

Application of Plastic Waste Management in Road Construction

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Abstract — In this paper presentation, the study of plastic waste such as plastic bags, bottles, cans, etc which are a huge problem for the society that can be reuse by certain processes. The waste can be used in the construction of road. The road formation with the plastic waste response a high tensile strength which is more necessary in the construction of road. By the use of plastic waste the roads are stronger with increase of Marshall Stability value. The presentation will company to the awareness among the reuse of plastic waste, environmental conditions and to withstand with the step. Plastic waste can increase strength by 100% and has no effect of radiation like ultraviolet rays. The study includes the tests performed to achieve the better resistance towards rain water, water stagnation, load withstanding, durability, maintenance cost, binding property etc.

Keywords— better resistance towards rain water, Marshall Stability, Municipal plastic waste.

Objectives

This study is conducted with the main objectives

- Reducing the plastic waste present in our environment and making solid waste management better.
- Reducing cost of road construction.
- Increasing various properties of road materials.

I. INTRODUCTION

According to recent study it is found that the 60 cities generates 15000 tonnes of plastic waste in India everyday, of which 6000 tonnes remain uncollected. This uncollected plastic is becoming a huge problem to the daily lifestyle. This plastic waste badly affects the environment as it cannot be decomposed and if it is destroyed by burning process, it will cause pollution. Plastic releases highly toxic gases like phosgene, carbon monoxide, chlorine, sulphur dioxide, nitrogen oxide etc. if it is burnt irresponsibly. To avoid all these problems, reuse of plastic waste by certain processes is a way. The plastic waste can be used in the construction of road.

The plastic waste such as carry bags, cups, polythene, polyethylene (PE), polypropylene (PP) polystyrene (PS) etc. up to 60 μ thickness can be used in construction of

plastic roads. PVC sheets and flux sheets cannot be used. The plastic waste is first of all introduced to the various basic processes like segregation, cleaning, shredding and collection. After the collection of shredded plastic, it is mixed in the road materials (i.e. bitumen and aggregates) for the construction of plastic road. There are two methods of mixing plastic to the road materials, first is dry method and second is wet method. Both the methods are done differently.[1] In India dry method is generally used. The plastic waste management as road construction is a better way of reusing the plastic as there is a lot of plastic waste generated every day. Moreover this technique is more economic as well as more efficient. The plastic roads give better quality and properties of road than normal bitumen roads.

II. LITERATURE REVIEW

Since plastic roads are new idea, construction processes may vary. In Jamshedpur, India, the roads are made from the mix of plastic and bitumen. These roads are constructed from recycled plastics, and the first step in constructing them into collect and manage plastic material. An innovative concept proposed by a Dutch company, Volkerwessels, aims to create roads entirely of recycled plastic.

Prof. C.E.G. Justo has observed that the percentage of plastic waste for preparing the specimen should be 0.8% of aggregate and saving 0.4% of bitumen by the weight of mixed proportion of aggregates.[2]

The plastic is the main problem on the earth which is bad for the environment as well as the living organisms. The concept of utilization of the plastic waste was found by Dr. R. Vasudevan in India. According to him, the plastic waste was separated among the solid waste management and then it is shredded, collected and break down into pieces such that the 4.75mm sieve passing and 1mm retained. Also the aggregates are of 12.5mm passed and 10mm retained are chosen for the construction of the plastic waste roads [6].

Dr. R. Vasudevan (2007) found that the coated plastic waste reduces the porosity, absorption of moisture and improve soundness. The plastic coated bituminous mix provides better material for the construction of flexible pavements as it shows higher Marshall Stability Value.[3]

III. METHODOLOGY

Waste plastic were collected from roads, garbage trucks, dumpsites and waste-buyers at Rs 8-10 per kg. For the project work, the plastic from houses also being collected like plastic bags, water bottles, milk bags, and others such as bread bags, etc. Generally, polyethylene of 60 micron or below is used for the further process so the plastic is being sorted. Less micron plastic is easily mixable in the bitumen at higher temperature ($165\pm 5^{\circ}\text{C}$). Collected Plastic was cut into fine pieces as far as possible by the help of mini plant. The shredded plastic were sieved through 4.75mm sieve and 1mm sieve retained was collected. Bitumen was heated up to the temperature 160°C . [4] Pieces of shredded plastic were added slowly to the hot bitumen of temperature around 170°C . The mixture was stirred for 30 minutes. In that time period temperature was kept to 170°C . Plastic-bitumen mixtures of different compositions were prepared and used for carrying out tests i.e. Penetration test, Ductility test, Flash point test & Fire point test, Stripping test, Ring and ball test and Marshall Stability value test.

