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Study On Use of Polythene in the Bituminous Concrete Mix as Per IRC Specification

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***Abstract*: The amount of plastic waste in municipal solid waste (MSW) is increasing due to population growth, urbanization, development activities and changes in the enemies of life leading to the loss of the entire world. Plastic waste disposal is therefore dangerous and a major problem worldwide due to their irreverent and unsightly appearance. As this is not scientifically unsustainable & it is possible to create pollution of land and water. This garbage plastic has reclaimed a portion of the standard equipment to improve the desirable features of certain road mixing machines. In the present text developed strategies for the use of plastic waste for the purpose of road construction and flexible pedestrian crossings. In the normal process of making bitumen is used as a binder. Such bitumen can be replaced with pieces of dirty plastic and a bitumen mixture can be used as an overlay layer for a flexible layer. This compactly modified plastic composite material exhibits better binding properties, durability, density and more water resistance.**

***Keywords*: Bitumen, VMA (Voids in Mineral Aggregates), VA (Air Voids), VFB (Voids filled with Bitumen).**

1. Introduction

The content of one or more polymers of a large organic molecule, which is solid in its entirety and in another case where it is produced or used in finished materials, can be formed by its flow, it is called 'Plastic'. The Plastics area unit is strong and gradually deteriorates; the chemical bonds that make up plastic are therefore strong and form the same evidence of resistance to natural processes of degradation. Plastics can be divided into 2major categories: thermoses and thermoplastics. The thermo setting tightens or "sets" irresistibly once heated. According to recent studies, plastics will remain unchanged for about 4500 years around the world and with the increase in the world's population and the growing demand for food and various other necessities, there will be an increase in the amount of waste produced daily. Multi-purpose plastic is found to be about five times more likely to dispose of naturally unhealthy municipal waste. it is a common sight in some urban and rural areas to search for empty plastic goods and various types of plastic fittings that fill the streets like pipes. Due to its biodegradability it creates water resistance and hygiene problems. In order to contain this back test is still being distributed whether this waste plastic can be used properly or not. Plastic waste is used as a hydrocarbon substitute to expand many hydrocarbon structures.

The area acquired a cleaner waste disposal facility called Plastic Roads and was found to be more efficient than conventional hydrocarbon. In addition, it was found that the roads had not been conveyed under disclosure once water connections had been identified. Consumption of a high percentage of plastic waste reduces the need for hydro-carbon by tens. Combined it will increase the strength and performance of the road. The plastic will expand the area where the hydrocarbon ice and thus nothing can be removed an extra high and simple way. Applying plastic waste to the construction eliminates the cracking of the plastered surface and reduces the immersion of drying to some degree.

The use of plastic waste contributes to a high level of damage and slippery handling of various materials and combined permits for obtaining permanent discharge prices and enjoys the limits required while plastic waste content is still far away from the weight of the compost. If the constant mixing time and the mixing temperature do not appear to be given by the bitumen-modifier mix, the modified hydrocarbon cannot show effective performance in the area, so premature failure is possible. Therefore, there is a local area bound for the meeting time, the meeting temperature and the changing content of all trademark markers. All of this should be taken into account when the losses and breakage of roads should be made of plastic waste of abuse. The plastic road would be a blessing in India. In the hot and humid climate of the hard plastic and eco-friendly plastic streets is a place of great blessings. This can be done by sharing the experience of the world from all kinds of plastic waste.

2. Literature Review

A. Boomika, M. A. Naveen, J. Daniel Richard et al. (2017): A nation's development mainly depends on the development of transportation of the country. As flexible pavement is majorly used in India, it is important that steps has to be taken to increase the life of the bituminous pavements. Flexible pavement is often subjected to problems like rutting, cracking, and other failures due to repeated traffic loads. In this project, we have used the waste materials like lignin and plastic as a replacement material for bitumen in the percentage of 5&10%, 10&15%, 15&20%, 20&25% respectively. It has been found that lignin can act as a binding material for asphalt hence

improving the properties of the bitumen. By the mix proportions which is analyzed and determined by series of tests like penetration, ductility, viscosity, softening point, it is found that the mix proportion of 15&20% has efficient results when compared to other proportions used.

