Plastic Waste Recycle in Road Construction For The Minimization of Cost And Waste

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Abstract- *The roads constructed using waste plastic, popularly known as Plastic Roads, are found to perform better compared to those constructed with conventional bitumen. The Indian Centre for Plastics in the Environment (ICPE) has been promoting the use of plastic waste to construct asphalt roads. A few trial roads have been paved successfully by combining waste plastic with bitumen. Plastic roads mainly use plastic carry bags, disposable cups, and bottles that are collected from garbage dumps as an essential ingredient of the construction material. When mixed with hot bitumen, plastics melt to form an oily coat over the aggregate and the mixture is laid on the road surface like a normal tar road.*

This paper focuses on the percentage of the particular type of plastic used in the bitumen plastic mix and its benefits over conventional bitumen road.

Keywords- Plastic Waste, Plastic roads, Road construction, Wearing course, Bitumen, Binder, Pavements, environment

I. INTRODUCTION

Plastic waste is always been used and disposal of it is ignored this is what causes a great problem.[4] It is a non-biodegradable product due to which these materials pose environmental pollution and problems like breast cancer, reproductive problems in humans and animals and genital abnormalities. Due to the problem of disposal of the plastic, it is better to recycle it in such a way that it can reduce the problem of its biodegradation. Plastic Recycling in road construction is the best use.[1] which is also leads to the waste reduction from the environment plus it helps to reduce the cost of the road construction[7] The experiments conducted in the laboratory depict useful results can substantially increase the stability and durability of roads plus, making it a very effective step towards eco-friendliness compared to conventional and traditional techniques of flexible pavements construction with the increase in strength of the road by using different type of proportion of plastic has just used to increase the strengths with the minimization of waste by avoiding the toxic plastic being used in the plastic road construction. This study of the different types of plastics has never been in concern in this paper the purpose was to look over the different plastic and their influences over the strength of the road with the waste and cost reduction.

II. LITERATURE REVIEW

The plastic waste and bitumen mix is a better binder compared to plain bitumen. When it used for road construction it can withstand higher temperature in some areas and load in the higher density areas. The coating of plastics over the aggregates reduces the porosity, absorption of moisture and improves soundness. The use of waste plastics for flexible pavement is one of the best methods for easy disposal of waste plastics in now days. Use of plastic bags in road help in many ways like Easy disposal of waste, better road and prevention of pollution in the environment stated R. Vasudevan [1]

The Wrappers of chocolates, chips, hand bags, cold drink bottles and all other forms of plastic create significant environmental and economic problem. In manufacturing firms, construction industries and products delivery services, use of plastic is a priority to handle and pack things comfortably due to its light weight, cost effectiveness and strength. Plastics cannot be banned as it will result in usage of natural resources like paper, wood at a great extent. This is stated by Yash Menaria1, Rupal Sankhla [2]

The Bottles, containers and packing strips etc. is increasing day by day. As a result amount of waste plastic also increases. Plastic waste, consisting of carry bags, cups and other utilized plastic can be used as a coating over aggregate and this coated stone can be used for road construction. The mix coated aggregate and tyre modified bitumen have shown higher strength. Use of this mix for road construction helps to use plastics waste. Once the plastic waste is separated from municipal solid waste, the organic matter can be converted into manure and used. Our paper will discuss in detail the process and its successful applications states Avula Vamshi [3]

The study of some of plastic waste materials which we can reuse by certain processing and use in road

construction..the materials as a result we are equipped with useful and valuable information about these materials. The discussed materials have many advantages over conventional/traditional materials and methods stated by Shweta N. Rokdey [4] Studies on the performance of plastic tar road conclusively proves that it is good for heavy traffic due to better binding, increased strength and better surface condition [5]

III. METHODOLOGY

As have seen in earlier studies of plastic roads people are only focussing on the minimization of the waste only but if we see it from the transportation and its costs point of view it is also important to see strength and quality of roads without potholes with the less maintenance work is also important. For that reason we have to choose the right proportion of different types plastic in the plastic bitumen mix to give the proper binding, coating and Marshall Stability value for its strength. And from the studies it has mentioned that the 10 % of the plastic waste in the bitumen mix is preferable for the Indian weather is consider by R. Vasudevan[1]

Table No. 1: Classification of plastics

Low Density Polyethylene (LDPE) sacks, milk pouches, bin lining, cosmetic and detergent bottles	Carry bags,
High Density Polyethylene (HDPE) bottle caps, house hold articles etc.	Carry bags,
Polyethylene Teryphthalate (PET) bottles etc.,	Drinking water
Polypropylene (PP) wrappers of detergent, biscuit, vapors packets, microwave trays for readymade meal etc.	Bottle caps & closures
Polystyrene (PS) packs, bottle caps, food trays, egg boxes, disposable cups, protective packaging, gutters; fittings, furniture, folders and pens, medical disposables.	Yoghurt pots, clear egg

