



# INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK



## SPECIAL ISSUE FOR 2<sup>nd</sup> NATIONAL CONFERENCE ON "Recent Trends and Development in Civil Engineering"

### A REVIEW ON, DESIGN AND CONSTRUCTION OF BITUMINOUS PAVEMENT USING PLASTIC WASTE

CHIRAG CHAVDA<sup>1</sup>, DEEPAK SAHARAN<sup>1</sup>, HARSHRAJSINH GOHIL<sup>1</sup>, CHIRAG MODI<sup>1</sup>, MITTAL PATEL<sup>2</sup>

1. UG Student, Department of Civil Engineering, Shankersinh Vaghela Bapu Institute of Technology, Gandhinagar, Gujarat – 382650
2. Assistant Professor, Department of Civil Engineering, Shankersinh Vaghela Bapu Institute of Technology, Gandhinagar, Gujarat – 382650

Accepted Date: 22/12/2018; Published Date: 01/02/2019

**Abstract:** 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 can also be a solution to plastic disposal. The waste plastic is mixed with hot bitumen or hot aggregates and resulted mix is used for pavement construction. This can strengthen the pavement and also increase its durability. This technology can prove to be a boon for a country like India. It's economical and eco-friendly.

**Keywords:** Bitumen, Pavement, Plastic waste, Aggregate, Chicken grid, recycling.



PAPER-QR CODE

Corresponding Author: CHIRAG CHAVDA

Access Online On:

[www.ijpret.com](http://www.ijpret.com)

How to Cite This Article:

Chirag Chavda, IJPRET, 2019; Volume 7 (6): 162-167

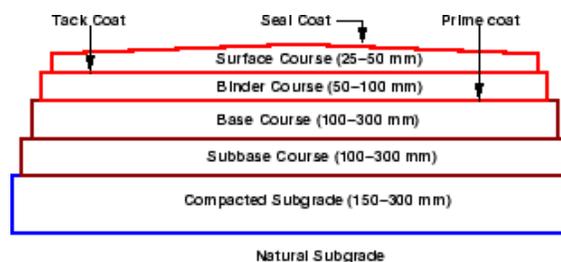
## INTRODUCTION

### Bituminous pavement

Bitumen is a black or dark-colored, cementitious material that can be found in different forms, such as rock asphalt, natural bitumen, tar and bitumen derived from oil, which is referred to as petroleum bitumen. Bituminous pavements are made with by-products of petroleum, such as asphalt. Weather and seasonal changes can cause roadways and the earth below them to rise or fall slightly. As these natural shifts occur, bituminous pavements allow the road surface to bend or flex slightly without breaking. Bituminous material softens when heated and can be prepared and applied in a wide range of concentrations. Thin layers of bituminous material are sometimes applied with a pressure sprayer to the base course or the top course. The bituminous material seeps into the crushed rock and penetrates the tiny spaces between the compacted rocks, binding the aggregate together.

The layers of conventional flexible pavement are-

- Formation level- the formation Level is the level at which excavation ceases and construction commences.
- Sub base -sub base is the layer of aggregate material laid on formation level.
- Base course-The base course is the layer composed of crushed stone, crushed slag etc.
- Surface course-The layer above the base course where bitumen is laid.
- Surface dressing-Thin film of bituminous binder above surface course



### Plastic wastes

Plastics are synthetic man-made materials, made from polymers, which are long molecules built around chains of carbon atoms, typically with hydrogen, oxygen, sulfur, and nitrogen filling in the spaces. You can think of a polymer as a big molecule made by repeating a small bit called a monomer over and over again; "poly" means many, so "polymer" is simply short for "many monomers". Plastics have become a vital asset for humanity. Though extensive research and new technologies have led to invent of newer and safer plastics, but drawbacks and challenges of plastics have never been resolved and impact is on the rise. Plastic is one of the major toxic pollutants of present time. Being composed of toxic chemicals and most importantly a non-biodegradable substance, plastic pollutes earth and leads to air pollution and water pollution.

The types of waste plastics used with bitumen are-

1. Poly-ethylene
2. PVC
3. Poly-styrene

The plastic is shredded before it is mixed with hot bitumen or hot aggregates. About 10 to 20 % of bitumen can be replaced by plastic in road construction.

