



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 7, July 2023

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

[ijirset@gmail.com](mailto:ijirset@gmail.com)

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# An Experimental Study on Plastic Blended Bituminous Concrete Mix Roads

N. Senthil<sup>1</sup>, S. Manikandan<sup>2</sup>

Assistant Professor, Gnanamani College of Technology, Pachal, Namakkal, Tamilnadu, India

PG Student, Gnanamani College of Technology, Pachal, Namakkal, Tamilnadu, India

**ABSTRACT:** Plastic waste causes major problem to the environment. It results pollution and global warming to the environment. now a days plastic is everywhere in today's lifestyle. This increase has resulted in a large amount of plastic waste. Example; plastic bags, plastic cups and plastic bottles. Plastic being a non- biodegradable product. several million tons of plastic waste are produced in India every year. To overcome this situation, we use waste plastics in road construction. The waste plastics are poly-ethylene, polystyrene, polypropylene. The waste plastics are shredded and coated over aggregate and mixed with hot bitumen and resulted mix is used for pavement construction. It has better flexibility which results in less rutting and less need for repair. Road surfaces remain smooth and absorb sound better. Plastic roads are more economical because reduce the need of bitumen by around 10%. It also reduces cost to around Rs 5000/km. stronger road with increased Marshall stability value.

## I. INTRODUCTION

The usage of plastic increased day by day. It is a very versatile material. It is a material that contain one or more organic polymer of large molecular weight solid in its finished state can be shaped by its flow. Plastic can be divided into two major categories thermoses and thermoplastics. Thermoses have high durability and strength because it solidifies irreversibly when heated, henceforth can be used primarily in construction applications. It may cause global warming and the greenhouse effect. Industrial revolution and its large-scale production plastic seemed to be a cheaper and effective raw material. Plastic is everywhere in today's lifestyle its disposal is a great problem and it creates many challenges to the society. It is a non-biodegradable product. The durability of plastic is high and it degrades very slowly. Every vital sector of the economy starting from agriculture to packaging, automobile, electronics, electrical, building constructions, communication sectors has been virtually revolutionized the application of plastics. In India nearly 5.6 million tons of plastics wastes are generated annually. Plastic is used for packaging, protecting devotions like packed food, packed water packing of any material. It is also used for over throwing off waste. The used plastic once unnerved to the environment it would not get putrefied. It causes most of the pollution and hazardous in the environment. Due to these materials pose environmental pollution and problems like breast cancer reproductive problems in humans and animals and genital abnormalities. Plastic will not solve itself and certain steps should be taken to ensure the proper disposal of the waste.

## NEED OF STUDY

In flexible pavement construction, bitumen is extensively used because of its, inherent cohesive nature, weathering resistance and ease of processing in the molten state as water-proof coatings, sealant and as well as binders. Bitumen is exposed to a wide range of temperature and loading condition. Pure bitumen is a viscous fluid at a temperature at about 30°C. It undergoes considerable deformation due to applied load over a period of time. This problem restricts its applications under conditions that warrant its use of extended period of time. Pure bitumen has very poor creep resistance and this exacerbated at high temperature and under sustained load.

## OBJECTIVE OF THE STUDY

- The major threat to the environment is the disposal of waste plastics which results in pollution, global warming, percolation of rain water, affects drainage property and soil fertility.
- To overcome this situation, we use waste plastic in bitumen road construction.
- The utilization of waste plastic in bituminous mixes enhances its properties and also its strength.
- In addition, it will also be a solution to plastic disposal and various defects in pavements.
- The waste plastic is shredded and coated over aggregate and mixed with hot bitumen then the resulted mix is used for pavement construction.



**II. LITERATURE REVIEW**

**REVIEW ON USAGE OF WASTE PLASTIC IN ROAD CONSTRUCTION**

Dr. R. Vasudevan has also stated use of waste plastic in bitumen increase the binding property as compared to the conventional bitumen. It improves the properties of bitumen resulting in increase in softening point and decrease in penetration value thus improving the durability.

