Utilization of Plastic waste in Bitumen Mixes for Flexible Pavement

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ABSTRACT

The situation of present way of life an entire restriction on the utilization of waste plastic can't be put, in spite of the fact that the waste plastic taking the substance of a demon for the present and the future age. In this way transfer of waste plastic is a difficult issue all inclusive due to their non-biodegradability and unaesthetic view. Since these are not arranged logically and probability to make ground and water contamination. This waste plastic in part supplanted the regular material to enhance wanted mechanical qualities for specific street blend.

In the present research work created procedures to utilize plastic waste for development motivation behind adaptable asphalts will be survey. In regular Street making process bitumen is utilized as folio. Such bitumen can be adjusted with squander plastic pieces and bitumen blend is made which can be utilized as a best layer of adaptable asphalt. The plastics from PET jugs to be utilized in blends for examine work. The measurements of plastic of 5 %, 7.5%, 10 %, 12.5% and 15 % utilized as substitution of bitumen. The advance plastics content is 10% with 5.25 % of bitumen content. In this paper concentrated on Marshall Test and extreme execution of hot blend black-top. In this examination work it is explored that the general cost of plastic blends bitumen spared 5.18 % cost as contrast with customary bitumen. Subsequently it is efficient and earth advantageous for development of plastic blend bituminous street.

Key words: Bitumen Mixes, Plastic Wastage, Flexible Pavement.

1. INTRODUCTION

Plastics, a versatile material and a friend to common man become a problem to the environment after its use. Disposal of a variety of plastic & rubber wastes in an eco-friendly way is the thrust area of today's research. Looking forward the scenario of present life style a complete ban on the use of waste plastic cannot be put, although the waste plastic taking the face of a devil for the present and the future generation. But the use of waste plastics in road construction is gaining importance these days because plastic roads perform better than ordinary ones and the plastic waste considered to be a pollution menace, can find its use.

Plastic road would be a boon for India. In hot and extremely humid climate durable and eco-friendly plastic roads are of greatest advantages. This will also help in reliving the earth from all type of plastic waste. In recent decades, the results of the increasing amounts of plastic waste derived from the bottles form a major part of the world's solid waste management problem. Several attempts were made on the use of plastic wastes in asphaltic cement mix to provide safely solutions to dispose of this waste through the use as an additive or as a partial substitution for the materials used in conventional asphalt concrete mixes.

The plastics waste coated aggregate is mixed with hot bitumen at the temperature range between 150^{o}C-165^{o}C. The resulted mix of temperature range 130^{o}C-140^{o}C is used for road Construction. The road laying temperature is between 110^{o}C-120^{o}C. Using the roller of 8 ton (min.) capacity. Coating is easy and the temperature needed is the same as the road laying temperature. Bitumen is bonded with the aggregate by means of plastic which acts as a binder.

2. RESEARCH REVIEW

They have mentioned that, Use of plastic in road construction is gaining importance these days because plastic roads perform better than ordinary roads and the plastic waste, otherwise considered to be a pollution menace can find its use. This paper deals with the investigations of the use of waste plastic for coating of aggregates in the bituminous mix. Optimum bituminous mixes are designed using ordinary aggregate and plastic coated aggregate.

The comparative study of the mixes is also presented. According to the study it is observed that, the properties of aggregates which mainly cause rutting action are improved using plastic coated aggregates, Considerable increase in Marshall Stability value, the optimum bitumen content is reduced. Above all the waste plastic which is a pollution menace can find its use in road construction and thereby solving the problem of pollution to a certain extent [6]. The author investigated that, the plastic roads include transition mats to ease the passage of tyres up to and down from the crossing. Both options help protect wetland haul roads from rutting by distributing the load across the surface. Recent studies in this direction have shown some hope in terms of using plastic-waste in road construction i.e., Plastic roads. The director of the Central Road Research Institute (CRRI) said that bitumen mixed with plastic or rubber improves the quality and life of roads. The deputy director of the CRRI said that polymers mixed with bitumen increased the construction cost up to six per cent, but increased the longevity of roads manifold. [7]

