

# Use of Plastic Waste and Titanium Dioxide in Bitumen Pavement

Patil Sanket<sup>1</sup>, Bagwe Kaustubh<sup>2</sup>, Biradar Sumeet<sup>3</sup> and Nitore Pranay<sup>4</sup> Mr. Jitendra Kachare<sup>5</sup>

<sup>1,2,3,4</sup>Shree L.R Tiwari College of Engineering

Mentor, professor at Shree L.R Tiwari College of Engineering

**Abstract**— The disposal of waste plastic poses a significant environmental threat, contributing to both pollution and climate change. Bituminous mixes gain strength and improved properties when plastic waste is used in them. Additionally, it will provide a solution to the problem of disposing of plastic and various pavement flaws, such as, ruts, corrugations, potholes etc. Polyethylene, polystyrene, and polypropylene are the types of waste plastic utilized. The shredded waste plastic is coated with aggregate, mixed with hot bitumen, and used to construct pavement. The pavement's durability and strength will both increase as a result of this. As a material for absorbing smoke, the titanium dioxide will absorb the vehicle's smoke. The hot, humid climate of India will benefit greatly from this innovative technology. It is cost-effective and environment friendly. We have talked about the design of pavement, and the process of flexible plastic pavement and plastic-smoke-absorbing pavement in this paper.

**Index Terms**— Flexible Pavement, Plastic Waste, Titanium dioxide, Eco-Friendly.

## I. INTRODUCTION

The removal of used plastic from the environment poses the greatest threat. The most significant issue on a highway are the corrugations and potholes. Plastic asphalt will be an improved answer for the above expressed issues. Plastic is a material that can be shaped by its flow and contains one or more organic polymers with a high molecular weight. In its finished state & Plastic is extremely durable and degrades very slowly. And further more plastic has a high impervious to debasement. Thermoses and thermoplastics are the two main types of plastic. Because they solidify irreversibly when heated, thermosets have high durability and strength, making them ideal for construction applications. Plastic is a waste that cannot be recycled and contributes to global warming and the greenhouse effect. Various experiments have been

conducted to determine whether waste plastic can be effectively reused. When waste plastic is added to hot aggregates, it forms a fine coating of plastic over the aggregate, according to various studies. When these aggregates are mixed with binder, they are found to have greater strength, resistance, and performance over time. Alongside bitumen, utilize squander plastic expands its life and perfection. It is cheap and good for the environment. Plastic shrinkage and drying shrinkage are both reduced when waste plastic is used in pavement construction. The asphalt pavement's abrasion and slip resistance are enhanced when waste plastic is utilised. In India, as a result of hot and very sticky environment, plastic asphalts of most prominent benefit.

Titanium di-oxide can use in surface course of pavement in order absorb the smoke from the vehicles. It also enhances the properties of the plastic, resulting in higher strength and high resistance.

## II. PROBLEM STATEMENT

The rate of plastic waste and air pollution has increased due to the urbanization, Industrialization, development activities, change in lifestyle & vehicle emission etc. As plastics non-biodegradable, it remains in environment for numerous years and disposing plastic wastes at land fill are unsafe since toxic chemicals percolate out in to the earth, and under-groundwater and pollute the water bodies. On other hand the traffic is growing with time. Due vehicular pollution which emitted the greenhouse poisonous gases in the atmosphere, which will causing damage to the ozone layer and effects on humans & other living creatures on the earth. At current the removal of waste plastic has turned into a significant squander the board issue on the planet. As a result, efforts have been made in this investigation to

determine whether waste plastic could be used in civil engineering projects. In present review the point is to explore the ideal utilization of waste plastic and titanium dioxide is use in bitumen for street flexible pavement.

### III. OBJECTIVE

The primary objective of this study is to make productive use of discarded plastic & smoke absorb material in a way that makes it beneficial to society.

- The main objective of our project is to make Environment “Green”.
- To design the flexible Pavement.
- To coat the aggregate with plastic and incorporate titanium di-oxide.
- To prepare a statistical model for the optimum utilization of plastic waste.
- To increasing the various mechanical properties of road materials.

### IV. SCOPE OF THE PROJECT

- To Protect our environment from Greenhouse gases & Air Pollution.
- To eradicate the potholes.
- It is more suitable in highly industrialised regions.
- To improve Life span of the flexible pavement.

