

Use of Waste Plastic in Construction of Bitumen Road

SAHIL GOLANDE¹, SHREYA THOMBARE², GAJANAN BINGOLE³, ADESH CHAMALWAR⁴

⁵Under guidance of Prof. RACHANA VAIDYA. Civil dept.

¹⁻⁵Department of Civil Engineering, ALARD COLLEGE OF ENGINEERING AND MANAGEMENT, MARUNJI, PUNE

Abstract :- Disposal of waste plastic bags has become a serious problem and waste plastics are burnt for clear disposal which is caused to environmental pollution. Utilization of waste plastic in different way can help to environment from pollution. Reuse of waste plastic in bituminous mixed has showed that the properties of mix are increased and waste plastic issue are also solved to some extent. In the process, the plastic waste is get cleaned and cut into a size that it can passes through 2.36 mm sieve using shredding machine. The aggregate is heated and the shredded plastic is well coated over the aggregates. This phenomena of plastic waste coated aggregates are mixed with hot bitumen to prepare mixed formula. The use of the innovative technology will help to increased the strength of the road construction, Increase the road life as well as will benefit to reduce the environment pollution. The present study investigates that the use of waste plastic as a modifier in construction of bituminous road can help in solving the problem of waste plastic. In this study the shredded plastic waste is mixed in hot aggregate and the plastic modified mixed is prepared using 10%, 12%, 14%. 20% and 25% plastic by weight of bitumen.

Keywords: Plastic Waste, Bitumen, Aggregates, Size of shredded plastic, Temperature, Micro-plastic.

1. INTRODUCTION:- As the world population increases, so amount and type of waste being generated. Various waste plastics generate today and tomorrow will remain as it is in the nature for hundreds and may be thousands of years. The plastic is a non-decaying waste material and results in pollution. One of the new waste materials used in the concrete and road construction is recycled plastic. Material, reuse of plastic in concrete and construction of road is considered as the most practical application. Research into new and innovative use of waste materials being undertaken world-wide and innovative ideas that are worthy of

this subject. Many privet firm and individuals, highway agencies have been completed or are in the process of completing the research on projects beneficial to environmental suitability and performance of using waste plastic in highway construction. These studies try to match societal need for safe and economic disposal of waste material with the help of environmental friendly highway industries, which needs better and cost - effective construction materials.^[3]

2. Plastics Roads :- General Introduction

Plastic use in road construction is not new. Plastic roads are made entirely of plastic or some of composite of plastic with other material. Use of waste plastic in road construction are different from standard road. Standard roads are constructed from bitumen or concrete. This roads are built by using recycled plastic. The first process is collection of waste plastic and manage the plastic material. The study on use of plastic waste has been completed by scientists and engineers for a quite long time. Recent studies in this way have shown some hope in terms of using plastic-waste in road construction is safe and good for the environment. An initial study was conducted in 1997 by the group to test for strength and durability. Construction of waste plastic roads mainly use plastic carry-bags, used cups and drinking bottles that are collected from dump yard as an important component of the construction material. The process of mixing with hot bitumen, plastics melt to form an smooth coat over the aggregate and the mixture is laid on the road surface like a normal tar road. By the use of this innovation we can solve the problem of disposal of plastic waste.

3. Plastic waste management :-

- Land filling :- The waste materials are store in a specific area, away from the city. This process may affect to -
 1. Affect to water recharge.
 2. Clogging of drainage.
 3. Reduce soil microbial activity.
 4. Water line clogging.
- Incineration:- Incineration is normally carried out above 700 degree C. Plastic materials such as PE, PP, PS, PVC produces gases like CO, CO₂ etc. and these gases cause global warming, air pollution, change in climatic condition etc.
- Decoration :- plastic waste like polystyrene (PVC tubes) are now commonly used for decoration purpose in area such as house, club, etc.^[3]

3.1. Use of Plastic waste in different construction :-

1. In Road construction :- The utility of the Waste Plastics-Bitumen-Aggregate mix for flexible pavement construction is characterized by studying two methods:

- Stripping value and
- Marshall stability value of the mix.

2. In Concrete :-

- Melted processed plastic:- In this process the recycled plastic are cut to 28 mm length.
- Shredded plastic:- The process in which the plastic is cut in to small particles.

➤ 3.2. Materials to be used :-

AGGREGATE:- Aggregates is used in surface course. It is divided into two types according to their dimension: coarse aggregates and fine aggregates.

