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USE OF WASTE PLASTIC WITH BITUMEN ON ROAD

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ABSTRACT

Bottles, containers and packing strips etc. is increasing day by day. As a result, amount of waste plastic also increases. This leads to various environmental problems. Many of the wastes produced today will remain in the environment for many years leading to various environmental concerns. Therefore, it is necessary to utilize the wastes effectively with technical development in each field. Many by-products are being produced using the plastic wastes. Our present work is helping to take care of these aspects. Plastic waste, consisting of carry bags, cups and other utilized plastic can be used as a coating over aggregate and this coated stone can be used for road construction. The mix polymer coated aggregate and tire modified bitumen have shown higher strength. Use of this mix for road construction helps to use plastics waste. Once the plastic waste is separated from municipal solid waste, the organic matter can be converted into manure and used. Our paper will discuss in detail the process and its successful applications.

Keywords: Plastic Waste, Modified Bitumen, Bitumen, Aggregates, Plastic Roads.

I.INTRODUCTION

Now-a-days disposal of different wastes produced from different Industries is a great problem. These materials pose environmental pollution in the nearby locality because many of them are non-biodegradable. Traditionally soil, stone aggregates, sand, bitumen, cement etc. are used for road construction. Natural materials being exhaustible in nature, its quantity is declining gradually. Also, cost of extracting good quality of natural material is increasing. Concerned about this, the scientists are looking for alternative materials for highway construction, and industrial wastes product is one such category. If these materials can be suitably utilized in highway construction, the pollution and disposal problems may be partly reduced. In the absence of other outlets, these solid wastes have occupied several acres of land around plants throughout the country. Keeping in mind the need for bulk use of these solid wastes in India, it was thought expedient to test these materials and to develop specifications to enhance the use of these industrial wastes in road making, in which higher economic returns may be possible. The possible use of these materials should be developed for construction of low volume roads in various parts of our country. The necessary specifications should be formulated and attempts are to be made to maximize the use of solid wastes in different layers of the road pavement. Post construction pavement performance studies are to be done for these waste materials for construction of low volume roads with two-fold benefits: (a)it will help clear valuable land of huge dumps of wastes; (b) it will also help to preserve the natural

reserves of aggregates, thus protecting the environment. Plastics are user friendly but not eco-friendly as they are non-biodegradable generally, it is disposed by way of land filling or incineration of materials which are hazardous. Plastic is versatile material and a friend to common man becomes a problem to the environment after its use. The better binding property of plastics in its molten state has helped in finding out a method of safe disposal of waste plastics. Road surface with neat bitumen can cause bleeding in hot climate, may develop cracks in cold climate, possess fewer loads bearing capacity and can cause serious damages because of higher axle load in present conditions due to rapid infrastructure development. Useful life of bituminous overlays has reportedly declined 7- 8 from average life of 5-6 years in the past to about 3-4 years at present as compared to average pavement life (5-6 years) in abroad. India must raise transportation system to a higher level both in terms of length and quality. This study presents the use of waste in hot bituminous mixes to enhance pavement performance, protect environment and provide low cost roads. Polymer and plastic modified bitumen, often abbreviated as modified bitumen is obtained with the incorporation of selected thermoplastics and shredded plastic from discarded waste, natural plastic or any other suitable elastomers in bitumen.

II.METHODOLOGY

Waste plastic bags were collected from roads, garbage trucks, dumpsites and compost plants, rag pickers, waste- buyers at Rs 5-6 per kg. Household plastic was also collected for the project work, like empty milk bags, used plastic bags etc. The collected Plastic waste was sorted as per the required thickness. Generally, polyethylene of 60 micron or below is used for the further process. Less micron plastic is easily mixable in the bitumen at higher temperature (160°c-170°c). It is clean by de-dusting or washing if required. Collected Plastic was cut into fine pieces as far as possible. The plastic pieces were sieved through 4.75mm sieve and retaining at 2.36mm sieve was collected. Firstly, Bitumen was heated up to the temperature about 160°c-170°c which is its melting temp. Pieces were added slowly to the hot bitumen of temperature around 160-170°c.The mixture was stirred manually for about 20-30 minutes. In that time temperature was kept constant about 160-170°c. Polymer- bitumen mixtures of different compositions were prepared and used for carrying out tests i.e. Penetration test, Ductility test, Flash point test & Fire point test, Stripping test, Ring and ball test and Marshall Stability value test.

TEST PERFORMED ON WASTE PLASTIC SEGREGATION PROCESS

Plastic waste collected from various sources is separated from other wastes.

Fig1. Segregation of plastic

CLEANING PROCESS Plastic waste is cleaned and dried.