The materials for the plastic road construction are Aggregate of size 12.5mmpassing and 10 mm retaining, bitumen, plastic waste collected from garbage and used in the shredded form. The tests for aggregates like Sieve Analysis of Aggregates, Aggregate Impact Value Test [IS: 2386 (part 4) 1963], Aggregate Crushing Value [IS: 2386 (Part 4) 1963], Abrasion test has taken and for bitumen includes Penetration Test [Is: 1203-1978], Softening Point Test [Is: 1205-1978], Ductility Test [IS: 1208-1978], Viscosity Test has taken etc. As per the IRC code for bitumen plastic mix the dry process of aggregates coating is been used. This paper focuses on different types of plastics like High density polyethylene(HDPE), Low Density Polyethylene(LDPE), polyethylene(PE), polypropylene(PP), polystyrene(PS), and without plastics the conventional and mix plastic etc. such different moulds just to check that which type of plastic gives the better Marshall stability value with minimization of waste. Further this can use that type of plastic in more proportion in plastic mix. The moulds were marked and kept for 24 in water.

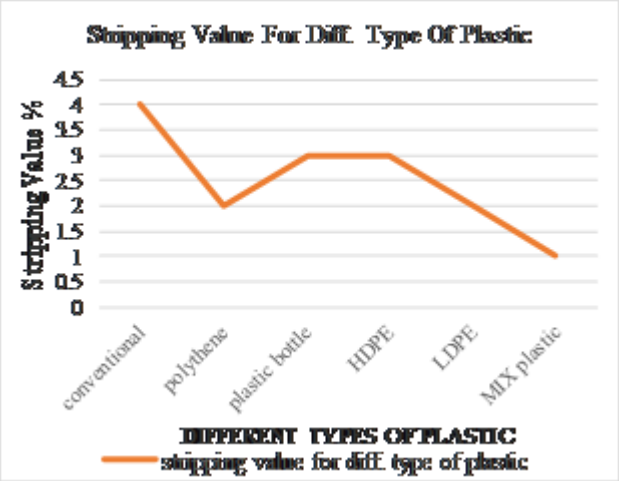
Fig 1: Marked moulds

Fig 2: moulds in water for 24 hrs

TESTAS ON THE MOULDS

Table No 1: Stripping Value Test

SR. NO.	DESCRIPTION OF SAMPLE	PERCENTAGE OF STRIPING VALUE (%)	MAX. PERCENTAGE
1	Conventional aggregate	4	5
2	Aggregate coated with polythene (10% plastic)	2	5
3	Aggregate coated with plastic bottles (10% plastic)	3	5
4	Aggregate coated with HDPE (10% plastic)	3	5
5	Aggregate coated with LDPE (10% plastic)	2	5
6	Aggregate coated with MIX (10% plastic)	1	5



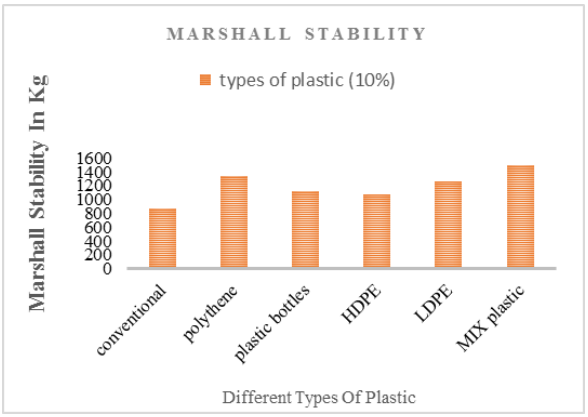
Graph No 1: Stripping Value Test Graph

Some types of aggregate have a lesser affinity with bitumen in comparison with water and hence stripping value of bitumen binder is done when the mix is immersed in water. The simple stripping test would be suitable to access whether the binder would adhere to aggregate when immersed in water. Several anti-stripping agents are available, which when used with the bituminous and the plastic mix reduce the stripping.