The research methodology for present study has adopted various tests to investigate the results on aggregate, bitumen and plastic and aggregate-bitumen-plastic mix. The tests conducted were Water Absorption, Aggregate Impact, Loss Angeles and Aggregate Crushing Test [IS: 2386 (part 4)-1963] for aggregates and Softening Point, Penetration Test and Ductility Test [IS: 1203-1978] for bitumen. For mixing the ingredients of road mix, dry process was adopted. In this process, waste plastic is mixed with aggregates and blends of polymer modified aggregate are prepared by mixing bitumen in it. These blends are later tested in laboratory and required optimum results are obtained. The increase of waste plastic in bitumen increases the properties of aggregate and bitumen. Use of waste plastic in flexible pavements shows good result when compared with conventional flexible pavements. The optimum use of plastic can be done up to 10%, based on Marshal Stability test. This has added more value in minimizing the disposal of plastic waste as an eco-friendly technique. Coating of polymer on the surface of the aggregate has resulted in many advantages, which ultimately helps to improve the quality of flexible pavement [8]. They studied Use of waste plastic in construction of bituminous road and stated that The increase in percentage of polymer decreased the penetration value. This shows that the addition of polymer increases the hardness of the bitumen. 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 conclusion of study is, 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 range of 5% to 10% [10]. They has studied the plastic wastes were shredded into small size, i.e. 2 mm to 4 mm, molten and thereafter coated over hot aggregate at 160 ^{o}c. Several roads have been built in this manner using polymer-coated–bitumen aggregate. Aggregate of 20mm, 10 mm. Stone Dust and Lime as Filler, 60/70, 80/100 grade bitumen. Waste plastic in the shredded form. The durability of the roads laid out with the shredded plastic waste is much more compared with roads with asphalt with the ordinary mix. Roads laid with plastic waste mix are found to be better than the conventional ones. The binding property of plastic makes the road last longer besides giving added strength to withstand more loads. While a normal 'highway quality' road lasts four to five years, it is claimed that plastic-bitumen roads can last up to 10 years. The cost of plastic road construction may be slightly higher compared to the conventional method. However, this should not deter the adoption of the technology as the benefits are much higher than the cost. It is hoped that in near future we will have strong, durable and eco-friendly roads which will relieve the earth from all types of plastic-waste [11].

3. METHODOLOGY

Most of the Indian highways are of covered surface by bitumen. A bituminous concrete as well as dense bitumen macadam are commonly used asphalt courses. Mix designs for DBM and BC are based on guideline given by MORTH. In mix design method improvements should finally aim to achieve long last perpetual pavements.

Mix design objectives are to provide sufficient workability to permit easy placement without segregation, sufficient flexibility to avoid premature cracking due to repeated bending by traffic, sufficient air voids in the compacted bitumen to allow for additional compaction by traffic, sufficient strength to resist shear deformation under traffic at higher temperature, sufficient bitumen to ensure a durable pavement and sufficient flexibility at low temperature to prevent shrinkage cracks. Basic intention is to efficiently utilize the waste plastic in constructive way so that it can be beneficial to society however main objectives of research work are to reduce bituminous content by the replacement of plastic waste and the properties of bituminous mix specimen due to coating of waste plastic materials.

