

Feasibility of Plastic Coat Road with respect to Cost and their performance

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Abstract – In recent times, with the advancement in technology, the many conventional road materials are replaced by new innovative materials to achieve a feeling of satisfaction towards economy, environment or speed of construction. A conventional and basic road material like Bitumen is also no exception to this idiom .Conventional Bitumen is , now-a-days , used by mixing Waste Shredded Plastic (WSP) , also popularly known as Economic Bitumen. This Bitumen are made by using waste plastic collected from municipal dumping yards and picked up from streets. This Study is conducted to analyze the engineering behavior of Plastic Coat Road with respect to cost and their performance.

In this study we generally focused on the cost of bitumen and their performance. So that we can reduce the cost of construction of road. For this we gathered the cost of binding material at their local place and according to percentage of stabilizer we estimate the cost of bitumen mixture in a cubic meter of raw material. Also we determine the properties of different percentages of waste plastic used in manufacturing. Basically we focused on solid waste dumping yards. According to all results and conclusion it find that plastic waste will going to be suited for manufacturing with different modified bitumen.

Key Words: Cost of Bitumen, Eco-friendly road, Waste Plastic Disposal, Increase Road life span

1. INTRODUCTION

The debate on the use and abuse of plastics vis-à-vis environmental protection can go on , without yielding results until practical steps are initiated at the grassroots level by everyone who is in a position to do something about it.

The plastic wastes could be used in road construction and the field tests withstood 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 present write-up highlights the developments in using plastics waste to make plastic roads. Plastic is everywhere in today's lifestyle. It is used for packaging, protecting , serving and even disposing of all kinds of consumer goods. With the industrial

revolution, mass production of goods started and plastic seemed to be a cheaper and effective raw material.

According to recent studies, Plastic can stay on earth for the year span of 4500 years without any change in his chemical property[1]. By the presence of plastic , some studies have linked the improper disposal of plastic cause's breast cancer , reproductive problems in humans and animals, and also decline in human sperm count and quality. If Govt. of India decided to put ban on the use of plastics on emotional platforms , the real cost would be higher.

1.1 Background

As early as 5000 years ago man has water proofing and binding agent use bitumen. The ancient civilization in Mesopotamia was familiar with bitumen, which was use for mumminification, cementing building blocks and water proofing irrigation canals. In Mohenjo-Daro in Indus valley, ritual pool water proofed with layer of bitumen on the wall has been found. The use of bitumen on road in recent times peeked up in 19th century. Natural rock asphalt was initially used, but as petroleum distillation began to grow as an industry to fuel the road vehicles, the residue found equally increasing use in constructing better roads.

1.2 Necessity of Plastic seal coat

- Stability to meet traffic demand by using plastic waste.
- Bitumen mixture content to ensure proper binding and water proofing .
- Voids to accommodate compaction due to traffic
- Flexibility to meet traffic loads , especially in cold season.
- Sufficient workability for road construction
- Economical plastic and bitumen mixture.

1.3 Objectives

- To study on reutilization processes of waste plastic.
- To study how to increase re-use of waste plastic.

- To compare cost of bitumen coat road and plastic coat road and their performances too
- To use Plastic as road seal coat material

2. THEORETICAL CONTENTS

Waste plastic is ground and made into powder; As per IRC 098:2013, waste plastic mixed with the bitumen is 6% – 8% of weight of bitumen. Use shredded plastic waste acts as a strong bitumen agent for tar making the asphalt last long. India consumption of Plastics will grow 15 million tonnes by 2015 and is set to be the third largest consumer of plastics in the world. Around 55% is being used for packing [2]. Another important observation was that the bituminous mixes prepared using treated binder could withstand adverse soaking conditions under water for longer duration.

The process is divided into four stages, as follows;

2.1 Collection of Plastic

Plastic Polyelthylene Terephthalte (PET) is very important raw material used in man-made fibers. PET is a kind of polyester material for fiber , Injection molded parts , as well as blow – molded bottles and jars. That can be available easily everywhere in waste form. Waste plastic carry bags are also one these ingredients. It can be collected from municipal solid waste dumping yards and street too.

