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EXPERIMENTAL PERFORMANCE AND ANALYSIS OF BIT – PLASTIC ROAD

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INTRODUCTION

1 GENERAL

In general there are two types of road rigid pavement roads and flexible pavement roads. For rigid roads material used is concrete and for flexible roads bitumen is used. In India mostly the flexible pavement roads are available. And for economical road construction new techniques, new material is used. The significant variation in daily and seasonal temperature demand improved road characteristics. Any improvement in the property of the binder is needed. Bitumen is a useful binder for road construction. Different grades of bitumen like VG 10, VG 20, VG 30 and VG 40 are available on the basis of their viscosity values. The steady increase in high intensity in terms of commercial vehicles, and the significant variation in daily and seasonal temperature demand improved road characteristics .Any improvement in the property of the binder is the needed.

Today the availability of the waste plastics is enormous, as the plastic materials have become part and parcel of daily life. They either get mixed with Municipal Solid Waste and or thrown over an area. If not recycled, their present disposal is either by land filling or by incineration. Both the processes have certain impact on the environment. Under this circumstance, an alternate use for the waste plastics is also the needed. Plastic waste when is mixed with hot bitumen, plastics melt to form an oily coat over the aggregate and the mixture is laid on the road surface like a normal tar road.

In the construction of flexible pavements, bitumen plays the role of binding the aggregate together by coating over the aggregate. It also helps to improve the strength of the road. But its resistance towards water is poor.

1.2 PREPARATION OF DESIGN MIX

1.2.1 Plain Bituminous Mix

Bitumen is a black oily, viscous material that is a naturally-occurring organic by product of decomposed organic materials. Also known as asphalt or tar, bitumen was mixed with other materials throughout prehistory and throughout the world for use as a sealant, adhesive, building mortar, incense and decorative application on pots , buildings, or human skin. The material was also useful in waterproofing canoes and other water transport. A good design of bituminous mix expected to result in a mix which is adequately (1) strong (2) durable (3) resistive to fatigue and permanent deformation (4) Environment friendly (5) economical and so on.

1.2.2 Various Mix Design Approaches

There is no unified approach towards bituminous mix design, rather there are a number of approaches, and each has some merits are demerits. Table 1summarizes [RILEM 17 1998] some of the important bituminous mix design approaches are as follows:

- Mix design method

- Recipe method
- Empirical mix design method
- Analytical method
- Volumetric method
- Performance related approach
- Performance based approach

The recent emphasis on bituminous mix design on performance related and performance based approaches. The requirement of a good mix design has changed from time to time. Table- 1 gives some idea of how the mix design requirements have changed from past to present.

Table 1. Requirements of Bituminous Mix Design

Past	Present
Stability	Stiffness
Durability	Permanent deformation
Economy	Fatigue
	Temperature susceptibility
	Low temperature cracking
	Moisture cracking
	Freeze-thaw
	Permeability
	Economical
	Environment friendly
	Workability
	Economy

Some of the above requirements are sometimes mutually conflicting. For example, the higher is the bitumen content; the better is the fatigue life, provided all the other parameters are kept unchanged. But with the increase of bitumen content, the resistance to rutting any decrease. Increase in bitumen content not accompanied by adequate amount of air voids will result in the fall of stability of the mix, the chances of bleeding will increase. The only way to increase bitumen content keeping sufficient air voids (VA) is by maxi mizing VMA and suitably gradation can be designed. Heavy duty bituminous pavements are composed of bituminous binder course and wearing course, for example, Dense Bituminous Macadam (DBM) and BC [MORT& H 2001), AS PER Indian specification. Same grades of bitumen are generally used for construction of these layers.

Generally same grades of bitumen are used for construction of these layers.

3.MATERIALS AND METHODOLOGY

3.1 GENERAL

Investigation of plastic waste materials aggregates and bitumen requires various field test and lab tests as explain after this chapter. This chapter presents material which is collected from site given below for plastic is mixed with bitumen in detail. The present chapter divided into three main sections. First section presents the physical requirement of aggregates and bitumen. Second section presents the properties of plastic. Third section presents the preparation plastic waste materials blended with bitumen.

