

# An Overview of Plastic Waste in Bituminous Pavement

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**Abstract**— The waste plastic and its disposal are a major threat to the environment, which results in the pollution and global warming. The utilization of plastic waste in bituminous mixes enhances its properties and its strength. In addition, it'll even be an answer to plastic disposal defects in pavement viz., pot holes, corrugation, ruts, etc. the waste plastic used are poly-ethylene, poly-propylene. The waste plastic is shredded & coated over combination ed with hot hydrocarbon and resulted mix is employed for pavement construction. This will not only strengthen the pavement and also increase its durability. The titanium-dioxide is used as a smoke absorbent material, which will absorb the smoke from vehicles. This innovative technology is going to be boon for Indian hot-humid climate. It's economical and eco-friendly. In this paper, we have discussed about the soil properties to be considered in design of pavement, pavement style, method of construction versatile and plastic-smoke absorbent pavement.

**Keywords:** Asphaltting, Bitumen, Non-Biodegradable, Plastic Waste, Flexible Pavement, Strength, Eradication of Pot Holes

## ABBREVIATIONS

- 1) CPCB: Central Pollution Control Board.
- 2) LDPE: low density polyethylene.
- 3) MSV: Marshall Stability.
- 4) PCA: Polymer-Coated Aggregate/ Plastic Coated Aggregate.
- 5) PE: Poly Ethylene.
- 6) PMB: Polymer modified Bitumen.
- 7) PP: Poly Propylene.
- 8) PS: Poly Styrene.

## I. INTRODUCTION

The major threat to the setting is that the disposal of waste plastic. In a highway, the potholes and corrugation are the major problem<sup>9</sup>. Plastic pavement is going to be a far better resolution to the on top of declared issues. A material that contain one or additional organic compound of huge relative molecular mass, solid in its finished state, can be shaped by its flow is called as "plastic". The durability of plastic is high, and it degrades terribly slowly. And plastic has high resistant to degradation. Plastic can be divided into two major categories- thermoses & thermoplastics<sup>2,3</sup>. Thermostats have high sturdiness and strength as a result of it solidifies irreversibly when heated, henceforth can be used primarily in construction application. Plastic is a non-degradable waste, causes greenhouse effect and global warming. The various experiments are allotted whether the waste plastic will be reused productively. The various literature indicated that the waste plastic once additional to hot aggregates can form a fine coat of plastic over the mixture and such aggregates once mixed with binder is found to own higher strength, higher resistance and better performance over a period of time. Along with hydrocarbon use waste plastic will increase its life and smoothness. It is

economical and eco-friendly. In addition of plastic waste in construction of pavements reduces the plastic shrinkage and drying shrinkage. The use of waste plastic can improve the abrasion & slip resistance of asphalt pavement<sup>4</sup>. In India, as a result of hot and intensely wet climate, plastic pavements of greatest advantage. In order absorb the smoke from the vehicles; titanium di-oxide can be used. It also enhances the mechanical properties of the plastic, resulting in higher strength and high resistance.

## II. OBJECTIVE

The objectives of this project are:

- To carry out the soil test.
- To design the flexible pavement
- To design the asphalt pavement with fine aggregate plastic bitumen mix
- To coat the aggregate with plastic and incorporate titanium di-oxide.
- To test the bitumen and the modified bitumen.

## III. SCOPE OF THE PROJECT

- To eradicate potholes
- To minimize the global warming, greenhouse gases and pollution.
- The lifespan of the roads can be increased.
- Eco-friendly in nature.

### A. *Plastics Roads - General Introduction*

Plastic use in road construction is not new. It is already in use as PVC or HDPE pipe mat crossings built by cabling along PVC or HDPE (high-density poly-ethylene) pipes to make plastic mats. The plastic roads embody transition mats to ease the passage of tyros up to and down from the crossing. Both options facilitate defend land haul roads from rutting by distributing the load across the surface. But the use of plastic-waste has been a concern for scientists and engineers for a quite long time<sup>6</sup>. Recent studies in this direction have shown some hope in terms exploitation plastic-waste in construction i.e., Plastic roads. A team of engineers from R. V. College of Engineering, Bangalore, have developed the way of mistreatment plastic waste for building. An initial study was conducted in 1997 by the team to check for strength and durability. Plastic roads principally use plastic carry-bags, disposable cups and PET bottles that are collected from garbage dumps as a vital ingredient of the development material. When mixed with hot bitumen, plastics soften to make associate in nursing oily coat over the mixture and therefore the mixture is arranged on the paved surface sort of a normal tar road.