Athira R. Prasad, Sowmya N J (2015): The use of waste materials like plastics and rubber in road construction is being increasingly encouraged so as to reduce environmental impact. Plastics and rubbers are one of them. The plastic waste quantity in municipal solid waste is increasing due to increase in population and changes in life style. Similarly, most tires, especially those fitted to motor vehicles, are manufactured from synthetic rubber. Disposal of both is a serious problem. At the same time, continuous increase in number of vehicles emphasizes on need of roads with better quality and engineering design. This waste plastic and rubber can be used to partially replace the conventional material which is bitumen to improve desired mechanical characteristics for particular road mix. In the present study, a comparison is carried out between use of waste plastic like PET bottles and crumb rubber (3%, 4.5%,6%,7.5%,9%by weight of bitumen) in bitumen concrete mixes to analyze which has better ability to modify bitumen so as to use it for road construction.

Ahmad K. Jassim (2017): Disposal of plastic waste in environment is considered to be a big problem due to its very low biodegradability and presence in large quantities. Therefore, finding alternative methods of disposing waste by using friendly methods are becoming a major research issue. In this research, high density polyethylene waste is mixed with Portland cement to investigate the possibility to produce plastic cement, and study the effect of replacing sand by fine polyethylene waste with different percentage on the properties of product. The experiments were done by using the waste of polyethylene packages include bottle and food crates in the range of 10% to 80% by volume as a short reinforcement structure. The results show that there is a possibility to produce plastic cement from polyethylene waste and Portland cement by using 60% and 40%, respectively. In addition, their density was decreased, ductility increased, and the workability improved, which lead to produce lightweight materials.

Farag Khodary, Y. Mohammed, A. Wazeri (2015): Fracture mechanics is one of the most important methodology that can be used to evaluate asphalt concrete mixtures resistance to crack propagation. Semi-Circular Bending (SCB)test is a fast and accurate three-point bending test, which was originally used in rock mechanics, and Visco elastic material. Asphalt concert material is investigated using semi cracked circular specimen (50 mm radius and 63 mm thickness. Crumb rubber was used as asphalt concrete mixtures modifiers in research with by 10% of the weight of bitumen. CaCo3was added to the crumb rubber modified heated bitumen by modification level namely 5%, 10%, 15%,20% and 25%. The result shows that crumb rubber/CaCo3nanocom-posite can be used as asphalt modifier and improve both Penetration and softening point for all modified bitumen. from the point of mechanical properties and fracture resistance modified asphalt concrete mixtures with 15% crumb rubber/CaCo3nanocomposite have higher than unmodified mixtures by 34.2% and it is appear that modified mixtures with 15% crumb rubber/CaCo3 nano-composite have two times higher Critical Energy Release Rate (J1C) than unmodified mixtures that means the modified mixtures is more resistance to fracture.

Nuha S. Mashaan, Asim Hassan Ali et. al. (2012): Roadways are considered one of the most important elements of infrastructure and they play an essential role in our daily lives. In road pavement construction, the use of crumb rubber in the modification of bitumen binder is considered as a smart solution for sustainable development by reusing waste materials. It is believed that crumb rubber modifier (CRM) could be one of the alternative polymer materials in improving bitumen binder performance properties of hot mix asphalt. This study aims to present and discuss the findings from some of the studies, on the use of crumb rubber in asphalt pavement.

