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# A Laboratory Study on Effect of Plastic on Bitumen

**Kolla Aswani Chandh[1], Shanagonda Akhila[2]**

[1]Department of Civil Engineering, Vignan's Institute of Technology and Aeronautical Engineering, Vignan hills Deshmukhi(V) Nalgonda (Dist)

[2]Department of Civil Engineering, Vignan's Institute of Technology and Aeronautical Engineering Vignan hills Deshmukhi (V) Nalgonda (Dist)

**Abstract:** ***Challenges are a way of life. From those challenges arise the Endeavour to find solutions. Two such challenges that countries with large populations face are effective disposal of plastic waste& establishing road network that is economical &durable. The sight of plastic waste littered around is a common sight in most urban areas. The first plastic waste road was laid in Bangalore in 2002 for a stretch of about 300 to 500 metres. As on date a total of 1400Km in Bangalore in different stretches 2Kms in Delhi & 6 Kms in Hyderabad was laid. The waste which is collected from various sources like apartments schools& by civil workers is put in a shredder. The shredded bits are then stored in bags for about a week to drain out the moisture from them. Later these are taken to a hot mixing plant located on outskirts of city, where it is mixed with asphalt& forms a compound called polymerized bitumen. This not only with stands monsoons but also the everyday wear& tear. Normally, the life span of a road is about 3years but plastic roads life span is about 6-7years.This is because the melting point of bitumen is 60to70degrees, whereas that of plastic is about130to140degrees.***

**Keywords:** Bitumen, Plastic, Biding, Moisture Absorption, Ductility, Softening point, Marshall Stability

## 1. Introduction

The threat of disposal of plastic will not solve until the practical steps are not initiated at the ground level. It is possible to improve the performance of bituminous mixed used in the surfacing course of roads. Studies reported in the used of re-cycled plastic, mainly polyethylene, in the manufacture of blended indicated reduced permanent deformation in the form of rutting and reduced low temperature cracking of the pavement surfacing. The field tests withstood the stress and proved that plastic wastes used after proper processing as an additive would enhance the life of the roads and also solve environmental problems. Plastic is a very versatile material. Due to the industrial revolution, and its large scale production plastic seemed to be a cheaper and effective raw material. Today, every vital sector of the economy starting from agriculture to packaging, automobile, electronics, electrical, building construction, communication sectors has been virtually revolutionized by the applications of plastics.

Plastic is a non-biodegradable material and researchers are found that the material can remain on earth for 4500years without degradation. Several studies have proven the health hazard caused by improper disposal of plastic waste. The health hazard includes reproductive problems in human and animal, genital abnormalities etc.

Looking forward the scenario of present life style a complete ban on the use of plastic cannot be put, although the waste plastic taking the face of devil for the present and future generation. We cannot ban use of plastic but we can reuse the plastic waste.

## 2. Materials Used

### 2.1 BITUMEN

Bitumen is used as binders in pavements constructions. Bitumen may be derived from the residue left by the refinery from naturally occurring asphalt. In India mostly 80/100 and 180/200 grade bitumen is used. Heavier grade cut backs, rapid setting emulsions or heavier grade tars may also be used. The grade of basic bitumen is altered either by controlled refining or by mixing with diesel oil or other oils. For single dressings on WBM base course, quantity of bitumen needed ranges from 17 to 195kg per 10m 2 areas and 10 to 12kg per 10m 2 area in case of renewal of black top surfacing. For second coat of surface dressing, the quantity of bitumen needed ranges from 10 to 12kg per 10m2 area. Bulk bitumen Lorries with tanks of capacity ranging from 5000 to 15000litres are used to transport bulk bitumen. As per PMC, the bitumen content in a mix should be 4% of weight by total mix for B.M.

Paving bitumen from Assam petroleum denoted as A-type and designated as grades A35, A90, etc. Paving bitumen from other sources denoted as S-type and designated as grades S35, S90, etc.

### 2.2 Plastic Material

Plastics are usually classified by their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics.

There are two types of plastics: thermoplastics and thermosetting polymers. Thermoplastics are the plastics that do not undergo chemical change in their composition when heated and can be moulded again and again. Examples include polyethylene, polypropylene, polystyrene, polyvinyl chloride, and Poly TetraFluoro Ethylene (PTFE)In the thermosetting process, a chemical reaction occurs that is irreversible. The vulcanization of rubber is a thermosetting process. Before heating with sulfur, the polyisoprene is a tacky, slightly runny material, but after vulcanization the product is rigid and non-tacky.

**Figure 1:** Bitumen

**Figure 2:** Plastic Material's

## 3. Methodology

The number of tests are conducted which can illustrate the durability of the plastic roads in the laboratory. As such

**3.1 Binding Test**
**3.2 Moisture Absorption Test**
**3.3 Soundness Test**
**3.4 Bitumen Content**
**3.5 Ductility Of Bitumen**
**3.6 Penetration Test**
**3.7 Specific Gravity Test**
**3.8 Softening Point**
**3.9 Marshall Stability**
**3.10 Flash & Fire point Test**

### 3.1 Binding Test

This test measures the binding strength compressive strength of the mixture used to make the road. Bending strength refers to the mixture ability to resist the deformation under heavy loads. Compression strength refers to the mixture ability to resist forces that attempt to compress or squeeze it.