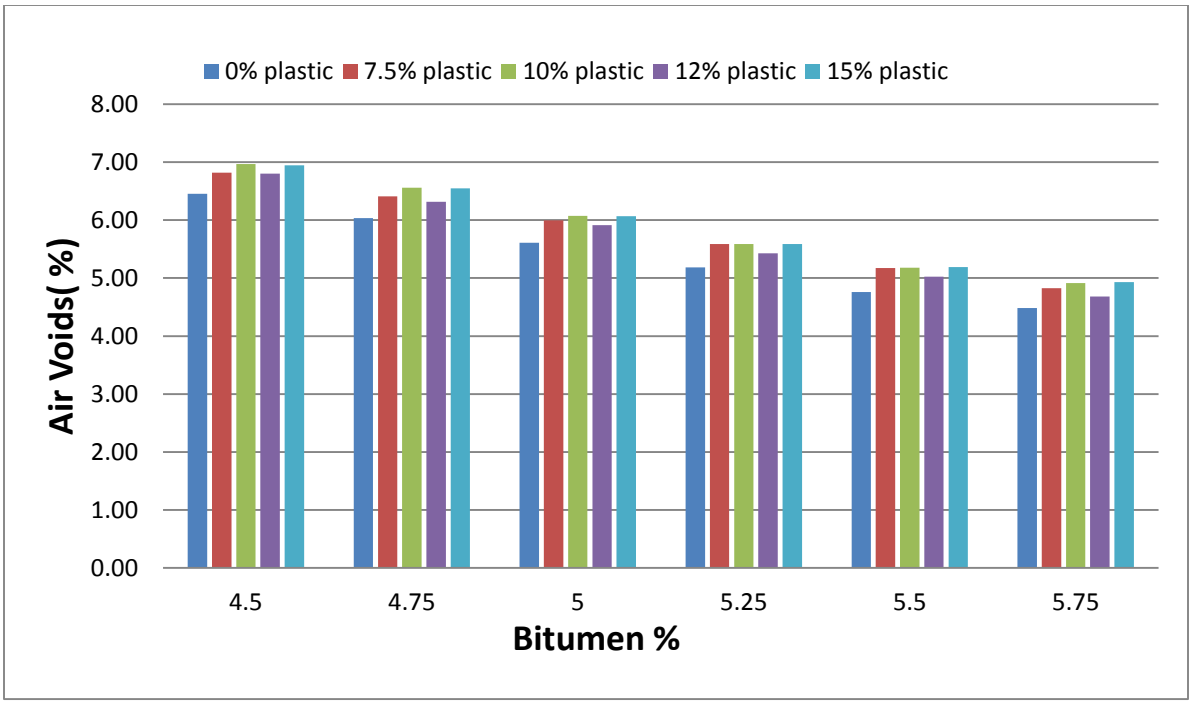
The Marshall tests were conducted for the semi dense bituminous concrete mixes. The tests were conducted on the samples prepared with both neat and plastic modified bituminous mixes. The Marshall Stability test was conducted on compacted cylindrical specimen of bituminous mix of diameter 101.6 mm and thickness of 63.5 mm. The load was applied perpendicular to the axis of the cylindrical specimen through a testing head consisting of a pair of cylindrical segment, at constant rate of deformation of 51 mm per min at the standard test temp of 60°C. The Marshall Stability of the bituminous mix specimen was defined as the maximum load carried at a standard test temp of 60°C. When the load was applied under specified test conditions. The flow value is the total deformation of Marshall Test specimen at the maximum load, expressed in mm unit. The Marshall Stability value of a compacted test specimen of bituminous mix indicates its resistance to deformation under applied incremental load and the flow value indicates the extent of deformation it under goes due to loading or its flexibility. The test specimen is prepared with varying bitumen content 2.5 % increments over a range that gives a well-defined maximum value for specimen density and stability.

To the incremental bitumen content plastic content of 7.5, 10, 12.5, 15 % is added to check the effect of plastic replacement on the Marshall properties of the mix. The Marshall Test results for test specimen prepared with neat semi dense bituminous concrete.