3. Material Used

A. Basic materials

The materials used are as follows:

- Aggregates
- Bituminous Binder
- Mineral Filler
- Polythene

1) Aggregate

Aggregate forms a granular component in a small concrete mix that contributes up to 90-95% of the weight of the mixture and offers many load-bearing features and strength characteristics of the mixture. Therefore, the quality and physical properties of aggregates should be controlled to ensure a good environment. The composite structures to be used in the stone display are shown below,

1) Aggregates should be lightly plastic. The presence of a fine compaction with a small mix can result in problems such as swelling and adhesion to the rock surface which can cause problems. Particles of clay and adhesive particles should be limited to only 1%.
2) Resistance or resistance to climate change should be measured by sulphate weight testing.
3) The amount of dust in the asphalt cement, by weight should be more than 1,2 & a minimum of 0.6.
4) It is recommended that AASHTO T-209 be used to determine the gravitational force of multiple concrete.
5) Aggregates of 2 types. i.e.
    a) Coarse Aggregate (CA)
    b) Fine Aggregate (FA) Coarse Aggregate (CA)

The aggregates stored at 4.75 mm AMA Sieve are called coarse aggregates.

The cartilage should be inspected for crushed rock, which

does not appear to be in good condition, free of dust particles, clay, vegetables and earth matter. They should have the following properties.

2) Bituminous Binder

Asphalt binder 60/70 and 80/1800 are used in this study. The bitumen used should have the following properties.

a) The level of bitumen used on the roads should be determined according to the climate and its application in the past.
b) It is recommended that the bitumen be accepted for supplier verification (and test results) and for the State project, validation samples. The admission process must provide details, with visible kitume structures in a proper manner.
c) The most important features of the used kitume on the roads are shown below. Each State must obtain this information (through in-lab testing or supplier) and must have specific requirements for each property without specific powers.

3) Mineral filler

Mineral filler contains, at best, an inert mineral substance added to the asphalt for hot mixing, increasing the stress and strengthening the strength of the mixture. These filters must exceed 75µm IS Sieve.

4) Polythene

Polythene used in OMFED milk packets was used as raw material in the preparation of samples. These are polythene packs collected; they were washed and rinsed in hot water for 3-4 hours. Then they dried up.

Specific Gravity of polythene = 0.907

4. Methodology

It involves mainly three processes:

a) Preparation of samples
b) Void analysis
c) Testing

Sample Preparation: The specifications of the Marshall sampling mould and hammer are given in table 1.

Table 1
Dimensions of Marshall Sampling mould & hammer

Apparatus	Value	Working Tolerance
Mould		
Avg internal dia, mm	101.20	± 0.5
Hammer		
Mass, kg	4.535	± 0.02
Drop Height, mm	457	± 1.0
Foot diameter, mm	98.5	± 0.5

Mixing Procedure: Mixing ingredients is done as follows: STP 204-8).

1) Necessary quantity of composite, fine composite & mineral composites.
2) These are stored in the oven at a temperature of 1600C for 2 hours, because a mixture of compounds will be put into the mix, so pre-heating is necessary.
3) Bitumen was heated again until it melted before mixing.
4) The required amount of polythene was weighed and stored in a container.
5) Aggregates were heated in a burner for a few minutes to maintain the temperature mentioned above.
6) The composite polythene is added to the aggregates and mixed for two minutes.
7) Thereafter, bitumen (60 gm), i.e.5% was added to the mixture and the whole mixture was stirred evenly and evenly. This was done for 15 to 20 minutes until they were thoroughly mixed which appeared to be the same colour throughout the mixture.
8) After that the mixture is transferred to the casting mould.
9) It was then compiled by Marshall Hammer.
10) Seventy-five no. beats are given on each side of the sample and therefore a total of 150 no. was beaten with a sample.
11) Then the moulded samples are stored separately and marked.