Naskar.M(2010) used 60/70 grade bitumen as controlled sample and blended it with waste plastic films of 2mm\*2mm size. The deliberation of waste to bitumen in blend was taken as 0,1,3,5 and 7% by weight of bitumen. Tests for thermal, rheological and physical properties were done and it was concluded that bitumen ability was improved by blending it with waste plastic. The optimum waste plastic content was taken as 5%.

Chaudhary, A.K. (2010) used kharkai river, jamsedhur, Jharkhand (India) soil along with HDPE waste from local rag picker. The waste strips were cut into 12mm length and placed arbitrarily in the soil sample with different percentages of 0.25%, 0.5, 1.0%, 2.0%, 4.0%, waste. The CBR value of the controlled samples.

Mr. R.Amol and S.Bale plastics will increase the melting point of the bitumen. It is hoped that in near future we will have strong, durable and eco- friendly roads which will relive the earth from all type of plastic waste. The durability of the roads laid out with shredded with plastic waste is much more compared with roads asphalt with the ordinary mix. Roads laid with plastic waste mix are found to be better than the conventional ones. The binding property of plastic makes the road last longer besides giving added strength to withstand more loads.

**REASON FOR USAGE OF PLASTIC ROADS**

In India, because of hot and extremely humid climate, plastic pavements of greatest advantage. In order to observe the smoke from the vehicle, titanium di-oxide can be used. it also enhances the mechanical properties of the plastic, resulting in higher strength and high resistance.

Bitumen is a useful binder for road construction. Different grades of bitumen like 30/40, 60/70 and 80/100 are available on the basis of their penetration values. Nowadays more bureau of Indian standards (BIS) Which is based on the viscosity test values. Different viscosity grade of bitumen with respect to penetration values are VG40 (30/40), VG30 (60/70), VG20 (70/80), VG10 (80/100). The steady increase in high traffic intensity in terms of commercial vehicles, the increase in overloading of trucks and the significant variation in daily and seasonal temperature demands improved road characteristics. Any improvement in the property of the binder is the need of the hour.

**SOURCES OF PLASTIC**

Plastics are mixed with bitumen to modify the properties. Modified bitumen possesses better quality. Today the availability of waste plastics is enormous, as the plastic material shave become part and parcel of daily life. They either get mixed with municipal solid waste and or thrown over land area. Their present disposal is either by land filling or by incineration. Both the processes are not eco-friendly. Under these circumstances, an alternate use for the waste plastics is also the need of the hour. Plastics are organic in nature and bitumen is also a mixture of organic compounds. Hence the mixture of the two is possible.

Plastic has a number of very important properties which exploited along or together make a significance and expanding contribution to construction needs.

**ROAD AGGREGATE CHARACTERISTICS**

|                     |                    |
|---------------------|--------------------|
| Color               | Black, grey, white |
| Strength            | Need to be good    |
| Surface roughness   | More preferred     |
| Porosity            | 2%- tolerance      |
| Moisture absorption | 2%- tolerance      |

**BITUMEN CHARACTERISTICS**

- Structure - long molecule
- Viscosity - not suitable beyond 160 degrees

**CHARACTERIZATION OF WASTE PLASTIC**

Plastic is a good binder and it has a capacity to attached to the applied surface. It can also change the property of the material and increases the strength



| % of plastic coating over aggregate | Compressive strength (mpa) | Bending strength (mpa) |
|-------------------------------------|----------------------------|------------------------|
| 10%                                 | 250                        | 325                    |
| 20%                                 | 270                        | 335                    |
| 30%                                 | 290                        | 350                    |
| 40%                                 | 320                        | 390                    |

**DIFFERENT TYPE OF WASTE PLASTIC**

| Types                            | Sources  |
|----------------------------------|--|
| Low density polyethylene (LDPE)  | Bags, sacks, in lining and squeezable detergent bottles etc.                                   |
| High density polyethylene (HDPE) | Bottles of pharmaceuticals, disinfectants, milk, fruit juices, bottle caps etc.                |
| Polypropylene (PP)               | Bottle cap and closures, film wrapping for biscuits, microwave trays for ready-made meals etc. |
| Polystyrene (PS)                 | Yoghurt pots, clear egg packs, bottle caps.  |

