INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume3, Issue3)
Available online at www.ijariit.com

Replace Of Asphalt with Waste Polythene in Bitumen Road

Mr. Yakub Ansari
Shram Sadhana Bombay Trust College of Engineering and Technology, Maharashtra
ansari_ykb@yahoo.co.in

Prof. F.I Chavan
Shram Sadhana Bombay Trust College of Engineering and Technology, Maharashtra
chavan.faruq@sscoetjalgaon.ac.in

Prof. M. Husain
Shram Sadhana Bombay Trust College of Engineering and Technology, Maharashtra
husain.mujahid@sscoetjalgaon.ac.in

Prof. Vajed Shaikh
MMANTC, Mansoora, Malegaon.
skvajed@gmail.com

Abstract: ***In India consumption of Plastic is 15 million tons up to 2015 and is set to be the third largest consumer of plastics in the world. India is a top 20 number country that dumps maximum plastic in the ocean. As per a survey conducted by Central Pollution Control Board (CPCB) in 60 cities of the country, the quantum of plastic waste generation is estimated to be 15,342.6 tons per day. Plastic is a non-biodegradable material and researchers found that the material can remain on earth for 4500 years without degradation. Several studies have proven the health hazard caused by improper disposal of plastic waste. The health hazard includes reproductive problems in human and animals. Looking forward the scenario of present lifestyle a complete ban on the use of plastic can't be put. Although the waste plastic taking the face of the devil for the present and future generation, we can't avoid the use of plastic but we can reuse it. The threat of disposal of plastic will not solve until the practical steps are not initiated at the ground level. It is possible to improve the performance of bituminous mixes used in the surface course of roads. Studies reported in the use of recycled plastic, mainly polyethylene, in the manufacture of blend indicated reduced permanent deformation in the form of rutting and reduced cracking and crazing of the pavement surface. The field tests withstand the stress and proved that plastic wastes used after proper processing as an additive would enhance the life of the roads and also solve environmental problems.***

The data we look above was a comparison of the consumption of plastic in World and in India. India generates 5.6 million metric tons of plastic waste annually, with Delhi generating the most of at municipality at 689.5 metric tons every day, according to a report from the Central Pollution Control Board (CPCB). CPCB submitted the report to the Indian Supreme Court, which said, "We are sitting on a plastic time bomb.

Keywords: Plastic, Bitumen, Polyethylene, Asphalt, Aggregate.

1. INTRODUCTION

TABLE NO. 01 YEAR WISE PLASTIC CONSUMPTION OF WASTE IN INDIA

SR.NO.	YEAR	CONSUMPTION(TONNES)
01	1996	61000
02	2001	400000
03	2006	700000
04	2011	135000
05	2016	174000

Nowadays we can use plastic in road construction purpose. Plastic increases the melting point of the bitumen and makes the road retain its flexibility during winters resulting in its long life. Shredded plastic waste acts as a strong binding agent for tar making the asphalt last long Processes for manufacturing bitumen mix road using plastic waste.

2.0 Classification of waste plastic

A) Polyethylene:

1. LDPE (Low-Density Poly-Ethylene): Low-density polyethylene this plastic waste available in the form of carrying bags generally in stores these plastic bags are very thin and also easily available.

2. HDPE (High-Density Poly-Ethylene): Generally High-density polyethylene type of plastic waste is available in the form of carrying bags and easily available in the market.

B) Polypropylene

This plastic may be available in the form of carrying 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.

2.1 Why use plastic

Plastic has a number of vital properties, which broken alone or together make a significant and expanding contribution to construction needs.

1. Durable & corrosion resistant.
2. Good insulation for cold, heat & sound saving energy and reducing noise pollution.
3. It is economical and has a longer life.
4. Maintenance free.
5. Hygienic & problems.
6. Ease of processing/ installation.
7. Lightweight.

2.3 Sources of waste plastic

1. Pre-use plastic

Pre-use plastic waste is likely to be the main source of plastics suitable for reprocessing from manufacturers of plastic products; in many instances, off-cuts can be reprocessed in-house. It is typically more valuable than post-use plastics waste, as it generally requires little processing to use in a new product.