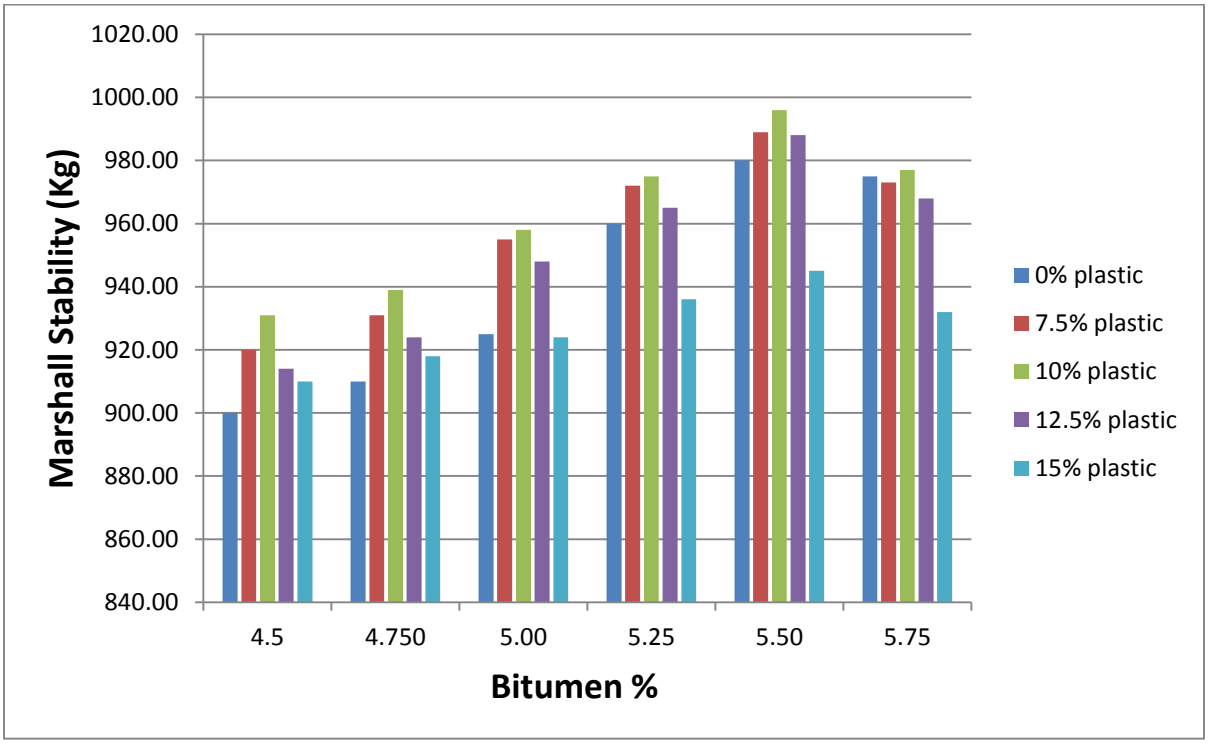
Fig1 Mixing of Shredded Plastic Waste into Aggregates and Arrangements of Samples in Marshall Test set up