**PROPERTIES OF PLASTIC**

| polymer | Solubility       |     | Softening temp in deg C | Product reported | Decom position Temp deg C | Products reported                               | Ignition temp range in deg C | Products reported   |
|---------|------------------|-----|-------------------------|------------------|---------------------------|---|------------------------------|---------------------|
|         | H <sub>2</sub> O | EPT |                         |                  |                           |   |                              |                     |
| PE      | Nil              | Nil | 100-120                 | No gas           | 270-350                   | CH <sub>4</sub> , C <sub>2</sub> H <sub>6</sub> | >700                         | Co, co <sub>2</sub> |
| PP      | Nil              | Nil | 140-160                 | No gas           | 270-300                   | C <sub>2</sub> H <sub>6</sub>                   | >700                         | Co, co <sub>2</sub> |
| PS      | Nil              | Nil | 110-140                 | No gas           | 300-350                   | C <sub>6</sub> H <sub>6</sub>                   | >700                         | Co, Co <sub>2</sub> |

**III. MATERIAL PROPERTIES**

**AGGREGATE**

These are chemically inert, solid bodies held together by the bitumen. aggregate comes in various shapes, sizes and materials ranking from fine particle of sand to large rocks. Generally flat and elongated particles are avoided or are limited to about 15% by weight of the total aggregate. Unit weight measures the volume that graded aggregate and the void between them will occupy in specimen. Selecting equal size of well graded aggregate reduce the voids content.

**FINE AGGREGATE**

Fine aggregate used for road concrete should be properly graded to give minimum void ratio and be free from deleterious material like clay, silt content and chloride contamination etc. Hence grading of fine aggregate is relatively different from that in normal concrete grading of fine aggregate should be such that it does not cause in increase in water demand for the concrete and should give maximum voids so that the fine cementitious particles to fill the voids. Hence it is desirable to use the coarser variety of fine aggregate having a high fineness modulus for making workable and strong concrete. The fine aggregate having is taken in saturated surface dry conditions.

**COARSE AGGREGATE**

Local aggregate comprising 125 mm, and less than 125 mm coarse aggregate in saturated surface dry condition, were used the coarse aggregates were crushed granite type aggregates coarse aggregate were obtained in crushed from majority of the particles were of granite type the quality is tested using impact test.