### Literature Review

- **Use of Biomedical Plastic Waste in Bituminous Road Construction:**

Bhageerathy K. P, Anu P. Alex, Manju V. S, Raji A. K; International Journal of Engineering and Advanced Technology (2014)

The quantum of plastic in solid waste is increasing due to increase in population, urbanization, development activities and changes in life style which is leading to widespread littering on the landscape. The disposal of waste plastic has thus become a serious problem globally due to their non-biodegradability. The deteriorating quality of roads is another area of concern as the present roads are not able to withstand the increasing traffic and also are less resistant to adverse weather conditions. Research is being carried out to develop suitable alternatives to the conventional road construction materials. In this work, the use of autoclaved medical plastic waste in the form of shredded syringes in road construction is tested. The main objective of the study was to investigate the performance of the bituminous mix modified with bio-medical plastic waste and to compare it with the normal mix. Medical plastic waste was collected from IMAGE (Indian Medical Association Goes Eco-friendly), Palakkad, Kerala, India. As part of the study, the properties of Plastic Coated Aggregates (PCA) were determined. The results showed improved properties for PCA when compared to normal aggregates. The properties of both the mixes were tested by conducting creep test and indirect tensile stiffness modulus test. <sup>[1]</sup>

- **Use of Biomedical Plastic Waste in Bituminous Road Construction:**

Tina Maria Sunny ,Assistant Professor, Department of Civil Engineering, SCMS School of Engineering and Technology, Karukkuty, Kerala (2018)

The amount of plastic in solid waste is increasing due to increase in population, urbanization and changes in life style which is leading to widespread littering on the landscape. The disposal of waste plastics has thus become a serious problem globally due to their non-biodegradability. The deteriorating quality of roads is another area of concern as the present roads are not able to withstand the increasing traffic and also are less resistant to adverse weather conditions. The present work deals with the use of autoclaved medical plastic waste (like glucose bottles, syringes etc.) in road construction. The study investigates performance of the bituminous mix modified with bio – medical plastic waste and compares it with the normal bituminous mix. Marshall Method of mix design is adopted. <sup>[2]</sup>

- **Plastic asphalt paving material and method of making same:**

Gary M. Fishback, Dennis M. Egan, Hilary Stelmar (1995)

An asphaltic concrete or paving material includes at least 5 percent, and preferably from 5 to 20 percent, of granular recycled plastic, which supplements or replaces the rock aggregate component of the mixture. The material produces a structurally superior paving material and longer lived roadbed. The plastic may include any and all residual classes of recyclable plastic, including thermosetting plastics and other plastics having little to no current widespread utility. The material produces roadbeds of higher strength with less total asphalt thickness and having greater water impermeability, and is most useful for all layers below the surface layer. The recyclable plastic component of the material is preferably a mixture of all recyclable classes 3 through 7, or of those materials from such classes from which potentially more valuable recyclable materials have been selectively removed. The paving product is preferably formed by a process of shredding or mechanically granulating used and industrial waste plastic to a no. 4 to 1/2 inch sieve size, and preferably to 1/4 inch to 3/8 inch granules. The granules are then treated with an energized activating medium such as plasma or a reducing flame, to activate the surface of the granules, preferably without burning or melting the plastic. The activated treated granules are then added to the aggregate and mixed with the asphalt binder to produce the paving material. A slurry or sand mix of plastic and binder may also be applied over an aggregate layer, base layer or roadbed.<sup>[3]</sup>

- **Review Paper on Bituminous Concrete Mixed Design for Road Construction:**

Rabindranath Ghosh, Upvan Kunmar, Shubham Gupta, Vivek Kumar, Azharuddin Malik (2017)

This research is conducted to study laboratory performance of bituminous mix design & to study volumetric properties of bituminous concrete. Firstly they conducted laboratory testing to find the physical properties of aggregate tests like Aggregate Impact value, Abrasion Test, Crushing value test, Flakiness and elongation Index (combined), Water absorption, Specific Gravity etc. Then they studied physical properties of bitumen test like Penetration test at 25 °C, Softening Point test, Ductility test at 27 °C, Viscosity at 150 °C, Specific Gravity etc. which satisfied the requirement of IS: 73-2006. Then, they studied Marshall Stability test. After all the tests and processes they came at the conclusion that the overall objective of this study is to determine the optimum ratio of bitumen aggregate mix for the design of flexible pavement, because if the percentage of bitumen is less than the required proportion then proper binding will not occur. On the other hand if its percentage increases than overall cost of construction is increased.<sup>[4]</sup>

