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"UTILASATION OF WASTE PLASTIC IN CONSTRUCTION OF ROAD"

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A B S T R A C T

Use of asphalt material and its mixture are used to improve the durability and performance of pavements. SMA requires stabilizing additives composed of cellulose fibres or mineral fibres to prevent draindown of mix. SMA was first implemented in European countries. The stone mastic asphalt is a gap graded mixture consisting of coarse aggregate, fine aggregate, stabilizers and binders. In the project work the main objective is to compare the results obtained by the fillers stone dust and coconut shell charcoal. The binder content has been varied from 4-6%. Binder of 60/70 penetration grade bitumen is used. For minimizing the cost and increasing efficiency different waste materials are used as fillers, coconut shell charcoal is one among them. It possesses properties such as resistance to crushing, resistance to freezing, surface moisture etc. Stability flow parameters and air void ratio are compared among the fillers. Marshall test method is use for carrying out this project.

***Keywords**: fiber-reinforced concrete, FRC, stress-strain .*

1. INTRODUCTION

1.1. Background:

India generates 1,88,000 tons of garbage every day. Plastic Waste in different forms is found to be almost 9% to 12% in municipal solid waste, which is toxic in nature. It is a common sight in both urban and rural areas to find empty plastic bags and other type of plastic packing material littering the roads as well as drains. Due to poor biodegradability it creates stagnation of water and associated hygiene problems.

In order to contain this problem, experiments have been carried out to know whether this waste plastic can be reused productively. The experimentation at several institutes, private organizations indicate that the waste plastic, when added to hot aggregate bituminous mix will form a fine coat of plastic over the aggregate and such aggregate, when mixed with the binder is found to give higher strength to the road, higher resistance to the water and better performance of the road over a period of time. Waste plastic such as carry bags, disposable cups and laminated pouches like chips, pan masala, aluminium foil and packaging material used for biscuits, chocolates, milk and grocery items can be used for surfacing roads.

Roads using plastic waste have been constructed through simple process innovation in various states like Tamil Nadu, Karnataka, Himachal Pradesh and to a lesser degree in Goa, Maharashtra and Andhra Pradesh.

Plastic, a versatile material and a friend to common man becomes a problem to the environment after its use. Most used materials like carry bags and bottles are made up of Polythene and Polypropylene. In addition to these, there are other moulded plastics. Today such solid wastes create big problem of pollution and its management. Polythene carry bags obtained from low density polyethylene films are widely used in India by wholesale traders as well as millions of retailers in almost every field and commerce. This has been a serious threat of disposal of these non-biodegradable bags after their use. An attempt has been made for laboratory assessment of utilizing polythene bags for modifying properties of stone aggregate as it is now established that from which these bags are manufactured is a good modifier of bitumen. Traditional tests have been mostly adopted as per Indian Road Congress (IRC) specifications to study the basic properties of stone aggregates.

2. LITERATURES REVIEW

1. **Vatsal Patel, Snehal Popli, Drashti Bhatt, Nitish M. Patil, V.G. Khurd** has studied about the "Utilization of Waste Plastic in Road 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.

2. **Indian Roads Congress IRC: 37-2012 -** Guidelines for the design of flexible pavements-August 2012 was studied about the waste plastic and its disposal is a major threat to the environment, which results in pollution and global warming. The utilization of plastic waste in bituminous mixes enhances its properties and also its strength.
3. **Amit gawande, g. S. Zamre, V. C. Renge, g. R.Bharsakalea and Saurabh tayde,** utilization of waste plastic in asphalting of roads,Scientific Reviews and Chemical Communications, 2(2), 2012, 147-157 – This paper studied about the The plastic waste quantity in municipal solid waste is increasing due to increase in population and changes in life style. Thus disposal of waste plastic is a hazardous and become a serious problem globally due to their non-biodegradability. Plastic roads are found to perform better than ordinary roads and therefore use of plastic road construction has gained importance these days.

4. **S. Kumar and S.A.Gaikwad,** Municipal Solid Waste Management in Indian Urban Centres construction of roads studied about the Plastic which is toxic in nature is found to be nearly 5% in Municipal Solid Waste (MSW). A major problem nowadays is the disposal of plastic wastes. These wastes are non biodegradable in nature causing environmental pollution and hygiene problems. The experimentation at several institutes indicated that waste plastic can be utilized in Asphalting of roads. The use of these wastes in road construction is based on Economic, Technical and Ecological criteria

5. **Ahmed trimbakwala, D.C.E., K. K. Wagh Polytechnic,** has studied about the The plastic wastes can be used in road construction and the field tests withstood the stress and proved that plastic wastes used after proper processing as an additive would enhance the life of the roads and also solve environmental problems. Plastic use in road construction is not new. It is already in use as PVC or HDPE pipe mat crossings built by cabling together PVC (polyvinyl chloride) or HDPE (high-density poly-ethylene) pipes to form plastic mats

3. PROPERTIES OF MATERIAL

Proportion of plastic waste:

The proportion of plastic waste are used by weight of bitumen,

- 0% of plastic waste
- 8% of plastic waste
- 9% of plastic waste
- 10% of plastic waste

Bitumen:

Bitumen acts as binding agent for aggregates in bituminous mixes. Generally in India bitumen used in road construction of flexible pavement is of grades 60/70 or 80/100 penetration grade. Both the grade of bitumen confirming to BIS standards will be used for the present studies.

