



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 Issue: VIII Month of publication: August 2017

DOI: <http://doi.org/10.22214/ijraset.2017.8163>

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Review on Reutilization of Plastic Waste in Paving Mixes

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Abstract: Plastic waste is one of the hazards to the environment and main issue is disposal of that waste. Now a day society has no other alternative because plastic is used up in the form of plastic bottles, plastic bags, and plastic sheets and other plastic materials etc. To control the plastic waste many efforts are taken. Related to this issue many efforts had to be done in the past few years on reutilization of plastic waste by Marshall Stability Method in bituminous mixes, but no significant results were obtained. Plastic waste was used in the form of low density polyethylene (LDPE), ethylene vinyl acetate (EVA), plastic, polymer, polypropylene (PP), polyethylene polypropylene polystyrene, polymeric poly packs, plastic bags, water bottles, PET. Permanent strain reduces by the addition of plastic waste in bituminous mixes. Optimum percentage of bitumen was reduced by reducing the use plastic waste in bituminous mixes. Plastic waste has not only improved the properties of bitumen, but also improved the properties of bituminous mixes. By the replacement with recycled material there will be reduction in the cost of road construction because this recycled material is cheaper than bitumen and easy to obtain. It improves the life of the road. Thus, the use of waste plastic ultimately improves the quality and performance of flexible pavement. Generally, the optimum quantity of plastic required in dense bitumen macadam is from 8% to 10%. Moreover this paper will draw our focus towards the improvements in properties of bituminous mixes when partially replacing with waste plastic.

Keywords: Plastic Waste, Disposal, Utilization, Marshall Stability Method, Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), Ethylene Vinyl Acetate (EVA), Plastic, Polymer, Polypropylene (PP), Polymeric Poly Packs, Polyethylene Polypropylene polystyrene, Plastic Bags, Water Bottles, PET.

I. INTRODUCTION

The Plastic waste is the major problem rising nowadays and it is the need of era to minimize or control the use of plastic materials. According to the survey done by India, a large amount of plastic waste is producing. The Plastic material are used in different forms like carry bags, plastic bottles, plastic sheets, other type of plastic materials etc. 50-60% of total plastic are used for packing purposes which are only used single time and then throw away in the form of waste. Plastic wastes are reliable and also non-biodegradable. The main drawback is that throwing of plastic waste may cause reproductive problems in humans and animals, breast cancer, genital abnormalities and much more. These plastic wastes get mixed with water, fall apart into tiny pieces, and take the forms of small pellets which cause the death of fishes and other water based life who mistake them as foodstuff material. Many times they are either land filled or consumed. Plastic wastes get mixed with the city based solid waste or thrown over a land area. All the above processes are not eco-friendly as they pollute the land, air and water. Under these conditions, another choice is reuse of this plastic waste by adopting some suitable methods to keep the environment safe and healthy. So we can use this waste as filler or additive in bituminous mixes to increase its properties. Economy should be maintained in bituminous mix design and therefore, addition of plastic waste in bituminous mixes will make the mix economical in terms of its construction as well as maintenance cost.

II. RESEARCH AND STUDIES ON REUTILISATION OF PLASTIC WASTE

Relevant research work and studies concerning reuse of plastic waste in bituminous mixes are reviewed here:

- [1] Abolfazl Hassani, Hossein Ganjidoust, Amir Abedin Maghanaki explained the use of plastic waste in asphalt concrete mixture as aggregate replacement. Their research was focused on the parameters of Marshall Stability, flow, Marshall Quotient (stability-to-flow ratio) and density. The replacement of aggregate by 20% of volume with PET granules would result in a reduction of 2.8% in bulk compacted mix density. The flow value in the plastic asphalt mix was lesser than that of the control mix samples.
- [2] Sabina, Khan Tabrez A, Sangita, Sharma DK & Sharma BM studied the comparative performance of properties of bituminous mixes containing plastic/polymer (PP) (8% and 15% by the weight of bitumen) with ordinary bituminous mix. Significant enhancement in properties like Marshall Stability, Retained Stability, Indirect Tensile Strength and Rutting was observed in PP

modified bituminous concrete mixes. Thus, in this study it was concluded that PP modified bituminous concrete mixes improved the performance in terms of durability and gave less susceptibility to moisture in actual field conditions.

[3] Jain PK, Kumar Shanta & Sengupta JB has found that rutting is accumulation of permanent deformations caused by repeated applications of traffic loads and it is stress controlled cyclic loading phenomenon. Polymeric poly packs are using for packaging of milk for distribution to consumers and such bags after consumption of milk are thrown away. Therefore, in this study these milk bags and other high density polyethylene (HDPE) based carry bags were used as additives in bituminous mixes. Results indicate that incorporation of WPPM in excess of 0.4% may be harmful to engineering properties of the bituminous mixes as excessive rutting was observed in laboratory samples. Use of WPPM in road construction is the best feasible option for disposal of non-biodegradable plastic waste.