2.2 Cleaning

Once the waste plastic has been identified and separated into one of its many forms the cleaning process can begin, this usually start with washing to remove paper labels , adhesive and other impurities.

2.3 Shredding

The Shredding stage is when the plastic is taken and loaded on to conveyor belts or directly into hoppers that funnel the clean scrap towards rotating metal teeth that rip the plastic into small pellets which are bagged up after wards ready for testing.



Fig-1: Shredding in RESIL Company, Jejuri

2.4 Collection

The shredded plastic waste passing through 2.36 mm and retains at 600µm. After collection plastic petals are use directly in bitumen for mixing.



Fig-2 : Collection of Shredded waste plastic

2.5 Shredding Machine

The electric motor available of 10 HP, 12 HP and 20 HP etc. and size of blades can be 8", 10", 12", 16" etc. The efficiency of the grinding machine varies with the power of electric motor and the size of blades the efficiency is in between 20 to 60 kg/hr.



Fig-3: Shredding Machine in RESIL, Jejuri

3. SEAL COATING

Traffic movement, especially at higher speeds can cause stones to break loose from road carpet. This creates the risk of flying stones. Loosing of stones from road surface may lead to starts Pot holes on the road. Seal coating is done in the spring and it is done in early summer before the heavy tourist traffics.

3.1 Functions of Bitumen Plastic seal coat

- Seal an existing bituminous surface against the intrusion of Air and water.
- Enriches an existing dry or raveled surface.
- Arrests the deterioration of a surface showing signs of distress.
- Provides a skid-resistant surface.
- Provides the desired surface texture.
- Improves light – reflecting characteristics where these are required(By use of light - colored Stone)

- Enables paved shoulders or other geometric features to be demarcated by providing a different texture or color.
- Provides a uniform- appearing surface.

3.2 Limitations of Plastic seal coat

- During melting / mixing of plastic and Bitumen mixture at hot mix plant ,it should be melt at above 1400 C to restrict the sticking mixture to boiler.
- Spraying of bitumen mixture on site is should also be sprayed at well maintained temp , it may cause blockage of nozzle of Spraying Gun and all Pumping Mechanism.
- Initially for new place where shredding machines are not available , the cost use of waste plastic is slightly more. (I.e. Transportation, collection,etc.)

4. LABORATORY STUDIES

Waste plastic were added by the varying the properties from 2-12percent by weight of bitumen with an increment of 2% (2,4,6,8,10 &12).

Table-1- Results of Test Carried out on Pure Bitumen and Plastic bitumen blend

Test	Normal Bitu.	2%	4%	6%	8%	10%	12%
Penetration (mm)	94	97.5	100.15	102.30	103.70	107	109
Ductility (cm)	93	93	91.5	86.7	86	83	81
Softening (o C)	44	44	44.8	45.8	45.6	46	47.2
Viscosity	53.7	54	69	75	81	87	92

5. CASE STUDY

Minimization of waste material is important aspect of the modern growth and development initiatives. Plastic is used in various domestic and industrial applications. Use of plastic bags and bottles is very common. The current review summarizes research on use of waste plastic.

Now, Many Government departments also involved in use of waste plastic in road construction. Pune Municipal Corporation initiated to do work on plastic and use it in road construction for better and green environment of Pune city.

5.1 Project Information

Name of Project : Construction of flexible pavement road by using waste plastic in Bhagwat Lane at Navi Peth ,Near Vaikunth Crematorium ,Pune.

Technical Details:

Date – 13rd December 2016 ,Monday
 Length of road – 150 Meters
 Aggregates(rock) – 220tonnes
 Pure Bitumen - 11 tonnes
 Shredded waste plastic(passing 2.36mm) – 1tonnes
 (Used according to IRC guidelines)

The Shredded plastic has been provided by Rudra Environmental Solutions(India) Ltd., Pune and has been collected by Keshav Sita Memorial Foundation Trust.

