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USE OF PLASTIC WASTE IN CONSTRUTION OF ROAD

[1] A. S. Sandbhor [2] J. K. Patil

JSPM'S RSCOE IInd Shift Polytechnic, Tathawade, Pune - 33

Department of Civil Engineering, Maharashtra, India

Abstract: *Disposal of waste materials together with waste plastic baggage has become a significant drawback and waste plastics cause environmental pollution. Utilization of waste plastic baggage in hydrocarbon combines has tested that these enhance the properties of mix additionally to determination disposal issues. Plastic waste that is cleansed is remove a size specified it passes through 2-3mm sieve victimization shredding machine. The aggregate mix is heated and also the plastic is effectively coated over the combination. This plastic waste coated mixture is combined with hot hydrocarbon and also the resulted mix is employed for construction. The utilization of the innovative technology won't solely strengthen the construction however conjointly increase the road life yet as can facilitate to boost the surroundings. Plastic roads would be a boon for India's hot and very wet climate, wherever temperatures oft cross 50°C and torrential rains produce disturbance, departure most of the roads with massive potholes. In my analysis work I even have done a radical study on the methodology of victimization plastic waste in hydrocarbon mixes and given the various tests performed on aggregates and hydrocarbon.*

Kyewords: Plastic, Bitumen, CO2

1. Introduction

India generates 1,88,000 tons garbage every day. Plastic Waste in different forms is found to be almost 9% to 12% in municipal solid waste, which is toxic in nature. Non-biodegradability of plastic in the environment has created numerous challenges for both urban and rural India. Common problems are choking of drains, stagnation of water, release of toxic gases upon open incineration. Research experiments in the public and private sector have been undertaken to address the growing environmental challenge. One of the solutions proposed and demonstrated was by Professor Vasudevan in utilizing waste environmental plastic in road construction. Road construction projects were pioneered in the state of Tamil Nadu followed by Karnataka as early as 2001. Both states have made significant progress since in rural and urban roads respectively. Other states such as Andhra Pradesh, Goa, Jharkhand, Delhi, and Maharashtra have demonstrated projects in other states as well. strength of concrete by small percentage. But for tensile strength it is more effective. There are number of advantages of using fibre reinforced concrete.

2. Related Work

Fransis Hveem "Optimum quantity of bitumen inroads"(1942) [1] who was a project engineer of California Department of Highways. He did not have any previous experience on judging, the required mix of its colour, hence he decided to measure various mixture parameters to find the optimum quantity of bitumen. He had

used the surface area calculation concept, (which was already in use, at that time for the cement concrete mix design), to estimate the quantity of bitumen actually required.

Anzar Hamid Mir "Plastic waste in pavement construction"(2015) [2] studied the visco-elastic nature of binders and found that the complex modulus & phase angles of the binders, need to be measured, at temperatures and loading rates which different resemble of climatic and loading conditions.

Kurmadasu Chandramouli "Plastic waste: its use in the construction of the roads "(2016) [3] reported that asphalt concrete using polyethylene modified binders were more resistant to permanent deformation at elevated temperature and found improvement in stripping characteristics of crumb rubber modified mix as compared to unmodified asphalt mix.

Amit P. Gawande "Economics And Viability Of the Plastic Road" (2013) [4] evaluated flexural fatigue life of asphalt concrete modified by 3% crumb rubber as part of aggregated and reported that fatigue life and creep properties of polymer modified mixes increased significantly as compared to unmodified asphalt mixes.

3. Methodology

Dry process:-

- Heat aggregate at 160° c to 170° c
- We need shredded plastic (2.36 to 4.75 mm)
- Add plastic in equal amount of heated aggregate
- Heat bitumen at 170° c then add it in aggregate.
- Then mix aggregate & bitumen
- Transfer it site

Wet process:-

- Heat aggregate at 160° c to 170° c
- We need shredded plastic (2.36 to 4.75 mm)
- Add plastic in heated bitumen directly
- Heat bitumen at 170° c then add it in aggregate.
- Then mix aggregate & bitumen usin mechanical stirrer.
- Transfer it site

- **Characteristics of the process are: -**
- Easy process without any new machinery
- Simple process without any industry involvement
- Use of lesser percentage of the bitumen and thus savings on bitumen resource
- Use of plastics waste for the safe and eco-friendly process
- Both Mini Hot Mix Plant and the Central Mixing Plant can be used
- Only the aggregate is polymer coated and bitumen is not modified
- Use 60/70 and 80/100 bitumen is possible
- No evolution of any toxic gases like a dioxin

- **Material Required :-**

Aggregate:-

Aggregates used in surface course is 10mm-20 mm

Bitumen:-

Bitumen acts as binding agent for aggregates in bituminous mixes. Generally in India bitumen used in road construction of the flexible pavement is of grades 60/70 or 80/100 penetration grade.

