all modified binders prepared, the penetration values decrease as waste plastic ratio increases whilst, softening point values increase as waste plastic ratio increases.
5. The coating of aggregates with waste plastic reduces the absorption of moisture.
6. By using waste commodity plastics in binder modification carries the advantage of a cheap, technologically effective means of enhancing conventional binder performance and offers an alternative way to manage plastic waste.
7. This has added more value in minimizing the disposal of plastic waste is the eco-friendly technique.

REFERENCES

1. Mercy Joseph Poweth (2013) "Study on use of plastic waste in road construction", ISSN: 2319-8753. Vol. 2, Issue 3.
2. Devesh ojha (2014) "A Proposed Design of Flexible Pavement using Waste Plastic" Volume-4, Issue-5, ISSN No.: 2250-0758.
3. AJIM S. SUTAR (2014) "Experimental investigation on use of low density polyethylene (LDPE) in bituminous road construction" ISSN: 0975 – 6744, Volume 3, Issue 2.
4. Pankaj P.Shedame (2014) "Experimental Study of Bituminous Concrete Containing Plastic Waste Material" e-ISSN: 2278-1684,P-ISSN: 2320-334X, Volume 11, Issue 3 Ver. II.
5. Avula Vamshi (2013) "Use of waste plastic in construction of bituminous road", ISSN: 2325-0224 123 Vol. 2.
6. Shweta N. Rokdey (2015) "Use of Plastic Waste in Road Construction" International Journal of Computer Applications (0975 – 8887).
7. Amit Kumar Sahu (2016) "Application of Waste Plastic Materials in Road Construction" SNCESR.
8. Apurva J Chavan (2013) "use of plastic waste in flexible pavements", ISSN 2319 – 4847, Volume 2, Issue 4.
9. H. K. SHARMA (2015) "Utilization of Waste Plastic in Construction of Pavement" e-ISSN: 2348 - 4470, print-ISSN: 2348-6406.
10. Yash Menaria (2015) "Use of Waste Plastic in Flexible Pavements-Green Roads" Open Journal of Civil Engineering, 5, 299-311.
11. Vatsal Patel (2014) "Utilization of Plastic Waste in Construction of Roads", Volume 3, Issue 4 ISSN No 2277-8179.
12. S.Rajasekaran (2011) "Reuse of Waste Plastics Coated Aggregates-Bitumen Mix Composite for Road Application – Green Method", e-ISSN: 2320-0847, Volume-02, Issue-11, pp-01-13.
13. AMIT P. GAWANDE (2013) "economics and viability of plastic road: a review", Journal of current chemical & Pharmaceutical Sciences, Pharm. Sc.: 3(4), 231-242, ISSN 2277-287.
14. P.B.Rajmane, "Effective Utilization of Waste Plastic In Construction Of Flexible Pavement For Improving Their Performance" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), ISSN: 2278-1684, PP: 27-30
15. Sangita (2011), "A novel approach to improve road quality by utilizing plastic waste in road construction", Journal of Environmental Research And Development, Vol. 5 No. 4, April-June 2011.
16. Anzar Hamid Mir (2015), "Use of Plastic Waste in Pavement Construction: An Example of Creative Waste management" IOSR Journal of Engineering (IOSRJEN) ISSN (e): 2250-3021, ISSN (p): 2278-8719 Vol. 05, Issue 02.
17. MAHESH M BARAD (2015), "use of plastic in bituminous road construction", journal of information, knowledge and research in Civil engineering, ISSN: 0975 – 6744, Volume 3, Issue 2.