5.2 Method of use of plastic by PMC

Dry process is recommended for isolated works. It is recommended that the percentage of shredded waste plastic will be 8% to 10% as the optimum plastic content for blending the bitumen in the construction of plastic roads.

5.3 With Mini Hot mix Plant

The stone aggregate mix is transferred to the mix cylinder where it is heated to 1650 C (as per IRC specification) and then it is transferred to the mixing peddler, while transferring the hot aggregate into the peddler ,calculated quantity of shredded plastics is sprayed over the hot aggregate within 30 seconds. The sprayed plastic films melts and gets coated over the aggregate ,thus forming an oily coating. Similarly, the bitumen is to be heated to a maximum of 160o C in a separate chamber and kept ready. At the mixing peddler, the hot bitumen is added over the plastic coated aggregate and the resulted mix is used for road construction. The roads laying temperature is between 1100 C to 1200 C. The roller used is normal 8-ton capacity.

5.4 For intensive works, Central Mixing Plant can also be used.

The operating Techniques for this are given below: The aggregate materials will be transferred to the cylinder through the conveyer belt. The shredded plastics will be sprayed over the aggregate while it is moving in the conveyer belt. The spraying is done by manual labors standing up on both side of the conveyer belt of the central mixing plant. The addition of plastics should be done quantitatively.

5.5 The amount of binder to be added is calculated and monitored

In the central mixing plant, at the control room the addition of bitumen is monitored. It is easy to know the amount of bitumen sprayed per minute inside the cylinder. Amount of plastic to be added is @8 % to 10% of bitumen, i.e. for each 10 Kgs/minute 1kg plastic is required , and for manual work also the process is adaptable accordingly.

5.6 Advantages of Central Mixing Plant

1. Mixing of the plastics over the aggregate is uniform.
2. The coating is better and the mixing of bitumen is being carried out at places like.
 - a. Inside the cylinder
 - b. During loading in the dipper.
 - c. During transferring the mix in the paver
 - d. During the spreading of the mix by the paver.

5.7 Advantages of Plastic Tar Road

A well-constructed plastic Tar Road will result in the following advantages.

- Strength of the road increased (Increased Marshall Stability Value)
- Better resistance to water and water stagnation, No stripping and have no pot-holes.
- Increased binding and better bonding of the mix , with Increased load withstanding property.
- No leaching of plastics, aided no effect of radiation like UV.

5.8 Photographs of PMC Project during road laying



Fig-4: Bituminous mix lying on site



Fig 5 : News reported by PMC Junior Engineer Mis.Rupali Dhage on ABP MAJHA channel.

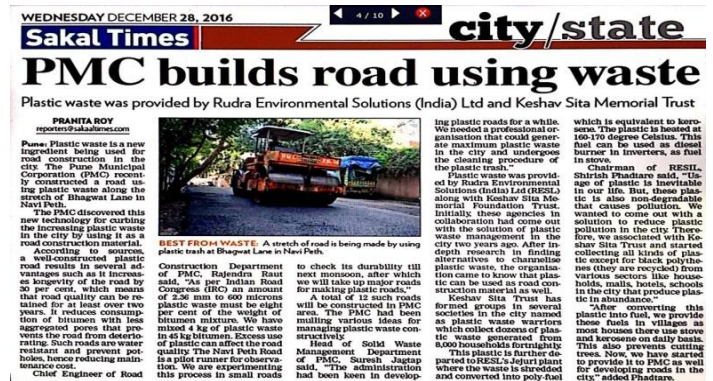


Fig 6 : News flash in Sakal Times

6. APPROX. COST ESTIMATION & COST COMPARISON

(Plastic bitumen blend seal coated road over pure Bitumen seal coated road)

Consider, Department have to complete construction of Road work of Length One Kilometers and width of 3.7 Meters after sealing the surface of proposed road with Liquid Bitumen.

