

Bitumen Mix Design with Waste Plastic: A Critical Research

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Abstract— Bituminous concrete (BC) is a composite material mostly use in construction project like road surfacing, airport, parking lots etc. it consists of asphalt or bitumen (used as a binder) and mineral aggregate which are mixed together & laid down in layers then compacted. Plastic are everywhere in today's lifestyle and are growing rapidly throughout particularly in a developing country like India. As these are non-biodegradable there is a major problem posed to the society with regard to the management of this solid wastes.

Keywords: Non Bio-degradable, Bitumen, Waste Plastic

I. INTRODUCTION

Bitumen is used as binders in pavements construction. Bitumen may be derived from the residue left by the refinery from naturally occurring asphalt. As per definition given by the American society of testing material bitumen has been defined as "Mixtures hydrocarbons of natural or progenies origin, or combination of both frequently accompanied by their non-metallic derivatives, which may be gaseous, liquid, semi-solid or solid, and which are completely soluble in carbon disulphide." Bitumen found in nature state known as asphalt contains large quantities of solid mineral matter.

A. IRC 111-2009-

The Bitumen of for the dense graded bituminous mixes shall comply with. Indian standard specification for viscosity-graded paving bitumen IS: 73

B. Indian Metrological-

The highest daily mean temperature and the lowest daily mean air temperature mentioned can be obtained for the weather station nearest to the project site from the Indian metrological organization (IMO).The IMO has data on daily mean high temperature for all 365 days in a year for all weather station based on historical records of the last 40-50 or more years .This daily mean high temperature on a specific day is the same daily "normal" high temperature for that day as usually reported in same newspapers. The highest may or pure of the 365 daily mea high air temperature(May or June) is used in the lowest daily mean air temperature (January)can also be obtained from the IMO.

C. Waste Plastic-

Waste plastic Bottles containers and packing strips etc. is increasing day by day. A result Amount of Waste Plastic increases. This leads to various environmental problems day by day .The waste plastic produced today will remain in the environment for many years leading to various environmental concern .It is necessary to utilize the waste plastic effectively with technical development in each field use. The mix polymer modified bitumen waste plastic heating Temperature 120° c to 140° c and plastic waste or plastic pollution is the accumulation of plastic objects in the earth's environment that adversely affects wild life ,wildlife habit, and humans.

II. LITERATURE REVIEW

Bindu and Beena (2010) studied how waste plastic acts as a stabilizing additive in stone mastic asphalt when the mixtures were subjected to performance tests including Marshall stability , tensile strength, compressive strength tests and tri-axial tests. There results indicated that flexible pavement with high performance and durability can be obtained with 10% shredded plastic.

Fernandez et al. (2008) studied Rheological evaluation of polymer modified asphalt binders by using thermoplastic elastomer styrene butadiene styrene (SBS) and they compared the properties of modified binder by addition of both the shale and aromatic.

Moghaddam and Karim (2012) reported that the utilization of waste material in asphalt pavement and reduce environmental pollution as well. Form their it is concluded that Polyethylene Terephthalate (PET) reinforced mixtures possess higher stability value, flow, fatigue life in comparison with the mixture without PET.

Wegan and Nielsen (2001) studied microstructure of polymer modified binders in bituminous mixtures by preparing thin sections of the specimen and analyzing that thin section by infrared Fourier transform spectrometer. When thin sections were illuminated with the UV-light, the polymer phase emits yellow light, fine and course aggregate often appear green, the bitumen phase is black and air voids or cracks appear with a yellow -green color

Herndon (2009) investigated moisture susceptibility of asphalt mixture using phosphorylated recycled polythene. They indicated that there is a significant reduction in moisture susceptibility with the addition of recycled unmodified polyethylene to asphalt concrete mixtures in both the wet process and the Dry process.

Jain et al. (2011) studied mitigation of rutting in bituminous roads by use of waste polymeric packaging materials and concluded that rutting of bituminous reduced to 3.6 mm from a value of 16.2 mm after application of 20000 adding optimum quality of polythene in bituminous mix for road ultimately improves payments performance.

Ahmadinia et al. (2012) carried out an experimental research on the application of waste plastic bottles (polyethylene terephthalate (PET)) as an additive in stone mastic asphalt (SMA). Wheel tracking, moisture susceptibility, resilient modulus and drain down tested were carried out in their study on the mixtures that included various percentages of waste PET 10 % by weight of Bitumen Contant. Their result show that the addition of waste PET in to the mixture has a significant positive effect on the properties of SMA which could improve the mixture resistance against permanent deformation (rutting), increase the stiffness of the mix, provide lower binder drain down and promotion of re-use and recycling of waste materials in a more environmentally and economical way.

