



Experimental Study On Utilisation Of Plastic Waste In Bituminous Pavement

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- I. **Abstract:** Disposal of waste material (plastic) is a major problem. Plastic waste is a non-biodegradable. Burning of these waste plastic bags causes highly environmental pollution. It mainly consists of low-density polyethylene. To use of waste material in Bituminous Road construction really impressive job, this material dumped into land leads to wastage of land. In this study use of Aggregate as a filler material bituminous concrete and waste plastic as coating material. Find its utility in bituminous mixes for road construction. Improvement in properties of bituminous mix provides the solution for disposal in a useful way.
- II. **Introduction:** Most of the Highways in India constructed with flexible pavement having wearing course with bituminous concrete. This Bituminous Concrete should be constructed to satisfy the recommendation and requirements of MORTH Section 509. This clause specifies the construction of Bituminous Concrete, for use in wearing and profile corrective courses.
- III. **Objectives:**
- To improve the volumetric properties of Bituminous mix design.
 - To utilize waste plastic in bituminous mixes.
 - To evaluate laboratory performance of Bituminous mix design.
- IV. **Literature Review:**
1. In the study done by Mr. Rajneesh Kumar, Dr. P. K. Jain in the publication for Use of Plastic Waste Along with Bitumen in Construction of Flexible Pavements in the year 2020, their basic intention behind this research is to utilize the waste plastic efficiently in a constructive way such that it proves to be useful to the society.
And their Main objectives of this project work are:
 - To coat the aggregates with waste plastic materials.
 - Check the properties of various bitumen mixes.
 - Check the properties of bitumen mix after the coating the waste plastic materials.
 - Compare the bituminous mixes with plastic waste coating and conventional ones.

Their study suggests that –

- Aggregate Impact value of control specimen was 5.43%. It reduced to 4.91% for PP8 and 4.26% for PP10. Reduction in value was 10% for PP8 and 22% for PP10. This shows that the toughness of the aggregate was increased to face the impacts.
- Crushing Value was reduced from 19.2% to 13.33% and 9.82% for PP8 and PP10 respectively. Value reduced by 30% for PP8 and 48% for PP10. Low aggregate crushing value indicates strong aggregates, as the crushed fraction is low.
- Specific Gravity of the aggregate increases from 2.45 for control specimen to 2.7 for PP8 and 2.85 for PP10 due to plastic coating.
- Stripping Value was reduced from 8% for control specimen to nil for PP8 and PP10. This shows that coated aggregate is more suitable for bituminous construction than plain aggregates.
- Water Absorption is also reduced to nil for PP8 and PP10 from 1.7% for control specimen.

2. In the study done by Dr. S L Hake, Dr. R M Damgir, Mr. P R Awsarmal in the publication for Utilization of Plastic waste in Bitumen Mixes for Flexible Pavement in the year 2019, 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.

Their study suggests that -

- Bitumen is bonded with the aggregate by means of plastic which acts as a binder.
- With 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.
- It is observed that, using plastic waste in bituminous mixes, the life of the road is increased and hence the maintenance expenditure is reduced.
- From cost analysis of project, it is observed that, percentage cost reduction for one cum material mix is 5.18%

3. In the study done by Mr. H. Naghawi, Mr. R. Al-Ajarmeh, Mr. R. Allouzi, Mr. A. Alklub, Mr. K. Masarwah, Mr. A. AL-Quraini, Mr. M. Abu-Sarhan, in the publication for Plastic Waste Utilization as Asphalt Binder Modifier in Asphalt Concrete Pavement in the year 2018, their main objective of this paper is to evaluate the use of plastic waste as a low-cost asphalt binder modifier. PET materials such as plastic bottles and plastic cups were used. Plastic waste was collected from houses and schools. The collected PET materials were chosen with a maximum thickness of 60 micron. This would facilitate mixing them with asphalt at the laboratory under its softening point. Also, in order to provide appropriate plastic particles, the bottles and cups were cleaned then slashed into small pieces then crushed and sieved such that it passes through 3-5 mm sieve using shredding machine.