#### 1) *Advantages*

- Reduce the need of bitumen by around 15%.
- Develop a technology which is eco-friendly.
- Improvements in fatigue life of roads.
- Increase the strength and better performance of the road.

- Use higher percentage of plastic waste.
  - The gases released during traffic conditions are absorbed by smoke absorbent.
- 2) *Disadvantages*
- Toxic present in the co-mingled plastic wastes would start leaching.
  - But the presence of chlorine will release HCL gas.

#### IV. LITERATURE REVIEW

Dr.R.Vasudevan - stated that the polymer bitumen bent in-to a better binder compared to plain bitumen. Blend has increased softening point and decreased Penetration value with a suitable ductility<sup>7</sup>.

Zahra Niloofar Kalantar - Many researches on PMA mixture have been conducted for the past two decades. In addition of new polymers to asphalt for the aim of enhancing the properties of asphalt over a decent temperature purpose in paving applications was contemplated quite it slow ago, recycled chemical compound value-added to asphalt have conjointly shown virtually a similar end it up the road pavement performance as compared to virgin polymers. This paper could be a review of the employment of polymers in asphalt pavement. In this study, a review article on the history and advantages of mistreatment waste and virgin compound in asphalt is bestowed followed by a review of general studies on using polymers in asphalt so as to enhance properties of pavement.

Amit Gawande - 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. Thus, disposal of waste plastic could be a menace and become a significant drawback globally because of their non-biodegradability and world organization aesthetic read. Since these are not disposed scientifically & possibility to create ground and water pollution. This waste plastic part replaced the standard material to enhance desired mechanical characteristics for explicit road combine. In standard road creating method for bitumen is employed as binder. Such bitumen is often changed with waste plastic item and bitumen combine is formed which may be used as a high layer coat of versatile pavement<sup>11</sup>. This waste plastic changed bitumen combine show higher binding property, stability, density and additional proof against water.

Sunil J. Kulkarni - Minimization of waste material is important aspect of the modern growth and development initiatives<sup>4</sup>. Plastic is employed in varied domestic and industrial applications. Use of plastic bags and bottles is very common. The disposal of plastic waste is major drawback because of non-biodegradable nature of plastic. The plastic can be used as feedstock for ethanol like products. It is often used for construction and alternative construction connected activities. The current review summarizes the analysis on use of waste plastic

Rishi Singh Chhabra - With in the highway infrastructure, a large number of originates materials and technologies have been invented to determine their suitability for the design, construction and maintenance of these pavements. Plastics and rubbers are one of them. Also considering the environmental approach, due to excessive use

of polythene in day to day business, the pollution to the environment is enormous. The use of plastic materials like carry luggage, cups, etc. is constantly increasing day by day<sup>10</sup>. Since the synthetic resin aren't perishable, the necessity of the present hour is to use the waste synthetic resin in some helpful functions. The use of these materials as a road construction proves eco-friendly, economical and use of plastic gives strength in the sub-base course of the pavement.

#### V. COMPARATIVE STUDY

##### A. Central Mixing Plant (CMP)

The dry method may also be dispensed victimization central admixture plant. The cut plastic is value added in conjunction with the combination within the conveyor. This is transferred into the hot cylinder. There combination is coated with plastic 1<sup>st</sup> so with the hydrocarbon. The mixer so prepared is then loaded in the dipper lorry and transported for road laying. CMP helps to process higher management of temperature and higher admixture of this material therefore serving to have a uniform coating. This is adopted in our project. The comparative study is finished by testing the conventional normal aggregates & plastic-coated aggregates, and also the hydrocarbon and changed hydrocarbon (10% of hydrocarbon replaced by plastic). The various tests that are carried out for the comparative study is

- Test on aggregates
  - 1) Aggregate crushing test.
  - 2) Los Angeles abrasion test.
  - 3) Impact test.
- Test on bitumen
  - 1) Penetration test.
  - 2) Softening point test.
  - 3) Viscosity test.
  - 4) Marshall Stability test.

#### VI. TESTS ON AGGREGATES

##### A. Aggregate Crushing Test

The strength of the coarse aggregate may be assessed by aggregate crushing test. The aggregate crushing worth provides a relative live of resistance to crushing beneath step by step applied compressive load. To achieve a high quality of pavement, aggregates possessing high resistance to crushing or low aggregate crushing value re preferred.