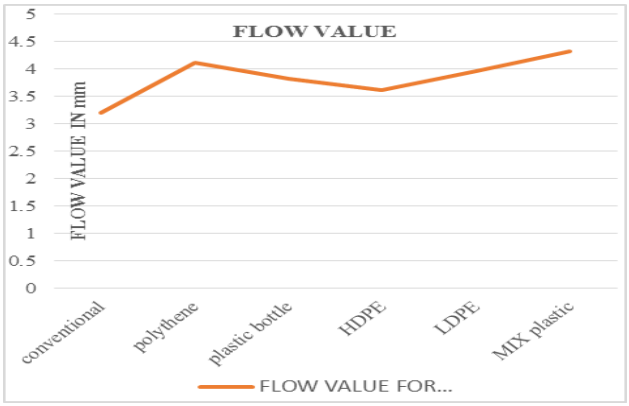
RESULT: From the above table and graph we concluded that the stripping value for mix plastic is the least and hence it will prove to be better as compared to other type of plastic. The use of LDPE and polythene in the mixture of plastic should be greater than the use of HDPE and plastic bottles as they yield lesser stripping value and hence should be used in the mix plastic.

Table No 2: MARSHALL STABILITY TEST

SAMPLE NO.	DESCRIPTION	4.17% OF BITUMEN CONTENT (gm)	(10% by wt.) PLASTIC CONTENT (gm)	MARSHALL STABILITY (kg)	FLOW VALUE (mm)
1	Conventional	50	0	870	3.2
2	Polythene	45	5	1340	3.47
3	Plastic bottles	45	5	1120	3.82
4	HDPE	45	5	1070	3.6
5	LDPE	45	5	1260	3.96
6	MIX plastic	45	5	1490	4.24



Graph No 2: Marshall Stability Graph



Graph No. 3: Marshall Stability Graph

RESULT: The maximum deformation at which a Marshall specimen fails is termed as flow value. From the results it can be observed that for the entire sample the flow value varies according to different types of plastic. The maximum flow value obtained for the mix plastic is 4.24mm. The load bearing capacity of road increases with the use of mix plastic. When polyethylene will be used in mix plastic we will get larger load bearing capacity followed by the use of LDPE, plastic bottles and HDPE with its quantity in decreasing order.

CALCULATIONS: (V_V, V_b, VMA, VFB)

Calculations for 4.17% of bitumen content and 10% plastic mix

Weight of sample in air (W_a) = 1200 gm
Weight of sample in water (W_w) = 620 gm
Weight of coarse aggregate (W_1) = 468 gm
Weight of fine aggregate (W_2) = 204 gm
Weight of filler materials (W_3) = 480 gm
Weight of bitumen (W_b) = 45 gm
Specific gravity of coarse aggregate (G_1) = 2.6
Spe. Gravity of fine aggregate (G_2) = 2.03
Spe. Gravity of filler materials (G_3) = 1.78
Spe. Gravity of bitumen (G_b) = 0.99

1. Void in mineral aggregates:
V_{MA} = 9.32
2. Voids fill with bitumen
V_{FB} = 84.22

Calculations for 4.17% of bitumen content and 0% plastic mix

Weight of sample in air (W_a) = 1200 gm
Weight of sample in water (W_w) = 620 gm
Weight of coarse aggregate (W_1) = 468 gm
Weight of fine aggregate (W_2) = 204 gm
Weight of filler materials (W_3) = 480 gm
Weight of bitumen (W_b) = 50 gm
Specific gravity of coarse aggregate (G_1) = 2.6
Spe. Gravity of fine aggregate (G_2) = 2.03
Spe. Gravity of filler materials (G_3) = 1.78
Spe. Gravity of bitumen (G_b) = 0.99

a) Specific gravity of specimen 1 bulk density (G_m) =2.068
b) air void (G_t)=2.011
c) Air void percent % =2.83%
d) Volume of bitumen V_b=8.68%
e) Voids in mineral aggregates =11.51
f) Voids filled with bitumen=75.41

IV. CONCLUSION

From the above table it can be seen that in conventional Bitumen roads i.e. with the use of no plastic there is a deflection of about 9 and it carries a load of 870 kg. On the other hand, when plastic is used the load bearing capacity of the road increases and the deflection decreases. The use of mixed plastic holds the maximum load bearing capacity with a moderate deflection. As we have made the roads of different types of plastic, conventional mix and mix plastic mix of proportion of 10% in the bitumen and aggregates out of them the polyethylene and mix plastic mould gave us the max. Load of 134 and 149 respectively as compared to other types.We can conclude that plastic waste of mix types like HDPE, LDPE, PE,PP,PS are can be used but the plastic type PE has to be maximum in that proportion to get better coating to the aggregates and then it gives better strength. And commonly used plastic polyethylene is also very easy to detect to the workers when it comes to the separation of the plastic. It doesn't required any of the extra knowledge of the plastics. The plastic roads by using 10 % of plastic waste including maximum proportion of polyethylene plastic waste in mix of plastic waste to increase the strength of the roads with the minimization of the cost and the waste. In plastic roads we get the approximately 6 % reduction in the cost as compared to the plain bitumen roads.

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