Waste plastic (or) high density polyethylene (HDPE) waste was collected from roads, garbage and also household wastes. Generally, polyethylene of 60micron or below is used for the further process; less micron plastic is easily mixable in the bitumen at higher temperature (160 °C-170 °C).

Collected plastic cut into fine pieces as far as possible, pieces were sieved through 4.75mm sieve and retaining at 2.36mm sieve was collected. o Firstly, bitumen was heated up to the temp about (160˚C -170 °C) who is its melting temp. The pieces were added slowly to the hot bitumen of temp around (160 °C-170 °C). The mixture was stirred manually for about 2030mintues.

The bitumen mixtures of different compositions were prepared and used for carrying out tests (i.e.), penetration test, softening point ,viscosity, ductility test, stripping value and marshal test.

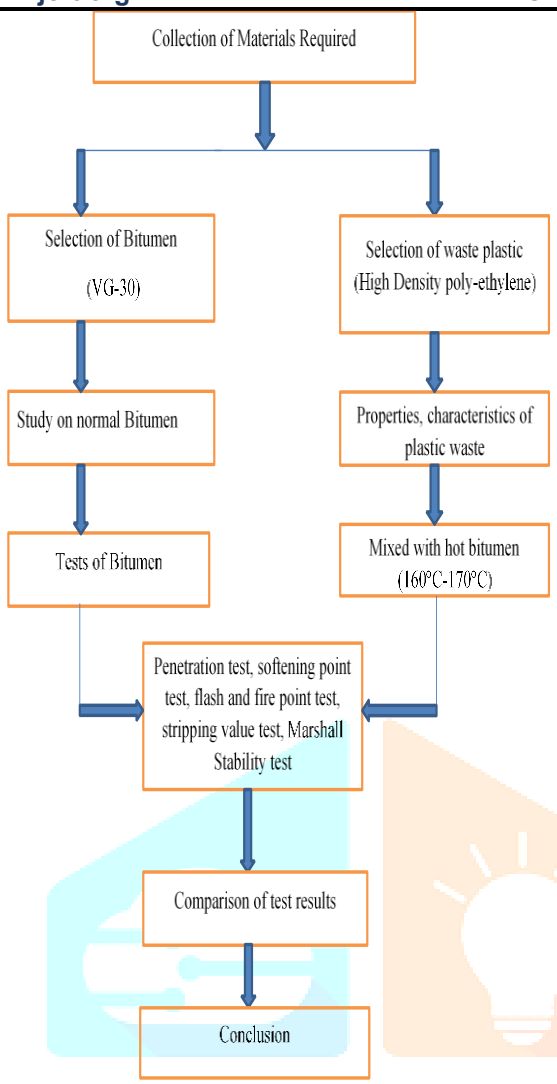


Figure 3.1 Methodology- Flow chart

3.2 MATERIALS

3.2.1 Aggregates

These are various types of mineral aggregates used to manufacture bituminous mixes can be obtained from different natural sources such as glacial deposits or mines are can be used with or without further processing. The aggregates can be further processed and finished to achieve good performance characteristics. Industrial by-products such as steel slag, blast furnace slag, fly ash etc. Sometimes used by replacing natural aggregates to enhance the performance characteristics of the mix. Aggregate contributes up to 90-95% of the mixture weight and contributes to most of the load bearing & strength characteristics of the mixture. Hence the quality and physical properties of the aggregates should be controlled to ensure a good pavement. Aggregates are of three types,

- Coarse aggregates
- Fine aggregates
- Filler

Figure 3.2 Aggregates

3.2.2 Bitumen

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 Materials bitumen has been defined by " Mixtures of hydrocarbons of natural or hydrogenous 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 di sulphide". Bitumen found in natural state known as asphalt contains large quantities of solid matter.

Figure 3.3 Bitumen

3.2.3 Important properties of bitumen

Viscosity of bitumen should be adequate at the time of mixing and compaction. It is achieved by heating prior to mixing and by use of cutbacks and emulsion.

In presence of water bitumen should not strip off from aggregate. Bitumen should be durable in all seasons. It should not become too soft during summers and develop cracks during winters.