Their study suggests that -

- PWM content of 7.43% by weight of OBC is recommended as the optimum PWM content needed for enhancing the performance of asphalt mixtures.
- Asphalt mix modified with 7.43% PWM by OBC % would significantly enhance stability by 42.56%, flow by 89.91% and strength by 13.54%.
- This improvement can be explained by the enhanced adhesion developed between asphalt and plastic waste coated aggregates caused by the intermolecular bonding which improves asphalt mix strength. This would be reflected in the enhanced durability and stability of the asphalt mix which would lead to enhancing pavement resistance to fatigue cracking and rutting or permanent deformation.

4. In the study done by Prof. Dawale S. A. in a publication for Use of waste plastic coated aggregates in bituminous road construction in the year 2016, he deals with coating process, analysis of properties of plain aggregate and waste plastic coated aggregate sample and its comparison. Their study suggests that -
 - Use higher percentage of plastic waste.
 - Reduce the need of bitumen.
 - Increase the strength and performance of the road.

5. In the study done by Dr. P. K. Jain, in a publication for Plastic Waste Modified Bituminous surfacing for rural Roads in the year 2012, he deals with current imperatives for use of plastic waste in bituminous road construction. It is found that shredded plastic waste of the size 2-8 mm may be incorporated conveniently in bituminous mixes used for road constructions. The optimum dose is 0.4-0.5 % by weight of bituminous mix and 6-8% by weight of bitumen. Plastic waste may also be used for up gradations of fly ash for its use as fine aggregate and filler in bituminous road construction. Their study suggests that -
 - Use of waste plastic in bituminous mixes improves properties and performance of roads.
 - Plastic waste modified mixes can also be used for construction for rural roads.
 - The optimum dose of plastic waste is 0.4% by weight of bituminous mixture and 8% by weight of bitumen.
 - Use of waste plastic in roads is ideal disposal solution.

6. In the study done by Mr. Rokade S in the publication for the use of Waste Plastic and Waste Rubber Tyres in Flexible Highway Pavements in the year 2012, an attempt has been made by him to use waste plastic. Marshal method of bituminous mix design was carried out for varying percentages to determine the different mix design characteristics.

7. In the study done by Sangita, Tabrez Alam Khan, Sabina, D.K. Sharma in the publication for Effect of waste polymer modifier on the properties of bituminous concrete mixes in the year 2011, they evaluate the effect of waste polymer (nitrile rubber and polyethylene in 1:4 ratio) modifier (WPM) on various mechanical properties such as Marshall stability, flow, Marshall quotient (stability to flow ratio), resilient modulus and permanent deformation potential of bituminous concrete overlays. The Marshall tests of the waste polymer modified bituminous concrete (WPMB) mixes, prepared through dry process, indicated the optimum waste polymer modifier content to be 8% (by weight of optimum bitumen content). The waste polymer modified bituminous mix containing 8% WPM showed considerable improvement in various mechanical properties of the mix compared to the conventional bituminous concrete mix. Their study suggests that -
 - The effect of waste polymer modifier (nitrile rubber and polythene) on various mechanical properties of the bituminous concrete mixtures was evaluated.
 - The Thermo-gravimetric analysis (TGA) results showed that waste polymer modifier (WPM) is thermally stable up to 230°C so will not degrade when blended with hot aggregates.
 - Various test results on 60/70 bitumen and aggregate satisfied the specified limits. Marshall stability, Marshall quotient and retained stability tests confirmed the optimum waste polymer modifier (WPM) content to be 8%.

8. In the study done by Mr. T. Awwad Mohammad and Sheeb Lina in the publication for the Use of Polyethylene in Hot Asphalt Mixtures, in the year 2007, they investigated the use of polyethylene, which is one type of plastomers, to modify asphalt mix properties was investigated. It is used as aggregate coating rather than modifying bituminous properties. The principal objectives of their research were to –
 - Study the effect of adding polyethylene on the hot mix asphalt.
 - identify which type of polyethylene yields the highest material performance.

- identify the best mechanism of adding the polyethylene to the asphalt mixture to achieve better mixture properties.
- determine the optimum percent of asphalt and polyethylene in the hot mix asphalt.