### 3.2 Moisture Absorption Test

To determine the extent to which the aggregate absorbs water. If the water absorption is high the road is likely to breakdown &develops potholes in the event of any water logging.

**Figure 3:** Moisture Absorption Test

### 3.3 Soundness Test

The weathering occurs because when water enters pores &voids in the mixture the salts dissolved in the water, crystallize. When the water evaporates more crystals is formed &this crystal causes the mixture to crack& break.

The freezing &Thawing can cause the porous aggregate tends to disintegrate prematurely.

### 3.4 Bitumen Content

This test is done to determine the bitumen content as per ASTM 2172

**Figure 4:** Bitumen Extractor

### 3.5 Ductility of Bitumen

The ductility of a bituminous material is measured by distance in `CM' to which it will elongate before breaking when a standard briquette specimen of the material Is pulled apart at specified speed &temperature.

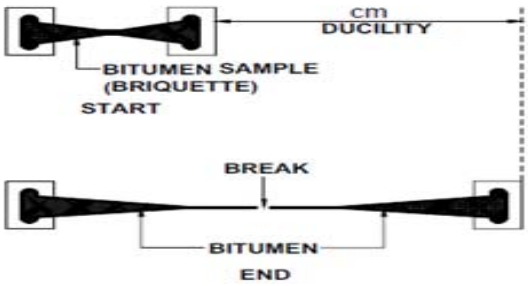


**Figure 5:** Ductility Test

### 3.6 Penetration Test

Penetration of a bituminous mixture is the distance in tenths of a `mm', that a standard needle would penetrate vertically into a sample of material under standard conditions of temperature, load& time.

**Figure 6:** Penetration Test

### 3.7 Specific Gravity Test

The ratio of mass of given volume of bitumen to the mass of equal volume of water, both taken at a recorded/specified temperature.

### 3.8 Softening Point Test

Softening Point of bitumen or tar is the temperature at which the substance attains particular degree of softening. As per IS: 334-1982, it is the temperature in ºC at which a standard ball passes through a sample of bitumen in a mould and falls through a height of 2.5 cm, when heated under water or glycerin at specified conditions of test. The binder should have sufficient fluidity before its applications in road uses. The determination of softening point helps to know the temperature up to which a bituminous binder should be heated for various road use applications. Softening point is determined by ring and ball apparatus.

**Figure 7:** Softening Point

### 3.9 Marhall Stability

This test is done to determine the Marshall stability of bituminous mixture as per ASTM D 1559. The principle of this test is that Marshall Stability is the resistance to plastic flow of cylindrical specimens of a bituminous mixture loaded on the lateral surface. It is the load carrying capacity of the mix at 60oC and is measured in kg.


**Figure 8:** Marshall Stability

### 3.10 Flash & Fire Point Test

Bituminous materials leave out volatiles at high temperatures depending up on their grade. These volatile catch fire causing a flash. This condition is very hazardous and it is therefore essential to qualify this temperature for each bitumen grade.

Flash Point: The Flash point of the material is the lowest temperature at which the vapour of substance momentarily takes fire in the form of a flash under specified condition of test

Fire Point: The Fire point is the lowest temperature at which the material gets ignited and burns under specified condition of test

## 4. Results

| *Test* | *Bitumen* | *Bitumen With Plastic* |
|---|---|---|
| Binding Strength | 275(KN) of compressive strength | 290(KN) of compressive strength |
| Moisture Absorption | 4% | 0.2% |
| Soundness | 5% of voids | 0% of voids |
| Ductility | 90cm | 74cm |
| Penetration | 63.50cm | 58.62cm |
| Softening Point | 52.6°C | 74.3°C |
| Bitumen Content | 33% | 3.1% |
| Marshall Stability | 340kg | 361kg |
| Specific Gravity | 2.63 | 1.05 |
| Flash Point Test | $175^0$C | $177^0$C |
| Fire Point Test | $180^0$C | $181^0$C |

## 5. Conclusion

By adding of plastic waste to the bitumen waste strengthened the pavement by improving the properties like Biding, Moisture absorption, Reduce the Bitumen Content, Penetration and Softening Point.

- Indirectly by this we could reduce the plastic waste from creating the Global Warming and Depletion of Ozone layer when on combustion of it.
- By addition of this plastic to the bitumen, we can increase the life span of the pavement when compared to the BT Pavement without Polymer usage.
- Plastic has the sticky nature which increases the Binding properties, which is useful for rapid setting of the pavements generally used in heavy traffic regions.
- By this the usage of Bitumen has reduced and was replaced by the polymer waste so as the cost of the pavement has been reduced to 15% of the total cost.

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## Author Profile

**Kolla Aswani Chandh** received B.Tech and M.tech degree in CIVIL Engineering and Transportation Engineering under JNTU KAKINADA in 2012 and 2016 respectively.

**Shanagonda Akhila** received B.Tech and M.tech degree in CIVIL Engineering and Structures under JNTU HYDERABAD in 2012 and 2014 respectively.