2. Post use plastic:

Post-use plastic waste suitable for recycling generally falls into one of five main categories:

a. Plastic Bottles:

Plastic bottles and pots, tubs and trays are found mainly in the household waste stream; however, they may also be one of the main plastic applications suitable for recycling.

b. Plastic film

The plastic film is a thin-gauge packaging used as a bag or cover. Examples include plastic shopping bags, rubbish bags, bubble wrap stretch wrap etc.

c. Rigid plastic

Rigid plastics cover a large range of products, such as pipes, crates, expanded polystyrene packaging, moldings, drums and other containers. These products are made from a variety of different polymer types and can come from almost any source, from hospitals and caterers to agriculture and large industry.

d. Plastic Foam: Plastic foams are frequently used in packaging; the most common being expanded polystyrene (EPS). Major electrical and car manufacturers, such as Sony, Panasonic, Sanyo, Hitachi and Honda and leading electrical retailers like Dixons and Powerhouse, all have successful, cost-effective EPS recycling schemes.

2.4 Advantages of Plastic Asphalt Road

The threat of disposal of plastic will not solve until the practical steps are not initiated at the ground level. A well-constructed Plastic Tar Road will result in the following advantages:

- Increased road strength (increased Marshall Stability Value)
- Better resistance to water and water stagnation
- No stripping and have no potholes
- Increased binding and better bonding of the mix
- Increased load withstanding property
- Decreased consumption of bitumen
- Reduced pores in aggregate and hence less rutting and raveling
- Better soundness property
- Reduced maintenance cost of the road
- Increased life span of the road

- Decreased plastic leaching
- No effect of radiation(like UV)

3.0 Bitumen

Bitumen is used as binders in pavements constructions. Bitumen may be derived from the residue left by the refinery from naturally occurring asphalt. In India mostly 80/100 and 180/200 grade bitumen is used. Heavier grade cutbacks, rapid setting emulsions or heavier grade tars may also be used. The grade of basic bitumen is altered either by controlled refining or by mixing with diesel oil or other oils. For single dressings on WBM base course, the quantity of bitumen needed ranges from 17 to 195kg per 10m2 areas and 10 to 12kg per 10m2 area in case of renewal of blacktop surfacing. For second coat of surface dressing, the quantity of bitumen needed ranges from 10 to 12kg per 10m2 area. Bulk bitumen Lorries with tanks of capacity ranging from 5000 to 15000litres are used to transport bulk bitumen. As per PMC, the bitumen content in a mix should be 4% of weight by total mix for B.M. The paving bitumen available in India is classified into two categories:

1. Paving bitumen from Assam petroleum denoted as A-type and designated as grades A35, A90, etc.
2. Paving Bitumen from other sources denoted as S-type and designated as grades S35, S90.

3.1 Important properties of bitumen are

The 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.

Cut-back bitumen: The asphaltic bitumen is very often mixed with comparatively volatile solvents to improve the workability of the material. The solvent gets evaporated leaving behind the particles together. This cutback bitumen is classified into slow, medium and rapid curing depending upon the type of solvent used. Emulsions: An emulsion is a mixture of normally two immiscible liquids. Asphalt gets broken up into minute globules in water in the presence of the emulsifiers. It improves the workability of bitumen or asphalt. As a result of emulsification, asphalt is available at normal temperature in the liquid form.

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3.2 Role of polyethylene in bituminous pavements.

Use of polyethylene in road construction is not new. Some aggregates are highly hydrophilic (water loving). Like bitumen, polyethylene is hydrophobic (water hating) in nature. So the addition of hydrophobic polymers by dry or wet mixing process to asphalt mix lead to improvement of strength, water repellent property of the mix. Polyethylene's get added to hot bitumen mixture and the mixture is laid on the road surface like a normal tar road. Plastic roads mainly use plastic carry-bags, disposable cups, polyethylene packets and PET bottles that are collected from garbage as important ingredients of the construction material. Polymer modification can be considered as one of the solutions to improvise the fatigue life, reduce the rutting & thermal cracking in the pavement. Creating a modified bituminous mixture by using recycled polymers (e.g., polyethylene) which enhances properties of HMA mixtures would not only produce a more durable pavement, but also provide a beneficial way of disposal of a large amount of recycled plastics.

