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TO ENHANCE THE STRENGTH OF BITUMINOUS ROADS USING WASTE PLASTIC

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Abstract - Bitumen commonly used as primary binder, is tested for its physical properties such as strength, durability etc. PET (polyethylene-tetra phthalate) which is commonly found in plastic bags, soft drink bottles is used as additive for bitumen mix. PET is most abundant plastic material used by mankind and is highly resistant to degradation with time (non biodegradable). Different percentage of PET (5%, 10%, 15%) is used. Satisfactory results were achieved when different properties were tested upon the test mix of PET and bitumen.

Keywords: Bitumen, strength, pet, plastic bags, non biodegradable

2. Introduction

Disposal of plastic waste is a real threat for environment, and it wouldn't go away just by doing nothing. On the other hand we have broken roads with no solution whatsoever for their condition. Several studies were conducted to test use of recycled plastic in bitumen road construction in border to reduce rutting and low temperature cracking of pavement surface. The field tests suggested that the mix was showing some hope in terms of the probable solution of the problem we have. Both the disposal of waste plastic and cracking of roads seemed to have one common solution. Plastic is a synthetic compound which is known for its non biodegradable properties (can take upto 5000 years for fully degeneration), these properties makes it waterproof, turns out. Melted properties of plastic (mainly polyethylene) are the nature of being highly sticky substance. These properties make it very desirable for being used as a binding agent with bitumen. Bitumen on the other hand show similar properties but is not stable in high summer temperature where plastic seem to have no issue holding up in solid state.

3. Methodology

The working procedure of this project is as follows:

1. Bitumen to conduct various tests is taken from the college premises.
2. Various tests such as Ductility tests, Softening point test and viscosity tests are conducted as per IS standards.
3. The materials taken were bitumen and PET wastes.
4. First bitumen was taken and heated for few minutes in a vessel and its standard physical properties such as ductility test, viscosity test and penetration test has been performed.
5. PET was added in 5% by weight and similar tests were conducted as done for the determining the standard properties of bitumen.
6. Similar tests were done by adding 5%, 10% and 15% of PET waste in the bitumen sample.
7. Results obtained for the various bitumen mixes sample are compared and conclusions are drawn on the basis of the results.

4. Materials required

Bitumen

Bitumen is a sticky, black and highly viscous liquid or semi-solid, in some natural deposits. It is also the residue or by-product of fractional distillation of crude petroleum. Bitumen composed primarily of highly condensed polycyclic aromatic hydrocarbons, containing 95% carbon and hydrogen (± 87% carbon and ± 8% hydrogen), up to 5% sulfur, 1% nitrogen, 1% oxygen and 2000 ppm metals. Also bitumen is Mixture of about 300 - 2000 chemical components, with an average of around 500 - 700. It is the heaviest fraction of crude oil, the one with highest boiling point ($525^{O}C$).

Various Grades of Bitumen used for pavement purpose

Grade: 30/40; Grade: 60/70; Grade: 80/100

Grade used in our experiment : 80/100

PET (Polyethylene tetra phthalate)

The most common thermoplastic polymer resin of the polyester family and is used in fibers for clothing, containers for liquids and foods, manufacturing, and in combination with glass fiber for engineering resin.

5. Results a nd Discussios

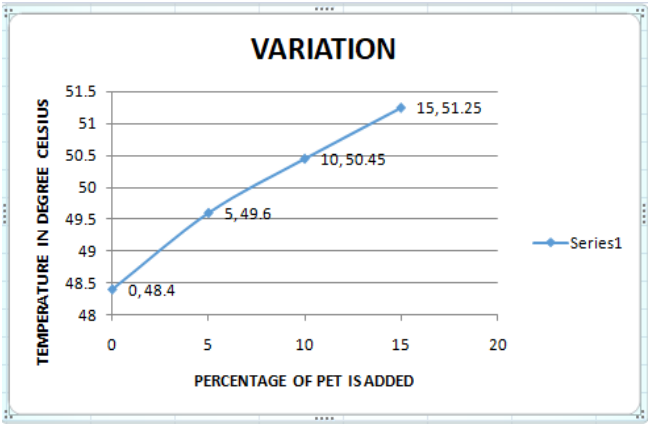
5.1 SOFTENING POINT TEST

Bitumen Grade = 80/100
Liquid used in the bath = Water
Period of air Cooling = Approximate 30 minutes
Period of cooling in water bath = Approximate 15 minutes

TABLE 1 (Temperature variation in different percentages of PET)

TYPE	VALUES
BITUMEN (80/100)	48.4 °C
WHEN 5% PET IS ADDED	49.6 °C
WHEN 10% PET IS ADDED	50.45 °C
WHEN 15% PET IS ADDED	51.25 °C

Graph 1 (Temperature variation in different percentages of PET)