### V. LITERATURE REVIEW

Dr. R. Vasudevan, (2007) – His states that the polymer-bitumen blend is a superior binder to plain bitumen. Blend has gives suitable ductility, a higher softening point and lower penetration value.

Amit Gawande (2012) -- This review intended to find the effective ways to reutilize the hard plastic waste particles as bitumen modifier for flexible pavements is about 5-10 % by weight of bitumen. Which is helps in substantially improving the Marshall stability, strength, fatigue life and other desirable properties of bituminous.

Sunil J. Kulkarni (2015) -- The Minimize of plastic waste material is important aspect of the modern growth and development initiatives. Use of plastic bags and bottles is very common. The disposal of plastic waste is major problem due to non-biodegradable nature of plastic. The plastic can be used as feedstock for ethanol like products. It can be

used for road construction and other construction related activities.

R. Manju Anand & Sathya. S (2017) – This review intended to improved road performance, the plastic is mixed with bitumen and aggregates. Plastic pavement is more durable than flexible pavement and can withstand heavy traffic. The utilization of plastic blend in bitumen will decrease the bitumen content by 10% and expands the strength and performance of the street. This new technology is eco-friendly. The current review summarizes the research on use of waste plastic.

### VI. EXPERIMENTAL PROGRAMME

#### VI.I Material & Its Physical Properties

Bitumen – The Present study used the VG-30 Penetration grade bitumen. Table 1 shows the test results and permissible limits of the tests carried out to check the physical properties of bitumen.

Table 1. Physical Properties of Bitumen.

Designation of Bitumen	Test Result	Permissible Limit	Test Method
Penetration Test	43.67mm	45 mm	IS:1203-1978
Softening Point Test	45.5 <sup>o</sup> C	47 <sup>o</sup> C	IS:1205-1978
Ductility Test		100	IS:1208-1978

Aggregate – In Present Study used the Aggregate size 20mm, 10mm, 4.75mm and stone dust etc.

Table 2. Aggregate Test results.

Designation of Aggregate	Test Result	Permissible Limit	Test Method
Impact Value Test	24.7%	≤30%	IS:2386 Part IV
Crushing Value Test	25.2%	≤30%	IS:2386 Part IV
Abrasion Test	21.4%	≤30%	IS:2386-Part IV

Plastic waste – In study used the plastic waste as thermoplastics like polyethylene, polypropylene, polystyrene, polyvinyl chloride, and polytetrafluoroethylene etc. Waste plastic is one of the materials that, when softened, improves its ability to bind. Because of this, softened plastic can be used as a good binder in bitumen.

- The used plastic waste in bitumen is about 15% of bitumen content according to test we conduct in marshall stability.
- The plastic waste will adjust to the size passing 2.36 mm sifter and held on 600 micron sieve.
- The quantity of dust and other impurities must not exceed 1%.

Titanium Di-Oxide – Properties of titanium dioxide are

Brilliant

Brilliance, colour strength, opacity and pearlescence unlike any other substances.

Resistant

Stability to heat, light and weathering prevents degradation of paint, in films and embrittlement of plastics.

Protective

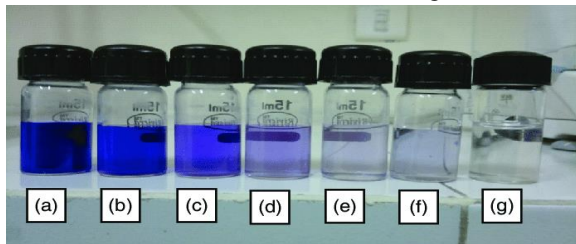
Ability to scatter and absorb UV radiation makes TiO<sub>2</sub> a crucial ingredient for sunscreen, protecting the skin from harmful, cancer-causing UV rays.

Powerful

Is used as a photocatalyst in solar panels as well as reducing pollutants in the air.

**Test perform on titanium dioxide :-**

- Name :- Methylene blue degradation of titanium dioxide .
- Process :-
- Cut the bitumen pavement top layer in any shape where you have apply the titanium dioxide .
- Then prepare the methylene blue solution .
- Insert the cut bitumen pavement in methylene blue solution .
- Then apply uv light rays with help of uv machine .
- Then keep it in for 2 hours to degrade the titanium dioxide .
- According to pollution gases it has absorb the solution blue colour will start fading .



a) 0% b) 15% c) 25% d) 35% e) 45% f) 55% g) 65%

IMAGE REFER FORM RESEARCH GATE WEBSITE

- According to the degradation of colour we will get reading that how much % of pollution gases has absorb by titanium dioxide pavement .

