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Use of Waste Plastic in Bituminous Road Construction

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***Abstract*: Plastic Bottles containers and packing strips etc. Is increasing day by day. As a result, amount of a waste plastic also increases with it. This leads to various environmental problems. Many of the wastes materials produced today will remain in the environment for many more years leading to various environmental concerns. Therefore, it is very necessary to utilize the waste material effectively with the technical development in each and every field. Many by – produced using the cups and other type of utilized plastic can be used as coating over aggregate and this coated stone can be used for road construction. The next polymer plastic coated aggregate and rubber modified bitumen have shown higher strength. Use of this mix road construction helps to use plastic waste. once the plastic waste material is separated from municipal solid waste, the organic matter can be converted into manure and used. This paper will discuss in detail the process and its successful applications.**

***Keywords*: Bitumen, Plastic, Polymer, Aggregate.**

1. Introduction

The major threat to the environment is the disposal of waste plastic material. In a highway, the potholes and corrugation is the major problem. Plastic road pavement will be a better solution to the above mentioned problems. A material which contains a one or more organic polymers of large molecular weight and solid in its finished state, can be shaped by its flow is called as "plastic". The durability of a plastic is high and it degrades slowly. And also plastic has high resistant to degradation. Plastic can be divided into two major categories- thermoses & thermoplastics. Thermo sets have high durability and strength because thermo sets solidifies irreversibly when they heated, henceforth can be used primarily in construction application. Plastic is a non-degradable waste, causes greenhouse effect and global warming. The various experimental procedure has been carried out whether the waste plastic material can be reused productively.

The various literature shows that the waste plastic material when added to high temperature aggregates will form a thin coat of plastic over the aggregate and such aggregates when mixed with binder material is found to have higher strength, higher resistance and better performance over a period of time. Along with bitumen, use waste plastic material increases its life time and smoothness. It is economical and eco- friendly. Addition of plastic waste material in construction of road pavements reduces the plastic shrinkage and drying shrinkage. The use of waste plastic improves the abrasion value & slip resistance of asphalt material pavement. In India because of hot and extremely humid climate, plastic road pavements of greatest advantage. Road surface with neat bitumen material 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 development of infrastructure. Useful life of bituminous overlays has reportedly declined 78 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 has to 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 Ease of Use

2. Objective

1. To carry out the bitumen test.
2. To carry out aggregate test.
3. To design the asphalt pavement with aggregate-plastic- bitumen mix.
4. To coat the aggregate with plastic and incorporate titanium di-oxide.
5. To test the bitumen and the modified bitumen

3. Methodology

Waste plastic bags were collected from environment like garbage trucks, dumpsites and compost plants, rag pickers, waste- buyers at Rs. 5-6 per kg. Household plastic waste was also collected for the project work, such as empty milk bags, used plastic bags etc. The collected Plastic waste material was sorted as per the required parameters. Generally, polyethylene plastic of 60 micron or below is used for the further process. Less micron plastic material is easily mixable in the bitumen material at temperature (160°c-170°c). It is clean by de-dusting and washing if required. Collected Plastic was cut into small 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 boiled 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 period 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.

4. Results and discussion

Table 1
Bitumen

S. No.	Property	Plain bitumen	10% bitumen replaced by plastic
1	Penetration	79	65
2	Ductility	62 N/mm²	6.5 N/mm²
3	Softening Point	59˚ C	70˚ C
4	Flash	183	240
5	Fire point	297	386

Table 2
Aggregate

S. no.	Property	Normal aggregate	Plastic coated aggregate
1	Specific Gravity	2.67	2.73
2	Water Absorption	2.13%	1.75 %
3	Impact Value	19.68 %	10.29 %
4	Crushing Value	23.32 %	14.22%
5	Abrasion value	16.79 %	5.67 %

Table 3
Plastic value table

Type Of Plastic	Chemical Formation	Density (gm/cm^3)	Softening point
Low Density Poly ethylene Plastic (LDPEP)	(-CH2-CH2-)n	0.9 to 0.95	100˚ C to 120˚ C
High Density Poly-ethylene Plastic (HDPEP)	(-CH2=CH2-)n	0.95 to 0.96	120˚ C to 130˚ C

Discussion:

a) The crushing value reduces from 23.32 to 14.22 for normal and plastic-coated aggregate. The value was reduced by 40%. Lower the aggregate crushing value higher is the strength.
b) The aggregate impact value of plastic-coated aggregate Was reduced by 9% than the normal aggregate. It's the higher toughness of plastic-coated aggregates.
c) Los Angeles abrasion value indicates the hardness of the aggregates. The abrasion value plastic coated aggregates were 11 % less than the normal aggregates.
d) The penetration value of bitumen is higher than the bitumen mixed with the plastic.
e) The bitumen softens 10 ºC less than the bitumen replaced with plastic.
f) The stability of modified bitumen (10% bitumen replaced by plastic) is higher than the normal bitumen.
g) 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.
h) 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.

Table 4
Consumption of plastics

Length	Width	Height	Wasteplastics needed
1000m	2m	2.5 cm	50 ton
15 cm	15 cm	2.5cm	0.3Kg

Material Needed	Normal Bitumen Road	Plastic Bitumen Road
30/40	11250 kg	10125 kg
Plastic waste	Nil	1125 kg
Cost	Rs. 393750	(BIT) Rs. 34375+(Plastic)Rs. 13500 = Rs. 367875
Cost Reduced	Nil	Rs. 25875.00
Carbon credit achieved on avoiding burning of plastic	Nil	3.5 Tones

5. Conclusion

a) The plastic mixed with bitumen and aggregates is used for the better performance of the roads. The polymer coated on aggregates reduces the voids and moisture absorption. This results in the reduction of ruts and there is no pothole formation. The plastic pavement can withstand heavy traffic and are durable than flexible pavement. The use of plastic mix will reduce the bitumen content by 10% and increases the strength and performance of the road. This new technology is eco- friendly.
b) The use of smoke absorbent material (titanium di-oxide) by 10% of polymer content can reduce the vehicular pollution.
c) Properties of bitumen modified with blended waste cooking oil and high density polyethylene for applications in flexible pavements was investigated in this research. The properties investigated include the specific gravity, penetration and softening point of the modified bitumen. The following are the conclusions made from the research:
d) The replacement of bitumen with WCO reduces the specific gravity and the softening point of the resulting binder. The penetration value of bitumen was however found to increase upon replacement with WCO.
e) The addition of HDPE reduces the penetration and increases the specific gravity and softening point of WCO-HDPE modified bitumen. HDPE added at 2.5%, 5% and 7.5% to the WCO modified bitumen results in lower penetration and

higher specific gravity and softening point when compared to the base bitumen.

f) A relationship was found to exist between the specific gravity and both the penetration and softening point of the modified bitumen investigated in the research. Increase in specific gravity results in an increase in the softening point and a decrease in the penetration of the modified bitumen.

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