# WASTE PLASTIC USAGE TO IMPROVE PROPERTIES OF BITUMEN IN ROAD CONSTRUCTION

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**ABSTRACT**
In the road construction various types of materials and design methods are used, for the reduction of environmental pollution, use of plastic waste in road construction is one of them. Since the plastic waste material is non-biodegradable, the use of plastic waste material in road construction can help us to reduce the plastic waste pollution to some extent.
A lot of research is going on all over the country to solve the problems which are related to the road construction.
The plastic waste (Low density polymer) in bitumen helps in increasing life of flexible pavement. Generally life of flexible pavement is 4 to 5years, while it is claimed that the plastic waste bitumen roads can last up to 10 years.
In this study, I have compare the results of normal bitumen and plastic waste (LDP) mix bitumen, to get the idea of how much percentage of plastic waste can be added in bitumen with respect to the weight of bitumen for the optimum performance of mix.

Results shows that as the percentage of plastic waste (LDP) is increased at 1.0%,3.0%,6.0% and 9.0% with respect to the weight of bitumen, the softening point bitumen plastic waste (LDP) mix increases, flash and fire point increases, penetration value decreases and ductility value decreases. Marshall Stability of dense bituminous mix at 1.0%, 3.0%, 6.0% and 9.0% of plastic waste (LDP), the flow value of mix decreases and the stability increases therefore; the optimum percentage of plastic waste (LDP) to get the desirable result is 3%.

## INTRODUCTION:

The utilization of plastic waste covered aggregate for the flexible pavement permits the reuse of plastic waste. Plastics are used in various types of packing materials and it is also used in day to day products such as milk packets, bags, cups, etc, these all are made up of plastic materials. After usage of these materials, they are thrown into the dust bin and it gets transferred to the municipal solid waste. As these plastics pieces are non-biodegradable in nature, they cause problems to the environment. In India consumption of plastic products are increasing day by day and the plastic waste which gets mixed with the domestic waste makes the disposal of municipal solid waste difficult. There are two methods to dispose municipal solid waste: 1) By burning the municipal solid waste 2) By land filled.

In the burning process of municipal solid waste cause's air pollution and the plastic waste which are burned produces harmful toxic gases like dioxins, nitrogen dioxide, sulphur dioxide, etc.

By utilization of the plastic waste in the flexible pavement, we can have eco-friendly constructions of roads and it can decrease the amount of plastic waste up to certain extent.

**PURPOSE:**

- The purpose is to study the properties of bitumen sample with varying percentage of plastic waste (low density polythene) added with respect to the weight of bitumen.
- To determine the optimum percentage of the plastic waste (low density polythene) which can be added in the bitumen sample so as to enhance its property and adequate use of plastic waste (low density polythene) can help in sustainable growthand increase the life of flexible pavement.

**Grade of bitumen = VG-30**

- Percentage of plastic wastes (LDP) to be added in bitumen with respect to the weight of bitumen = 9%
- Here we are using low density polythene having size greater than equal to 30 micron
- Period of cooling at room temperature = 30 minute
- Period of cooling in water bath before trimming of the sample = 30 minute
- Period of cooling in water bath after trimming of the sample = 90 minute
- Test temperature 27°C plus minus 0.5°C
- Rate of pulling 50 plus minus 2.5mm per minute

| Test property | Briquette number | Mean value |
|---|---|---|
| | 15 cm | 15.66 cm |
| Ductility in cm | 18cm | |
| | 14cm | |

Table 5.20

Fig.-5.5

Fig.-5.6

- **5.6 Marshall Stability Test of Bitumen Sample (ASTM D-1559)**

- The plastic wastes (LDP) are collected from the dump yards and are segregated according to microns sizes. The segregated plastic wastes are cleaned and dried. Then the plastic wastes are divided into high density polyethylene and low density polyethylene. Thereafter, the plastic wastes are shredded by using the shredding machine into2mm-4mm sizes each separately. On the other side bitumen is heated up to 150 degree Celsius. The shredded plastic wastes (LDP) are added to the hot bitumen and mixed. Additions of the shredded plastic wastes (LDP) to the bitumen are at different percentages (1%, 3%, 6% and 9%).Test results are compared and finally the optimum percentage of adding plastic waste (LDP) to the bitumen is found.