Now,

- Cost of Pure Bitumen in Kilograms is in between Rs.32/ Kg to Rs.40/Kg

(As per Hindustan Petroleum Corporation Limited)

- Surface Area of Road which have to cover-up by Bitumen = (Length of Road) × (Width of C/way) = 1000 meters × 3.7 meters = 3700 Sq.M.
- Cost of Gravels chips = Rs.500/- to Rs.700/- per 1 brass (i.e. 2.83 Cub.M.)

As Per IRC Guidelines,

For all types road surface requires Volume of Bitumen 0.98Kg - 1.10Kg per Sq.M for Seal Coating.

Hence,

6.1 Road Seal Coat with Pure Bitumen

- Total Volume of Bitumen required for Seal Coat = (Surface of Road) × (Vol^M of Bitu. reqd. per Sq.M.) = 3700 Sq.M. × 1 Kg ... (Say, 1Kg Bitu. is reqd. per Sq.M.) = 3700 Kg.
- Total Volume of Gravel chips required for Seal Coat = (Surface area of road) × (Thick. of gravel chips layer) = 3700 Sq.M. × 0.005M. (i.e. 5mm) = 18.5 Cub.M.

- Cost of Pure Bitumen for Seal coating of proposed road

$$= \left[\frac{\text{Total Volume of Bitumen}}{\text{Required for Seal Coat}} \right] \times (\text{Rate of Bitu. per Kg})$$

$$= (3700 \text{ Kg.}) \times (40) \dots (\text{Say, Rate of Bitu. is Rs.40/Kg})$$

$$= \text{Rs.1,48,000/-}$$

- Cost of Gravel chips

$$= \left[\frac{\text{Total Vol}^M \text{ of Gravel Chips}}{\text{Required for Seal Coat}} \right] \times (\text{Rate of chips in brass})$$

$$= 18.5 \text{ Cub.M.} \times [\text{Rs.}600 \div (2.83\text{Cub.M.})]$$

$$= 18.5 \text{ Cub.M} \times \text{Rs.} 212$$

$$= \text{Rs.} 3922$$
- Total Cost of Road seal coat project

$$= \left[\text{Cost of Pure Bitumen for Seal Coating of proposed road} \right] + (\text{Cost of gravel chips})$$

$$= \text{Rs.}1,48,000 + \text{Rs.} 3922$$

$$= \text{Rs.}1,51,922 \approx \text{Rs.}1,52,000/-$$

$$= (296 \text{ Kg}) \times (11 \text{ Rs./Kg})$$

$$= \text{Rs.}3256$$

- Cost of Seal coating of proposed road with Mixture of Bitumen & Waste Plastic

$$= \left[\text{Actual cost of bitu. reqd. after plastic mixing} \right] + (\text{Total Cost of Plastic})$$

$$= [(3700\text{Kg} - 296\text{Kg}) \times 40] + \text{Rs.}3256$$

$$= \text{Rs.}1,39,416/-$$
- Total Cost of Road seal coat project

$$= \left[\text{Cost of Plastic Bitumen blend for Seal Coating of proposed road} \right] + (\text{Cost of gravel chips})$$

$$= \text{Rs.}1,39,416 + \text{Rs.} 3922$$

$$= \text{Rs.}1,43,338 \approx \text{Rs.}1,44,000/-$$

6.2 Road Seal Coat with Bitumen and Shredded Waste Plastic

As Per IRC 098:2013 Guideline ,

For Road construction use of Plastic waste mixing in bitumen is in between 6% to 8% of weight of Bitumen.

- Cost of Waste Shredded Plastic in Kilograms is in between Rs.10/Kg to Rs.16/Kg (Above Rate is given by Rudra Environmental Solutions (India) Ltd.)

