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Liquid Seal Coat on Bituminous Concrete Road Using Waste Plastic

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***Abstract:** In latest studiesmany new innovations and new ideas are implemented to replace many conventional road materials to achieve a feeling of satisfaction towards economy, environment and modern road construction ideas. 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, 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 liquid seal coat using plastic waste in it to compare respective cost and their performances.*
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*

I. INTRODUCTION

The municipal waste plastics can be used in road construction for eco-friendly environment and the field tests of constructed road withstood the engineering properties 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 write-up displays the developments in use of plastics waste to make plastic roads. Plastic is everywhere in today's lifestyle. Plastics which are used for packaging, protecting, serving and even disposing of all kinds of consumer goods. In the industrial revolution, mass production of goods started and plastic seemed to be a cheaper and effective raw material.

According to studies by some other researchers plastic can stay on earth for the span of approximately 4 to 5 thousand years without any change in their chemical property and decomposition too. 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.

A. 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 used for mummification, 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.

B. Necessity of Plastic Seal Coat

*1)*Stability to meet traffic demand by using plastic waste.
*2)*Bitumen mixture content to ensure proper binding and water proofing.
*3)*To accommodate the voids in road compaction due to traffic
*4)*To provide flexibility tomeet trafficloads,especially incold season.
*5)*Sufficient workability for road construction
*6)*Economical plastic and bitumen mixture.

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C. Objectives

1) To study on reutilization processes of waste plastic.
2) To study how to increase re-use of waste plastic.
3) To compare cost of bitumen coat road and plastic coat road and their performances too
4) To determine the engineering properties of Plastic coated road.
5) To compare the performance of Bitumen coat road and Plastic-Bitumen coated road.
6) To use Plastic as road seal coat material

II. 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 16.2 million tonnes by 2016 and is set to be the third largest consumer of plastics in the world. Around 55% is being used for packing [2].
The process is divided into four stages, as follows;

A. Collection of Plastic

Plastic carry bags is very important raw material used in man-made fibers. That can be available easily everywhere in waste form. It can be collected from municipal solid waste dumping yards and street too.The waste plastic carry bags are collected from dump yards of Shahada city municipal corporation Dist. Nandurbar and from various garbage points like Shahada bus stand, Market, etc. Collections of waste carry bags also collected by door to door visiting.

B. Cleaning of Collected Plastic

Rinse with clean water and dry with a clean, soft cloth. Avoid using abrasive cleanser that may scratch the plastic. Use a tub/tile/sink cleaner; nonabrasive, all-purpose cleaner; or a paste of baking soda and water. Apply the cleaner to the surface or on a damp sponge and rub gently.

C. Shredding of Collected Plastic Using Scissor

The shredding stage is when the waste plastic is taken after cleaning of it. Here Shredding is done manually by hand cutting using scissors.

Fig-1: Shredding of collected plastic by scissor.

D. Collection

The collection of shredded plastic waste which is passing through 2.36 mm sieve and retains at 600µm. After collection, plastic petals are put directly in hot bitumen bowser and mixed it gently.

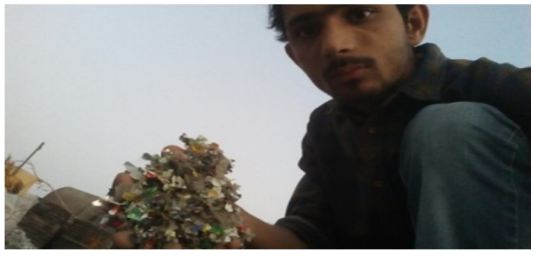

Fig-2 : Collection of Shredded waste plastic

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III. 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.

A. Functions of Bitumen Plastic Seal Coat

1) Seal an existing bituminous road surface against the intrusion of Air and water.
2) Enriches an existing dry or raveled surface.
3) Arrests the deterioration of a surface showing signs of distress.
4) Provides a skid-resistant surface.
5) Provides the desired surface texture.
6) Improves light – reflecting characteristics where these are required(By use of light - colored Stone)
7) Enables paved shoulders or other geometric features to be demarcated by providing a different texture or color.
8) Provides a uniform- appearing surface.