4. EXPERIMENTAL PROGRAMME

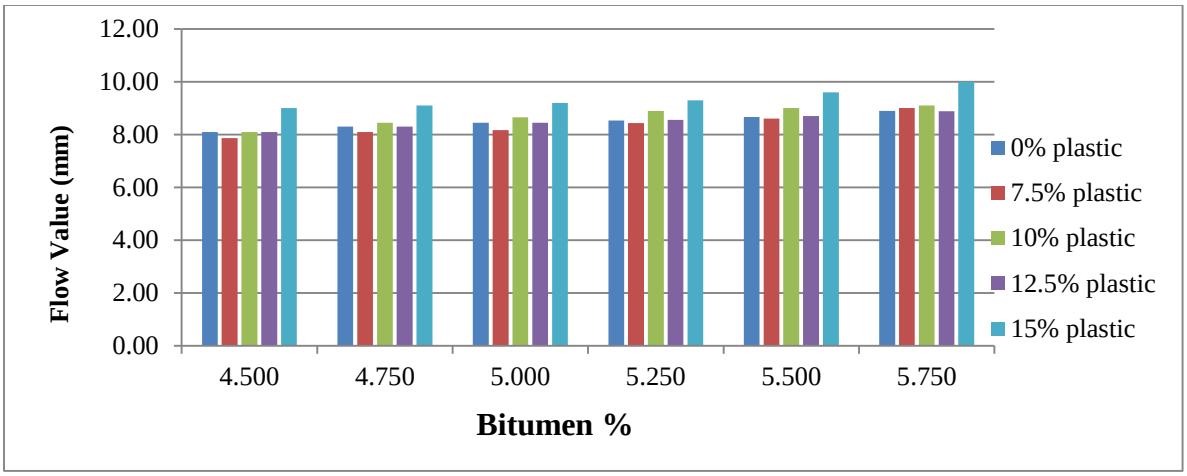
Marshall Stability of a test specimen is the maximum load required to produce failure when the specimen is preheated to a prescribed temperature placed in a special test head and the load is applied at a constant strain (5 cm per minute). While the stability test is in progress dial gauge is used to measure the vertical deformation of the specimen. The deformation at the failure point expressed in units of 0.25 mm is called the Marshall Flow value of the specimen. The plastic content of 7.5, 10, 12.5, and 15 % is added to check the effect of plastic replacement on the Marshall properties of the mix of bitumen. The bitumen percentage variation with air voids, Marshall Stability, VMA, density and flow value shows the behavior of plastic percentage on bitumen. As evaluation shows that, the Marshall Stability test shows the as plastic percentage increases up to 10 % plastic replacement then it will go down. The graph 1, 2,3,4,5 shows the waste plastic percentage replacement of bitumen to shows behaviors and respective effect on bitumen concrete mixes. These graphs shows results for plastic replacement is as follows.



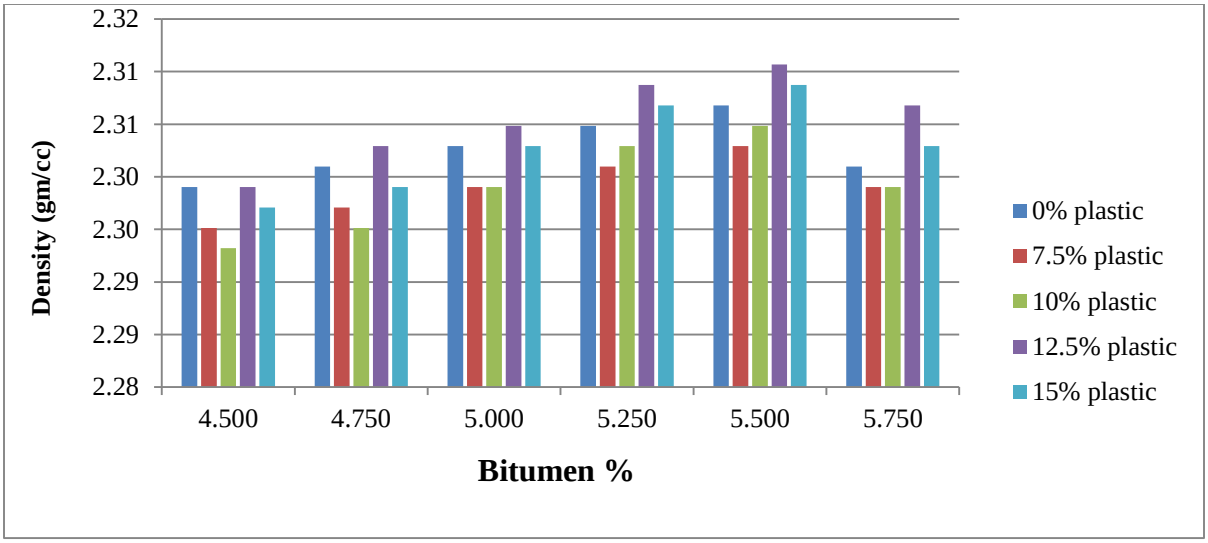
Graph 1: Bitumen Percentage v/s Air Voids