VI.II Procedure of Design Mix

Mixing by Mini Hot Mix Plant :

Step 1: Plastic waste of PE, PP and PS cut to size 600 micron & 2.36mm by using shredding machine.

Step 2: Similarly, the bitumen must be heated to 160 degrees Celsius to ensure proper bonding and prevent proper binding. (temperature control is very important)

Step 3: Add the shredded plastic waste to the hot aggregate in the mixing chamber. The aggregate is uniformly coated in 30 Secs, resulting in a greasy looking plastic coated aggregate obtained.

Step 4: Approximately 10 % of the bitumen material will be added to the pavement surface with smoke absorbing materials (titanium di-oxide).

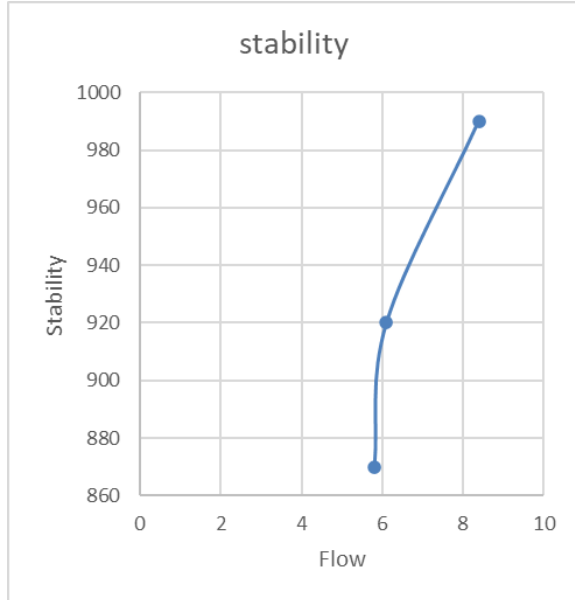
Step 5: Hot bitumen is then added to the plastic-coated aggregate and the resulting mixture is used to make roads. Road temperature ranges from 110°C to 120°C. The roller used has a capacity of 8 tons.

VII. MARSHALL STABILITY TEST

Marshall stability is the maximum load that must be applied to cause a test specimen to fail when it is preheated to a specified temperature, placed in a special test head, and subjected to a constant strain of 5 cm per minute. While the steadiness test is in progress dial check is utilized to gauge the upward distortion of the example. The Marshall Flow value of the specimen is the deformation at the failure point expressed in units of 0.25 mm. To determine how plastic replacement affects the mix of bitumen's Marshall properties, plastic content of 10%, 15% and 20% is added. Thus taking optimum reading into consideration and varying % of Plastic in Bitumen the results are as follows:

Sr.No	1	2	3
Bitumen Content	84 gm	84 gm	84 gm
Plastic Content	8.4	12.6	16.8
Stability (Kg)	870	920	990
Avg. Stability (Kg)	926	926	926
Flow Value (mm)	5.8	6.10	8.4
Avg. Flow Value (mm)	6.76	6.76	6.76

After doing test by replacing bitumen by 10%, 15%, 20% we able to know that replacing 15% of plastic will increase stability as well flow value is under 8. 20% has more stability but flow value is exceeding 8 so we cannot use 20%. Therefore we are using 15% plastic.



Graph of marshall stability.

### VIII. CONCLUSION

Hence we conclude that plastic mixed with bitumen and aggregates is used for the better performance of the roads. The plastic coated on aggregates reduces the voids and moisture absorption.

This can results in the reduction of ruts and there is no pothole formation. The plastic pavement has ability to carry heavy traffic and are durable than normal flexible pavement. The use of plastic mix will reduce the bitumen content by 15% according to the test we conducts and increases the strength and performance of the road. This new technology is eco-friendly.

The use of smoke absorbent material (titanium dioxide) by 10% of bitumen content can reduce the vehicular pollution. And by using both of plastic and titanium dioxide we can make the pavement with more strength and durability as well as pollution killing eco friendly modified pavement.

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