Waste plastic modifiers:

Modifiers are generally used to enhance the properties of bituminous concrete mixes by reducing the air void present between the aggregates and also to bind them together so that no bleeding of bitumen will occur. For the present study plastic waste such as carry bags, water bottles, milk packets, glasses, cups, etc will be used as a modifier.

Processing details:

i. Collection of waste plastic.

ii. Cleaning and shredding of waste plastic.

iii. Mixing of shredded waste plastic, aggregate and bitumen.

4. BASIC PROCESS

Waste plastic is ground and made into powder; 3 to 4 % plastics mixed with the bitumen. Plastic increases the melting point of the bitumen and makes the road retain its flexibility during winters resulting in its long life. Shredded plastic waste acts as a strong “binding agent” for tar making the

asphalt last long. By mixing plastic with bitumen, the ability of the bitumen to withstand high temperature increases. The plastic waste is melted and mixed with bitumen in a particular ratio. Normally, blending takes place when temperature reaches 45.5℃ but when plastic is mixed, it remains stable even at 55℃. The vigorous tests at the laboratory level proved that the bituminous concrete mixes prepared using the treated bitumen binder fulfilled all the specified Marshall mix design criteria for surface course of road pavement. There was a substantial increase in Marshall Stability value of the BC mix, of the order of two to three times higher value in comparison with the untreated or ordinary bitumen. Another important observation was that the bituminous mixes prepared using the treated binder could withstand adverse soaking conditions under water for longer duration.

5. PLASTIC, AGGREGATE, BITUMEN INTERACTION MODEL

The shredded plastics on spraying over the hot aggregate melted and spread over the aggregate giving a thin coating at the surface. When the aggregate temperature is around 1400° C to 160℃ the coated plastics remains in the softened state. Over this, hot bitumen (160℃) is added. The added bitumen spreads over the aggregate. At this temperature both the coated plastic sand bitumen are in the liquid state, capable of easy diffusion at the inter phase. This process is further helped by the increase in the contact area (increased surface area). These observations may be explained as follows. Waste polymers namely PE, PP and PS are hydrocarbons with long chains. The bitumen is a complex mixture of asphaltenes and maltenes which are also long chain hydro carbon. When bitumen was mixed with plastic coated aggregate a portion of bitumen diffuses through the plastic layer and binds with aggregate. The plastic layer has already bonded strongly with aggregate. During this process three dimensional internal cross linked net work structure results between polymer molecules and bitumen constitutes. Therefore the bond becomes stronger and the removal of bonded bitumen becomes difficult.

6. MATERIAL COST COMPARISION FOR 1 KM OF ROAD

Reusing plastic waste to pave roads is an experiment that has been successfully conducted in many places, such as Kala-massery in Kerala and in Kolkata and Bangalore. The first technology approach, developed by Bangalore-based K K Plastic Waste Management Limited, entails using plastic waste along with bitumen – the ingredient conventionally used to make roads [6]. Not only does the road become a receptacle for plastic waste, but it also has a better grip. This dry process helps to use good quantity of plastic waste in road construction. A model calculation is given in Table 2. A model is being worked using Tirunelveli, a town in Tamil Nadu. The plastics waste collected is around 650 tonnes/ annum. The roads available are approximately 400km and their annual requirement of plastic waste to lay plastic road is more than 600 tons. So the total waste generated could be used for road laying. The life of the road is increased and hence the maintenance expenditure is reduced.

7. DETAILS OF THE SITE

Location of site:

The site is situated near Kalvan, Devla, and Dist. Nashik. It is 6 km away from Devla on Wajgaon-Kharde Road. Site is 25 km away from the Hot Mix Plant and 65 km from Nashik.

Details of the Road:

It is single lane Bituminous Road of 3.5m width and because of it is connected to Major District Road therefore the name given to that Road was MDR-39.