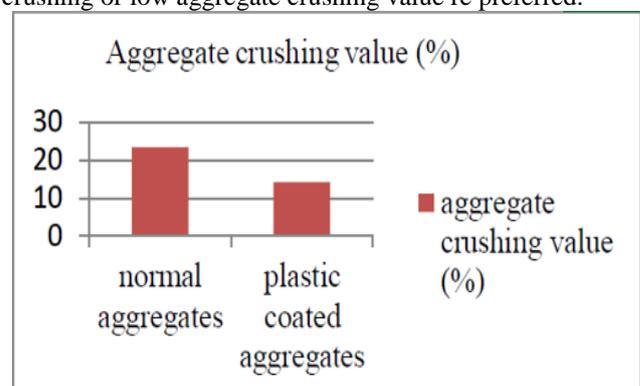


Fig. 1: Aggregate crushing value

### B. Abrasion Tests

Due to the movements of traffic, the road stones utilized in the surface course are subjected to wearing sporting action at the highest. Hence road stones should be hard enough to resist the abrasion due to traffic. Abrasion tests are meted out to check the hardness property of stones and to determine whether they are appropriate for the various construction road construction works. The abrasion checks on combination is also meted out victimization anyone of the subsequent 3 tests

- Los Angeles abrasion test
- Deval abrasion test
- Dory abrasion test

However, Los Angeles abrasion test is preferred as the test results have been correlated with pavement performance.

### C. Los Angeles Abrasion Test

The principle of Los Angeles abrasion check is to search proportion wear thanks to the relative rubbing action between the combination and out the percentage wear due to the relative rubbing action steel balls used as abrasive charge. Pounding action of those balls additionally exists throughout the check and thus the resistance to wear and impact is evaluated by this check.

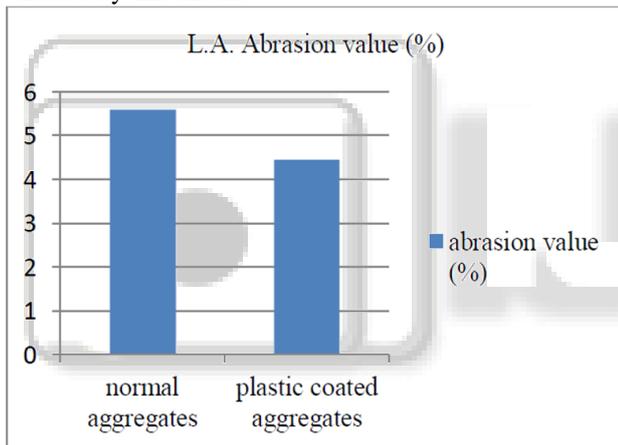


Fig. 2: Aggregate Los Angeles Abrasion value

### D. Impact Test

The test is designed to evaluate the toughness of stone or the resistance of the aggregates to fracture under repeated impacts is called impact test. The aggregate impact test is commonly carried out to evaluate the resistance to impact of aggregates and has been standardized by ISI. The combination impact price indicates a relative live of aggregate to impact, which has a different effect than the resistance to gradually increasing compressive stress. The aggregate impact value should not normally exceed 30% for aggregate to be used n wearing course of the pavements. The maximum permissible price is thirty fifth for bituminous macadam and 45 % for water certain macadam base course.

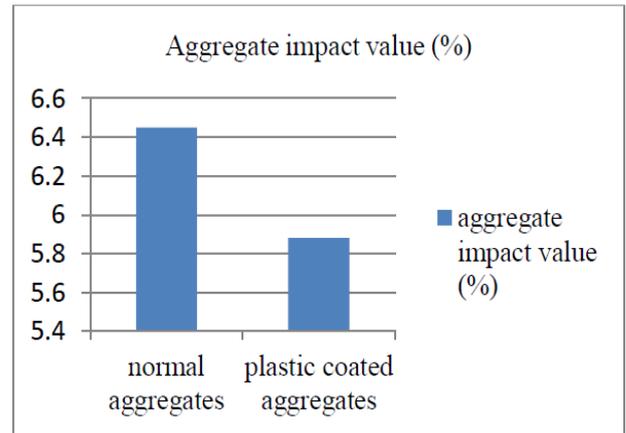


Fig. 3: Aggregate impact value

### E. Tests on Bitumen Penetration Test

Penetration test is to determine the hardness of the bitumen. The penetration of a bitumen is the distance in tenths of millimeter that a standard needle will penetrate the bitumen under a load of gm applied for seconds at c. penetration value indicates the softness of bitumen higher the penetration softer is the bitumen).