Road Tar: This bituminous material is obtained by the destructive distillation of organic matters such as wood, coal shale etc, In the process of destructive distillation, the carbonation results in the production of crude tar which is further refined by distillation process.

3.2.4 Physical properties [ICSC: 0612]

3.3 PLASTIC MATERIAL

Plastics are usually classified by their chemical structure of the polymers backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. Plastics can also be classified by the chemical process used in their synthesis, such as condensation, poly addition, and crosslinking.

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 tetra fluoro 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 polisoprene is a tacky, slightly runny material, but after vulcanization the product is rigid and non-tacky.

The properties of plastics are defined chiefly by the organic chemistry of the polymer. Such as hardness, density and resistance to heat, organic solvents, oxidation, and ionizing radiation.

Figure 3.4 Plastic waste (HDPE)

3.3.1 Types of Plastics

PET, polyethylene terephthalate

HDPE, high-density polyethylene

PVC, polyvinyl chloride

LDPE, low – density polyethylene

PP, polypropylene

PS, polystyrene

Boiling point	: greater than 300°C
Melting point	: 54-173°C
Relative density (water=1)	: 1.0 – 1.18
Solubility in water	: none
Flash point	: greater than 200°C
Auto ignition temperature	: 400°C

Plastics are durable and degrade very slowly, the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Since the 1950s, one billion tons of plastic have been discarded and many persist for hundreds or even thousands of years. Perhaps the biggest environment threat from plastic comes from hurdles, which are raw materials from which all plastics are made. They are tiny pre-plastic pellets that kill large numbers of fish and birds that mistake them for food. Prior to the ban on the use of CFCs in extrusion of polystyrene (and general use, except in life-critical fire suppression systems: see Montreal Protocol), the production of polystyrene contributed to the thermoplastics can be remitted and reused, and thermoset plastics can be extrusion process.

3.3.2 Classification of plastic waste

a) Polyethylene:

LDPE (Low Density Poly-Ethylene)

Low Density poly-Ethylene this plastic waste available in the form of carry bags generally in stores these plastics bags are very thin and also easily available.

HDPE (High Density Poly-Ethylene)

Generally High Density Poly-Ethylene type of plastic waste is available in the form of carry bags and easily available in the market.

b) Polypropylene

This plastic may be available in the form of carry bags or solid plastic it's depend upon the use and need of the industries. It is available in the form of plastic bottles and mat sheets etc.

3.4 PREPARATION OF PLASTIC WASTE MATERIAL

3.4.1 Plastic Waste Scenario

The use of plastic materials such as carry bags, cups, etc,. is constantly increasing. The consumption of plastics has increased from 4000tons/annum to 4 million tons/annum and it is expected to rise 8 million tons/annum during the year 2010. Nearly 50 to 60% of the total plastics are consumed for packing.

3.4.2 Plastic Waste Blending Materials

a) Preparation of blend

Polyethylene carry bags are cut into pieces using a shredding machine. They are sieved and the plastic pieces passing through 4.75mm sieve and retaining at 2.36mm sieve gets collected. These plastics pieces are added slowly to the hot bitumen of temp around a 170-180°C. The mixture stirred well using mechanical stirrer for about 20-30 minutes. Polymer-bitumen mixtures of different composition can be prepared and used for carrying out various tests.

b) Characterization of Plastic Waste-Bitumen blend for flexible pavement

The utility of the plastic waste blended bitumen-aggregate mix for flexible pavement construction is characterized by studying stripping value and Marshall Stability Value of the mix for the blends having a maximum of 15% plastic waste.

3.5 TESTS

This test describes the experimental works carried out in this present investigation. There are a number of tests to assess the properties of bituminous materials. The following tests are usually conducted to evaluate different properties to bituminous materials.

- Penetration Test
- Softening Point Test
- Flash and Fire point Test
- Stripping value Test
- Marshall Stability Test

RESULTS AND DISCUSSION

1. PENETRATION TEST

Penetration test is one of the important tests to assess the quality of bitumen. The below table shows the penetration value for conventional and modified bitumen.

