



## A New Advancement in Road Construction: Application of Plastic Waste in Bituminous Pavement

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**Abstract:** Plastics are non-biodegradable substances and toxic in nature which creates health hazard. Also result in pollution and global warming. So, plastic waste should be reused to reduce the imminence to the environment. As we know that India is located latitudinally in the northern hemisphere and longitudinally in eastern hemisphere that's why sunlight reaches here for maximum duration which causes softening of bitumen, to reduce this effect we can use plastic waste with bitumen in road construction to increase its softening point and reduce chances of bleeding. By using shredded plastic with bitumen, can enhance the durability and strength of road. Ordinary mix don't provide such strength and durability to road. It can also reduce road fatigue. This ingenious technology is economical as well as eco-friendly.

**Keywords:** Plastic Waste, Aggregates, Strength, Bitumen, Road Construction.

### I. INTRODUCTION

Nowadays, plastic production is increasing in worldwide which become a major threat for our environment. It is a non-degradable substance which responsible for global warming, greenhouse effect, etc. Burning of plastic produces hazardous air pollutant which are responsible for sever health problems. In ocean, jellyfishes & sea turtle, mistake plastic bags and balloon ribbons for jelly medusa. Grazing and scavenging animals like as cows, seagulls, dogs, and camels, often devour plastic that has been infected with human food. Due to improper management of plastic waste, it also become a biggest threat to drainage system.

According to a September 2017 report by the Central Pollution Control Board (CPCB), 25,940 tons of plastic waste is generated per day by India. Plastic has been grouped into two main polymer families i.e. thermoplastic (which soften on heating and harden again on cooling) and thermosets (which never soften once moulded). Thermoplastic constitute about 94%, such as PET (Polyethylene Terephthalate) & PVC (Polyvinyl chloride), which can be recycled. And the remaining 6% belongs to the thermosets and other categories of plastics (Sheet moulding compound, fibre reinforced plastic, multilayer thermocol, etc.) which are non-recyclable.

**Estimated plastic waste generation is 33,60,043 Tons/Annum during the year 2018-19:**

Fig. 1. shows the State and UT – wise plastic waste generation (Tons/Annum) across the country.

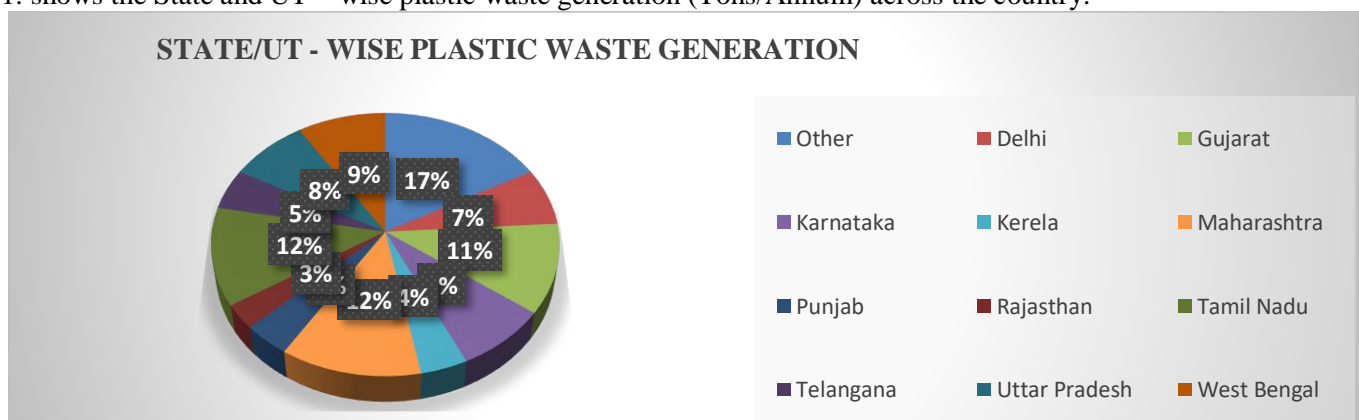


Fig. 1: State/UT wise Plastic waste generation

Table 1: Plastic consumption in Bihar.

S. No.	Year	Consumption
1	2018-2019	68903.328 tons
2	2017-2018	2280.000 metric tons
3	2016-2017	2280.000 tons

Some steps should be taken to control the harm of plastic waste. Use of plastic waste with bitumen are already in practice and many studies represents that the mixing of plastic waste with bitumen can increase lifespan of pavement, improve the smoothness and can increase the resistance as well as contact friction between tyres of vehicle and pavement get improved. Use of plastic waste with bitumen can save millions of rupees, conserve nature and further improve the quality of road pavement.