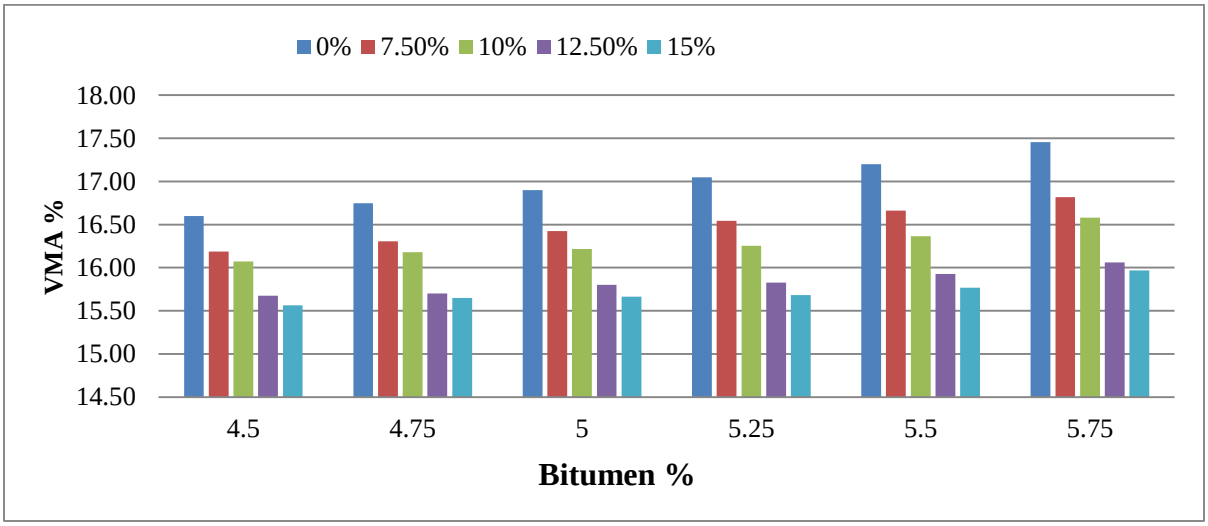
Graph 2: Bitumen Percentage v/s Marshall Stability



Graph 3: Bitumen Percentage v/s Flow Value



Graph 4: Bitumen Percentage v/s Density



Graph 5: Bitumen Percentage v/s Voids in Mineral Aggregate

5. CONCLUSION

1. The optimum bitumen content of the neat semi dense bituminous concrete mixes showed 10% higher when compared with modified semi dense bituminous concrete mixes with waste plastic.
2. The Marshall Stability of neat semi dense bituminous concrete mixes at optimum bitumen content showed 1.6% lower when compared with modified semi dense bituminous concrete mixes with waste plastic.
3. The bulk density of neat semi dense bituminous concrete mixes at optimum bitumen content showed 0.43% higher when compared with modified semi dense bituminous concrete mixes with waste plastic.
4. The volume of Air Voids of neat semi dense bituminous concrete mixes at optimum bitumen content showed 8.1% lower when compared with modified semi dense bituminous concrete mixes with waste plastic.
5. Voids filled with bitumen for neat and plastic modified semi dense bituminous mixes were within the limits specified by MORTH and Voids in mineral aggregates for both neat and modified mixes were within the limits.
6. The semi dense bituminous concrete mixes with 10% waste plastic exhibited better results for Marshall, Hence use of waste plastic may be recommended. However this has to support by further lab investigations and based on field performance investigations.
7. Bitumen is bonded with the aggregate by means of plastic which acts as a binder.
8. With the increase of waste plastic in bitumen increases the properties of aggregate and bitumen.
9. Use of waste plastic in flexible pavements shows good result when compared with conventional flexible pavements.
10. It is observed that, using plastic waste in bituminous mixes, the life of the road is increased and hence the maintenance expenditure is reduced.
11. From cost analysis of project it is observed that, percentage cost reduction for one cum material mix is 5.18%.

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