ENACTMENT OF UTILIZATION OF WASTE PLASTIC AND RUBBER IN FLEXIBLE PAVEMENTS

Mr. M. VIKASH V.N.V.L. SRI INDIRA, G. RAMASAIKIRAN, V. ANIL, A. VINAY
Asst. professor, Department of Civil Engineering, Aurora's Technological & Research Institute, Hyderabad, India.
Department of Civil Engineering, Aurora's Technological & Research Institute, Hyderabad, India.
Department of Civil Engineering, Aurora's Technological & Research Institute, Hyderabad, India.
Department of Civil Engineering, Aurora's Technological & Research Institute, Hyderabad, India.
Department of Civil Engineering, Aurora's Technological & Research Institute, Hyderabad, India.

Abstract: The Disposal of waste materials including waste plastic bags has become a serious problem and waste plastics are burnt for apparent disposal which causes environmental pollution. The utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of the mix in addition to solving disposal problems. Plastic waste whichis cleaned is cut into a size such that it passes through a 2-3mm sieve using a shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste-coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The mix will be carried out in the proportion of 0%, 0.4%, 0.8% & 1.2% of HDPE plastic and 0%, 1%, 2% & 3% of Crumb rubber.

***Keywords*--plastic waste, bitumen, aggregates, plastic roads**

I. INTRODUCTION

Today the availability of waste plastic and rubber is enormous. The disposal of rubber and plastic waste through landfilling or Incineration has a certain impact on the environment. 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. But its water resistance is poor. To overcome this problem here the properties of Bitumen is improved by blending it with waste rubber and plastic.

Classification and types

Rigid Pavement.
Flexible pavement

Why to use plastic?

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. Anti-stripping agents are being used. A common method to improve the quality of bitumen is by modifying the rheological properties of bitumen by blending it with organic synthetic polymers like rubber and plastics. Studies on this subject are going on both at the national and international levels.

Thermal study

A study of the thermal behavior of the polymers namely polyethylene, polypropylene, and polystyrene shows that these polymers get softened easily without any evolution of gas around 130-1400C, this has been scientifically verified. At around 3500C, they get decomposed releasing gases like methane, ethane, etc., and above 7000C, they undergo combustion producing gases like CO and CO2.

Classification of Plastic Waste

a) Polyethylene

LDPE (Low-Density Poly-Ethylene):

Low-density poly-ethylene is this plastic waste available in the form of carry bags generally in stores these plastic 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 depends upon the use and need of the industries. It is available in the form of plastic bottles and mat sheets etc.

Objectives:

- To determine the basic properties of aggregates, bitumen,plastic wastes used and Crumb rubber.
- To select the optimum percentage of plastic waste (PET) and rubber (fine size) to be blended with commonly used bitumen to produce maximum compressive strength.
- To study the Marshall properties of the Dense BituminousMacadam and bitumen concrete mixes with PET bottles and crumb rubber so as to determine how they affect the properties of mixes and to compare it with each other andwith the conventional mix.

II. LITERATURE REVIEW

i. Gawande (2012)

Gave an overview on waste plastic utilization in asphalting road by using both wet and dry method. They said that use of modified bitumen with the addition of processed waste plastic of about 5-10% by weight of bitumen helps in improving the longevity and pavement performance with marginal saving in bitumen usage and according to them use of waste plastics in the manufacture of roads and laminated roofing also help to consume large quantity of waste plastics.

ii. Kalantar (2010)

Investigated the possibility of using waste PET as polymer additives for binder in asphalt mix. Waste PET is powdered and mixed in proportions 2, 4, 6 , 8 and 10 % (by the weight of OBC) with bitumen at temperature 150 C. PET modified binder resulted in higher resistance to permanent deformation and higher resistance to rutting due to their higher softening point when compared to conventional binders.

iii. Kalantar (2010)