Coarse aggregates are the aggregate which are retained on the 2.36 mm sieve.

Fine aggregates are defined as the aggregate that are pass through the 2.36 mm sieve.

BITUMEN:- Bitumen behave as binding medium for aggregates in bituminous mixes. Generally in India bitumen used in road construction is of grades 60/70 or 80/100 penetration grade.

WASTE PLASTIC MODIFIERS:- The mixture of bitumen and modified aggregate are generally used to improves the properties of bituminous mixes by reducing the air void present between the aggregates and also to hold together so that no bleeding of bitumen will take place.

4. PROCESSING DETAILS:-

- Collection of waste plastic.
- Cleaning and shredding of waste plastic.
- Mixing of shredded plastic waste, aggregate and bitumen.

COLLECTION OF WASTE PLASTIC:- Waste plastic is collected from roads, garbage trucks, dumpsites or compost plants, or by purchase from rag-pickers or waste-buyers at Rs 5-6 per kg Rag-pickers.



Fig. 1

COLLECTION AND SEPERATION OF PLASTIC WASTE.

CLEANING AND SHREDDING OF WASTE PLASTIC:- Waste plastic trash in the form of thin layer carry-bags, used cups, bottles, etc. these are sorted, de-dusted, washed if necessary. Cleaned waste plastic is cut into a size between 1.18mm.



Fig.2

CLEANING AND SHREDED OF PLASTIC WASTE.

MIXING OF GRANULATED WASTE PLASTIC, AGGREGATE AND BITUMIN :- The aggregate mix is heated to 1650c in plant. Similarly the bitumen is heated up to a almost of 160°c. The 10% of waste plastic to the weight of bitumen are added in the special mechanical device is developed which will spray the plastics inside the chamber to coat the aggregate effectively.^[1]

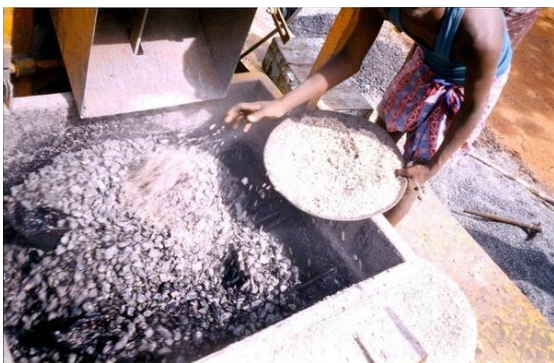


Fig.3

MIXING PROCESS

MICRO-PLASTIC :-

Micro-plastics are small pieces less than 5 mm in length which can be harmful to human health as well as environment and aquatic life. As they are tiny in shape can affect land also. The precaution should be taken while in the process of shredding or cutting process. This micro-plastic is increasing day by day and appear on surface of ocean. To decrease the micro-plastic,

The insect that can decomposed plastic can help solve this problem. The name of this insect is The greater wax moth has a ability to decompose the plastic.

5. METHODOLOGY :-

5.1 Waste plastic used as aggregates :-

Before we use the recycled of waste plastic in construction of roads, includes the some modification and process these includes the following methods :-

5.1.1 Chemical Modification:-

Plastic can be recycled by chemical modification or De-polymerization. There are two ways to achieve de-polymerization

- a) Hydrolysis (Chemical Decomposition).
- b) Pyrolysis (Thermal decomposition).

The technology of de-polymerizing single condensation polymers such as urethanes, PET (poly-ethylene-tere-phthalate), nylon, and poly-methyl-Meth-acrylate is relatively easy. It is very complicated to chemically improve mixed plastics to make useful and Economical chemical.

5.1.2 Mechanical Recycling:-

Mechanical recycling of plastics is the processes which assume melting, shredding of waste plastics. Plastics must be sorted earlier to mechanical recycling Technology is being established to sort-out plastics automatically, using various techniques such as X-ray, infrared and near infrared spectroscopy, electrostatics and flotation. the plastic is melted down directly and mould into a new shape, or melted down after being shredded and then processed into granules called re-granulate. The chemical and

physical properties of these recycled plastics is increased were compared with normal mixture of aggregate and bitumen.

The properties of a melt-blown bottle prepared from 100% post-consumer high-density.