[4] Bale Amole S., A review of various plastic wastes for use in the construction of roads has been discussed. Plastics will raise the melting point of the bitumen. The use of the inventive technologies not only strengthens the road construction but also raise the road life. Also, it helps to improve the environment and creates a source of income. In the areas having high temperature, plastic roads would be a boon. In this paper it was explained that if in future we use plastic waste for constructing pavements then we will get strong, durable and eco-friendly roads which will relieve the earth from all type of plastic-waste.

[5] Adane Legesse and Muleta Diriba revised that Survey on the usage of plastic bags, their disposal and adverse impacts on environment: A case study in Jimma City, Southwestern Ethiopia. A semi-structured questionnaire was caused to collect data from 230 randomly selected respondents. Some of the bigger issues were animal death (167, 72.60%), blockage of sewage lines (162, 70.43%), deterioration of natural beauty of an environment (144, 62.60%) and human health problems (119, 51.73%). In order to reduce the issues associated with plastic bag wastes, it was recommended that (1) not to use plastic bags (banning of product), and (2) to use eco-friendly alternative materials (bags) formed from clothes, natural fibers and paper (aware the adverse effect of plastic wastes on environment, human health and animals etc). Therefore the central government in collaboration with other concerned authorities of the city would inspire people to use environment-friendly alternative materials, such as cloth bags, paper bags and natural fiber bags.

[6] Rasel H. M., Rehman M. N. and Ahmed T.U. has studied the effect of addition of waste PVC that has been used previously as mineral water bottles, pipes, electrical fittings etc. He investigated the properties of mix by adding PVC in bitumen (2.5%, 5%, 7.5%, 10%, 12.5%, 15%, 17.5% and 20% by the weight of bitumen). The investigation directly concentrated on the test of strength properties of coarse aggregates and Marshall Design properties of bituminous mixes according to the test procedure. On the basis of experimental results, the following conclusions were made:

1) The scrap PVC available from domestic and other waste was applied to modify the bitumen to obtain high strength mixes and to get better adhesion properties of bitumen.

2) The recommended proportion of the PVC modifier was up to 10% by the weight of bitumen that would be consumed for construction of road in hot climate where low penetration grade bitumen was used.

[7] Afroz Sultana, SK, Prasad K. S. B. has studied the utilization of waste plastic as a strength modifier in surface course of Flexible and Rigid Pavements. Its present study investigated the potential consumption of waste plastic as a modifier for asphalt concrete and cement concrete pavement. Different ratios of plastic waste such as Polypropylene (PP), Low Density Polyethylene (LDPE), and High Density Polyethylene (HDPE) by weight of asphalt were mingling with 80/100 paving grade asphalt. Marshall Stability test, loss of stability test was conducted by using plastic coated aggregates and polymer modified bitumen on HMA mixtures. Result showed that:

By enlarging the percentage of plastic, the stability values increased and required quantities of binder contents were reduced.

Based on the stability values, the optimum percentage of plastic was 6% and 8% for plastic coated aggregate samples and polymer modified bitumen samples respectively.

Based on stability values the plastic coated aggregate samples were highly stable than polymer modified bitumen samples.

The low density polythene type of plastic obtained better performance values than polypropylene.

By conducting the loss of stability test, the results obtained were greater than 75% and this showed that these mixes will perform well in adverse situations.

By conducting compressive strength of cubes using plastic coated aggregates, there was no significant increase in the strength of cubes.

[8] Wan Mohd Nazmi Wan Abdul Rahman, Achmad Fauzi Abdul Wahab studied the Green Pavement Using Recycled Polyethylene Terephthalate (PET) as Partial Fine Aggregate Replacement in Modified Asphalt. The objective of this research work was to determine optimum quantity of PET and the effect usage of recycled PET as partial fine aggregate in modified asphalt mixture by

determining the permanent deformation and stiffness behavior. The result obtained from the lab testing revealed that the maximum permanent deformation at 20% replacement with recycled could reduce cost of road construction because this recycled material was cheaper than bitumen and it is easy to obtain this material. It could be concluded that the application of recycled PET modified asphalt gives more advantages compared to the conventional.

[9] Gawandea Amit, Zamarea G., Rengea V.C., Taydea Saurabh, Bharsakale G. has studied an overview of plastic waste utilization in asphaltting of roads. The use of modified bitumen with the addition of processed waste plastic of about 5-10% by weight of bitumen helps in substantially enhancing the Marshall stability, strength, fatigue life and other desirable properties of bituminous concrete mix which enhances the longevity and pavement performance with marginal saving in bitumen usage. The use of waste plastics in the manufacturing of roads and laminated roofing also make it easier to consume large quantity of waste plastics.