**Introduction:**

- The upper layers of flexible pavement such as wearing course or the surface course has to with stand wear and also the tear due to traffic loads and it is also exposed to various atmospheric conditions and it also take the effect of the temperature variations therefore it is necessary that high quality bituminous mix to be laid over the road surface so as it can resist the effect of temperature cracking and fatigue failure and deformations of the road surface.
- **Apparatus:**
- Compaction assembly mould, sample extractor, experiment head, experiment machine, etc.
- **Procedure:**
- a. The bitumen is heated to 140ºC - 1650ºC. The shredded plastic waste (plastic covers, milk covers) is added to the bitumen.

- b. The aggregate size 6mm, 10mm, 20mm ,stone dust and cement are weighed to all total of 1200 gm. and then heated to 150ºC.

- c. The heated aggregate and the plastic waste added bitumen is mixed and transferred to the compaction mould.

- d. The specimen is given 75 number of blow on the topside of the

- e. Sample mix with standard hammer (450mm, 4.86kg).reverse the specimen and 75 blows is given on the other side.
- f. The mould is kept undisturbed for 24hours.The specimen from the mould is gently removed.
- g. A sequence of sample is prepared by a similar Method with varying quantities of bitumen content with percentage of plastic wastes.

- h. The mould is immersed in hot water bath at 60ºc for30min. The mould is tested for its stability and flow.

**Observations:**

- In this experiment we are dense bituminous mix design.
- Percentage of plastic wastes added (low density polythene) is with respect to the weight of bitumen.
- Total weight of mix= 1200 gm.
- Percentage of coarse aggregate to be added in the total mix
- 20 mm aggregate = total weight 336 gm. that is 28 %
- 10 mm aggregate = total weight 300 gm. that is 25%
- 6 mm aggregate = total weight 324 gm. that is 27%
- Percentage of finer aggregate to be added in the mix
- Stone dust = total weight 216 gm. that is 18%
- Percentage by weight binder material to be added in the mix
- Bitumen (VG-30) = 4.25 % that is 51 gm.
- Cement = total weight 24 gm. that is 2%

| Properties | 1%, plastic waste (LDP) added bitumen | 3%, plastic waste (LDP) added bitumen | 6%, plastic waste (LDP) added bitumen | 9%, plastic waste (LDP) added bitumen |
|---|---|---|---|---|
| Stability in KN | 16.87kN | 16.93kN | 17.32kN | 20.86kN |
| Flow in mm | 5.63mm | 2.83mm | 1.1mm | 1.23mm |

Table 5.21


Fig.-5.7

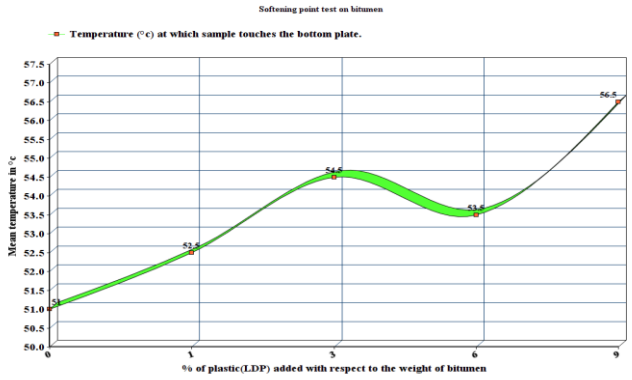
Fig.-5.8

## RESULTS & DISCUSSION

**Determination of Softening Point Test of Bitumen**
The grade of bitumen on which test are performed is VG-30. Method of test according to IS 1205-1978.

Table 6.1

| | % of plastic (LDP) with respect to weight of bitumen sample. | Mean Temperature |
|---|---|---|
| Temperature at which sample touches the bottom plate | 0 % | 51 °c |
| | 1 % | 52.5°c |
| | **3 %** | **54.5°c** |
| | 6 % | 53.5°c |
| | 9 % | 56.5°c |




Graph 6.1: softening point of Plastic waste (LDP)-bitumen mix

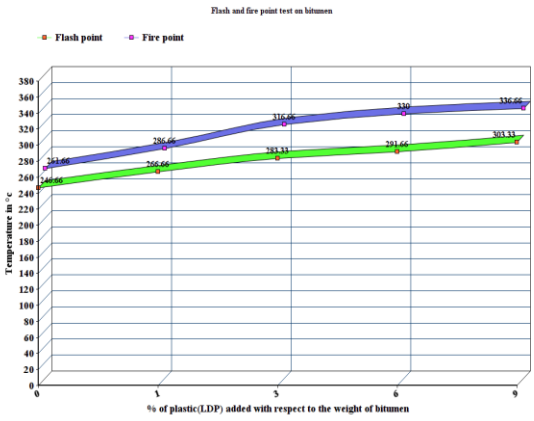
**Remarks:**
It is observed that as the percentage of plastic waste (low density polymer) is increased with respect to the weight of bitumen the softening point of the bituminous plastic waste (LDP) mix sample increases.