5.1.3 Thermal Reprocessing:-

Thermal reprocessing involves of heating a thermoplastic at very high temperatures, thus making the plastic to melt. Then the plastic is converted into a new product as it cools. This method does not includes the modification of the chemical composition of the plastics. Thermal reprocessing is quite uncomplicated if it is applied to relatively pure thermoplastics. So that, thermal reprocessing could not be applied to thermosets (such as cross linked polyesters) because they cannot soften at high temperatures without degrading. Thermal reprocessing becomes a lot more complex if various thermoplastics are mixed together. This process is used to separate the various plastics. Separation of different plastics can be easy or complicated depending upon the source of the waste.^[1]

5.2 Waste plastic used in road pavement :-

5.2.1 Plastics - as Binder and Modifier :-

Plastics waste (carry bags, bottle, bags etc.) on heating moderate around 130-140 degree C. A study has shown that there is no gas formed in the temperature range of 130-180 degree C. Moreover the moderate plastics have a binding property. Hence, the molten plastics materials can be used as a binder and they can improves

their binding property. This plastic is a good modifier for the bitumen which is used for road construction.

Waste plastics are available sufficient in the form of carry bags, cups and bottles. While the Use of these materials to enhance the property of bitumen can help in many ways like,

- (1) Easy disposal of waste,
- (2) Better road,
- (3) Prevention of pollution.
- (4) Increased the life of road.
- (5) Solving the problem of waste plastics.
- (6) Give more strength and durability to road.^[2]

6. TEST TO BE CONDUCTED :-

In the mix of the Aggregate-Bitumen-Plastic in flexible pavement, the test to be conduct are as follows:

TEST ON BITUMEN :

1. Penetration test – penetration container
2. Ductility test – Ductility test equipment (mould)
3. Viscosity test – Tar/Bitumen viscometer
4. Softening point test –softening point test apparatus (circular ball)

To comparing the result on bitumen without plastic and bitumen with plastic as follows,^[4]

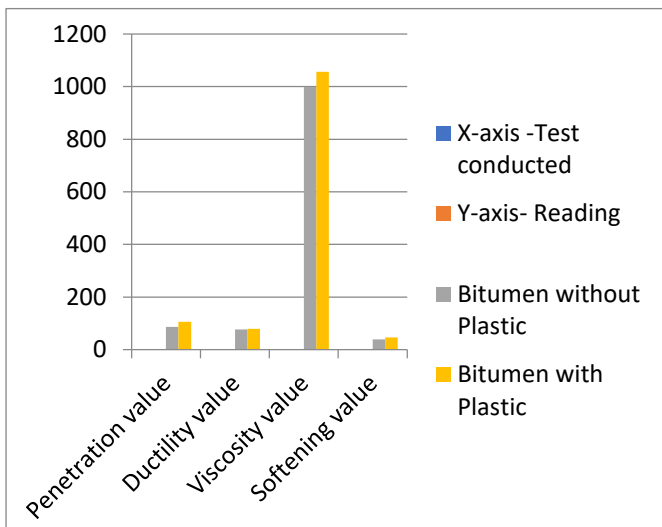
Table no.1

| Sr. No | Tests | Test result for Bitumen without Plastic | Test result for Bitumen with Plastic | Recommended value |
|--------|-------------------|---|--------------------------------------|-------------------|
| 1 | Penetration value | 86.67 | 105.67 | 80-100 mm |
| 2 | Ductility value | 76.4 | 79.17 | >75 cm |
| 3 | Viscosity value | 998.5 | 1055.5 | 800-1200 sec |
| 4 | Softening value | 39.35 | 46.25 | 40 °C |

replacement. As population increases, the waste plastic is increases and causes the Pollution. That waste plastic is used in constructions, therefore it helps to decrease in pollution. It helps to avoid general disposal technique of waste plastics namely land filling and incineration which have certain burden on environment.

REFERENCES:

- 1)“Application or innovation in Engineering and management”. International Journal- By- Apurva J. Chavan. Volume 2 (2013)
- 2)“AN OVERVIEW ON WASTE PLASTIC UTILIZATION IN ASPHALTING OF ROADS” Journal By - Amit Gawande (2012)
- 3)Journal- Dr. R. Vasudevan -Utilizations of waste plastic for flexible pavement, Indian Highways (Indian road congress) volume 34 no.7 (July 2006).
- 4) 4) “Edition World scientific publishing co., Singapore”. Journal By - Dr. Yung-Hung And Nazih Shammass (July 2014)



Graph showing comparative study of Bitumen without plastic and bitumen with plastic

7. CONCLUSION :-

As the above information, we studied that the waste plastic can be recycled and this recycled waste plastic is used in constructions of road pavement and in cement concrete as aggregate