

USE OF PLASTIC WASTE IN ROAD CONSTRUCTION

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Abstract: Plastic which is toxic in nature is found to be nearly 5% in Municipal Solid Waste (MSW). 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. In addition it will also be a solution to plastic disposal & various defects in pavement viz., pot holes, corrugation, ruts, etc. the waste plastic used are poly-ethylene, poly-styrene, poly-propylene. The waste plastic is shredded & coated over aggregate & mixed with hot bitumen and resulted mix is used for pavement construction. This provides a solution to the problem of effective disposal of plastic waste at the same time increases the strength and durability of the road, addresses the environmental, economic and most importantly safety issue.

Keywords: Plastic waste, Bitumen, incineration, segregation, absorption, marshal value, non biodegradable, polymer, land filling, dry process, et process.

I. INTRODUCTION

Plastic is everywhere in today's lifestyle. The main problem is what to do with the plastic waste. Use of plastic waste which is non biodegradable is rapidly growing and researchers have found that the material can remain on earth for 4500 years unchanged and without degradation. This threat of disposal of plastic will not solve itself and certain practical steps have to be initiated at the ground level. On the other hand the road traffic is increasing with time hence there arises a need to increase the load bearing capacities of roads[1]. The various experiments have been carried out whether the waste plastic can be reused productively. The various literature indicated that the waste plastic when added to hot aggregates will form a fine coat of plastic over the aggregate and such aggregates when mixed with binder is found to have higher strength, higher resistance and better performance over a period of time. Along with bitumen, use waste plastic increases its life and smoothness. It is economical and eco-friendly. Addition of plastic waste in construction of pavements reduces the plastic shrinkage and drying shrinkage. The use of waste plastic improves the abrasion & slip resistance of asphalt pavement.[2]

II. PROBLEMS WITH DISPOSAL OF PLASTIC WASTE

Disposal of plastic waste has emerged as an important environmental challenge and its recycling is facing roadblocks due to non-degradable nature. Because plastic does not decompose biologically, the amount of plastic waste in our surroundings is steadily increasing. Plastic waste is often the most objectionable kind of litter and will be visible for months in landfill sites without degrading.



The primary methods employed for the disposal of plastic wastes are:

(i) Incineration: Incineration is a waste treatment process that involves the combustion of organic substances contained in waste materials[3]. Incineration of waste materials converts the waste into ash, gas, and heat.



(ii) Land filling: The Landfill Directive defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies to all landfills, defined as waste disposal sites for the deposit of waste onto or into land.

III. METHODOLOGY

1. Segregation

Plastic waste collected from various sources must be separated from other waste. Maximum thickness is 60 microns.

2. Cleaning Process

Plastic wastes get cleaned and dried.

3. Shredding process

Plastic waste is shredded or cut into small piece. The different types of plastic wastes are mixed together.

4. Collection process

The plastic waste retaining in 2.36 mm is collected

5. Mixing

By mixing plastic with bitumen the brittleness overcomes and elastic nature enhances. The plastic waste is melted and mixed with bitumen in a particular ratio. There are two important processes used for bitumen mix flexible pavement, they are:

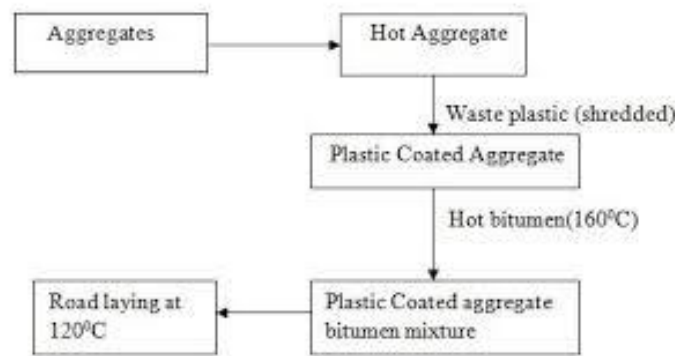
(i) Dry process

(ii) Wet process

(i) Dry Process:

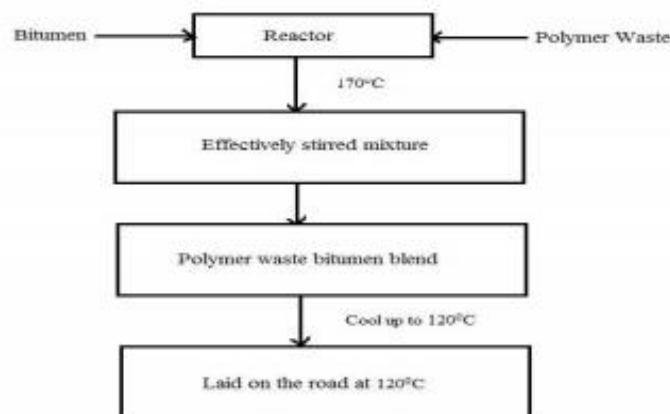
For the flexible pavement, hot stone aggregate (170°C) is mixed with hot bitumen (160°C) and the mix is used for road laying. The aggregate is chosen on the basis of its strength, porosity and moisture absorption capacity as per IS coding. The bitumen is chosen on the basis of its binding property, penetration value and viscous-elastic property[4]. The aggregate, when coated with plastics improved its quality with respect to voids, moisture absorption and soundness.