**6.2 Flash and fire point of bitumen of bitumen**

The grade of bitumen on which test are performed is VG-30. Method of testing is then according to IS 1209-1978.

| % of plastic (LDP) added with respect to the weight of bitumen sample | Flash point | Fire point |
|---|---|---|
| 0 % | 246.66°C | 261.66°C |
| 1 % | 266.66°C | 286.66°C |
| **3 %** | **283.33°C** | **316.66°C** |
| 6 % | 291.66°C | 330°C |
| 9 % | 303.33°C | 336.66°C |

Table 6.2




Graph 6.2 Flash and fire point test of Plastic waste (LDP)-bitumen mix.

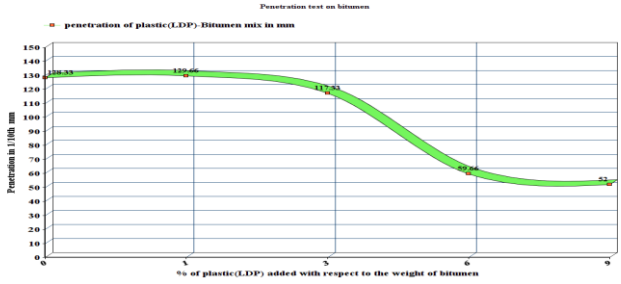
**Remarks:**

Flash and fire point of bitumen sample increases with increase in the percentage of plastic waste (LDP) with respect to the weight of bitumen used.

**6.3 Penetration test of bitumen**

Table 6.3

| Method of test is according to IS-1203-1978. Grade of bitumen used vg-30. **% of plastic (LDP) added with respect to the weight of bitumen sample.** | **Penetration 1/10th mm** |
|---|---|
| 0 % | 128.33 mm |
| 1 % | 129.66 mm |
| **3 %** | **117.33 mm** |
| 6 % | 59.66 mm |
| 9 % | 52 mm |




Graph 6.3

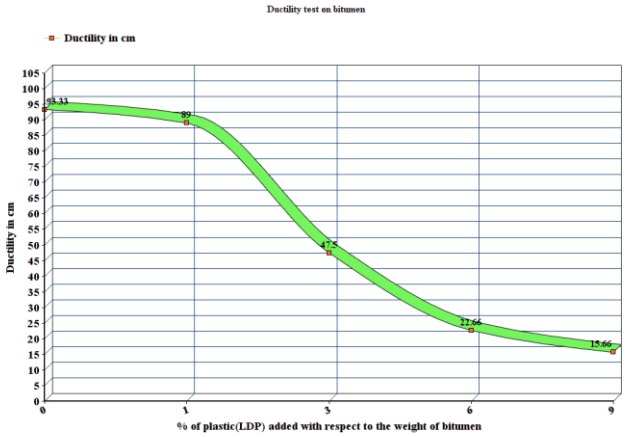
**REMARKS**

In the bitumen sample as the percentage of plastic waste (LDP) is increased with respect to the weight of bitumen, the penetration value of the bitumen sample is reduced.

6.4 Ductility test of bitumen

Table 6.4

| Method of testing according to IS 1208-1978. Bitumen sample used vg-30. **% of plastic (LDP) added with respect to the weight of bitumen sample.** | **Ductility in cm** |
|---|---|
| 0 % | 93.33 cm |
| 1% | 89 cm |
| **3 %** | **47.5 cm** |
| 6 % | 22.66 cm |
| 9 % | 15.66 cm |




Graph 6.4

**Remarks:**
Ductility of the bitumen sample decreased as the percentage of plastic wastes (LDP) added to the bitumen sample is increased.

**6.5 Marshall stability test of bitumen**

Bitumen used VG-30. Method of testing is according to ASTM D-1559.

