A REVIEW STUDY ON THE USE OF WASTE POLYETHELENE TEREPHTHALATE IN ASPHALT CONCRETE MIX

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***Abstract*: Plastics are commonly used substances which play an important role in almost every aspect of our lives. The widespread generation of plastics waste needs proper end-of-life management. The highest amount of plastics is found in containers and packaging's, but they also are found in durables and disposable goods. Diversity of plastics applications is related with their specific properties, low density, easy processing, good mechanical properties, good chemical resistance, excellent thermal and electrical insulating properties and low cost. Increasing urbanization and industrialization have contributed for increased plastic generation. Safe disposal of waste plastic is a serious environmental problem. They pose a threat to the environment essentially due to the lack of an efficient collection and disposal system, as they are non-biodegradable. Plastics are most commonly used in the form of carry bags, packaging material, containers etc. This paper presents a review study to utilization of waste PET in the asphalt pavement.**

***Keywords*: waste plastic modified binder, asphalt mixture, mechanical performance, and road pavement.**

1.0 INTRODUCTION

Hot-Mix Asphalt (HMA) is the most widely used paving material around the world. It's known by many different names: HMA, asphaltic concrete, plant mix, bituminous mix, bituminous concrete, and many others. An asphalt plant is a plant used for the manufacture of asphalt, macadam and other forms of coated road stone, sometimes collectively known as blacktop or concrete. The manufacture of coated road stone demands the combination of a number of aggregates, sand and a filler (such as stone dust), in the correct proportions, heated, and finally coated with a binder, usually bitumen based or, in some cases tar, although tar was removed from BS4987 in 2001 and is not referred to in BSEN 13108/1. The temperature of the finished product must be sufficient to be workable after transport to the final destination. A temperature in the range of 100 to 200 degrees Celsius is normal. It is a combination of two primary ingredients aggregates and asphalt binder. Aggregates include both coarse and fine materials, typically a combination of different size rock and sand. The aggregates total approximately 95% of the total mixture by weight. They are mixed with approximately 5% asphalt binder to produce HMA. By volume, a typical HMA mixture is about 85% aggregate, 10% asphalt binder, and 5% air voids. Additives are added in small amounts to many HMA mixtures to enhance their performance or workability.

1.1 CLASSIFICATION OF WASTE PLASTIC

A) Polyethylene:

1. LDPE (Low-Density Poly-Ethylene): Low-density polyethylene this plastic waste available in the form of carrying bags generally in stores these plastic bags are very thin and also easily available.

2. HDPE (High-Density Poly-Ethylene): Generally High-density polyethylene type of plastic waste is available in the form of carrying bags and easily available in the market.

B) Polypropylene

This plastic may be available in the form of carrying bags or solid plastic it depends upon the use and need of the industries. It is available in the form of plastic bottles and mat sheets etc.

1.2 LITERATURE REVIEW

Mushtaq Ahmad et al studied the Improvement of Asphaltic Concrete by Using Waste Polyethylene Terephthalate (PET). This study examines properties of waste plastic water bottles, polyethylene terephthalate (PET). The waste polymer was added to the normal bitumen penetration grade (80/100) prepared Marshall Samples using ACW-14 to investigate Marshall Parameters of polymer modified bitumen and compare with conventional bitumen. Thermal analysis of PET waste polymer was carried out using TGA and DSC to study decomposition and melting temperature of the waste polymer and also select suitable type of polymer because compatibility of the material is an essential. Basic penetration, softening point, ductility test was performed and study finding shows that penetration and ductility decrease while softening point increase by addition of polymers. Penetration grade 80/100 bitumen is selected as a binder. ACW-14 aggregate was used in this study. Study justified with the past Marshall Stability of the bitumen increase 50-60% by addition of waste polymer, study findings shows that by addition of 9.0% highest Marshall Stability in mix was achieved and likewise stiffness, flow and voids filled with bitumen properties of the Marshall Mix was improved Percentage of the void total mix found to decrease while increasing modified bitumen contents in the Marshall Mix.