Fig2. Cleaning of plastic

SHREDDING PROCESS

Plastics will be shredded or cut into small pieces.

Fig3. Shredded plastic

COLLECTION PROCESS

The plastic waste retaining on 2.36 mm IS sieve is collected.

Fig4. Collection of shredded plastic

TEST PERFORMED ON AGGREGATE

Aggregate impact value test

Los Angeles abrasion test

Water absorption test

Specific gravity test

Stripping value test

TEST PERFORMED ON BITUMEN

Penetration value test

Ductility test

Flash & fire point test

Softening point test

PREPARATION OF SAMPLES

Six Marshall Stability samples will be prepared out of which three will be with the plastic of varying percentage (5%, 10%, and 15%) and three samples without plastic waste.

PERFORMING MARSHALL STABILITY TEST

Marshall Stability test will be performed on all the samples prepared. The Marshall Quotient is also within the range of tolerance, thus showing that the plastic waste (polyethylene) blended bitumen mix is better and more suitable for flexible pavement construction.

II.FINDINGS

TEST ON AGGREGATE

TABLE: RESULT OF TEST ON AGGREGATE

Stone Aggregate	Plastic Content (%)	Aggregate Impact Value	Los Angeles Abrasion Value	Specific Gravity	Water Absorption	Stripping Value

Without Plastic	0	10.79%	12.85%	2.5	3.2%	1%
With Plastic	10	9.27%	11.70%	2.66	2%	Nil
	15	8.94%	10.65%	2.7	1.1%	Nil

TEST ON BITUMEN

TABLE RESULT OF TEST ON BITUMEN

Test	Result	Range
Ductility test	77.50 cm	Minimum 40 cm
Penetration value	83 mm	80-100 mm
Softening point	48.25^0C	$45\text{-}60^0$C
Flash point test	280^0C	$> 175^0$C
Fire point test	302^0C	

TABLE COMPARISION BETWEEN PLAIN BITUMEN AND MODIFIED BITUMEN

(10% plastic waste)

Sr.no	**Tests conducted**	**Test results**	
		Plain bitumen	***Modified bitumen (10% plastic replaced)***
1.	Penetration test	68mm	58mm
2.	Ductility		

		83mm		52mm	
3.	Flash point	235°c		260°c	
4.	Fire point	251°c		295°c	
5.	Stripping value	0.4%		0.0%	
6.	Softening point	Temp.in°c	Time in sec	Temp.in°c	Time in sec
		53	334	64 5	50

MARSHELL STABILTY TEST

TABLE MARSHELL STABILITY AND FLOW VALUE

Sample No.	Bitumen content (%)	Plastic content (% by weight)	Marshall stability(kg)	Flow value (mm)
1	4	0	950	3.1
2	5	0	1170	3.3
3	6	0	1240	3.6
4	4	5	1560	3.9
5	5	10	1720	4.5
6	6	15	1980	5

MATERIAL COST COMPARISION

TABLE MATERIAL COST COMPARISION FOR 1KM ROAD

Description	Unit	Rate/unit	For control mix		For modified sample	
			Quantity	Amount(Rs)	Quantity	Amount(Rs)
Material						
Aggregate	Ton	597	545.06	325400.88	495.65	295903.05
Bitumen	Ton	35000	31.78	112300	28.85	1009750
Plastic waste	Ton	6000			2.885	17310
Total material cost				1437700.88		1322963.05

III.RESULTS

The increase in percentage of polymer decreased the penetration value. This shows that the addition of polymer increases the hardness of the bitumen. The penetration values of the blends are decreasing depending upon the percentage of polymers and the type of polymer added. The ductility decreased by the addition of plastic waste to bitumen. The decrease in the ductility value may be due to interlocking of polymer molecules with bitumen. Flash and fire point increased with the increase in the percentage of polymer. The polymer bitumen blend road surfaces are less affected by fire hazards. This shows that the blend has better resistance towards water. This may be due to better binding property of the polymer bitumen blend. The softening point increased by the addition of plastic waste to the bitumen. Higher the percentage of plastic waste added, higher is the softening point. The influence over the softening point may be due to the chemical nature of polymers added. The increase in the softening point shows that there will be less bleeding during summer. Bleeding accounts, on one side, increased friction 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 polymer-bitumen blend.

IV.CONCLUSION

The addition of waste plastic modifies the properties of bitumen.

The modified bitumen shows good result when compared to standard results.

The optimum content of waste plastic to be used is between the ranges of 5% to 10%.

The problems like bleeding are reduce in hot temperature region.

Plastic has property of absorbing sound, which also help in reducing the sound pollution of heavy traffic.

The waste plastics thus can be use and it ultimately improves the quality and performance of road.

Total material cost of the project is reduced by 7.99%

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