[10] Kapil Soni, K.K Punjabi has found that with the use of waste plastic, performance of bituminous concrete mix will increase. The waste plastic modified bitumen mix showed better binding property, stability, stiffness, density and extra resistant to water. He concluded that the waste polythene consumed in the mix will get coated over aggregates of the mixture and it will reduce the porosity, absorption of moisture and also improve the binding property. 4.5 % Polythene Waste was showing its better performance as compared to other mixes. The rutting action was enhanced by using the plastic coated aggregates.

[11] Sreedevi B. G., Salini P. N has studied about the road surface using bituminous mix with plastic coated aggregates. It was all laboratory study which was conducted on semi Dense Bituminous Concrete (SDBC), Bituminous Concrete (BC) and Dense Bituminous Macadam (DBM). The study showed increase in Marshall Stability value by 1.5 to 2 times on addition of Plastic Coated Aggregates. The quantity of bitumen also reduced more than 10% by weight. When compared with the control mix, the stretches reconstruction of surface using plastic coated aggregate have shown enhanced functional performance in terms of better surface condition, delayed pot hole and crack initiation and progression, desirable frictional resistance and surface texture.

[12] S. Rajasekaran, Dr. R. Vasudevan, Dr. Samuvel Paulraj, studied the reuse of waste plastics coated aggregates bitumen mix composite for road application by green method. Waste plastics, mainly used for packing were made up of Polyethylene, Polypropylene, polystyrene. The higher Marshall Stability value in the range of 18-20KN was occurred and the load bearing capacity of the road was increased by 100%.

[13] Dr. Hamed M. Jassim, Omar T. Mahmood, Sheelan A. Ahmed on the basis of the materials used and laboratory tests performed in this study, author concluded the following points:

The different types and sizes of bottles were utilizing to modify the asphalt mixture performance.

Fine size of shredded plastic waste particles added to the asphalt mixture, which increases Marshall Stability.

[14] Bhageerathy K. P, Alex Anu P., Manju V. S, Raji A. K. has studied the use of biomedical plastic waste in bituminous road construction. This study looked into the performance of the bituminous mix modified with bio-medical plastic waste and also its comparison with the conventional mix. The following conclusions:

Optimum plastic content was getting as 5 percent by weight of bitumen content.

The aggregate crushing value was decreases.

The aggregate impact value showed percentage losses.

Los Angeles abrasion value of plastic coated aggregates was found to less as compared to normal aggregates.

The permanent strain was also low.

[15] Tapase A.B. and Kadam D.B. worked on the performance evaluation of polymer modified bitumen in flexible pavement. On the use of plastic waste as partial replacement to bitumen in flexible pavement was considered in the present work. The work consists of an experimental approach towards waste management and finding alternative to conventional materials in flexible pavements. To simulate with the field conditions Marshall Stability Method was considered to carryout experimental work. The goal of work was to look into the effect of plastic waste in flexible pavement and to suggest the most appropriate percentage of bitumen that would be replaced by plastic waste for the improvement of roads. Number of laboratory tests has been carried out by replacing bitumen by plastic waste. The results obtained in laboratory investigation indicated major gain in strength with substantial saving in cost.

III.CONCLUSIONS

The Conclusion by studying various research papers are as follows:-

- A. Plastic waste was used in the form of high density polyethylene, low density polyethylene (LDPE), Ethylene Vinyl Acetate (EVA), plastic, Polypropylene (PP), polymer, polymeric poly packs, plastic bags, water bottles, pipes, electrical fittings, PET.
- B. Permanent strain is reduced by the addition of plastic waste in bituminous mixes.

- C. Optimum bitumen content was used nearly as 5% and the large amount of plastic waste was used in bituminous mixes.
- D. The optimum percentage of plastic waste was used 8% by the weight of bitumen. Range for plastic waste was used 2%-20% by the weight of bitumen and in the form of coated aggregate.
- E. Plastic waste has not only improved the properties of bitumen, but also improved the properties of bituminous mixes.
- F. By the replacement with recycled material, the cost of road construction was reduced because this recycled material is cheaper than bitumen and easy to obtain.
- G. It also improves the level of performance and the service life of the road.
- H. The higher Marshall Stability value was obtained in the range of 18-20 KN and the load bearing capacity of the road was increased by 100%.
- I. Thus, the use of waste plastic ultimately improves the quality and performance of flexible pavement.

As we have discussed, plastic are non-biodegradable and also unhealthy to environment, thus, disposal of plastic is a matter of great trouble, therefore use of plastic waste in the road construction is an effective way of disposing of waste plastic.

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