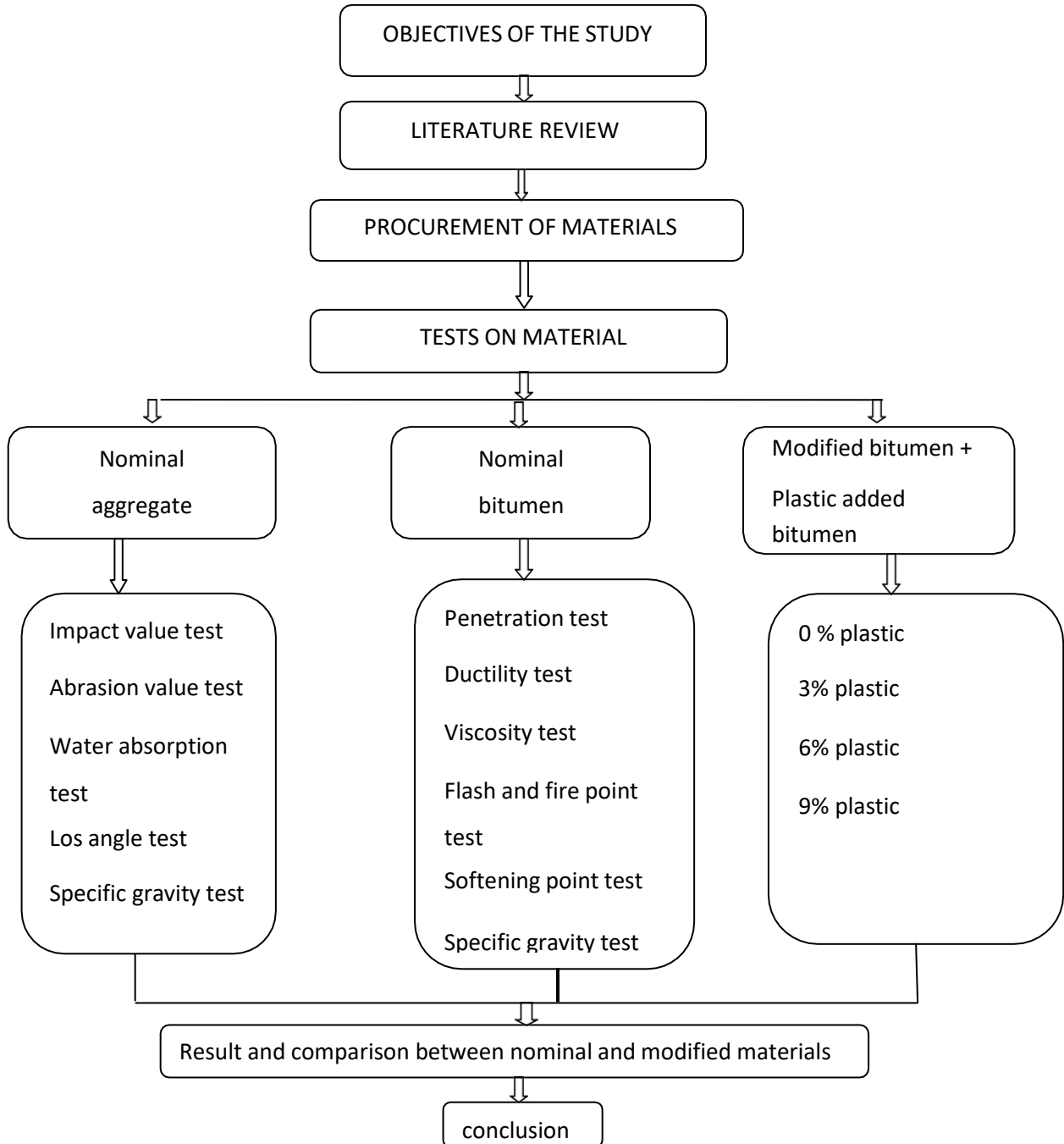
**BITUMEN**

Bitumen is normally called as Asphalt which is produced by refining crude oil. Used as a binder in road building products, it is a very viscous, dark brown or black material. Bitumen is obtained by vacuum distillation. Generally, penetration grade 20/30 is a standard penetration grade bitumen usually used as a paving grade bitumen suitable for road construction.

**PLASTIC**

Plastic are non-biodegradable and lightweight materials it may leads to waste and they are leads to ground and water pollution. It may be of different grades and different level. It leads the road into more stability.

**IV. METHODOLOGY**





**V. MARSHALL MIX DESIGN METHOD**

The Marshall Mix design method consists of 6 basic steps,

1. Aggregate selection
2. Asphalt binder selection
3. Sample preparation (including compaction)
4. Stability determination using the hveem stabilimeter
5. Density and voids calculations
6. Optimum asphalt binder content selection

**COMPARISION OF NORMAL AND PLASTICADDED BITUMEN TEST ON ROAD AGGREGATES**

| Si. No | Name of the test         | Observed value | Permissible limit |
|--------|--------------------------|----------------|-------------------|
| 1      | Crushing value test      | 27.19%         | Max 30%           |
| 2      | Impact value test        | 20.7%          | Max 30%           |
| 3      | Water absorption test    | 2.5%           | -                 |
| 4      | Specific gravity         | 2.78           | -                 |
| 5      | Los angles abrasion test | 16%            | -                 |

**TEST ON NORMAL BITUMEN**

The normally using bitumen for the highway making having 60/70 grade isto be tested.

| Si. No | Name of the test     | Observed value | Permissible limit |
|--------|----------------------|----------------|-------------------|
| 1      | Penetration test     | 72mm           | 100               |
| 2      | Ductility test       | 80mm           | 100               |
| 3      | Softening point test | 65             | 75                |
| 4      | Specific gravity     | 1.01           | 0.99              |
| 5      | Flash and fire test  | 100, 268       | 272, 220          |
| 6      | Viscosity test       | 09:46:13       | 12 min            |

