

# Experimental Study of Composite Flexible Pavement Using Waste Plastics And Tyres

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**Abstract**— Our project deals with the details and successful application of non –biodegradable waste such as waste plastic and waste tyre in pavement design. The low density waste plastics(LDP) such as poly-ethylene(PE) and poly-styrene(PS) mainly small plastic cups and plastic covers below 60 micron. This is used to modify the bitumen(plastic modified bitumen). This will helps to increase the marshall stability value, binding property, resistance towards friction and abrasion. The mix proportion is designed by conducting marshall stability test.

The waste tyres which is non-bio degradable is can be used to replace a partial percentage of aggregate it will alter the properties. The waste tyres chopped and cutted below 12.5 mm and it is used.The main aim of the project is to find the suitable mix design ratio for utilization of solid wastes in road construction and solid waste management and it will increases the strength and durability of the road.

**Keywords**—poly-ethylene,poly-strene,plastic modified bitumen, marshall stability

## I. INTRODUCTION

Steel Waste plastic contribute major part of the solid waste. The waste plastic disposal of india is about 14 ton per day. These non-bio degradable have great environmental impact. The dispose of the solid waste causes various environmental problems.The disposal rate is increasing year by year at a great percentage.

Concern over the effective utilization of this solid wastes is still a problem. This solid waste is can be utilized in various field of engineering mainly in construction field. This solid wastes can be utilized in road construction and also in

building construction as a modifier and as a replacing for normal conventional materials.

In road construction field the solid wastes is can be used to modify the properties of bitumen which will increase various characteristics properties of the bitumen. It can be used for replacing the aggregate also. The utilization of the solid waste in road construction not only increases the properties of the road pavement but also it's a effective disposal method to reduce the amount of the waste plastic and tyres.

## II.PROPERTIES OF MATERIALS

### 1.Bitumen

Bitumen is a non-crystalline viscous material, black or dark brown, which is substantially soluble in carbon disulphide (CS<sub>2</sub>), possessing adhesive and water-proofing qualities. It consists essentially of hydrocarbons and would typically comprise at least 80% carbon and15% hydrogen, the remainder being oxygen.

Physical properties:

Bitumen's main property is that of a very strong and durable adhesive that binds together a very wide variety of other materials without affecting their properties.

Its durability is essential to major engineering projects such as roads and waterways where it must do its job for 20years or more.

Bitumen is insoluble in water but is soluble in numerous organic solvents. As it is highly waterproof, it can act as an effective sealant

It also resists action by most acids, alkalis and salts.

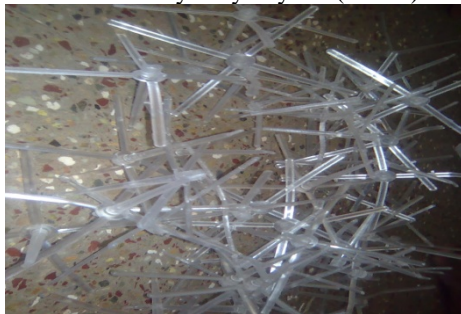
It does not contaminate water so it can be used to line watercourses

It is a thermoplastic material: it softens and becomes liquid with the application of heat and hardens as it cools. Bitumen can be spread.

2.Types and characteristics property of waste plastics and tyres



Low Density Polyethylene(LDPE)



Polystyrene(PE)

Types:

- ✓ Films ( Carry Bags, Cups) thickness up to 60micron (PE, and PS)
- ✓ Hard foams (PS) any thickness
- ✓ Soft Foams (PE ) any thickness.
- ✓ Laminated Plastics thickness up to 60 micron (Aluminum coated also) packing materials used for biscuits, chocolates, etc.,

Properties:

Binding Property:

The plastic materials have good binding property which is proofs better toward the bitumen.

Resistance towards water absorption:

The plastics have a negative tendency towards the water absorption. So plastic modified bitumen shows repulsive tendency towards water.

Tyres:



Chopped tyres

Properties of waste tyre:

- 1.Resistance towards abrasion
- 2.Negative tendency towards water absorption
- 3.Good stress absorption mechanism
- 4.Better strength reliability and durability

Chemical Properties:

The main properties of crumb tyres are.,

SL.NO	PROPERTIES	CRUMB
1	Loose density (Kg/m <sup>3</sup> )	295-330
2	Compacted density (Kg/m <sup>3</sup> )	360-470
3	Absorption values (%)	1.6-2.3
4	Specific gravity	1.15
5	Activity	NON-REACTIVE
6	Intrnal friction angle (°)	15-23
7	Cohesion values (Kpa)	3.2-11.3
8	Permeability (cm/sec)	1.5-12
9	Heating value (KJ/Kg)	28,000-35,000

III.PRELIMINARY TEST ON MATERIALS

A. Testing of bitumen

1. Penetration test

It measures the hardness or softness of bitumen by measuring the depth in tenths of a millimeter to which a standard loaded needle will penetrate vertically.