Their study suggests that -

- the modified mixture has a higher stability and VMA percentage compared to the non-modified mixtures. This would positively influence the rutting resistance of these mixtures.
- The air void contents of the modified mixture are not far from that of the non-modified mixture. Air void proportion around 4% is enough to provide room for the expansion of asphalt binder to prevent bleeding or flushing that would reduce the skid resistance of the pavement and increase rutting susceptibility.
- Overall, using the polyethylene in asphalt mixture reduces pavement deformation; increase fatigue resistance and provide better adhesion between the asphalt and the aggregate.

9. In the study done by Dr. R. Vasudevan, S.K. Nigam, R. Velkennedy, A. Ramalinga Chandra Sekar, B. Sundarakannan in the publication for Utilization of Waste Polymers coated Aggregate for Flexible Pavement and Easy Disposal of Waste Polymers in the year 2007, they used virgin and recycled polymers. But when higher percentage of plastics waste was used, the polymer got separated from the blend. Hence a new innovative technique was developed by the author and the heated stone aggregate was first coated with plastics generated from wastes like carry bags, films, foams, and multi layers and the plastics waste coated aggregate (PCA) was used as the raw material for flexible pavement.

Their study suggests that -

- PCA is then mixed with 60/70 or 80/100 bitumen and the mix is used for road construction.
- PCA + Bitumen mix showed better binding property.
- The sample showed higher Marshall Stability value.

10. In the study done by Mr. Narayan P. V., Bandopadhyay T. K. in the publication for Waste Plastic for Road Construction in the year 2004, in the Volume 2-Issue 3 of Envis, an article on the "Use of Plastics waste in construction of Tar Road" was published. The advantage of using Waste Plastics in road construction was discussed in the article. India Centre For Plastics in The Environment (ICPE) organised a Technical Presentation to the officials of Solid Waste Management Department (EWM) of Municipal Corporation of Greater Mumbai (MCGM) on 08th October 2024, Mr. T. K. Bandopadhyay made the joint presentation. The MCGM officials were satisfied with the technical presentation and invited ICPE to co-ordinate and assist MCGM in laying the road using plastic waste, which is causing a waste management problem to the Municipal Corporation. Accordingly, the trial was organized on 6th and 7th December, 2004. Waste plastics replaced about 7-8% by weight of bitumen. (For new road, this goes up to 15%). Stripping test conducted after the mixing operation proved that the adhesion of the "stone – plastics waste – bitumen aggregate" was good. 1st Road Laying/Repairing Place was at New Prabhadevi Road (G-S Ward). 2nd Road Laying/Repairing Place was Opp. Poonam Park, Parsee Lane, Lal Baugh area (F-S Ward).

Their study suggests that Plastics Waste could be successfully mixed with stones and bitumen at the highspeed asphalt plant and the condition of the tar road, when laid properly, was good. Cost of waste plastics was around Rs. 6 per kg vis-à-vis cost of bitumen being around Rs. 14 per kg. Hence there was a saving in cost of tar road construction. Condition of the road, inspected periodically, was found to be good. Proposal has now been made to MCGM to adopt this technology for constructing tar roads in the Mumbai Municipal area

11. In the study done by Prof. C.E.G. Justo, Dr. A. Veeraragavanin the publication for Utilisation of Waste Plastic Bags in Bituminous Mix for Improved Performance of Roads in the year 2002, Prof. C.E.G. Justo states that addition of 8.0 % by weight of processed plastic for the preparation of modified bitumen results in a saving of 0.4 % bitumen by weight of the mix or about 9.6 kg bitumen per cubic meter (m³) of BC mix. Modified Bitumen improves the stability or strength, life and other desirable properties of bituminous concrete mix.

Conclusion:

It has been noticed that adding plastic to a bituminous mixture improves the properties of aggregate and bitumen when compared to normal mixes. Laboratory test results will be assessed to anticipate the behaviours of bituminous pavements with and without plastic waste, and to determine if the use of waste plastic in bituminous mixes will be superior than that without plastic waste. The volumetric properties of Marshall mix design will be investigated.

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