

UTILISATION OF PLASTIC WASTE IN ROAD CONSTRUCTION FOR SUSTAINABLE DEVELOPMENT

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Abstract— Plastic has always been an extremely toxic material with taking 1000 years to decompose in the landfills. The only way to breakdown plastic is through photo degradation and it requires sunlight. Out of the municipal waste generated, plastic constitutes for 12%, which is toxic in nature. A study at Waterloo Collegiate Institute recently demonstrated that certain types of bacteria can break down plastic. Waste plastic can be reused effectively for sustainability and for environment friendly purpose. Plastic waste when added to hot aggregate can form a fine coat of plastic over the aggregate and such aggregate, when mixed with the binder is found to give higher strength, higher resistance to water and better performance over a period of time are the indications of several experimentations at institutes.

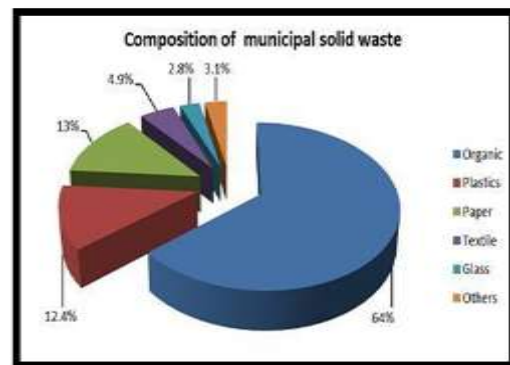
Keywords— Solid Waste, Bitumen, Plastic, Environment

I. INTRODUCTION

India has witnessed massive growth in consumption and production of plastics. The management of the waste for discarded plastic due to urbanization has become a daunting task in the recent past. The municipal waste is channelized to dumpsites (landfills) and it takes more than 1000 years for the waste to breakdown the plastic as there is no sunlight and photo degradation cannot take place.



Img. No. 1 Dumping ground in Mumbai
(Source: Mid Day national news)



Img. No. 2: Composition of solid waste (Source: Composition of Municipal Solid Waste in Ahmedabad, Author's Estimates)

The most promising way to recycle a certain portion of this waste, consisting of HDPE (High Density Poly Ethylene), LDPE (Light Density Poly Ethylene), and crumb rubber, is to use it in the construction of roads and other infrastructure works. 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. The plastic roads include transition mats to ease the passage of tyres up to and down from the crossing. Both options help protect wetland haul roads from rutting by distributing the load across the surface.

II. OBJECTIVES OF THE PROJECT

- Study and development of eco-friendly construction material.
- To develop a pavement surface that has better weathering resistance.
- To study the properties of material when subjected to various tests

III. METHODOLOGY

The methodology has been divided into 3 parameters.

- Material specification
- Processing at site
- Experimental procedure

A. MATERIAL SPECIFICATIONS:

1. Aggregates:

Aggregates are classified into 2 categories:

1. Coarse aggregates: These are the aggregates retained on 2.36mm IS sieve
2. Fine aggregates: these are the aggregates which pass through 2.36mm IS sieve and are retained 0.075mm IS sieve

2. Bitumen :

Bitumen is one of the most commonly used binding materials. Bitumen grade ranging from 60/70 to 80/100 are generally adopted for regular pavement construction.

3. Waste plastic modifiers:

Waste plasticizer modifiers play a vital role in bituminous concrete. These plasticizers fill up the void space between the aggregates. Besides that modifiers also help in binding the aggregates.

B. PROCESSING DETAILS:

The various steps involved in processing of plastic waste and mixing it with aggregates has been explained below:

- Collection of waste plastic.
- Segregation and shredding of waste plastic.
- Mixing of shredded waste plastic, aggregate and bitumen in central mixing plant



Img. No. 3a

Img. No 3a: Heated aggregates



Img. No. 3b

Img. No 3b: Adding of shredded plastic



Img. No. 3c

Img. No 3c: Aggregate plastic bitumen mix

C: EXPERIMENTAL PROCEDURE:

1. Central mixing plant is used for dry process.
2. Shredded plastic and aggregates are added on the conveyor belt. This shredded plastic and aggregates is later transferred to a hot cylinder.
3. A coat of plastic is given to the aggregate and later of bitumen.
4. The mixture so obtained is transported to the site with the help of dripper lorry for road laying.
5. Quality assurance is ensured due to CPM (Central Mixing Plant).

In the bitumen mix various varying proportion of plastic was added, the results observed from varying proportions are shown as below.

Various tests were conducted on bitumen which are tabulated as follow:

TABLE I
RESULTS OF VARIOUS TESTS ON BITUMEN

%of bitumen	Ductility (cm)	Penetration (mm)	Softening point
Nil	75	97	70
1%	65	96	55
2%	55	92	51
3%	21	81	52
5%	10	53	74
10%	9	43	82

This shows that higher percentage of plastics in polymer modified bitumen is not favourable.

Various tests were also conducted on aggregates which are tabulated below:

TABLE II
AGGREGATE IMPACT TEST RESULT

Percentage of plastic	Aggregate impact value
Nil	26.2
10 %	22.1

TABLE III
AGGREGATE CRUSHING VALUE

Percentage of plastic	Aggregate crushing value
Nil	24.20
10%	14.25

IV. RESULTS

1. The impact value of the plastic coated aggregates was reduced by 10% than normal aggregates. This indicates that plastic coated aggregates have higher toughness
2. The crushing value was reduced from 26.2(normal aggregates) to 22.1(plastic coated aggregates). The lower crushing value indicates higher strength.
3. The penetration of bitumen mixed with plastic is less as compared with ordinary bitumen, which is a desirable property.
4. The plastic added bitumen has higher softening point than ordinary bitumen, almost 12⁰ more.

V. CONCLUSION

The following can be inferred from the study conducted:

1. **Enhancement in road performance on addition of plastic to bitumen and aggregate mix.**
2. **Addition of plastic improves the wear and tear resistance of pavement surface which is indicated by a lower penetration test result.**
3. **Plastic added bitumen is more resistant to varying temperature conditions (alternate heating and cooling cycle). Higher degree of softening point is an indicator of it.**
4. **In the long run, plastic added bitumen is more durable and economical, provided further studies on cost, material and equipment optimisation are carried out**

VI. ACKNOWLEDGEMENT

The author would like to convey his gratitude to Mast. Sushil Thorat for his constant motivation and support throughout this research along with positive guidance and constructive criticism.

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