
Analysis In The Application Of Plastic Waste As A Constructive Material In Flexible Pavement

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Abstract: Road construction is the main sign of the development of any country. Day to day increase in the usage of roads leads to frequent deterioration. It causes timely maintenance of roads and sometimes reconstruction also. As the construction cost of the roads is high, one should take pre measures to lessen the maintenance cost. A project is successful not only when it is executed economically but also when the maintenance cost is low. Any material can be given more strength by adding some additives regarding its nature and structure, likewise in roads. Safeguarding of pavements requires a precise approach for the execution of sustainable roads. Due to the increased axel load and speed of the vehicles the ability of bituminous layers is been lessened resulting in seepage, rutting, pot holes. On other hand, day to day increase of various types of wastes that are non-bio-degradable are increasing drastically which in turn are a threat to life. One such type of waste is plastic which is highly impossible to get decomposed in the earth surface. Both these problems can be solved by providing a solution involving by using plastic waste in flexible pavement construction.

1.INTRODUCTION:

Road construction is the main sign of the development of any country. Day to day increase in the usage of roads leads to frequent deterioration. It causes timely maintenance of roads and sometimes reconstruction also. As the construction cost of the roads is high, one should take pre measures to lessen the maintenance cost. A project is successful not only when it is executed economically but also when the maintenance cost is low. Any material can be given more strength by adding some additives regarding its nature and structure, likewise in roads. Safeguarding of pavements requires a precise approach for the execution of sustainable roads. Due to the increased axel load and speed of the vehicles the ability of bituminous layers is been lessened resulting in seepage, rutting, pot holes. On other hand, day to day increase of various types of wastes that are non bio-degradable are increasing drastically which in turn are a threat to life. One such type of waste is plastic which is highly impossible to get decomposed in the earth surface. Both these problems can be solved by providing a solution involving by using plastic waste in flexible pavement construction.

2.LITERATURE REVIEW:

To reduce the cost of construction and maintenance of pavements plastic is used since many years. Many researches are also going on about the usage of plastic waste in India as an alternate additive material in road construction.

Dr. R. Vasudevan stated that “Bitumen content used is reduced as the amount of plastic is increased instead of bitumen. Abrasive nature of the roads has decreased to a larger extent”.[1]

R Bajpai et al states that “Stripping value reduces from 8% for modified mix to zero for PP8 and PP10. This shows that plastic coated aggregate is well suitable for flexible pavements construction than conventional aggregates”.[2]

Jamdade P.K et al states that “Water absorption capacity effects more comparing to the conventional aggregates”.[3]

Y.F. Quiet al states that “SMA mixtures shows prominent rutting resistance when compared to the dense graded mixture. The more the extent of stone to stone contact is present, the higher will be the rutting resistance”.[4]

V.S.Punithet al states that “The rutting, pot holes can be reduced by the addition of PE in the asphalt mix. An amount of 5% by weight of asphalt of PE is best for the increment of the performance of stone mastic asphalt mixes”.[5]

3.OBJECTIVES:

The main objectives regarding the usage of plastic waste in flexible pavement construction are

- To reduce the cost of construction by reducing the amount of bitumen binder used.
- To reduce the increase of plastic waste disposing problems.
- To obtain the optimum content of plastic that should be used in flexible pavement construction.

4.MATERIALS:

4.1.Plastic:

The term plastic is derived from the Greek word “plastikos”, meaning fit for molding. This refers to the material’s malleability or plasticity which allows it to be cast into different variety of shapes[6]. It has low density, low electrical conductivity, transparency. Generally plastics are available in various forms like Polyethylene terephthalate (PET), Polyvinyl Chloride (PVC), Polystyrene, Polymethyl methacrylate etc. Shredded plastic which passes through 4.75 mm sieve and retains on 2.36mm sieve is considered as the additive. In this study 5% of PE by weight is added as the coating material for the conventional aggregates.