AMIT P. GAWANDE reviewed the economics and viability of plastic road. In this study Polymer Modified Bitumen is used due to its better performance. But in the case of higher percentage of polymer bitumen blend, the blend is a more polymer dispersion in bitumen, which get separated on cooling. This may affect the properties and quality of the blend and also the road laid using such blend. The process is eco friendly. Segregating plastic from the MSW at municipal yard involves application of resources, the cost of which runs into crores of rupees. A substantial amount of this can be saved. Lab tests and real time tests have revealed that the life expectancy of a plastic road, compared to a normal road is at least 100% more. This technique adds a cumulative benefit to National Economy also gives contribution to environmental benefits, employment generation and agricultural efficiency.

Salomao Pereira de Almeida et al evaluated the Mechanical Properties and Durability of Concrete Produced with Micronized PET Blocks for the Production of Floor Interlocked**.** This work aims to analyse the mechanical properties and durability of concrete blocks to interlocked paving produced with the partial replacement of fine aggregate by micronized polyethylene terephthalate (PET). In this study, the durability of the blocks, performing the tests: water absorption, abrasion resistance, inspection via scanning electron microscopy, resistance to sulfates (consequently, porosimetry and X-ray); aging by rain cycles and heat (erosion, cavitation, weight loss, loss of strength and leaching); The obtained results indicate an improvement of the mechanical properties and durability of concrete. We could observe a significant increase in compressive strength, in some cases exceeded the level of 50 MPa; it has been considered highly resistant floor. The concrete also showed low water absorption and high resistance to sulfate.

Somesh Jethwani et al studied the Utilization & Specification of Plastic Waste in Bituminous Roads. This study intends to create awareness and introduce various aspects for better utilization of plastic for betterment of road construction. The durability of the roads is much more than general, highway quality" roads. Approximately two times. Plastic in tar prevents water seepage, thus plastic roads can withstand water stagnation more effectively. Roads with plastics are having very low maintenance than conventional roads. Though plastic roads may initially cost a little higher than conventional roads, low maintenance, and increased durability compensates well. Roads with plastic not only dispose of plastic waste but increase the quality of roads. Marshall Stability number is increased and water resistant properties of the roads are improved to a notable level. Such roads have nil maintenance and can be constructed without the addition of any heavy machines. Thus, such roads should be adopted in developing countries like India where rutting, raveling and potholes are serious causes of accidents. The presence of chlorine in the plastic can release harmful gasses during laying process. It is important to take precautions during laying process. If the proper process is not adopted, plastic may state to leach out after some time.

Aymen Awad et al studied the utilization of waste plastics to enhance the performance of modified hot mix asphalt. The study was conducted to find out any treatment for the problem of the management of plastic municipal solid waste (MSW) in Jordan using as additive in the modification of road aggregate performance. In the same time, this will contribute to reduce the environmental impact of the plastic solid waste. This refused plastic was utilized to improve the asphalt performance. The first sets of experiment were carried out upon a six samples were tested with asphalt percentages of (5, 5.5, 6, 6.5, 7 and 7.5) at 60oC and the results gave that the optimum asphalt ratio was to be 7%. The second sets of testing were conducted for the optimum amount of refused plastic added to another six sets of samples tested at different percentage of refused plastic as follows (2, 2.5, 3, 3.5, 4 and 4.5 %) at 60oC and the results gave that the optimum ratio of plastic added was 4%. The results of the comparative study between hot mix asphalt and modified hot mix asphalt show that the addition of plastic has a significant positive effect on the properties of HMA, and mitigating the adverse effect on the environment. It is concluded that an improvements of physical properties of propylene-asphalt mixture specimens in comparison with conventional asphalt specimens at optimum ratios had been deducted. The stability of conventional asphalt specimens was lower than the stability of (PR) asphalt mixture specimens.

Wan Mohd Nazmi Wan Abdul Rahman et al studied the recycled polyethylene terephthalate as partial fine aggregate replacement properties and behaviour of asphalt mixtures for road pavements. The primary objective of this study is to evaluate optimum bitumen content and the characteristic of recycled polyethylene terephthalate (PET) as partial fine aggregate replacement in asphalt mixtures for road pavements by determining the rutting, fatigue and stiffness properties. The percentage of recycled PET replaces fine aggregate in asphalt mixture start up 25% and bitumen content start from 4 to 6% of weight of asphalt mixture. The result shows the highest value stiffness modulus of 0% PET modified asphalt reach at 5.5% bitumen content. The entire PET modified asphalt appears to be capable in resist rutting of road pavement. Meanwhile 5% and 15% PET modified asphalt show more fatigue resistance than unmodified asphalt at 1800 cycles. In conclusion, the 5.5% bitumen content and additional 5% replacement aggregate of recycled PET plastic on asphalt mixture would enhance all engineering properties of asphalt mixture for road pavement.