Table 4.1- Observation for the Penetration test

S.No	Penetration Trials	Modified bitumen (% of plastic replaced)			
		0 (conventional)	10	15	20
1	Trial 1	368	342	378	317
2	Trial 2	304	349	342	317
3	Trial 3	348	339	375	335
	Average value of Bitumen	340	343	365	323

The modified bitumen (20%) gives the less penetration value than conventional bitumen and also gives better consistency. Plastic in bitumen increase the suitability of bitumen for use under different climatic conditions. It may use in highly hot climate area to with stand the high temperature.

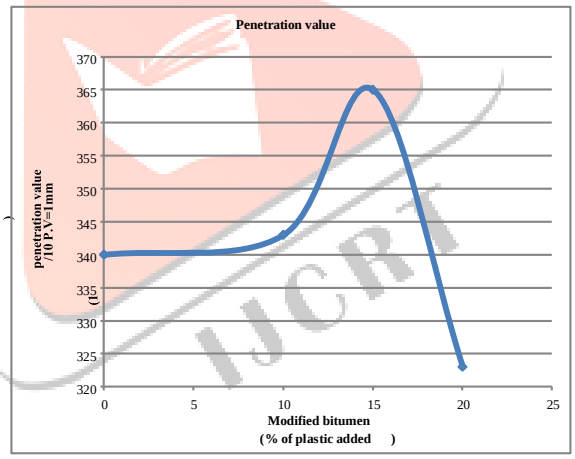


Figure 4.1-Variation in penetration of bitumen with increase in % of plastic

2. SOFTENING POINT TEST

The experiment has been performed successfully and the softening point came out to be 80°C is 10% of bitumen replaced by waste plastic. Bitumen having this softening point is used in city's having highest maximum temperature. To avoid the problems of rutting and bleeding this bitumen should be used in the hot climatic region.

Table 4.2- Observation for the softening point test

S.No	Modified bitumen (% of plastic replaced)	Softening point (Temperature in °C)
1	0 (conventional)	55
2	10	67
3	15	70
4	20	80

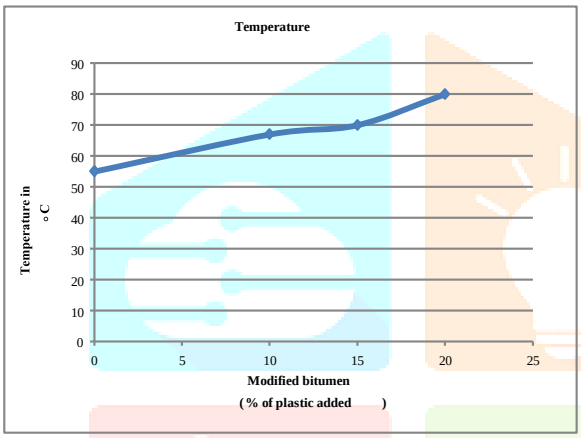


Figure 4.2- Variation in softening point of bitumen with increase in % of plastic

3. FLASH AND FIRE POINT TEST:

The flash point is taken as the temperature read on the thermometer at the time of flame application the causes a bright flash in the interior of the cup in the closed system for open cup it is instance when flash appears first at any point on the surface of the material is 234°C. The heating is continued until the volatiles ignite and material continuous to burn for 5 seconds. The temperature of the sample material when this occurs is recorded as the fire point is 358°C.

Table 4.3- Observation of flash and fire point test

Modified bitume(% of plastic replaced)	Flash point	Fire point
0 (conventional)	219°C	342°C
10	226°C	354°C
15	232°C	355°C
20	234°C	358°C

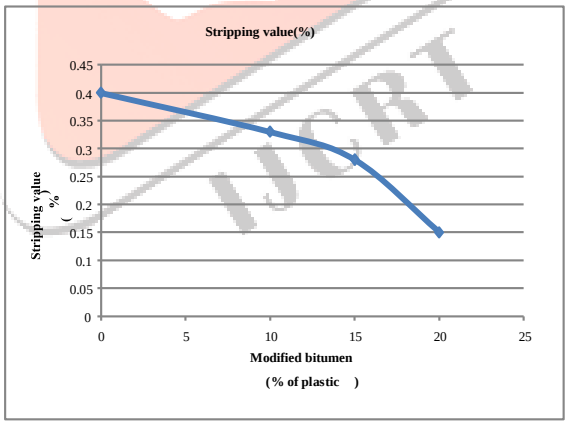
Figure 4.3- a) Variation in flash point of bitumen with increase % of plastic