Fig. 1. Marshall sampling mould

A. Void analysis

The samples were weighed in air and also immersed in water so that water replaces the air present in the voids of specimens. But some amount of water will be absorbed by the aggregates which give flawed results. Therefore, the samples were coated with paraffin wax so that it seals the mix completely and checks the absorption of liquid into it.

$$VMA = \left(1 - \frac{Gmb}{Gsb} \times Ps\right) \quad \text{..... (1)}$$

$$VA = \left(1 - \frac{G_{mb}}{G_{mm}}\right) \quad \text{..... (2)}$$

$$VFB = \left(\frac{VMA - VA}{VMA}\right) \quad \text{..... (3)}$$

$$Pba = 100\left[\frac{1}{Gsb} - \frac{1}{Gse}\right] \times Gb \quad \text{..... (4)}$$

Where,

P_{ba} = Absorbed bitumen content as a percentage by weight of aggregates

G_{mb} = Bulk specific gravity of the mix

G_{mm}= Maximum theoretical specific gravity of the mix

G_{sb} = Bulk specific gravity of aggregates

G_{se} = Effective specific gravity of aggregates G_b = Specific gravity of bitumen

VMA = Voids in Mineral Aggregates VA = Air Voids

VFB = Voids filled with Bitumen.

$G_{sb} = M_{agg}$/ volume of (aggregate mass + air void in aggregate + absorbed bitumen) (5)

$G_{se} = M_{agg}$/volume of (aggregate mass + air void in aggregate) (6)

$G_a = M_{agg}$/volume of aggregate mass (7)

$G_{mm} = M_{mix}$/volume of mix air voids (8)

$G_a = M_{mix}$/bulk volume of the mix (9)

$G_{se} = (M_{mix} - M_b)/[(M_{mix} / G_{mm}) – (M_b/ G_b)$ (10)

To calculate value of G_{mb} we need to calculate the bulk volume of the sample for which 3 readings are needed. i.e.

- Weight of sample in air
- Weight of paraffin coated sample in air
- Weight of paraffin coated sample in water

Marshall Stability Value:

It is defined as the maximum load at which the specimen fails under the application of the vertical load. It is the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute (2 inches/minute). Generally, the load was increased until it reached the maximum & then when the load just began to reduce, the loading was stopped and the maximum load was recorded by the proving ring.

Marshall Flow Value:

It is defined as the deformation undergone by the specimen at the maximum load where the failure occurs. During the loading, an attached dial gauge measures the specimen's plastic flow as a result of the loading. The flow value was recorded in 0.25 mm (0.01 inch) increments at the same time when the maximum load was recorded.

Two readings were taken from the dial gauge i.e. initial reading (I) & final reading (F) The Marshall Flow Value (f) is given by

$$f = F - I$$

5. Results

Three samples had been tested for each percentage of the polythene. The average of the three values had been taken for the analysis. All the average values have been mentioned below in the table:

Table 2
The average values of the test conducted

Polythene (%)	Unit weight (G_{mb})	VMA (%)	VA (%)	VFB (%)	Mean S (kN)	Mean F (mm)
0	2.307	16.73	5.457	67.24	14.35	4.167
1	2.297	15.84	4.307	72.837	14.46	3.47
2	2.28	15.26	3.387	77.903	14.55	3.07
3	2.246	15.33	3.183	79.25	15.54	2.97
4	2.21	15.193	2.64	82.643	17.72	2.87
5	2.187	13.207	2.817	81.27	15.94	2.73