4.0 Aggregates

There are various types of mineral aggregates used to manufacture bituminous mixes can be obtained from different natural sources such as glacial deposits or mines and can be used with or without further processing. The aggregates can be further processed and finished to achieve good performance characteristics. Aggregate contributes up to 90-95 % of the mixture weight and contributes to most of the load bearing & strength characteristics of the mixture.20 Hence, the quality and physical properties of the aggregates should be controlled to ensure a good pavement. Aggregates are of 3 types:

Coarse aggregates

The aggregates retained on 4.75 mm sieve are called as coarse aggregates. Coarse aggregate should be screened crushed rock, angular in shape, free from dust particles, clay, vegetations and organic matters which offer compressive and shear strength and shows good interlocking properties.

Fine aggregates

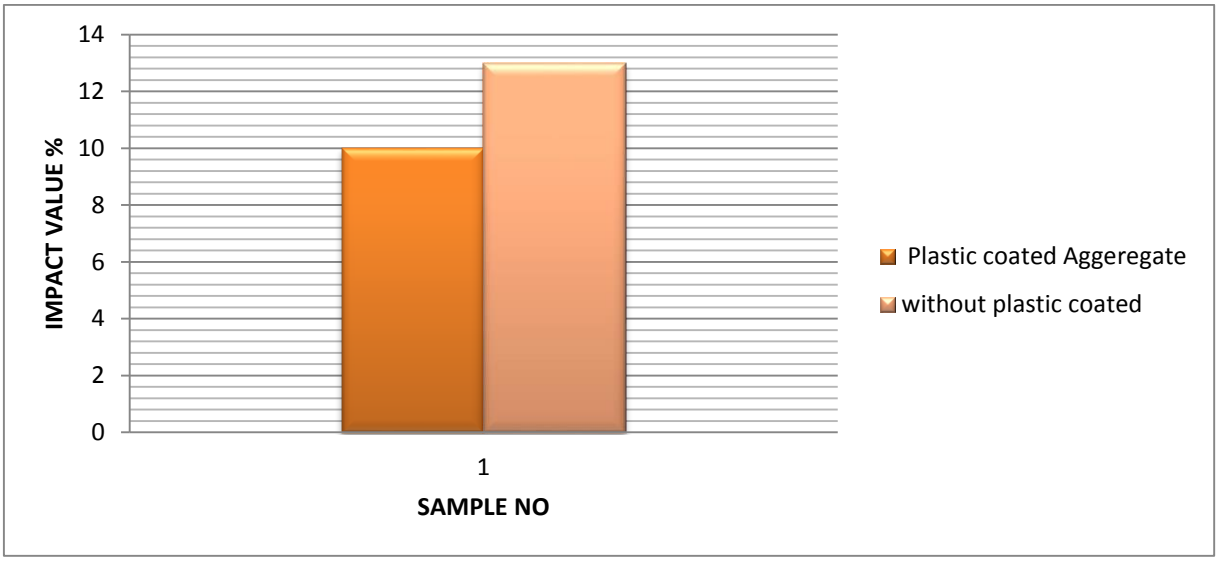
Fine aggregate should be clean screened quarry dusts and should be free from clay, loam, vegetation or organic matter. Fine aggregates, consisting of stone crusher dusts were collected from a local crusher with fractions passing 4.75 mm and retained on 0.075 mm IS sieve.

5.0 RESULT AND DISCUSSION

5.1 Aggregate impact value

Sr.no	Item	Test on without plastic coated aggregate	Test on plastic coated aggregate
1	Weight of Oven Dried Sample(W1)	604gm	670gm
2	Weight of fraction passing 2.36mm IS sieve (W2)	78gm	70gm
3	Weight of fraction Retained on 2.36mm IS	523gm	540gm
4	AIV: (W2/W1)X100	(78/604)x100=13gm	(70/670)x100=10gm

TABLE NO. 02 OBSERVATION TABLE FOR IMPACT VALUE TEST



The coating of plastics improves Aggregate Impact Value, thus improving the quality of the aggregate. Also, a poor quality of aggregate can be made useful by coating with polymers. It helps to improve the quality of flexible pavement. This shows that the toughness of the aggregate to face the impacts.