B. Limitations of Plastic Seal Coat During Practical Implementation

1) During melting and mixing of plastic in bitumen bowser it must be melt at above 150^{o} C to resist the sticking mixture to boiler.
2) Spraying of bitumen mixture on site is must be sprayed at well maintained temp, it may cause blockage of nozzle of Spraying Gun and all mechanism.
3) Initially cost of useof plastic waste utilization and other (i.e. Transportation, collection, etc.) Is slightly more.

Fig -3**:** Bitumen bowser with spraying mechanism

C. General Difficulties

1) After collection of waste plastic main difficulty is occurred how to clean up the plastic.
2) Cleaning of plastic required more water.
3) Shredding of plastic is also one of difficult task and which is done by manually by using scissors.
4) Shredding with scissor is too much tedious and hectic work.

D. Technical Difficulties During Field Work

1) Primarily Experiment has to done manually without any mechanism of bitumen boiling & Spraying.
2) Firstly Experiment is done by manually by drum heating at site & spraying is done try bitumen sprinkling bucket.
3) Stirring of plastic during addition of plastic in Bitumen bowser.
4) Due to lack of stirring mechanism mixing of plasticis done manually and at High temperature the risk of burning of hands during mixing & stirring is should be possible.
5) Inadequate mixing may lead the experiment to blockage of Mechanism or Nozzle of bowser.

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Fig - 4: Stirring of added waste plastic in bowser

IV. LABORATORY STUDIES

Waste plastic were added by the varying the properties from 2-12 percent 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%
Peneteration (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

V. CASE STUDY

A. Problem Statement

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 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.

B. Project Information

Name of Project: Under P.W.D, Shahada, Kalsadi – Padalda Road S.H.-2 Km.16/200 to 16/300, Tal.Shahada, Dist. Nandurbar.

Technical Details**:**

Length of road – 100 Meters

Pure Bitumen - 294 Kg

Shredded waste plastic (passing 2.36mm) – 24 Kg

(Used according to IRC guidelines) The plastic has been collected from municipal corporation Shahada, Dist. Nandurbar and shredded it.

C. Method of use of plastic

Dry process is recommended for isolated works. It is recommended that the percentage of shredded waste plastic will be 8% as the optimum plastic content for blending the bitumen in the liquid seal coat.

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D. Photographs of Project during Road Seal Coating

Fig-4 Bituminous mix lying on site

VI. COST ESTIMATION & COST COMPARISON

As per permission given by Public Works Division Shahada the length of road is 100 meters and width of 3 meters.
Now,

A. Cost of Pure Bitumen in Kilograms is Rs.29/ Kg
(As per Bitumen supplying contractor)

B. Surface Area of Road which have to Cover-Up by Bitumen Liquid seal coat
= (Length of Road) × (Width of Carriageway)
= 100 meters × 3 meters
= 300 Sq.M.

C. Cost of Gravels chips = Rs.500/- to Rs.700/- Per 1 Brass (i.e. 2.83Cub.M.)
As Per IRC Guidelines,
For all types road surface requires Volume of Bitumen 0.98Kg - 1.10Kg per Sq.M for Seal Coating.
Details of seal coating with pure bitumen the total cost required is given by Contractors experience about road works.. *Road*

D. Seal Coat with Pure Bitumen

1) *Total Volume of Bitumen required for Seal Coat:*
= (Surface of Road) × (Vol^{M} of Bitu. reqd per Sq.M.)
= 300 Sq.M. × 0.98Kg

……(As per PWD 0.98Kg Bitu. is reqd. per Sq.M)
= 294 Kg.

2) *Total Volume of Gravel Chips required for Seal Coat:* = (Surface area of road) × (Thickness of gravel chips layer)
= 300 Sq.M. × 0.005M. …..(i.e. 5mm)
= 1.5Cub.M.