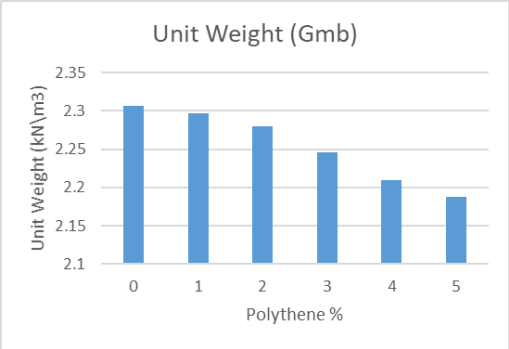

Fig. 2. Unit weight with different proportions of polythene

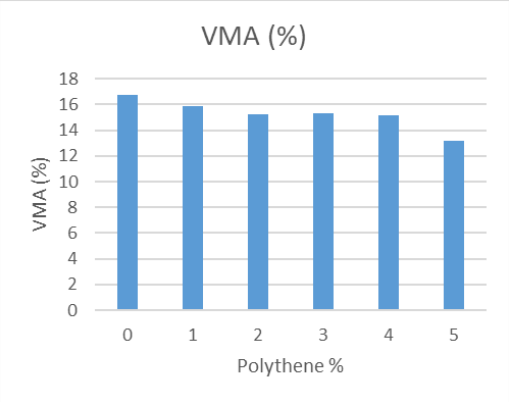

Fig. 3. VMA % with different proportions of polythene

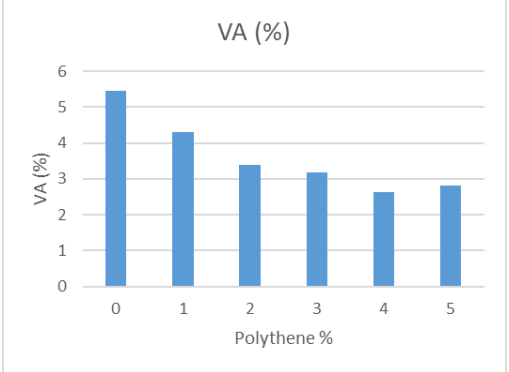

Fig. 4. VA % with different proportions of polythene

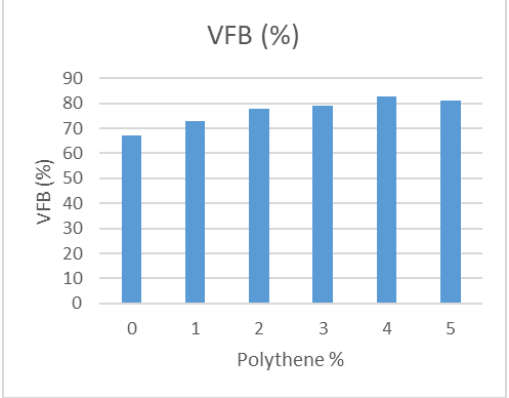

Fig. 5. VFB % with different proportions of polythene

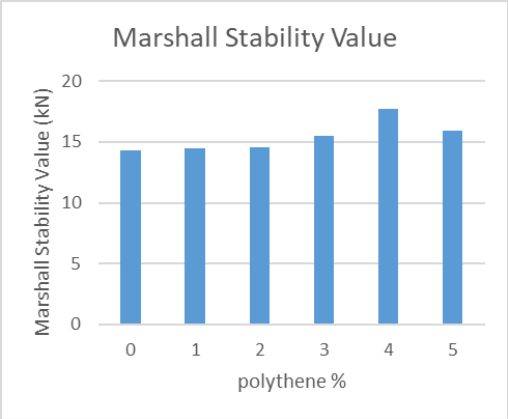

Fig. 6. Marshall Stability Value with different proportions of polythene

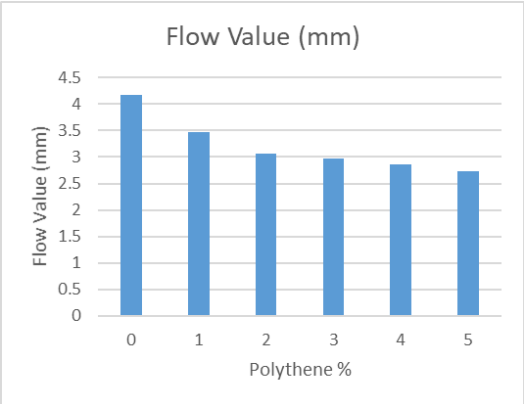

Fig. 7. Flow value with different proportions of polythene

6. Conclusion

From the study following conclusion were made:

1. The Marshall stability value increased by increasing the polythene in mix upto 4% after that the value starts to decreases.
2. The flow value of mix decreases with the increase in the polythene percentage.
3. The resistance against heavy loading increased.
4. The parameters like VMA, VA and VFB are under IRC specifications.
5. The use of plastics not only preserve our environment but also give us better pavement.
6. The plastics gives better bonding between the aggregates and bitumen.
7. This can be used in our country where temperature is very high.

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