5.2 Water Absorption of fine and coarse aggregate

Fig.1 IMPACT TEST

TABLE NO 03 W.A. OF WITHOUT PLASTIC COATED AGGREGATE

SR NO	TYPE OF AGGREGATE	WEIGHT OF SURFACE SATURATED DRY SAMPLE(g) (A)	WEIGHT OF DRY SAMPLE (B) (g)	% OF WATER ABSORPTION W.A= (A-B/B)x100	AVERAGE % OF WATER ABSORPTION
01	Fine 10mm	2800	2703	3.5	2.77
02	Fine10mm	3000	2940	2.04	
03	Coarse20mm	2000	1935	0.8	1.125
04	Coarse20mm	2100	2072	1.35	

TABLE NO 04 W.A. OF PLASTIC COATED AGGREGATE

SR NO	TYPE OF AGGREGATE	WEIGHT OF SURFACE SATURATED DRY SAMPLE(g)	WEIGHT OF DRY SAMPLE (g)	% OF WATER ABSORPTION W.A= (A-B/B)x100	AVERAGE % OF WATER ABSORPTION
01	Fine 10mm	2800	2750	1.8	1.7
02	Fine10mm	3000	2950	1.6	
03	Coarse20mm	2000	1990	0.5	0.7
04	Coarse20mm	2100	2080	0.9	

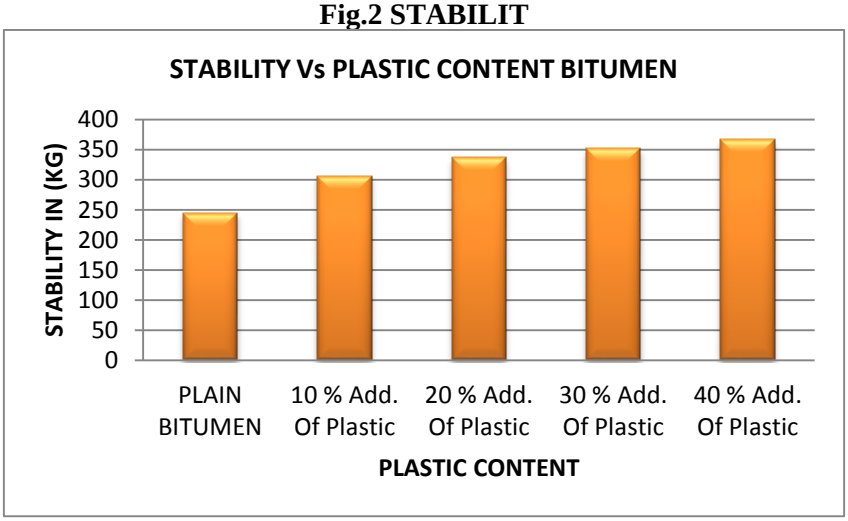
TABLE NO.05 RESULT OF MARSHAL STABILITY TEST ON BITUMEN

SR. NO	SAMPLE (% age of plastic replaced with bitumen content)	WEIGHT OF BLOCK (W1 gm)	WT. OF BLOCK IMMERSED IN WATER FOR 5 MINUTES (W2 gm)	WT. OF BLOCK PUT IN WATER (W3 gm)
1	Without addition of plastic	991.0	1006	615
2	10% addition of plastic	981.5	991	590
3	20% addition of plastic	963	982	590
4	30% addition of plastic	854	870	515
5	40% addition of plastic	990	1005	500

TABLE NO. 06 STABILITY OF THE BITUMEN AFTER ADDITION OF PLASTIC

BITUMEN CONTENT	STABILITY (kg)				
	PLAIN BITUMEN	10% ADDITION OF PLASTIC	20% ADDITION OF PLASTIC	30% ADDITION OF PLASTIC	40% ADDITION OF PLASTIC
	245	306	337	352	367