Waste Plastic Modifiers:-

Modifiers are generally used to enhance the properties of bituminous concrete mixes by reducing the air void present between the aggregates and also to bind them together so that no bleeding of bitumen will occur. For the present study plastic waste such as carry bags, water bottles, milk packets, glasses, cups, etc will be used as a modifier.

Plastic, Polymer and Rubber

Bitumen is a visco elastic material, because of bitumen pavement possess the flexibility and plays a very important role in pavement performance. Use of plastic waste and crumb rubber which is obtained from waste tire rubber from vehicles in the construction of flexible pavement is gaining importance, Since 1843 polymers are being used in bitumen as modifier. In the year 1950, North America and the Europe started to use latex rubber where the research started in 1930. Because of high expense of the polymer, USA was limited to use Polymer εodified Rubber (PεA) in the end of 1970.

Bituminous mixture is stable which one of the most important properties of bitumen is. The optimum stability is the design stability which can be withstand the traffic condition as required. If the stability is not enough it will cause striping, shoving and higher flow of the road surface.

To prevent the pavement from these kinds of failure there must be low flow. Flow is the property of which is responsible in reducing stability. There is relation between hot climate rutting and cold climate cracking because of the sensitive response of bitumen due to temperature variation and imposed traffic load. To improve the performance and the quality of the asphalt addition of the polymers is a very effective way. The very first company which started to use poly phosphoric (PPA) as a modifier in bitumen without the blowing of air is TOSCO (The Oil Shale Company). There are some virgin polymers of that can be classified into 5 groups. Table 1 shows the summary of these polymers and their advantages and disadvantages along with the current use as bitumen modifiers.

Table 1. Characteristics of polymers used to modify bitumen

Polymer	Advantages	Disadvantages	Uses
Polyethylene (PE)	High temperature resistance Aging resistance High modulus low cost	Hard to disperse in the bitumen Instability problems High polymer contents are required to achieve better properties No elastic recovery	Industrial uses Few road applications
Polypropylene (PP)	No important viscosity increase even though high amount of polymer are necessary (ease of handling and layout) High RandB low penetration Widens the plasticity range and improves the binder's load resistance	Separation problems No improvement in elasticity or mechanical properties low thermal fatigue cracking resistance	Isotactic PP is not commercially applied Ataxic PP is used for roofing
Polyvinylchloride (PVC)	lower cracking PVC disposal	Acts mostly as filler	Not commercially applied

4. Results

- **Test**
- **Preparation of Modified Bituminous Binders**

The collected Plastic waste was cut into small pieces as far as possible. It is clean by washing. The plastic pieces were sieved through 4.75 mm. sieve and retaining at 2.36 mm sieve was collected. Firstly, Bitumen was heated up to the temperature about 160° -170° c which is its melting temp. Pieces were added slowly to be the hot bitumen of temperature around 160-170° c. The mixture was stirred manually for about half an hour. In that time of period temperature was kept constant about 160-170° c. Plastic-bitumen mixtures of different compositions were prepared for experimental procedures. The percentage of modifier varied from 1% to 9%.

Different percentages of modifier (waste plastic fibers) added to VG 30 grades of bitumen affected the physical properties of the binder in terms of penetration, softening point, ductility and viscosity which is presented in Table 4.

1. Penetration Test Results

The Penetration values are decreasing significantly when VG 30 grade bitumen are mixed with the modifier and this variation is much more when firstly plastic is added in bitumen. And after this when continuously increases plastic modifier by the 1% of weight, small decrement is occur in the penetration value, and after 8% this decrement is more than the previous value of penetration. Thus there is a significant decrease in the penetration values for modified blends, indication the improvement in their temperature susceptibility resistant characteristics.

2. Ductility test results

The binders possessing high ductility have good cementing qualities in the road surface and adhere well to aggregates. It may be seen that he ductility values for VG 30 bitumen modified with 9 percent modifiers are low compared to 8 percent modifier. The ductility values decrease with increase in percentage of modified.

Table 2 Properties of modified bitumen

Bituminous Binder+%Modifier	Penetration	Ductility	Softening Point	Viscosity at 60° C, poise
VG 30 Bitumen	63.00	93.00	50.00	2689
VG 30+1%	56.231	92.522	50.654	4430
VG 30+2%	55.941	91.804	51.155	6850
VG 30+3%	55.253	91.102	51.822	7100
VG 30+4%	54.614	90.451	52.355	7900
VG 30+5%	54.121	89.784	52.92	7200
VG 30+6%	53.665	88.240	53.524	6450
VG 30+7%	52.001	88.355	54.00	6725
VG 30+8%	51.851	87.661	54.821	7290
VG 30+9%	50.555	86.256	56.757	7500

3. Softening point test results

The softening point is increase when plastic percentage is increases modifiers bitumen and this is due to the bitumen becomes increasingly viscous. Softening point of VG 30 grade bitumen, increase to more than 55^0 c by addition of 9 percent fibers. Therefore 8 percent should be the upper limit for VG 30 bitumen. The results show that lower percentage of plastic fibers can be used in road construction satisfactorily.