**TEST ON PLASTIC ADDED BITUMEN**

The test which is done on the plastic added bitumen which is either coated on the surface of the aggregate or to be mixed with heated bitumen. It is used to find the elasticity, thickness of the modified bitumen. The plastic which may contain several properties that may leads to the variation in the results of normaland modified bitumen.

| Si. No | Name of the test     | Observed value | Permissible limit |
|--------|----------------------|----------------|-------------------|
| 1      | Penetration test     | 64mm           | 100               |
| 2      | Ductility test       | 43.2mm         | 100               |
| 3      | Softening point test | 57             | 75                |
| 4      | Specific gravity     | 1.01           | 0.99              |
| 5      | Flash and fire test  | 259, 317       | 272, 220          |
| 6      | Viscosity test       | 10:08:40       | 12min             |



**MARSHALL STABILITY TEST ON NORMAL BITUMEN**

| Bitumen added | Marshall strength | Flow value | W <sub>b</sub> | G <sub>t</sub> | G <sub>m</sub> | V <sub>v</sub> | V <sub>b</sub> | VMA   | VFB   |
|---------------|-------------------|------------|----------------|----------------|----------------|----------------|----------------|-------|-------|
| 4%            | 825               | 2.73       | 46             | 2.58           | 2.23           | 13.5           | 6.77           | 20.27 | 33.39 |
| 4.5%          | 985               | 2.8        | 52             | 2.57           | 2.248          | 12.8           | 7.35           | 20.15 | 36.47 |
| 5%            | 1150.5            | 3.1        | 58             | 2.56           | 2.283          | 10.82          | 8.32           | 19.14 | 43.46 |
| 5.5%          | 1115.5            | 3.32       | 64             | 2.55           | 2.32           | 9.01           | 9.29           | 18.3  | 50.76 |
| 6%            | 980               | 3.46       | 70             | 2.54           | 2.27           | 10.6           | 9.89           | 20.49 | 48.26 |

Where,

- W<sub>b</sub>- weight of bitumen
- G<sub>t</sub>- theoretical specific gravity
- G<sub>m</sub>- bulk specific gravity
- V<sub>v</sub>- air voids percent
- V<sub>b</sub>- percent volume of bitumen
- VMA- voids in mineral aggregate
- VFB- voids filled with bitumen

**VI. CONCLUSION**

- ❖ Plastic will increase the melting point of the bitumen. Plastic roads will be used for the satisfactory performance with good skid resistance, good texture value, stronger and less amount of progressive unevenness over a period of time.
- ❖ The use of the innovative technology not only strengthened the road construction but also increased the road life as well as help to improve the environment and also create a source of income.
- ❖ The analysis in the paper reveals that durability strength and cost.
- ❖ Plastic roads would be a boon for India’s hot and extremely humid climate, where temperature frequently cross 50 degree Celsius.
- ❖ It is hoped that in near future we will have strong, durable and ecofriendly roads.
- ❖ These roads which will relieve the earth from all types of plastic waste.
- ❖ It will also indicate the better stability value, indicating higher strength, less flow value and more air voids.
- ❖ This shows that the use of waste plastic that reduces the binder content from 5.33% to 4.83% in the BC mix hence it will help to save the total cost of the pavement construction.
- ❖ Plastic waste can be used as a coating material in bituminous concrete mixture for road construction.

**VII. FUTURE SCOPE**

- ✚ As the population increases, the solid waste also increases proportionally. The best alternative is the usage of waste as construction material assuring a good disposal.
- ✚ As this method is economic the practice would be on satisfactory extent aiding the future generations for a good solid waste management.
- ✚ The recycled plastic would shorten construction time and promote the reuse of those materials.
- ✚ Asphalt every year contributes to release into the air 1.6 million tons of CO<sub>2</sub>, the environment impact would be substantially reduced.
- ✚ Plastic roads would last for 50 years and would require few maintenance works.
- ✚ It will be almost indestructible, impervious and fire resistance, which will bear temperature from -40 to +80 degrees.
- ✚ The plastic road surface would be placed on the sand while cables and tubes would lie in the gap between soil and pavement.



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**Impact Factor: 8.423**



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