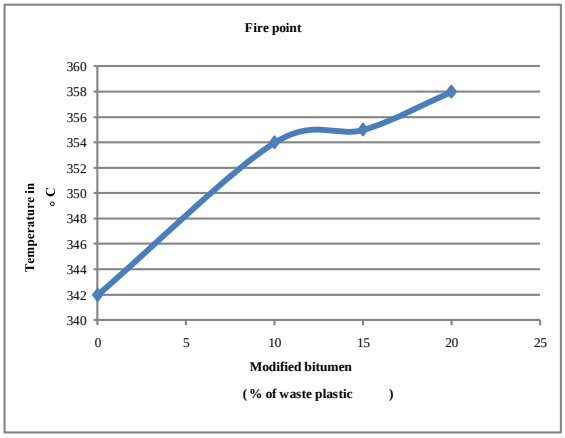
4. STRIPPING VALUE TEST

The stripping value tests of aggregates have a lesser affinity with bitumen in comparison with water and hence stripping value of bituminous binder is done when the mix is immersed in water.

Table 4.4 Observation of stripping value test

S.No.	Modified bitumen (% of plastic)	Stripping value(%)
1	0(conventional)	0.40
2	10	0.33
3	15	0.28
4	20	0.15





5.MARSHALL STABILITY TEST

The Marshall stability of mix is defined as a maximum load carried by a compacted specimen. Marshall Stability method is used in pavement design to determine the optimum binder content (OBC) in bitumen pavement.

Table 4.6- Observation of Marshall Stability test

S.No	Plastic content %	
1	0 (conventional)	35
2	10	38
3	15	42
4	20	45

Marshall Stability is related to the resistance of bituminous materials to distortion, displacement, rutting and shearing stresses. The Stability is derived mainly from internal friction and cohesion. This test is extensively used in routine test programs for the paving jobs. This is the test which helps us to draw Marshall Stability vs. bitumen.

CONCLUSION

Plastics will increase the melting point of the bitumen. The use of the innovative technology not only strengthened the road construction but also increased the road life as well as helps to improve the environment and also creating a source of income. Plastic roads would be a boon for India's hot and extremely humid climate, where temperature frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes. It is hoped that in near future we will have strong, durable, and eco-friendly roads which will relieve the earth from all types of plastic was of bitumen by around . In this present project work, based on the laboratory studies it can be concluded that more than 10% and less than 30% of plastic waste can be suitable adopted in making the new roads with the plastic waste. In short we can conclude that, using plastic waste in mix help reduction in need of bitumen by around 15%,increase the strength and performance of road, avoid use of anti-stripping agent, avoid disposal of plastic waste by incineration and land filling and ultimately develop technology, which is eco- friendly.

REFERENCES

TEXT BOOKS

1. ASTM D 1559, Test method for resistance of plastic flow of bituminous mixtures using Marshall Apparatus, Volume 23, pp.1456-1464
2. Gawante A, Zamare G, Renge V.C, Tayde S. (2012) - An overview on waste plastic utilization in asphalting of roads, Journal of Engineering Research and Studies Vol.111/ Issue 11.
3. Prusty B. (2012) – Use of polyethylene in bituminous concrete mixes, published
4. B.TECH project NIT RKL.
5. Punith V. S (2012) and Veeraragavan A (2012) - Behavior of asphalt concrete mixtures with reclaimed polyethylene as additive, Journal of materials in civil Engineering, Volume 19, pp.500-507.
6. Sabina, Khan T.A, Sangita, Sharma D.K and Sharma B.M (2009) - Performance evaluation of waste plastic/polymers modified bituminous concrete mixes, Journal of Scientific and Industrial Research , Volume 68,pp.975-979.
7. Vasudevan R (2004) – Use of plastics waste in construction of Bitumen road.
8. Wegan V, Nielsen C.B (2001) – Microstructure of polymers modified binders in bituminous mixtures, PP.1-19.