## II. LITERATURE REVIEW

Generation of plastic waste is the most dissipated developing wastes streams & estimated from the rate of expansion is increasing every year. One of the best solutions to this problem is to reuse this waste into roadways construction.

**R. Manju et al. (2017)** concluded that when polymer is coated on aggregates it reduces the void and moisture absorption. This result in reduction of ruts and there is not pothole formation. The use plastic mix will reduce the bitumen content by 10% and increase the strength and performance of the road. The use of smoke absorbent material (titanium dioxide) by 10% of polymer content can reduce the vehicular pollution.

**Mr. Mahesh M. Barad et al. (2015)** concluded that if higher percentage of polymer bitumen mix is used, the mix is a more polymer dispersion in bitumen, which get separated on cooling. This may affect the road laid using such mix. In the modified process plastic waste is coated over aggregates which helps to have better binding of bitumen with the plastic waste coated aggregated due to increase area of contact between polymer & bitumen.

**Huda Shafiq & Anzar Hamid et al. (2016)** concluded that plastic roads will be most feasible for a country like India where temperature is around 50°C and the heavy monsoon to create havoc, leaving the road with potholes & ruts. It is hoped that in near future we will have strong durable & eco-friendly roads that will relieve the earth from all type of plastic waste.

**Sunil J. Kulkarni et al. (2015)** concluded that minimization of waste material is important aspect of the modern growth & development initiative. Plastic is used in various domestic & industrial application. Use of plastic bag and bottle is very common. The disposal of plastic waste is the main problem because of its non-biodegradable nature. The plastic may be used as feedstock for ethanol like products. It can be used for road construction and other construction related activities.

**Rishi Singh Chhabra et al. (2014)** concluded that in the highway infrastructure large number of originates material and technologies have been invented to know their suitability for the design, construction and maintenance of these pavement. Plastic and rubber are one of them which is also considering the environmental approach, due to abundant use of polythene in day-to-day business, the pollution to the environment is enormous. The use of plastic material such as carry bags, cups, etc. is increasing linearly in day-to-day. Since the polythene are not bio-degradable, the need of the current hour is to use the waste polythene in some beneficial purpose. The use of these materials as a road construction proves eco-friendly, economical & gives strength in the sub-base course of the pavement.

**Amit Gawande et al. (2012)** concluded that the quantum of plastic waste in municipal solid waste (MSW) is increasing due to increase in population, urbanization, development activities and changes in life style which leading widespread littering on the landscape. Disposal of waste plastic is hazardous and become a major problem globally due to their non-biodegradable nature and un aesthetic view. Since these are not disposed scientifically & possibility to create ground and water pollution. This waste plastic is partially used to replace the conventional material to improve desired mechanical characteristics for particular road mix. In conventional road making process bitumen is used as binder. Such bitumen can be modified by mixing with waste plastic pieces and this modified mixture can be used as a top layer coat of flexible pavement. This modified mix show better binding property, stability, density and more resistant to water.

## III. MATERIALS & TESTS

Material used:

- A. Aggregate
- B. Bitumen
- C. Plastic Waste

### A. Aggregate:

Aggregates are the important material in construction of pavement. It transfers load to the subgrade soil. It also bear stresses which occurs due to traffic on roads. Shape of aggregates, adhesive with bitumen, durability, toughness, hardness and strength are some desirable properties of road aggregates.

Some of the test conducted on aggregates are Crushing Test, Impact Test, Los Angeles Test, flakiness and Elongation Index.

Table 2: Result of the tests performed on aggregates.

<i>S. No.</i>	<i>Test</i>	<i>Property Determined</i>	<i>Result</i>
1	Impact Test	Toughness	11.213%
2	Crushing Test	Crushing Strength	19.8%
3	Los Angeles Test	Abrasion	24.2%
4	Shape Test	Flakiness Index	12.7%
5	Shape Test	Elongation Index	10.3%

**B. Bitumen:**

Bitumen is a dense, highly viscous and petroleum based hydrocarbon found in deposits such as oil sands and pitches lakes or is obtained as a residue of the distillation of crude oil. It is black or brown in colour and obtained in solid or semi-solid state. Desirable properties of bitumen depend on the type of mixing and the construction.

Some of tests conducted on bitumen are Softening Point Test, Penetration Test, Flash & Fire Test, Ductility Test, etc.

Table 3: Result of the tests performed on bitumen.

<i>S. No.</i>	<i>Test</i>	<i>Result</i>
1	Penetration Test (mm)	76 mm
2	Softening Point Test (°C)	47° C
3	Ductility Test (mm)	65 mm

**C. Plastic Waste:**

Plastic waste should be collected first and then cleaned and dried. After that it will be shredded in shredding machine of sizes between 2.36mm to 4.75mm. Agglomerator is used for shredding. Aggregates are heated to around 170°C and shredded plastic wastes are added over it with constant mixing. Plastic gets softened and coated over aggregate. Different percentage of plastic coating is used.