IV. GUIDELINES FOR PLASTIC ROADS BY MINISTRY OF RURAL DEVELOPMENT

The plastic roads are not subjected to stripping when it comes in contact with water. The maximum thickness of plastic is to be 60 micron. PVC sheets and flux sheets should not be used. Plastic waste should be free from dust and should be shredded. CRRI specified that the shredded plastic must pass through 3mm sieve but according to Dr. R. Vasudevan, it should pass through 4.75mm sieve and retain on 1mm sieve. Percentage of shredded waste should be 8% of bitumen by CRRI and 10% of bitumen by Dr. R. Vasudevan for dry process. Bitumen grades should be 60/70 or 80/100 as binder. Aggregates should be heated to a temperature of 160 to 170°C in a chamber. Plastic waste should be spread in layers. In another chamber, bitumen is to be heated at a temperature of 160°C . Bitumen should be mixed with hot aggregates. Road laying of BC should be $115\pm 5^{\circ}\text{C}$. Roller should be used of normal capacity (i.e. 8 to 9 tons). Plastic coated aggregates improve aggregate impact value.

V. BASIC PROCESSES

5.1 Segregation

The plastic waste is separated from the solid waste management, where the solids are being thrown away from the society. The farm where it is kept for waste is chosen to be use in the plastic road.



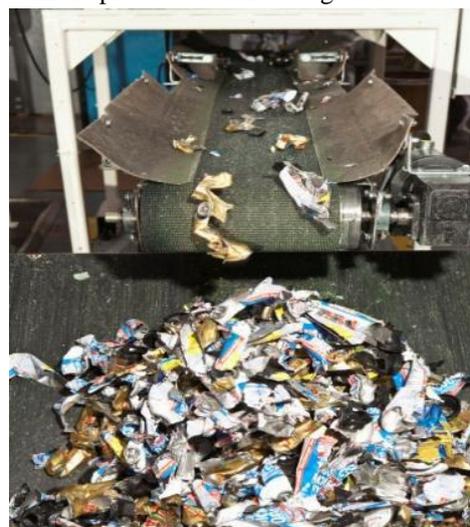
5.2 Cleaning

The segregated plastic waste is taken away from the waste and is cleaned with the help of water and kept for dry condition. The dry process can be done by mechanical as well as manual. For big projects it is normally done with the help of machines.



5.3 Shredding

In this process, plastic waste is shredded or cut into small pieces. Various plastics are mixed together.





5.4 Collection

The plastic waste after shredding i.e. broken pieces of plastic is then formed into the balls and they are kept in the sieves. The sieves of 4.75mm passed and 1mm retained is chosen for the collection of the plastic waste.[1]

VI. METHODS

There are basic two methods

1. Dry Process
2. Wet Process

Basically the dry process is taken in the work as to see the economic and environmental effect.

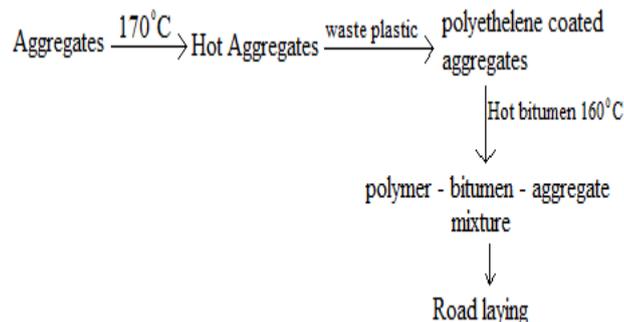
6.1 Dry Process :

- Aggregates are heated to $165\pm 5^{\circ}\text{C}$ in mini hot mix plant.
- Heated aggregates are then placed with the shredded plastic waste
- The shredded plastic waste is added to 6±2 equal proportion to make bonds with the aggregates.
- The bitumen is also heated to $155\pm 5^{\circ}\text{C}$ in other mini plant.
- The heated aggregates with shredded plastic waste is mixed together
- The mixed proportion is then laid on road as Bearing Coarse at the temperature of $120\pm 5^{\circ}\text{C}$.

