

Plastic Waste Recycle in Road Construction for the Minimization of Cost and Waste

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Abstract- *Plastic is a toxic waste found in nature and major problem with dealing it, like how to dispose it without causing much harm to the environment. Several institutes have mentioned in their studies that the waste plastic can be utilized in the bitumen road and it can be used to minimize the problems caused by the plastic waste and also to minimize the cost of the road construction of the bitumen road by replacing bitumen with the plastic(Plastic roads). Bitumen is used as a good binder and the plastic can be the substitute in some percentage for the road concentration in wearing course of the pavement. 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 for a prolonged period of exposure to variation in climatic changes Above all, the process helps to dispose waste plastics usefully and easily [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 1. Classification of plastics

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

The materials for the plastic road construction are Aggregate of size 12.5mm passing 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.



Figure 1. Marked moulds



Figure 2. moulds in water for 24 hrs

TESTAS ON THE MOULDS

Table 2. 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 |

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 3. 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 |

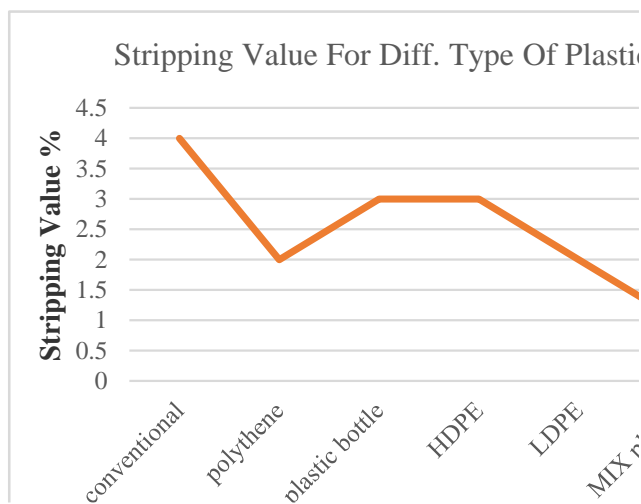


Figure 3. Graph No 1: Stripping Value Test Graph

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.

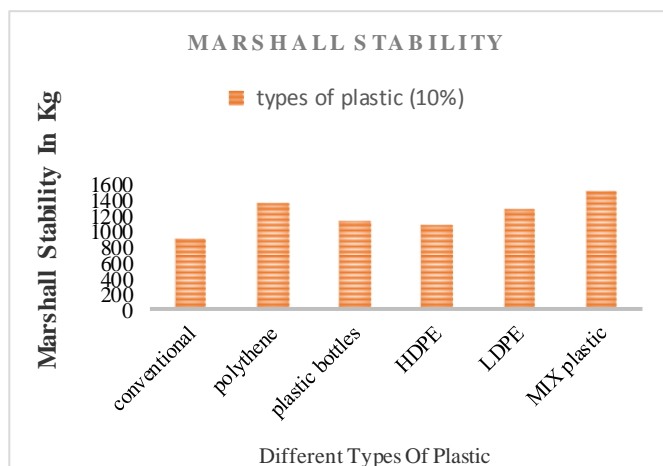


Figure 4. Graph No 2: Marshall Stability Graph

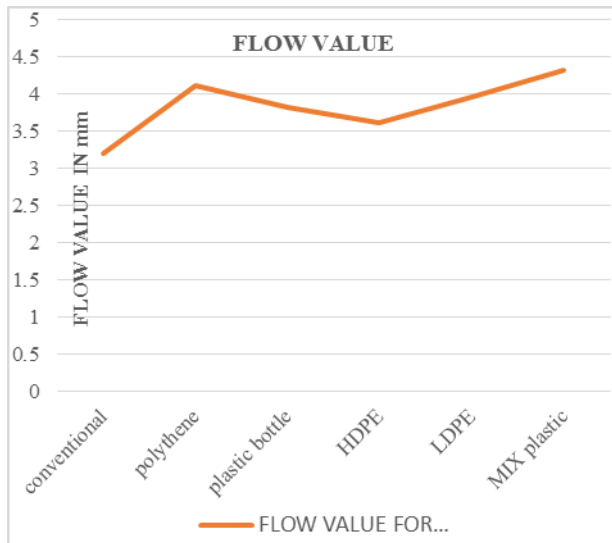


Figure 5. Graph No. 3: Marshall Stability Graph

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: (VV, Vb, 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:

$$VMA = 9.32$$

2. Voids fill with bitumen

$$VFB = 84.22$$

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

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

IV. CONCLUSION

From the above table it can be seen that in conventional bitumen roads i.e. that it has more stripping value and lesser Marshall Stability value. 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. We have defined the strength for various type of plastic this will help us to know which type of plastic should be used in excess in order to get the maximum load bearing capacity. The used of plastic that do not yield greater load bearing capacity and causes higher deflection can be avoided.

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