The hot plastic waste coated aggregates are mixed with hot bitumen 60/70 or 80/100 grade (160°C).

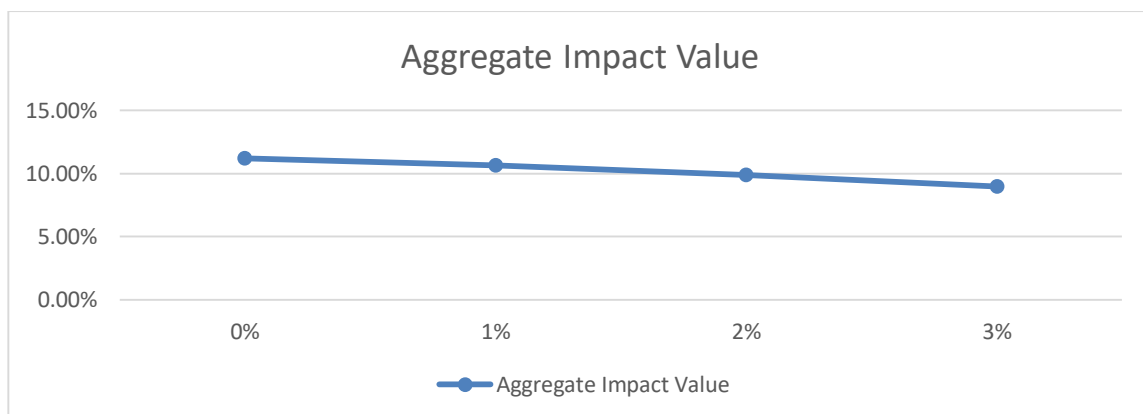
Polymer coating helps in better binding of bitumen with plastic waste coated aggregate as bonding area of contact between polymer and bitumen increases. Voids also get reduced. This prevents the absorption of moisture and oxidation of bitumen by entrapped air. Due to which rutting and raveling gets reduced and there is no potholes formation. Durability of road increases.

Tests which were performed on the coated aggregates are in the following ways:

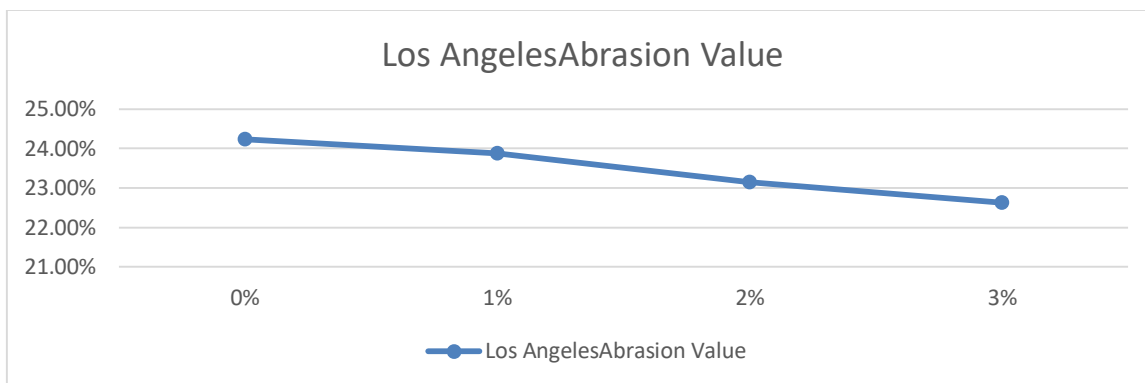
- i. Impact test
- ii. Los Angeles abrasion test

Table 4: Result of test performed on aggregates coated with plastic.

<i>S. No.</i>	<i>Percentage of Plastic (%)</i>	<i>Aggregate Impact Value</i>	<i>Los Angeles Abrasion Value</i>
1	0	11.21%	24.23%
2	1	10.63%	23.87%
3	2	9.87%	23.14%
4	3	8.96%	22.62%



Graph 1: Variation in aggregate impact value with increase in percentage of plastic.



Graph 2: Variation in Los Angeles abrasion value with increase in percentage of plastic.



Fig. 2: Los Angeles Abrasion Test.