Result: The penetration value increases with the increase in the plastic content. The penetration value gradually decreases from 68 to 58. It shows the increases of the hardness of the modified bitumen and it is good for the road.

2.Ductility test

Ductility is the property of bitumen that permits it to undergo great deformation or elongation.

Ductility is defined as the distance in cm, to which a standard sample or briquette of the material will be elongated without breaking.

Result: The ductility value decreases with the increase in the plastic content. The elongation ability of the bitumen reduces with increase in the plastic content. There is a rapid decrease in the elongation from plastic content 3 to 9.

### 3. Flash point test

At high temperatures depending upon the grades of bitumen materials leave out volatiles. And these volatiles catch fire which is very hazardous and therefore it is essential to qualify this temperature for each bitumen grade. BIS defined the flash point as the temperature at which the vapour of bitumen momentarily catches fire in the form of flash under specified test conditions.

Result: The bitumen shows flash point value 235°C but the plastic content increases the flash point value also increase. 6 to 9 percentage plastic content shows an increase up to 260°C from the 235°C. The bitumen with high softening point is good for Indian hot climatic condition.

### B. Testing of Aggregate

#### 1. Los angles abrasion test

It is used to find the hardness or abrasion value of the aggregate with the help of los angles abrasion value machine.

Result: The abrasion value is 37.8% the maximum permissible limit of the abrasion value is 40% according to the IS standard. So this aggregate is suitable for road construction.

#### 2. Impact test

It is used to evaluate the toughness of the aggregate to resist under various impact during traffic loading.

Result: The aggregate impact value is 26.25 ( the maximum limit is 30% according to IS specification). So the aggregate is suitable for road construction.

#### 3. Flankiness index test

It is used to find the flankiness index of the given sample. It is considerable importance in the gradation requirements of various types of mixes in bitumen road.

Result: The flankiness index value of the given sample is 14.31%. The maximum limit is 15%. So the grading of the aggregate is good. So it can be used for road construction.

#### 4. Elongation index test

It is used to find the elongation index of the given aggregate sample.

Result: The elongation index for the test sample is 14.42% ( As per as IS specification the maximum is 15%). So the grading is suitable for road construction

## IV Marshall Mix Design

It is used to determine the stability, flow value, air voids, voids in mineral aggregate, voids filled with bitumen. The Marshall stability and flow test provides the performance prediction measure for the Marshall mix design method. The stability portion of the test measures the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute. Load is applied to the specimen till failure, and the maximum load is designated as stability. During the loading, an attached dial gauge measures the specimen's plastic flow (deformation) due to the loading. The flow value is recorded in 0.25 mm (0.01 inch) increments at the same time when the maximum load is recorded. The important steps involved in Marshall mix design are summarized next.

Preparation of mix:

1. Air voids
2. Bitumen
3. Fillers
4. Fine aggregate
5. coarse aggregate

Method of Mixing:

The plastic can be mixed by the two process for the bitumen mix process of the flexible pavement

Dry Process,  
Wet Process.

Dry Process:

For the flexible pavement the molten plastic is mixed with hot aggregate at 170°C. In dry process plastics are used to modify the properties of aggregate such as abrasion, crushing and impact value.

Wet Process:

In wet process the waste plastic is mixed with bitumen to form plastic modified bitumen. This will alter the properties of bitumen such as penetration, ductility, softening point, flash point and fire point. In this waste plastic and bitumen are treated together at a temperature of 170°C and it is then treated with hot aggregate.

## V RESULTS AND DISCUSSION

The 9% plastic content shows increase in Marshall stability, increase in voids filled with bitumen up to 67.81% and reduction in voids in minerals up to 15.63 both these values show good binding and reduce the chance of bitumen displacement. The air void ratio also reduce due to increase in plastic content.

The penetration value also reduced to 58 at 9% plastic content it shows an increase in strength of the bitumen. At 9% of plastic the softening point is 550 and higher softening point is good for road in hotter region. The flash point and fire point also increases up to 260 and ductility value is 54.

Results by various test conducted the 9% plastic content shows better results so 9% plastic used for modified bitumen .

The chopped tyre below 12.5mm is used up to 3% of the total aggregate weight due its temperature limitation. In colder areas the usage can be increased.

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