- **Use of plastic waste in flexible pavement construction:**

G.H V Sai Simha, LalitKumar; Amity University, Haryana, India (2017)

Generally, the road network in India and abroad carries both the passenger and freight transport. India has a road network of over 54, 72, 144 kilometers and it is the world's second largest network. Most of the investigations stated that in India due to the increase of traffic day by day the application of wheel loads on the flexible roads are very high. So, the stability of flexible pavement is decreasing due to wheel load and deformation of roads is getting increased day by day. To overcome this problem the properties of the bitumen on the roads should be improved by adding additives to the bitumen known as bitumen modifiers. In India, the majority of the plastic waste mainly consists of Polyethylene, polypropylene and polyolefin. In this paper, the natural rubber is used as the modifier to convert the normal bitumen to modified bitumen, because of similar properties to that of plastic waste categorized under polyolefin. Marshal method of bituminous mix design was carried out for various percentages of natural rubber in bitumen and various different mix design characteristics has been determined.<sup>[5]</sup>

- **Recycling plastics waste for highway and earthworks construction:**

Modzel Wilhelm Dipl-Ing (1993)

Plastics waste material is converted into a material for use in highway construction and earthworks, by adding minerals. After the plastics mass has been softened, the minerals are mixed through as fillers, sand or splinters, and reduced to loose materials with the required cubic granular size, to be shaped, broken or cut. The mineral dust is extracted and/or an adhesive coating is applied through heating or pretreatment, using bitumen, synthetic resin or another bonding agent while the mass is still plastic, giving a covering on all sides or over part of the surfaces. The material is then reduced to the required grain size by breaking or cutting.<sup>[6]</sup>

- **Use of Plastic Waste in Road Construction:**

Shweta N. Rokdey, P. L. Naktode, M.R. Nikhar (2015)

In this paper 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. This project will conduct a study on recycling plastic waste and blending it with bitumen to lay roads in India and compare with the environmental and economic conditions. Some of these materials are relatively cheaper and provide more strength as compared to traditional road materials. This project will come up with useful information and creating awareness amongst the learner in the industry regarding waste material. So that one can have a step towards further detailed information about these materials and thus be able to implement on field which will definitely improve the level of construction.<sup>[7]</sup>

## **CONCLUSION**

After studying the mentioned research papers & tests conducted by us, we have found that the 10% plastic wastes mixed with bitumen and aggregates are used for the better performance of the roads. The polymer coated on aggregates reduces the voids and moisture absorption. This results in the reduction of ruts and there is no pothole formation. The plastic pavement can withstand heavy traffic and are durable than flexible pavement. The use of plastic mix will reduce the bitumen content by 10% and increases the strength and performance of the road.

## **REFERENCES**

1. [https://www.business-standard.com/article/pti-stories/15-342-tn-plastic-waste-generated-in-india-everyday-dave-116080200866\\_1.html](https://www.business-standard.com/article/pti-stories/15-342-tn-plastic-waste-generated-in-india-everyday-dave-116080200866_1.html)
2. <https://www.explainthatstuff.com/plastics.html>
3. [http://en.termwiki.com/EN/bituminous\\_pavement](http://en.termwiki.com/EN/bituminous_pavement)
4. Use of Biomedical Plastic Waste in Bituminous Road Construction: Bhageerathy K. P, Anu P. Alex, Manju V. S, Raji A. K; International Journal of Engineering and Advanced Technology (2014)
5. Use of Biomedical Plastic Waste in Bituminous Road Construction: Tina Maria Sunny, Assistant Professor, Department of Civil Engineering, SCMS School of Engineering and Technology, Karukkuty, Kerala (2018)
6. Plastic asphalt paving material and method of making same: Gary M. Fishback, Dennis M. Egan, Hilary Stelmar (1995)
7. Review Paper on Bituminous Concrete Mixed Design for Road Construction: Rabindranath Ghosh, Upvan Kumar, Shubham Gupta, Vivek Kumar, Azharuddin Malik (2017)
8. Use of plastic waste in flexible pavement construction: G.H V SaiSimha, Lalit Kumar ;Amity University, Haryana, India (2017)
9. Recycling plastics waste for highway and earthworks construction: Modzel Wilhelm Dipl-Ing (1993)
10. Use of Plastic Waste in Road Construction: Shweta N. Rokdey, P. L. Naktode, M.R. Nikhar (2015)