SL. No.	Penetration Value (mm)	Penetration Value (mm) Modified Bitumen (10%)
1	78	68
2	63	49

Table 1: Test result of penetration value of bitumen vs Penetration Value (mm) modified Bitumen

### F. Softening Point Test

The principle behind this check is that softening purpose is that the temperature at that the substance attains a specified degree of softening beneath nominal condition of the check. Softening purpose denotes that the temperature at that the bitumen attains a specific degree of softening beneath the specifications of this check. The test is conducted by ring and ball apparatus. A chance containing check sample of bitumen is suspended in liquid like water or glycerin at a given temperature. A steel ball is placed upon the bitumen sample and the liquid medium is heated at a rate of 5-degree centigrade per minute. Temperature is noted once the softened bitumen touches the metal plate that is nominal at a distance below. Generally, higher softening purpose indicates lower temperature status and is most popular in hot climates.

Sample No	Softening point(°C) (plain bitumen)	Softening point(°C) 10% bitumen replaced by plastic
1	69.2	80.7
2	70	81.2

Table 2: Test result of softening point of bitumen and modified bitumen (bitumen replaced by plastic)

### G. Viscosity Test

Viscosity is defined as the inverse of fluidity. Viscosity so defines the fluid property of bituminous material. Viscosity is the general term for consistency and is the measure of resistance to flow. Many researchers believe that grading of bitumen should be by absolute viscosity units instead of the

conventional penetration units. The degree of thinness of the binder at the applying temperature greatly influences the strength characteristics

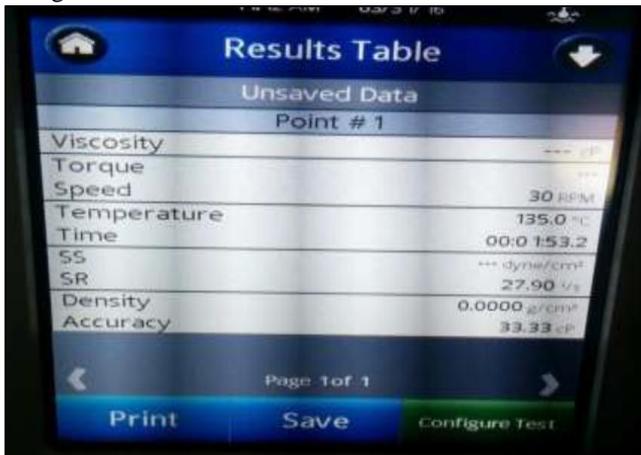


Fig. 4: Digital test result presentation of viscosity.

#### H. Marshall Stability Test

S. No	Bitumen content(%)	Modified bitumen(gm)
1	4.5	5.9
2	5.0	6.0
3	5.5	6.6
4	6	7.2

Table 3: Percentage of bitumen content

S.No	Bitumen Content (%)	Weight of mix(g)	Weight in air(g)	Weight in water (g)	Stability of bitumen		Flow (mm)	Diameter (cm)	height (cm)
					Plain bitumen	Modified bitumen			
1	4.5	1255.5	1256.5	733	14.7	17.95	1.99	10	6.3
2	5	1253	1255.5	734	19.47	23.44	2.38	10	6.4
3	5.5	1257	1259	736	13.46	18.21	2.88	10	6.5
4	6	1268	1270	748	8.9	13.10	2.59	10	6.4

Table 4: Test results of Marshall Stability test

#### VII. SUMMARY

##### A. Result and Discussion

- The crushing value reduces from 23.35 to 14.25 for normal and plastic-coated aggregate. The value was reduced by 40%. Lower the aggregate crushing value higher is the strength.
- The aggregate impact value of plastic-coated aggregate was reduced by 9.5% than the normal aggregate. It's the higher toughness of plastic-coated aggregates.
- Los Angeles abrasion value indicates the hardness of the aggregates. The abrasion price plastic coated aggregates were 21<sup>st</sup> but the traditional aggregates.
- The penetration value of bitumen is higher than the bitumen mixed with the plastic.
- The bitumen softens 10oC less than the bitumen replaced with plastic.
- The stability of modified bitumen (10% bitumen replaced by plastic) is higher than the normal bitumen.

#### VIII. CONCLUSION

The plastic mixed with bitumen and aggregates is 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 will face up to serious traffic and area unit sturdy than versatile pavement. The use of plastic mix will reduce the bitumen content by 10% and increases the strength and performance of the road. This new technology is eco-friendly. The use of smoke absorbent material (titanium di-oxide) by 10% of polymer content can reduce the vehicular pollution.

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