6.2 Wet Process :

- Waste plastic by direct mixing with hot bitumen at 160°C .
- In this process the mechanical stirrer is needed.
- It requires lot of investment and also bigger plants.[1]

VII. Construction Process (Dry process)



VIII. ADVANTAGES AND DISADVANTAGES

8.1 Advantages :

- The biggest advantage is that it is environmental friendly.
- The strength is increased twice to the normal roads.
- There is no damage effect of radiation such as ultra-violet rays.
- Binding property is much better than the normal roads.
- There is less chances of rutting in the road.
- The road provides better resistance towards rainwater.
- The Marshall Stability value is increased.
- The cost of road construction is decreased.
- Maintenance cost of such construction is almost zero.
- Disposal of waste plastic will be no longer being a problem to the environment
- For two lane of $1\text{km} \times 3.5\text{m}$ road, about 1 ton of plastic is used and 1 ton of bitumen is saved.

8.2 Disadvantages :

- The toxics present in the plastic waste may start leaching during cleaning process.
- The presence of chlorine may release harmful gases at the time of road laying
- The road can leach at the time of first rain.

IX. COMPARISON BETWEEN ORDINARY ROADS AND PLASTIC WASTE ROADS

Sr. No.	Properties	Ordinary Roads	Plastic waste Roads
1	Tensile strength	Less	High
2	Softening Point	More	Less
3	Binding property	Good	Better
4	Cost of pavement	Normal	Less
5	Seepage of water	Yes	No
6	Stripping (pot holes)	More	No
7	Durability of road	Good	Better
8	Environment friendly	No	Yes
9	Maintenance cost	More	Almost Nil
10	Marshall Stability Value	Less	More

X. RESULT AND DISCUSSION

In the result it has been found that the by adding plastic waste to the road construction it increases the Marshall Stability Value. It normally saves the 10% of bitumen in comparison to ordinary roads.



XI. FUTURE SCOPE

The plastic waste from all the areas such as residential, commercial, industrial, institutional etc. is collected by the municipal department which is then collected to the dump yards or is sent for landfill or incineration. All these give bad effect on environment. Incineration causes high amount of pollution which produces various types of disease to the human being as well as to the animals. Landfill with plastic waste decreases the soil properties and dump yards acquire large amount of area which can become barrier in developing a particular area in future. It can cause problems in making building or any structure over there. Moreover plastic waste is getting generated with huge amount without proper disposal at public places, beaches, historic places, rivers etc. which also affect on environment like blockage in rivers and canals, harmful effects to the plants and trees, life risk for animals, health issues etc.

The main reason of all the above problems is plastic, so plastic must be recycled or reused. As about 15000 tons plastic waste is generated every day, there will a large amount of this waste which can be reused in the construction of plastic roads. The plastic waste should be kept separately from the household waste and it should be kept separated to the last stage of solid waste management, so that all the plastic waste can be kept separately at the end and can further be sent for reuse in road construction. The government should help in this work and should provide various equipments for plastic road making. If all

these processes are applied then the road construction can become economic and efficient and in future, there will be less plastic, better environment and better roads.

XII. CONCLUSION

The plastic waste is increasing day to day. Polymers polyethylene, polypropylene and polystyrene shows the adhesion property in molten state. Plastic will increase the melting point of the bitumen. Hence, the use of plastic waste for pavement is one of the best method for easy disposal of waste plastic.

Moreover the plastic roads give better properties than normal bitumen roads. The quality of plastic roads is really great. These have more tensile strength, more Marshall Stability value, more durability and the most important thing is that it is economic and efficient. These roads are long lasting and also the maintenance cost is almost null.

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