In this process the shredded plastics are poured over the heated aggregates, thus forming plastic coated aggregates which are then mixed with hot bitumen to form plastic coated aggregate bitumen mixture for laying roads. The coating of plastic decreases the porosity and helps to improve the quality of the aggregate and its performance in the flexible pavement[5].



(ii) Wet Process:

These are the method used for formation of polymer based modified bitumen, in which the waste polymer directly added with bitumen and heated upto temperature of 170°C so that proper blend is to be formed with proper dispersion of waste polymer into bitumen, then the hot mix is then cooled upto 120°C into another chamber, which is then added to the aggregate in paddling chamber[6]. The mix is to be cooled because when hot mix poured on aggregate the there are chances to form air pocket into small gap of aggregate and chances in lower the strength of rods and chances of rutting of roads. After addition of modified bitumen at 1100C on aggregate, it is then laid on the road and then spreader material is compacted by 8 ton roller.



IV. RESULT

The results of the studies on the extraction of bitumen by dry process showed that the bonding between stone aggregate and bitumen is improved due to the presence of polymers[7]. This may be explained by the following tables.

Table-1: Bitumen Extraction at certain Interval

Plastic Content (% By Weight)	Bitumen Extracted After 5 Min %	Bitumen Extracted after 10 min %	Bitumen Extracted after 15 min %
0	95.0	97.0	98.0
0.5	63.0	87.9	92.3
0.75	62.7	85.3	90.7
1.0	60.6	76.2	82.8

Use of higher percentage of plastic waste reduces the need of bitumen by 10-12%. It also increases the strength and performance of the road[8].

Table-2: Improved Characteristics of plastic coated aggregate

%of plastics	Moisture Absorption	Soundness	Voids	Aggregate crushing test
Nil	4%	6%	4%	24%
1%	1%	Nil	2.2%	19.5%
2%	1%	Nil	1%	18%
3%	0.5%	Nil	Nil	NA
5%	0.32%	Nil	Nil	NA
10%	0.15%	Nil	Nil	NA

Note: The above value shows that the plastic coated aggregate shows improved quality which is responsible for the better performance of the road.

V. CONCLUSIONS

Polymer Modified Bitumen is used due to its better performance. In the modified process (dry process) plastics waste is coated over aggregate. This helps to have better binding of bitumen with the plastic-waste coated aggregate due to increased bonding and increased area of contact between polymer and bitumen. The polymer coating also reduces the voids. This prevents the moisture absorption and oxidation of bitumen by entrapped air. This has resulted in reduced rutting, raveling, and there is no pothole formation. The road can withstand heavy traffic and show better durability. The use of the innovative technology will not only strengthen the road construction but will also increase the road life as well as help to improve the environment and will also create a source of income.

Future Scope of Bitumen Roads:

The main scopes of plastic roads are:

- (i) Economic in terms of bitumen: The shredded plastic in form of polymer covers the aggregates and thus occupies a larger portion of the road reducing the quantity of bitumen needed.
- (ii) Efficient management of non-biodegradable waste: Plastic is a harmful and non-biodegradable waste responsible mainly for land pollution. Utilizing it for road construction will result in its efficient management.
- (iii) Easy process without any new machinery: It is a simple and easy technique which does not involve any complex or new machinery.
- (iv) Enhanced durability: The addition of plastic to bitumen will help in improving the strength and durability of the pavement.

A well constructed plastic bitumen road will result in the following advantages:

- (i) Strength of the road increased (increased Marshall Stability Value)
- (ii) Better resistance to water and water stagnation
- (iii) No stripping and have no potholes in the pavement
- (iv) Increased binding and better bonding of the bitumen mix
- (v) Increased load withstanding property of road.
- (vi) Overall consumption of bitumen decreases.
- (vii) Maintenance cost of the road is almost nil.
- (viii) The road life period is substantially increased.
- (ix) No effect of radiation like UV.

- Every bracketed in-text reference number must have a corresponding end-text reference with full, accurate bibliographic information

- Format bibliographic information as exemplified below. Consult the “How to Present End-Text References” document for examples of other kinds of resources.

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