Tests which were performed on the polymer modified bitumen:

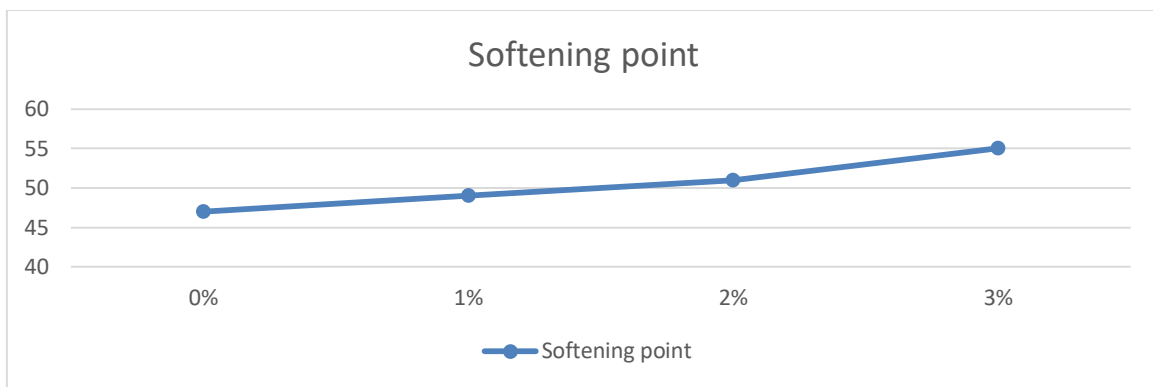
- i. Softening point test
- ii. Penetration test



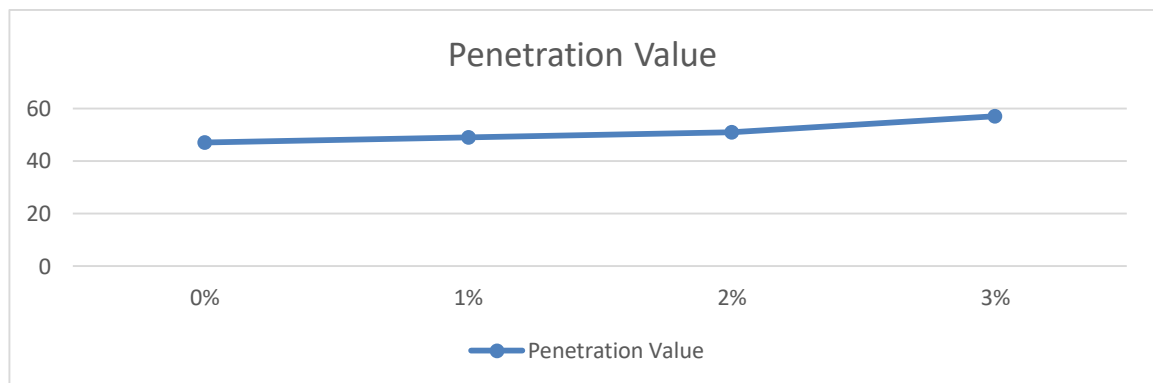
Fig. 3: Softening point test apparatus

Table 5: Results of the tests conducted on bitumen modified with different percentage of plastic.

S. No.	Percentage of Bitumen (%)	Percentage of Plastic (%)	Softening Point (°C)	Penetration value (mm)
1	100	0	47	76
2	99	1	49	68
3	98	2	51	60
4	97	3	55	57



Graph 3: Variation in softening point of bitumen with increase in percentage of plastic.



Graph 4: Variation in penetration value of bitumen with increase in percentage of plastic.

From above graph we can say that impact and abrasion value decreases after coating aggregates with plastic which means plastic coated aggregates are tougher or more impact resistant. Penetration value is decreased and softening point is increased when some percentage of plastic is replaced with bitumen. Hence, chances of bitumen to bleed and rate of rutting decreases.

#### IV. CONCLUSION

Plastic has become an important part of our livelihood. That is why plastic waste is also increasing day by day. Biggest disadvantage is that it can't be decomposed. We can use plastic waste in construction of road as it increases the strength and will help in disposal of plastic wastes.

In highways, potholes and corrugation becomes a major issue for us while driving vehicles. Although these potholes are responsible for major accidents sometimes. Only use of bitumen in construction of road can increase the chances of bleeding at higher temperature and cracks develop at lower temperature. To overcome from these problems, plastic waste can be mix with bitumen in some fixed ratio for road construction.

#### V. TEST REFERECES

Table 6: Test preferences performed on aggregate.

<i>S. No.</i>	<i>Test</i>	<i>Reference Code</i>
1	Impact Test	IS 2386 (Part IV) - 1963
2	Los Angeles Test	IS 2386 (Part IV) - 1963
3	Shape Test	IS 2386 (Part 1) - 1963

Table 7: Test preferences performed on bitumen

<i>S. No.</i>	<i>Test</i>	<i>Reference Code</i>
1	Penetration Test	IS 1203-1978
2	Softening Point Test	IS 1205-1978

## VI. REFERENCE

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