3) *Cost of Pure Bitumen for Seal Coating of Proposed Road :*
= [Total Volume of Bitumen Required for Seal Coat] × [Rate of Pure Bitu. per Kg.]
= (294 Kg.)× (29 Rs./Kg)
= *Rs.8,526/-*

4) *Cost of Gravel Chips:*
= [Total Vol^{M} of Gravel Chips Reqd. for Seal Coat] × [Rate of gravel chips / brass]
= 1.5 Cub.M. × [Rs.600 ÷ (2.83Cub.M)]…..(1brass = 2.83 Cub.M.)
= 1.5 Cub.M × Rs. 212

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= Rs. 318

5) *Rent of Bowser and all Setup:* = Rs.1200 / Hours (with heating)

6) *Total Cost of Road Seal Coat Project:*

= [Cost of pure bitumen for seal coating] + [Cost of gravel chips]

+ (Rent of bowser and all setup)

= Rs.8526 + Rs. 318 + Rs.1200

= Rs.10,044≈***Rs.10,100***/-

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
	Total	≈ Rs.9

E. Road Seal Coat with Bitumen and Shredded Waste Plastic

As Per IRC 098:2013 Guideline , Road construction use of Plastic waste mixing in bitumen is in between 6% - 8% of weight of Bitumen.

1) Cost of Waste Shredded Plastic in Kilograms is in between Rs.9/Kg to Rs.13/Kg
(Above Rate is given by as per condition and place of waste plastic)

2) *Total Volume of Waste Shredded Plastic required for Seal Coat:*

= [Total Vol^{M} of Bitu. reqd. for Seal Coat] × 8%

= (300 Kg) × $(\frac{8}{100})$

= 24 Kg

3) *Total Cost of Waste Shredded Plastic required for Seal Coat:*

= [Total Volume of Waste Shredded Plastic reqd. for Seal Coat] × [Rate of plastic / Kg]

= (24 Kg) × (9 Rs./Kg)
= Rs.216

4) *Cost of Seal Coating of Proposed Road with Mixture of Bitumen & Waste Plastic:*

= [Actual cost of bitumen reqd. after plastic mixing] + [Cost of Plastic reqd.]
= [(300Kg – 24Kg) × 29] + Rs.216
= Rs.8220/-

5) *Total Cost of Road Seal Coat Project:*

= [Cost of Plastic Bitumen blend for Seal Coating] + [Cost of gravel chips]

+ (Rent of bowser and all setup)

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= Rs.8220 + Rs. 318 + Rs.1200
= Rs.9738 /- ≈***Rs.9,800/-***

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.10,100/-	Rs. 9,800/-

VII. OBSERVATIONS AND RESULTS

A. Observations (limitations) of Plastic Seal Coat

1) During melting and mixing of plastic and bitumen mixture at bowser it must be melt at above 150^0 C to resist the sticking mixture to boiler.
2) Some practical difficulties are arises due to lack of proper mixing mechanism
3) Spraying of bitumen mixture on site is must be sprayed at well maintained temp, it may cause blockage of nozzle of Spraying Gun and all mechanism.
4) Initially cost of use of plastic waste utilization and other (i.e. Transportation, collection, etc.) is slightly more.

B. Results

1) While Comparing Cost of Bitumen coat road and Plastics coat road, it seems that Plastics coat road is economically feasible. (3% - 4% cost saving)
2) Performance of Plastic-Bitumen coated road is better.
3) Plastic bitumen coated road is Environment friendly
4) Plastic Bitumen coated road requires minimum curing period.

VIII. CONCLUSION

A. The Properties Determined Experimentally are;

1) Penetration of Blend = 103.70 at 8% plastic added
2) Ductility of blend = 86 cm
3) Softening point = 45.6o C
4) Viscosity = 81
5) Discovered better alternative way to re-use Waste plastic.
6) Enhancement in Re-use of waste plastic in Road Construction.
7) By comparing above Sites Plastic coat Road is Best suitable than Pure Bitumen coat road.
8) Helps to increase Durability and Shining of roads by plastic seal coating.