Fig.2 STABILIT

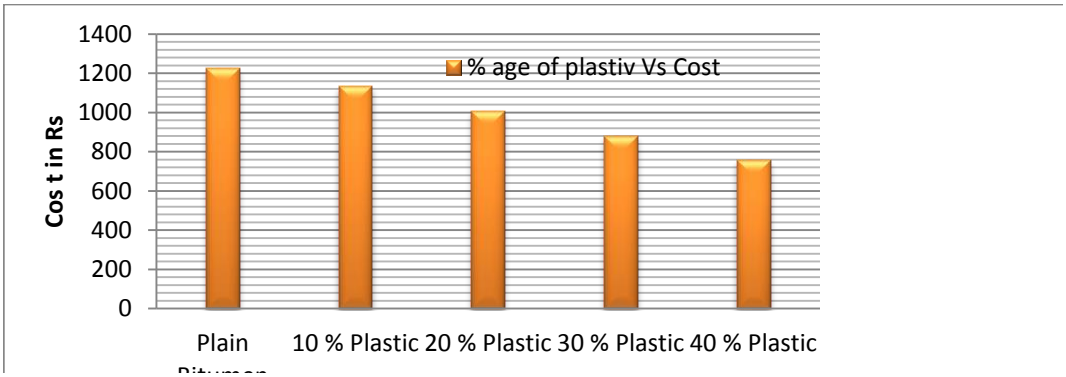


6.0 COST BENEFIT FOR 10 METER SQUARE AND HAVING THICKNESS 25MM
Total volume of road= (10X0.025) =0.25 cum.
For 1cum.m asphalt= 2.6 tone=2600kg
Wt. of asphalt for 0.25 cum= 0.25x2.6= 0.65 tone = 650kg
Volume of bitumen for **BC-II Asphalt is 5.4 %** of total volume = ((5.4/100)x0.25)= 0.0135 cum.m
Amount of bitumen= 0.0135x2600=36kg
Cost of bitumen per kg= 35Rs/kg
Cost of waste plastic per kg= 5Rs/kg

TABLE NO.07 For 10 meter square of 25 mm Thickness

Material needed	Plain bitumen	10% plastic coated	20%plastic coated	30%plastic coated	40% plastic coated
Bitumen(kg)	36	32.4	28.8	25.2	21.6
Waste plastic(kg)	00	3.6	7.2	10.8	14.4
Cost(Rs.)	1225	1134	1008	882	756

Fig. 3 chart of Cost Benefit



Having width= 3m, having Length= 1000m, having thickness = 0.025mm
Volume for 1km road = 75cum.
Volume of bitumen for **BC-II Asphalt is 5.4 %** of total volume = ((75) x (5.4/100)) = 4.05 cum.m
4.05x2600=10530 kg.

7.0 Cost of road project with plain bitumen for 1 km= 10350x35= 3, 68,550 Rs/-
STAGE –I
If we replace 10% with waste plastic
The cost of road project with 10% addition of plastic for 1 km plastic road.
For plastic
10% plastic = ((10530) x (10/100)) = 1053kg
Cost of plastic= 1053x5=**5,265 Rs/-**

For Bitumen
Quantity of bitumen=10530-1053= 9477kg
Cost of bitumen= 9477x35= **3, 31,695 Rs**
Total cost of project Addition of plastic with 10%
5265+331695= **3, 36,960 Rs.**
Total cost of project with plain bitumen
3, 68,550 Rs
Hence the cost of road construction is 3, **68,550 Rs** when we used the plain bitumen without the addition of waste plastic. And when we use Waste plastic with **10%** replaced by bitumen the cost of construction of the road is **3, 36,960 Rs. That is 31,590 Rs. is saved.**

TABLE NO.08 COST ANALYSIS OF ROAD PROJECT

SR. NO	PERCENTAGE OF PLASTIC	COST OF ROAD PROJECT FOR LENGHT 1 KM
01	NIL	3, 68,550 Rs
02	10%	3, 36,960 Rs.
03	20%	3, 05,370 Rs.
04	30%	2, 73,780 Rs
05	40%	2, 42,190 Rs

CONCLUSION

1. The test result shows that with an increase of waste plastic in bitumen increases the properties of aggregate and bitumen.
2. Using of waste plastic in flexible pavements shows the good result when compared with conventional flexible pavements.
3. The optimum use of plastic can be 3% to 4% of bitumen based on Marshal Stability test.
4. This has added more value in minimizing the disposal of plastic waste is the eco-friendly technique
5. Plastic will increase the melting point of the bitumen.
6. This innovative technology not only strengthened the road construction but also increased the road life. Plastic roads would be boon for India's hot & extremely humid climate, where temperature frequently crosses 50 degrees.

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