The use of waste materials like plastics and rubber in road construction is being increasingly encouraged so as to reduce environmental impact. Plastics and rubbers are one of them. The plastic waste quantity in municipal solid waste is growing due to the increase in population and changes in lifestyle. Similarly, most tiers, especially those fitted to motor vehicles, are manufactured from synthetic rubber. Disposal of both is a serious problem. At the same time, the continuous increase in the number of vehicles emphasizes the need of roads with better quality and engineering design. This waste plastic and rubber can be used to moderately replace the conventional material which is bitumen to improve desired mechanical characteristics for a particular road mix. In the present study, an evaluation is carried out between the use of waste plastic like PET bottles and crumb rubber (3%, 4.5%, 6%, 7.5%, 9% by weight of bitumen) in bitumen concrete mixes to analyze which has better ability to modify bitumen so as to use it for road construction.

iv. Apurva Chavan (2013)

She says that " using plastic waste will help reduction in need for bitumen by around 10%, increase the strength and performance of road". Mrs.Vidula swami (2012) says that"the addition of plastic increases the hardness of the bitumen".

III. MATERIALS USED

Aggregate

Aggregates are coarse particulate rock-like materials consisting of a collection of particles ranging in size from < 0.1 mm to > 50 mm. It includes gravel, crushed rock, sand, recycled concrete, slag, and synthetic aggregate. Aggregate is a granular material, such as sand, gravel, crushed stone, crushedhydraulic cement concrete, or iron blast-furnace slag, used with a hydraulic cementing medium to produce either concrete or mortar. Types of aggregates include Coarse aggregate and fine aggregate. The aggregate of each type is further sub-divided into many types and classified based on its size. The technique of Sieve Analysis is used for gradation ofaggregate for use in concrete and for other applications.

Fig. 1 Aggregate

Bitumen

Bitumen, also known as asphalt in the United States, is a substance produced through the distillation of crude oil that is known for its waterproofing and adhesive properties. Bitumen production through distillation removes lighter crude oil components, such as gasoline and diesel, leaving the "heavier" bitumen behind. The producer often refines it several times to improve its grade. Bitumen can also occur in nature: Deposits of naturally occurring bitumen form at the bottom of ancient lakes, where prehistoric organisms have since decayed and have been subjected to heat and pressure.

VG-30 Bitumen

VG-30 is especially used to construct extra heavy-duty Bitumen pavements that need to tolerate significant traffic loads. It can be used instead of 60/70 penetration bitumen grade.

Because of having good thermal susceptibility, we use VG30 in areas that have a higher temperature. VG-30 bitumen is also suitable for use in hot and rainy weather conditions instead of bitumen penetration grades. The more viscose the bitumen, the fewer the chance of being affected by water

Fig. 2 Bitumen

Waste Plastic

Plastic waste, or plastic pollution, is 'the accumulation of plastic objects (e.g.: plastic bottles and much more) in the Earth's environment that adversely affects wildlife, wildlife habitat, and humans. The millions of tons of plastic swirling around the world. But plastic pollution arguably poses a bigger threat to the plants and animals, including humans who are based on land.

Very little of the plastic we discard every day is recycled or incinerated in waste-to-energy facilities. Much of it ends up in landfills, where it may take up to 1,000 years to decompose, leaching potentially toxic substances into the soil and water. The terrestrial microplastic pollution is much higher than marine microplastic pollution –estimated at four to 23 times higher, depending on the environment.

Fig. 3 . HDPE plastic granulates

Crumb Rubber

Crumb rubber is recycled rubber produced from automotive and truck scrap tires. During the recycling process, steel and tire cord (fluff) are removed, leaving tire rubber with a granular consistency. Continued processing with a granulator or cracker mill, possibly with the aid of cryogenics or by mechanical means, reduces the size of the particles further. The particles are sized and classified based on various criteria including colour (black only or black and white). The granulate is sized by passing through a screen, the size based on a dimension (1/4inch) or mesh (holes per inch: 10, 20, etc.). Crumb rubber is often used in artificial turf as cushioning.