4. Viscosity

When bitumen is blended with polymer, a multi phase system is formed; one such phase is rich in asphaltenes not absorbed by the polymer which enhances the viscosity by the formation of more complex internal structure. The flow behavior of a bituminous material described in terms of viscosity, exhibits Newtonian and non-Newtonian characteristics depending on the composition and source of the crude .Temperature and loading also affect the behavior describing the viscoelastic properties of the material. In VG 30 grade bitumen with viscosity of 60^0 C shows increase in viscosity with the increase in polymer concentration. However, Non-Newtonian behavior is observed with the decrease in viscosity as shear rate increases for polymers at 8% concentration. This non-Newtonian phenomenon is dependent on the internal structure of the Polyethylene.

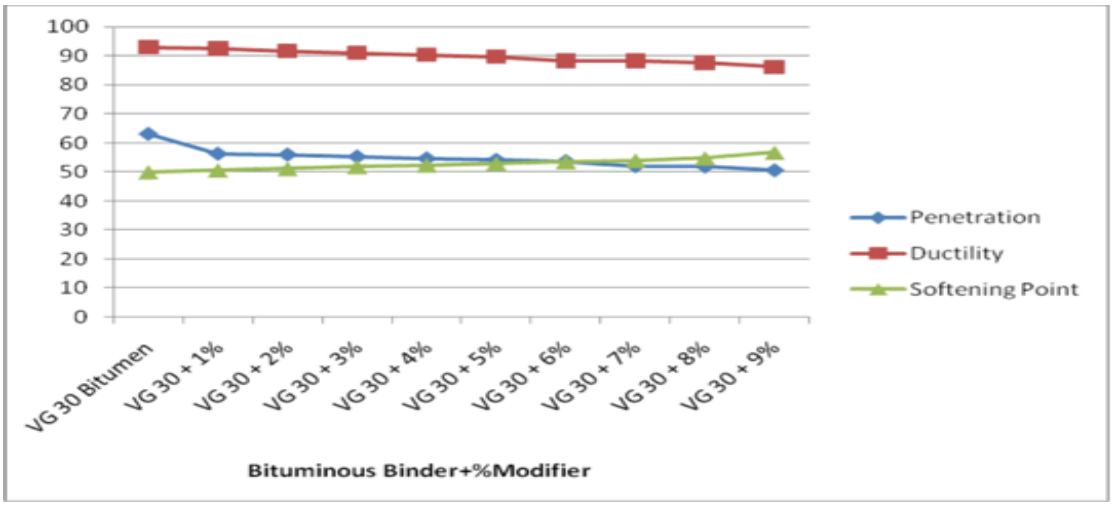

Fig 1 Properties of Modified Bituminous Mix

Thus the increase in percentage of polymer decreased the penetration value. This shows that the when plastic are start adding the bitumen hardness are increases. Also the penetration values of the bituminous mix are decreasing this is depending upon the percentage of polyethylene by weight are added. The ductility is decreased by the addition of plastic waste to bitumen. The decrease in the ductility value is due to binding properties of ethene monomers molecules with bitumen. The softening point of the bituminous mix is also increased by the addition of polyethylene into the bitumen. With increasing the percentage of plastic waste by weight the softening point is also increases. The increment in softening of point may be due to the chemical nature of plastic waste are added. The increase in the softening point shows that there will be less bleeding during summer. So friction was reduces for the moving vehicles and on the other side, if it rains the bleedings accounts for the slippery condition. Both these adverse conditions are much reduced by plastic-bitumen blend.

5. Conclusion

we can conclude that, the using plastic waste in mix will help reduction in need of bitumen by around 10%, increase the strength and performance of road, avoid use of anti stripping agent, avoid disposal of the plastic waste by incineration and land filling and ultimately develop a technology, which is eco-friendly. Increased traffic conditions will and are reducing the life span of roads. Plastic roads are means of the prevention and ultimately will be the cure. It will save millions of Rupees in future and reduce the amount of resources used for construction. The generation of waste the plastics is increasing day by day. The major polymers, of namely polyethylene, polypropylene, and polystyrene show adhesion property in their molten state. Plastics will be the increase the melting point of the bitumen. Hence, the use of the waste plastics for pavement is one of the best methods for easy disposal of waste plastics. The use of the innovative technology not only the strengthened of the road construction but also increased the road life as well as creating a source of income. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures 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 the strong, the durable and eco-friendly roads that will relieve the earth from all type of plastic waste.

We compared standard concrete block with fibre reinforced concrete block.

We got compressive strength of standard concrete block 20.76 N/mm^2.

We got compressive strength of fibre reinforced concrete block 23.08 N/mm^2.

Hence, we conclude that fibre reinforced concrete has more strength than standard concrete block. Therefore, fibre reinforced concrete should be used for construction purposes.

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