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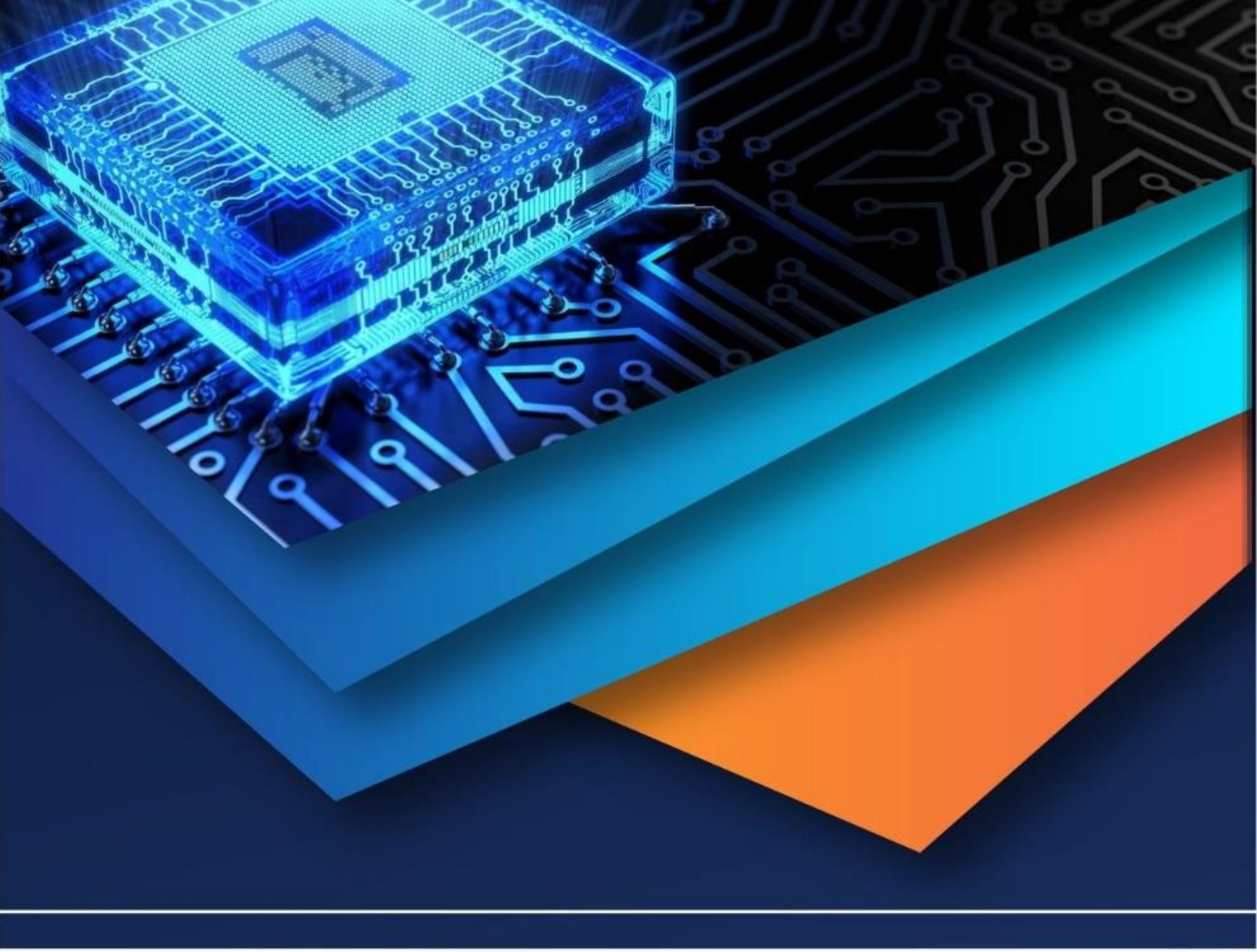

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