- **Name of the road:** MDR-39, Wajgaon - Kharde
- **Length of flexible pavement:** 146m
- **Chainage of road:** 6/125 to 6/188 – PE 10 – 60m 5/927 to 5/955 – PP 10 28m 5/897 to 5/927 – PE 8 – 30m 5/869 to 5/897 – PP 8 – 28m
- **Terrain:** Plain
- **Location maps:**

Map No.01 Map of Maharashtra **Map No. 02: Map of India**

Map No. 03: Map of Nashik District

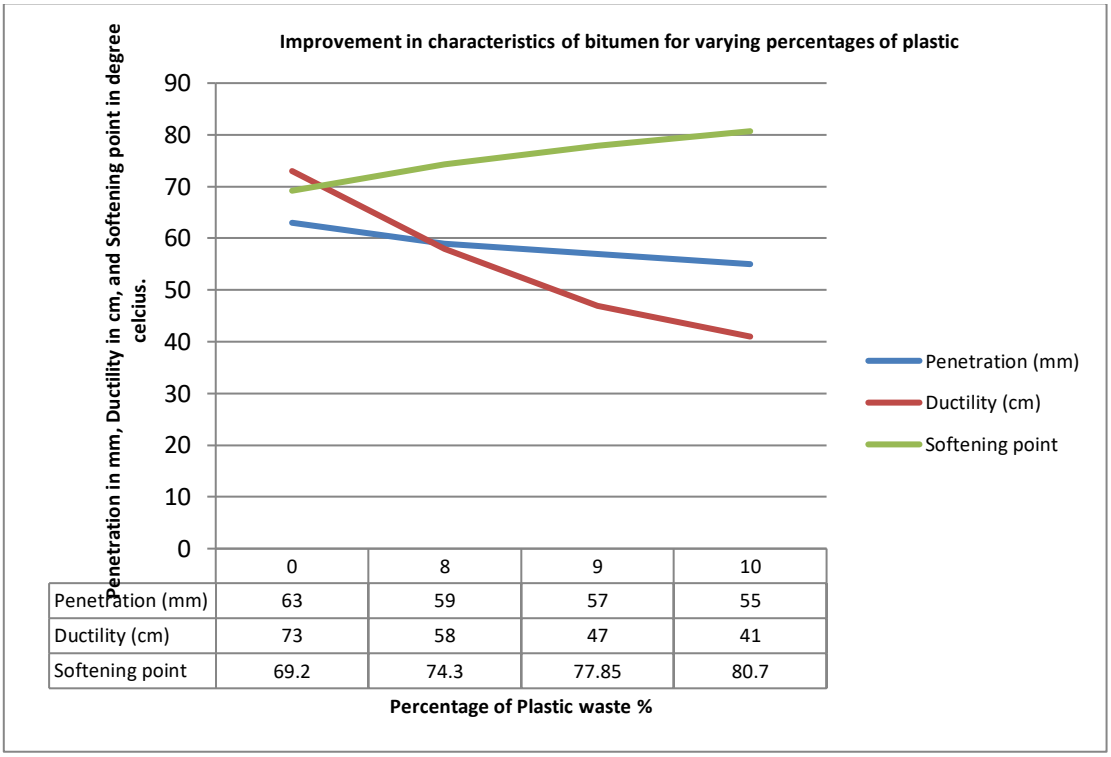
Map No. 04: Location map of site (Wajgoan - Kharde Road)

Results of Tests on Bitumen:

Tests / % of plastic	Penetration Test (mm)	Ductility Test (cm)	Softening Point Test (°C)
0%	63	73	69.2
8%	59	58	74.3
9%	57	47	77.85
10%	55	41	80.7

Table No. 02: Observations for tests on bitumen

Following are the graph which shows the comparison of performed tests value :



5.1.2 Comparison between ordinary bitumen roads & waste plastic bitumen road :

Properties	Ordinary Road	Polymer Road
Binding property	Good	Better
Softening point	More	Less
Penetration value	Less	More
Tensile strength	Less	High
Stripping (pot holes)	More	No
Seepage of water	Yes	No
Durability of roads	Good	Better
Cost of pavement	Normal	Less
Maintenance cost	More	Almost nil
Environment friendly	No	Yes

Table No. 03: Comparison between ordinary bitumen roads & waste plastic bitumen road

8. CONCLUSION

Looking into the above aspects it was seen that the waste plastics can be used to improve the physical properties of the bitumen. This modified bitumen is applicable in the construction of flexible pavements in order to increase the durability and performance. Following are the comparisons of the results obtained after conducting the tests.

1. The penetration of the bitumen which was initially 63mm at 0% of plastic is used in bitumen. And at the 8%, 9%, and 10% of % of plastic used in bitumen 59mm, 57mm and 55mm, result was found. These shows to grade the material in terms of hardness. Grading of bitumen helps to assess its suitability in different climatic conditions and types of construction.

2. The ductility value of bitumen was 73cm at 0% of plastic used in bitumen. And at the 8%, 9% and 10% of plastic is used in bitumen 58cm, 47cm, 41cm result was found. These shows its property to elongate under traffic load without getting crack in road construction and it also shows the ability to stretch. In flexible pavement design, it is necessary that binder should form a thin ductile film around the aggregate, so that the physical interlocking of the aggregate is improved.

3. The softening point of the bitumen was found to be 69.2℃ when 0% of plastic used in bitumen. And at the 8%, 9%, 10% the value are 74.3℃, 77.85℃ and 80.7℃ result was found. It shows the bitumen having the higher softening point is preferred in warmer places.

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