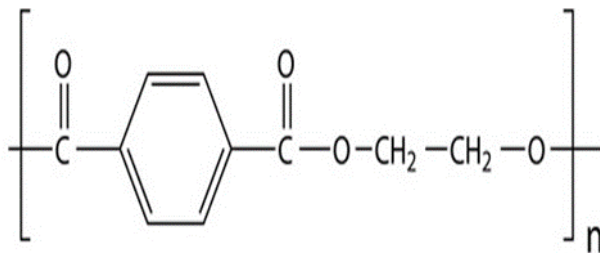


Fig.1

Source:<https://omnexus.specialchem.com/selection-guide/polyethylene-terephthalate-pet-plastic>



Fig.2

Source: <http://www.industrytap.com/pet-bottle-just-threw-away-can-become-construction-material-walls/33079>

The various properties of PE are mentioned in the tabular form given below.

S.No.	Properties of PE	Standard Limits
1	Specific Gravity	0.962-0.94
2	Water Absorption, %	<0.1
3	Elongation, %	50-600

Table.1



Fig.3 Shredded Plastic

4.2.Bitumen:

Bitumen is a black and viscous material which is usually found in liquid or semi solid state. It is obtained as the byproduct of petroleum. Mainly bitumen is used road construction as a binder with aggregates which forms as a coating for the aggregates. Aggregates coated with bitumen is considered as asphalt concrete. Bitumen is generally graded based on its viscosity. It is also used as a water proofing material. In a general asphalt mix around 7 – 10% of asphalt is used. But in SMA only 5% asphalt is used. As per IRC80/100 is the standard penetration grade bitumen that is used for highway construction in India.



Fig.4

Source: <https://en.wikipedia.org/wiki/Asphalt#/media/File:Bitumen.jpg>

As per ASTM standards the various properties and acceptable limits of bitumen are mentioned in the below table.

S.No.	Properties of Bitumen	Acceptable Limits
1	Penetration at 25°C	80/100
2	Specific Gravity	0.97-1.02
3	Flash Point, °C	175
4	Softening Point, °C	35-70
5	Ductility	75

Table.2

4.3.Aggregates:

Aggregates contains of coarse to medium grain sized particles which are used for construction. Aggregates are obtained from quarry as a finished material from the naturally formed rocks. Aggregates are used as the base material for many transportation related constructions. Aggregates that are passing through 12.5 mm sieve and retaining on 10 mm sieve are considered for the road construction.[7]



Fig.5

Source: <https://www.aboutcivil.org/properties-of-road-aggregates.html>

As per IS code of practice 2386-1963 the various properties of aggregates are mentioned in the below table.

S.No.	Properties of Aggregates	Standard Value
1	Crushing Value,%	10-35
2	Abrasion Value,%	<35
3	Impact Value,%	<35
4	Specific Gravity	2.5 -2.9
5	Water Absorption,%	0.1-2.0
6	Stripping value,%	5

Table.3

5.EXPERIMENTAL DETAILS:

5.1. Tests on Aggregates:

The various tests that are conducted on both conventional aggregates and modified aggregates are listed in the below tabular form. These tests are based on IRC 2386-1963.

S. No.	Test Performed	Conventional Aggregate	Modified Aggregate(5% of PE)
1	Water Absorption, %	1.2	0.9
2	Impact Test,%	17.6	12.4
3	Crushing Test,%	21.3	18.7
4	Abrasion Value,%	23.2	20.1
5	Marshall Stability, kg	410	460

Table.4

5.2. Tests on Bitumen:

Bitumen tests that are performed are mentioned in the below tabular form with the obtained values. These tests are conducted based on MORTH specifications.[8]

S. No.	Test Performed	Result Obtained
1	Specific Gravity	1.03
2	Penetration Value	90
3	Softening Point	39
4	Ductility(cm)	85

Table.5

6.RESULTS AND DISCUSSION:

- The modified mix has more water resisting capacity when compared to the conventional mix.
- The durability of the aggregates will be increased as the layer of aggregates are covered by plastic.

- The abrasion value is less for the modified aggregates than that of the original aggregates.
- Strength will be increased due to the increase of Marshall stability value.

7.CONCLUSION:

- By using the plastic waste in road construction the binding nature of the mix is increased.
- It is cost effective as the amount of bitumen is reduced.
- Disposal problems of plastic will be reduced.
- Roads that are laid in areas having about 50°C temperatures also can be modified with plastic waste.
- Stripping and pot holes are almost reduced because of its water absorption capacity.
- Some amount of noxious HCL gases may release in the presence of chlorine while laying the roads.
- Leaching may be observed due to the presence of toxics.

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