Table 6.5

| **% of plastic (LDP) added with respect to the weight of bitumen mix sample.** | **Stability in kN** | **Flow in mm** |
|---|---|---|
| 0% | 15.83kN | 5.70mm |
| 1 % | 16.87 kN | 5.63 mm |
| **3 %** | **16.93 kN** | **2.83 mm** |
| 6 % | 17.32 kN | 1.1 mm |
| 9 % | 20.86 kN | 1.23 mm |

**Conclusion and Recommendation**

From this study, the following observations are made:

a) VG-30 bitumen which are generally used in flexible road construction. In the present research work, it was observed that the softening point of plastic waste (LDP) mix bitumen is increased by the increase of percentage of plastic waste (LDP) in bitumen from 1%, 3%, 6% and 9% respectively by 2.84%, 6.86%, 4.90% and 10.78%.
**For the 3% of plastic waste (LDP) optimum, the softening point is increased by 6.86%**

**b)** In the present research work, it was observed that the flash and fire point of plastic waste (LDP) mix bitumen is increased by the increase of percentage of plastic waste (LDP) in bitumen from 1% ,3%, 6% and 9% respectively by 8.10%, 14.86%, 18.24% 22.97% and fire by 9.55%, 21.02%, 26.11% and 28.63%.
**For the 3% of plastic waste (LDP) optimum, the flash point is increased by 14.86% and fire point is increased by 21.02%.**

c) In the present research work, it was observed that the penetration value of plastic waste (LDP) mix bitumen is decreased rapidly by the increase of percentage of plastic waste (LDP) in bitumen from 1%, 3%, 6% and 9% respectively by 1.036%, 8.57%, 53.51% and 59.47%. Since the consistency of bitumen materials are measured by penetration test, the higher value of penetration represents softer consistency. In warmer area, lower penetration grade bitumen is preferred and in colder area, bitumen having high value of penetration is preferred.
**For the 3% of plastic waste (LDP) optimum, the penetration value is decreased by 8.57%.**

d) In the present research work, it was observed that the ductility of plastic waste (LDP) mix bitumen is decreased rapidly by the increase of percentage of plastic waste (LDP) in bitumen from 1%, 3%, 6% and 9% respectively by 4.63%, 49.10%, 75.72% and 83.22%. Tensile properties of bitumen materials are measured by ductility test. Bituminous materials used in road construction should have sufficient ductility; otherwise the road surface would crack due to temperature variations or by the traffic load stresses which may cause the pavement to become pervious that can result in damage of the pavement structure. During day time, the pavement surface expands and during night time, pavement surface contracts. So, if the bitumen does not have sufficient ductility, cracking will occur in the pavement surface
**For the 3% of plastic waste (LDP) optimum, the ductility is decreased by 49.10%. As per 1208-1978, the minimum ductility of VG-30 bitumen at 25 degree Celsius is 40 cm. Therefore at 3% of plastic waste (LDP) it is within the permissible limit.**

e) In the present research work, it was observed that the Marshall Flow value of plastic waste (LDP) dense bituminous mix of surface course is reduced and the Marshall

Stability value is increased by the increase of percentage of plastic waste (LDP) in bitumen from 1%, 3%, 6% and 9% respectively by 1.23%, 50.35%, 80.70%, 78.42% and stability by 6.57%, 6.95%, 9.41%, 31.77%.

**For the 3% of plastic waste (LDP) optimum, the Marshall Stability value is increased by 6.95% and the flow value is decreased by 50.35%.**

Since now days as the plastic waste materials are increasing day by day there efficient disposal has become difficult. The recycle of the waste plastic (LDP) material in the road construction has given us a new ray of hope and getting new innovative method so we can go towards the sustainable development of the city and thus by dropping man made dangerous impacts on the environment.

The following result concluded that for the optimum performance of the surface course of flexible pavement and to give us improved properties of bitumen material we can use plastic waste (LDP) of 3% with respect to weight of bitumen to give the desired results.

## II. **ECONOMIC ANALYSIS**

Economic analysis of the plastic road was done considering the material necessity for paving 4 inch thick wearing course on standard 12 feet wide lane of one kilometer length roadway section. Using LDP content of 3% by weight of bitumen will save the 3% bitumen. We have surveyed a lot of recycling agencies and municipal waste organization agencies. From which we came to know that the processing cost of waste plastic bottles (including the collection cost, cleaning & shredding cost) was estimated to be Rupees (Rs) 40 per kg. It was found that 8% percent of the required bitumen can be replaced with waste plastic (LDP) thus reducing the cost by approximately Rs.53000.00 per kilometer per lane in assessing the same to conventional (unmodified) asphalt mix in road construction

## FUTURE SCOPE OF WORK:

To improve the life of flexible pavement using various other materials in combination with the plastic waste (LDP) like: powdered glass, fly ash, shredded pieces of rubber or tyres etc.

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