Dhirar T. Mohammed et al investigated Pyrolisis PET Utilization in Asphalt Binder. This study investigates the ability of improving the performance of the asphalt binder by using Polyethylene Terephthalate (PET). The results showed that, the morphology and properties of the modified asphalt are dependent on the type of polymer and polymer content. At low polymer contents, the samples revealed the existence of dispersed polymer particles in a continuous bitumen phase, whereas at high polymer contents a continuous polymer phase has been observed. Polymer modification improved the conventional properties of the base bitumen such as; penetration, softening point, temperature susceptibility, this means better performance in hot weather.

M. Sulyman et al reviewed the Recycled Polyethylene Terephthalate (PET) in Engineering Materials: This paper provides a summary of experimental efforts on the utilization of poly (ethylene terephthalate) (PET) in civil engineering projects, mainly in

road pavement, cements and concretes. Presented data indicate that use of waste PET for modification of asphalt, cement and concretes improved their selected properties, which makes economical this approach. Furthermore, using of waste PET in building materials reduce plastic wastes and especially recycled PET may be applied for modifications of road pavement asphalt and also building concretes. Usage of new polymeric materials, which has significant effect on environment pollution. Scientific reports proved that plastic wastes and especially recycled PET may be applied for modifications of road pavement asphalt and also building concretes.

CONCLUSION

Following are the various conclusions drawn after studying the various researches:

1. PET can be used as a modifier for asphalt binder for sustainable management of plastic waste as well as for improved performance of asphalt.
2. The use of waste plastic for road construction can save the environment, increase the service life of roads, reduce the consumption of petroleum products and serve the society with additional income for those associated with it.
3. It is concluded that an improvements of physical properties of propylene-asphalt mixture specimens in comparison with conventional asphalt specimens at optimum ratios had been deducted.
4. Compatibility can be better when the polymer is exposed to thermal degradation.
5. Generally, the addition of PET polymer can decrease the penetration, increase softening point, increase the penetration index, and that is better in hot climates.
6. The percent loss of air and heat decreases with the addition of polymers.

REFERENCES

[1] Polyethylene Terephthalate (PET)", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 8, August 2015.

[2] AMIT P. GAWANDE, "Economics and viability of plastic road: a review", Journal of current chemical & Pharmaceutical Sciences, J. Curr. Chem. Pharm. Sc.: 3(4), 2013, 231-242 ISSN 2277-2871.

[3] Somesh Jethwani Mushtaq Ahmad et al, "Improvement of Asphaltic Concrete by Using Waste, "Utilization & Specification of Plastic Waste in Bituminous Roads", International Journal of Engineering Research ISSN:2319-6890 (online),2347-5013(print) Volume No.6, Issue No.2, pp :91-94

[4] Aymen Awad, " Utilization of waste plastics to enhance the performance of modified hot mix asphalt", International Journal of GEOMATE, Dec., 2017, Vol. 13, Issue 40, pp. 132-139 Special Issue on Science, Engineering & Environment, ISSN: 2186-2990, Japan DOI: https://doi.org/10.21660/2017.40.170603.

[5] Wan Mohd Nazmi Wan Abdul Rahman, "Characterization of recycled polyethylene terephthalate as partial fine aggregate replacement properties and behaviour of asphalt mixtures for road pavements", ARPN Journal of Engineering and Applied Sciences, VOL. 11, NO. 6, MARCH 2016 ISSN 1819-6608

[6] Noor Zainab Habib, Ibrahim Kamaruddin, Madzalan Napiah and Isa Mohd Tan. (2012). Effect of Mixing Process on Polypropylene Modified Bituminous Concrete Mix Properties. World Academy of Science, Engineering and Technology Vol: 5 2011-10-26.

[7] Dhirar T. Mohammed, "Evaluation of Pyrolisis PET Utilization in Asphalt Binder", International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463 Vol. 3 Issue 9, Sept.-2014, pp: (114-121).

[8] Navarro, F.J., Partal P., Martı´nez-Boza F., and Gallegos C., "Thermo-rheological behaviour and storage stability of ground tire rubber-modified bitumens", vol. 83, pp. 2041–2049, 2004.