Sr. No	Particulars	Apprx. Rate (Rs./kg)
1	Waste Plastic	0
2	Collection of plastic	2
3	Transportation	2
4	Cleaning/Shredding	2
5	Labor Charges	3
6	Machinery Charges including electricity/ Maintenance	2
	Total	≈ Rs.11

- Total Volume of Waste Shredded Plastic required for Seal Coat

$$= \left[\frac{\text{Total Volume of Bitumen}}{\text{required for Seal Coat}} \right] \times 8\%$$

$$= (3700 \text{ Kg}) \times \left(\frac{8}{100} \right)$$

$$= 296 \text{ Kg}$$
- Total Cost of Waste Shredded Plastic required for Seal Coat

$$= \left[\frac{\text{Total Volu}^M \text{ of Waste Shredded Plastic}}{\text{Plastic required for Seal Coat}} \right] \times (\text{Plastic per Kg})$$

Conventional bitumen seal coat cost	Modified Bitumen seal coat cost
Rs. 1,52,000/-	Rs. 1,44,000/-

The reduction in cost of modified bitumen seal coat is about 4% to 6 % less than that of Conventional Bitumen Seal Coat.

Calculation displays construction cost difference between Pure Bitumen road and Plastic mixed bitumen road .The modified has added advantage of premium properties due to presence of inherent anti striping agents and anti oxidants. Based on the above prices of convectional and modified bitumen prices are as follow ,

Conventional Bitumen (Rs/MT)	Plastic modified Bitumen(Rs/MT)
Rs.40,000/-	Rs. 37,600/-

7. CONCLUSION

- The properties determined experimentally are;
 - Penetration of Blend = 103.70 at 8% plastic added
 - Ductility of blend = 86 cm
 - Softening point = 45.6o C
 - Viscosity = 81
- Discovered better alternative way to re-use Waste plastic.
- Enhancement in Re-use of waste plastic in Road Construction.
- Declination of waste plastics in Municipal dumping yards.
- By comparing above Sites Plastic coat Road is Best suitable than Pure Bitumen coat road.

- Helps to increase Durability and Shining of roads by plastic seal coating.
- By this study, many new businesses like Bitumen Modifier and Eco-friendly environment are may lead in Construction industry.

8. REFERENCES

[1] Anzar hamid mir "Use of plastic waste in pavement construction: an example of creative waste management" vol. 05, issue 02 (february. 2015), ||v1|| pp 57-67

[2] S.Rajasekaran" Reuse of waste plastics coated aggregates-bitumen mix composite for road application – green method", e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-02, Issue-11, pp-01-13 www.ajer.org

[3] Amit Gawande, "Utilization of Waste Plastic in Asphaltting of Roads", Sci. Revs. Chem. Commun.: 2(2), 2012, 147-157 ISSN 2277-2669

[4] Bhageerathy K. P, "Use of Biomedical Plastic Waste in Bituminous Road Construction" ISSN: 2249 – 8958, Volume-3 Issue-6, August 2014

[5] Mercy Joseph Poweth, "Study on Use of Plastic Waste in Road Construction" ISSN: 2319-8753Vol. 2, Issue 3, March 2013

[6] Avula Vamshi, "Use of Waste Plastic In Construction of Bituminous Road" , Journal of Engineering (JOE) ISSN: 2325-0224 123 Vol. 2, No. 3, 2013, Pages: 123-128

[7] Parth H. Sadadiwala, , "Utilization of Waste Plastic in Bituminous Mix", ISSN (online): 2348 – 7550, Volume No 03, Special Issue No. 01, March 2015

[8] Amol S. Bale, "Potential Reuse of Plastic Waste in Road Construction: A Review", E-ISSN 0976-3945

[9]Srinivasa Raju Penmetsa, "Productive Re-Use of Municipal Plastic Waste to Improve Temp. Resistance and Reduce Rain Water Infiltration in Flexible Pavements", ISSN 0976 – 6308 (Print)ISSN 0976 – 6316(Online) ,Volume 6, Issue 3, March (2015), pp. 01-09© IAEME: www.iaeme.com/Ijciat.asp,Journal Impact Factor (2015): 9.1215 (Calculated by GIS)

[10] Shweta N. Rokdey, " Use of Plastic Waste in Road Construction", International Journal of Computer Applications (0975 – 8887), International Conference on Quality Up-gradation in Engineering, Science and Technology (ICQUEST2015)