Rahman and wahab (2013) use recycle polyethylene terephthalate (PET) as partial replacement of fine aggregate in modified asphalt in their investigation. In term of economic value, it shows that this recycled PET could reduce cost of road construction because this recycled material is cheaper than bitumen and easy to obtain, which also improves the level of performance and the service life of the road. It can be concluded from their study that the application of recycled PET modified asphalt gives more advantage compared to the conventional asphalt mixture especially in termed of permanent deformation.

III. MATERIALS & METHODOLOGY

Bitumen sample grade for (VG 40) and waste plastic polyethylene terephthalate (PET) mix 10%

A. Solubility Test of Bitumen

The bitumen content of a bituminous material is measured by means of its solubility in carbon disulfide. In the standard test for bitumen content (ASTMD4) a small sample of about 2g of the asphalt is dissolved in 100ml of carbon disulfide and the solution is filtered through a filtering mat in a filtering crucible. Sample of VG-40 Bitumen

S.No.	Characteristic Parameters	Unit	Observed value
1.	Weight of Dry Sample (w	g	2.000
2.	Weight of Gooch Crucible (w	g	181.94
3.	Weight of Gooch Crucible After the test (w	g	181.95
4.	Matter Soluble in Trichloroethylene $[w_1-(w_3-w_2)]*100/w_1$	%	99.50

B. Penetration Test

Sample of bitumen by determine the distance in tenths of millimeter that a standard needle vertically penetrates the bitumen specimen under known Conditions of loading time and temperature. Mostly used method of measuring the consistency of a bituminous material at a given temperature classification measure of quality. Hardness or softness of Bitumen by measuring the depth in tenths of a millimeter which a standard in 5 seconds.

- First reading 134-165 = 31
- Second reading 134- 166 = 32
- Third reading 141-170 = 29
- Largest value of penetration = 32mm.

C. Softening Point Test

The principle behind this test is that softening point is the temperature and which the substance attains a particular degree of softening under specified condition on the test. The softening point of asphaltic bitumen and fluxed native asphaltic, road tar, coal tar pitch. As per IS: 1205 -1978

S. No.	DISCRIPTION	BALL-1	BALL-2
1.	Softening point °c	52.1	55.2
2.	Average softening point °c	(52.1+55.2)/2	53.65

D. Flash & Fire Point²

This test is done to determine the flash point and the fire point of asphaltic bitumen and fluxed native asphalt, cut back bitumen and blown type bitumen as per IS:1209-1978. The principal behind this test is given below:

E. Flash Point

The flash point of a material is the lowest temperature at which the application of test flame causes the vapors from the material to momentarily catch fire in the form of flash under specified conditions of the test.

F. Fire Point

The fire point is the lowest temperature at which the application of test flame causes the material to ignite and burn at least for 5 seconds underspecified condition of the test.

G. Calculation

- Rate of temperature 1 minute = 13°c
- Flash point (time*temp) 17*13 = 221°c
- Fire point 18*13 = 234°c

H. Ductility Test

The ductility of a bituminous materials is measured by the distance in centimeters to which it will elongate before breaking when a briquette. Specimen of the materials of the form described under pulled a part of a specified speed and at a specified temperature.

S. No	DESCRIPTION	BRIQUETTE No		
		1	2	3
1	Initial reading (cm)	0	0	0
2	Final reading(cm)	80	82	83
3	Ductility = Final-Initial (cm)	80	82	83

Ductility Value (cm) = 81.66 cm

IV. RESULT

S. No.	CHARACTERSTICS	GRADE (PMB)	METHOD OF TEST
1	Penetration	32	1203-1970
2.	Softening point	53.65	1205-1978
3.	Flash point	221	1209-1978
4.	Fire point	234	1209-1978
5.	Ductility	81.66	1208-1978
6.	Solubility test	99.50	1216-1978

A. Cost Estimate

Grade of Bitumen VG 40

48 Rupee per kg bitumen and (10% add waste plastic)

12 Rupee per kg waste plastic

$$48 \times 90 \div 100 = 43.2$$

$$12 \times 10 \div 100 = 1.2 \text{ per } 10\%$$

$$= 43.2 + 1.2$$

Total Rupee = 44.4

Profit = 48-44.4 = 3.6 (1 kg bitumen)

Profit = total cost + total profit = 44.4 + 3.6

1 kg bitumen = 48 Rupee

1 kg bitumen saving of cost = 3.6 Rupee

- 1) Flexible road pavement.
- 2) Polymer modified bitumen used only for wearing course.
- 3) Semi dense bituminous concrete (SDBC).
- 4) Bituminous concrete (BC).

V. CONCLUSION

- By adding waste plastic to the bitumen properties of bitumen has been optimized.
- Not only waste plastic improved the properties of bitumen but also improve the properties of bituminous mix.
- Thus, the use of waste plastic ultimately improves the performance and quality of flexible pavement.
- As plastic are non- biodegradable and also harmful to environment thus, disposal of plastic is a matter of great concern therefore use of waste plastic in the road construction is an effective way of disposal of waste plastic.
- Bitumen cost reduced.

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