Fig. 4 Crumb rubber powder

IV. TESTS

Marshall stability test

Procedure:

Prepare the concrete in the required proportions and make the Specimens are heated to 60 ±1oC either in a water bath for 30-40 minutes or in an oven for a minimum of 2 hours. The specimens are removed from the water bath or oven and placed in the lower segment of the breaking head. The upper segment of the breaking head of the specimen is placed in position and the complete assembly is placed in position on the testing machine. The flow meter is placed over one of the posts and is adjusted to read zero. Load is applied at a rate of 50 mm per minute until the maximum load reading is obtained. The maximum load reading in Newton is observed. At the same instant, the flow as recorded on the flow meter in units of mm was also noted.

Fig.5. Mixing of bitumen

Fig. 6. Marshall stability test

Flow (mm)	BULK DENSITY (gm/cc)	AIR VOIDS (%) Vv	VMA (%)	VFB (%)
3.4	2.3	4.68	15.93	70.6
3.5	2.314	4.1	15.42	73.39
3	2.312	4.19	15.49	72.98
MORTH AND IRC RECOMMENDATIONS				
2.5-4	02-03	03-05	Min 13	65-75

Table 2: Marshall stability values for modified and normal bitumen

S.NO	HDPE PLASTIC %	CRUMB RUBBER %	BITUMEN %
1.	0	0	5.5
2.	0.4	1	
3.	0.6	1.1	
4.	0.8	1.2	

Table. 1 Different % of HDPE plastic and CR added to bitumen

WEIGHT OF MIX (g)	WEIGHT OF AIR (g)	WEIGHT OF WATER (g)	STABILITY OF BITUMEN (kfg)	
			MEASURED	CORRECTED
1200	1213	687.91	421	1490.34
	1190	678.04	338	1196.52
	1196	681	352	1246.08

Table 2: Marshall stability values for modified andnormal bitumen

V. CONCLUSION

- The generation of waste plastic and rubber is increasing day by day. The use of waste plastic and rubber bitumen mix forms better material for pavement construction.
- Use of plastics and rubber for pavement is the best method for disposal of wastes.
- Plastic will increase the melting point of bitumen; this innovative technology not only strengthen the construction but also increased the road life.
- This method will also help making roads faster and it is also environment friendly.
- The modified bitumen mix shows better properties than normal bitumen.
- The highest value of penetration, softening point and ductility is obtained at 0.8% replacement of HDPE plastic and 2% replacement of crumb rubber.

- The Marshall stability value has increased by 25% by using modified bitumen.
- This results in cost control and increases the life period of pavement and requires low maintenance.

VI. REFERENCES

1. IS – 2386: 1963 – Tests for aggregates.
2. IS – 73: 2013 – Bitumen pavement specifications.
3. IS – 1202 to 1208: 1978 – Bitumen tests.
4. Pavement design by R. Srinivasa kumar.
5. Highway Engineering by S. K. Khanna.
6. Athira R Prasad1, Dr. Sowmya N J2,1PG Student, dept of civil engg, Associate professor, dept of civil engg, KVGCE, Sullia Karnataka, India.
7. Ministry of Road Transport and High Ways, Manual for construction and supervision of Bituminous works, New Delhi, November 2001.
8. Mohammad T. Awed and Lina Shabeeb "The use of polyethylene in hot asphalt mixtures", American Journal of Applied Sciences 4 (6): 390-396, 2007. ISSN 1546 - 9239© 2007
9. Md. Nobinur Rahman, M. A. Sobhan, T.U. Ahmed and Mohammad Ahmed uzaman, "Performance Evaluation of Waste Polyethylene and PVC On Hot Asphalt Mixtures" in American Journal of Civil Engineering and Architecture, 2013, Vol.1, No. 5, 97-102.
10. Apurva J Chavan, Lecturer at Pravatibai GenbaMoze, "Use of Plastic Waste in Flexible Pavements" in International Journal of Application or Innovation in Engineering and Management (IJAIEM) as Volume 2, Issue 4, April 2013. ISSN 2319 – 4847.
11. Sandhya Dixit, Prof. Deepak Rastogi "Studies on the Improvement of Characteristics of Bitumen with Use of Waste Plastic" in International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 3, March 2013).