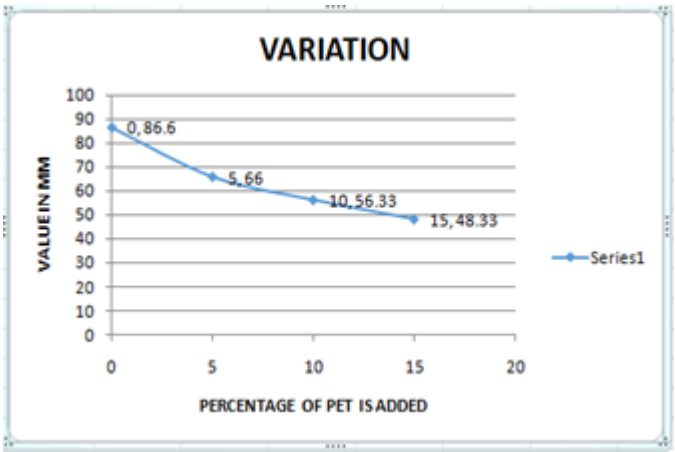
5.2 PENETRATION TEST

Pouring Temperature = 90°C - 100°C
Period of cooling in Atmosphere = Approximately 1 hour
Room Temperature = 27°C
Period of cooling in water bath = Approximately 1 hour
Actual Test Temperature = 30°C

TABLE 2 (Penetration variation in different percentages of PET)

TYPE	VALUES
BITUMEN (80/100)	86.6 mm
WHEN 5% PET IS ADDED	66 mm
WHEN 10% PET IS ADDED	56.33 mm
WHEN 15% PET IS ADDED	48.33 mm

Graph 2 (Penetration variation in different percentages of PET)



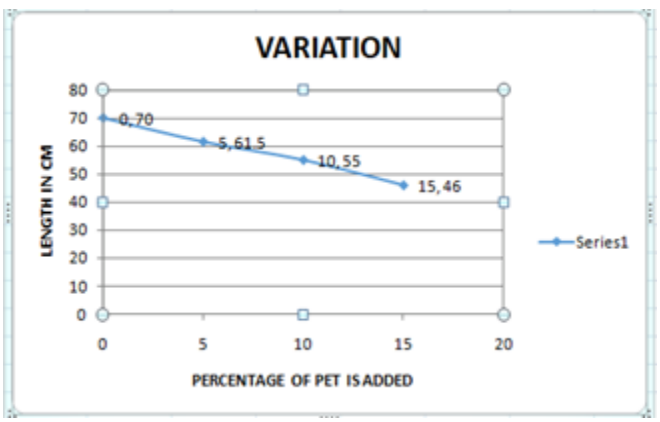
5.3 DUCTILITY TEST

Weight of sample = 200gm
Test Temperature = 27°C
Grade of bitumen = 80/100

TABLE 3 (Length variation in different percentages of PET)

TYPE	VALUES
BITUMEN (80/100)	70 cm
WHEN 5% PET IS ADDED	61.5 cm
WHEN 10% PET IS ADDED	55 cm
WHEN 15% PET IS ADDED	46 cm

Graph 3 (Length variation in different percentages of PET)



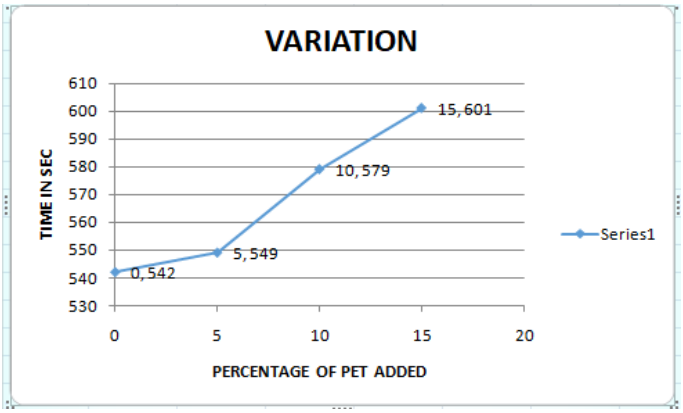
5.4 VISCOSITY TEST

Grade = 80/100
Size of orifice = 10 mm
Specified temperature = 60 °C

TABLE 4 (Time variation in different percentages of PET)

TYPE	VALUES
BITUMEN (80/100)	542 sec
WHEN 5% PET IS ADDED	549 sec
WHEN 10% PET IS ADDED	579 sec
WHEN 15% PET IS ADDED	601 sec

Graph 4 (Time variation in different percentages of PET)



6. CONCLUSION

This review intended to find the effective ways to reutilize the hard plastic waste particles as bitumen modifier for flexible pavements. The use of recycled waste plastic in pavement asphalt represents a valuable outlet for such materials. The use of modified bitumen with the addition of processed waste plastic of about 5-10% by weight of bitumen helps in substantially improving the strength, fatigue life and other desirable properties of bituminous concrete mix, resulting which improves the longevity and pavement performance with marginal saving in bitumen usage. The process is environment friendly. The use of waste plastics in the manufacture of roads and laminated roofing also help to consume large quantity of waste plastics. Thus, these processes are socially highly relevant, giving better infrastructure.

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