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USE OF HDPE WASTE IN BITUMINOUS CONCRETE FOR FLEXIBLE PAVEMENTS - REVIEW

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Abstract- Disposal of plastic waste is very big problem for our society/country/world, this is our common duty to dispose the waste materials effectively so environment not filled with wastes toxic gasses. This study fully on environmental healthy condition because of utilization of plastic waste type high density polyethylene effectively and with these we generates a better, economical and durable mix. Generally we have two types of pavements are in use i.e. flexible pavements and rigid pavements. The huge use of waste is possible because the more use of flexible pavements as road pavements. Engineers try to make a mix which is good for environment, fulfill road conditions, better resistance to rain, temperature effects and economical these all characteristics shall be fulfill by waste plastic as per literature survey. After observations of this study we shall be able to recommend these replacements with an optimum percentage.

Key Words: plastic waste, environment, flexible pavement, highways, rigid pavement, HDPE

INTRODUCATION

The major threat to the environment is the disposal of waste plastic. In a highway, the potholes and corrugation is the major problem. Plastic pavement will be a better solution to the above stated problems. The durability of plastic is high and it degrades very slowly. And also plastic has high resistant to degradation. Plastic is a non-degradable waste, causes greenhouse effect and global warming. The various experiments have been carried out whether the waste plastic can be reused productively. The various literature indicated that the waste plastic when added to hot aggregates will form a fine coat of plastic over the aggregate and such aggregates when mixed with binder is found to have higher strength, higher resistance and better performance over a period of time. Along with bitumen, use waste plastic increases its life and smoothness. Addition of plastic waste in construction of pavements reduces the plastic shrinkage and drying shrinkage. The use of waste plastic improves the abrasion & slip resistance of asphalt pavement. In India, because of hot and extremely humid climate, the plastic pavements are of greatest advantage.

LITERATURE REVIEW

In the construction of asphalt pavement, hot bitumen is coated over hot stone aggregate and rolled. Bitumen acts as a binder. Use of plastic waste to modify the bitumen and also the use of PCA are being studied to find better results for the better performance of the pavement. Various studies done on the process are mentioned below:-

1. **Strommer, et al., (1991) [1]** stated that the process for the production of a binder modified with synthetic material for building materials, especially street-building material, in which for the formation of the binder, molten bitumen together with a thermoplast or a thermoplast mixture, preferably an olefin polymer, is subjected to a homogenization treatment. To the mixture containing the bitumen and a thermoplast or a thermoplast mixture, there is supplied in the form of kinetic energy an amount of energy corresponding to the difference between the treatment temperature and the disintegration temperature of the thermoplast or thermoplast mixture to form readily reacting molecular fragments of the thermoplast or thermoplast mixture.

2. **Patrick, et al., (1996) [2]** carried out a study on the potential use of crumb sized ground tyre rubber, obtained from recycling waste tyres, as an additive to bitumen. Crumbed rubber had been used either mixed with bitumen or incorporated as part of the aggregate fraction in hot asphalt mixes. The justification for its use was based on an increased life or a reduction in layer thickness, resulting in reduced cost per square meter.

3. **Dr. Vasudevan, et al., (2011) [3]** stated that the polymer bitumen blend is a better binder compared to plain bitumen. Blend has increased softening point and decreased Penetration value with a suitable ductility. Waste plastics, mainly used for packing are made up of PE, PP and PS, their softening point varies between 110 °C and 140 °C and they do not produce any toxic gases during softening. But the softened plastics have a tendency to form a film like structure over the aggregate, when it is sprayed over the hot aggregate at 160 °C. The formed PCA is a better raw material for the construction of flexible pavement. PCA was then mixed with hot bitumen of different types and the mixes were used for road construction. PCA + bitumen mix showed improved

binding property and poor wetting property. The sample showed higher Marshall Stability value in the range of 18–20 kN and the load bearing capacity of the road is increased by 100% and there is no pothole formation. The roads laid since 2002 using PCA + bitumen mixes are performing well. A detailed studies on the performances of these roads shows that the PCA bitumen mix roads are performing well. This is an eco friendly and economic process too.

4. **Kalantar, et al., (2012) [4]** stated that many researches on PMA mixture has been conducted for the past two decades. Although addition of virgin polymers to asphalt for the purpose of enhancing the properties of asphalt over a wide temperature range in paving applications was contemplated quite some time ago, recycled polymer added to asphalt have also shown almost the same result in improving the road pavement performance as compared to virgin polymers. This paper is a review of the use of polymers in asphalt pavement. In this study, a critical review on the history and benefits of using waste and virgin polymer in asphalt is presented followed by a review of general studies on using polymers in asphalt in order to improve the properties of pavement.

5. **Gawande, et al., (2012) [5]** stated that the quantum of plastic waste in municipal solid waste (MSW) is increasing due to increase in population, urbanization, development activities and changes in life style which are leading to widespread littering on the landscape. Thus disposal of waste plastic is a menace and become a serious problem globally due to their non-biodegradability and unaesthetic view. Since these are not disposed scientifically & possibility to create ground and water pollution. This waste plastic partially replaces the conventional material to improve desired mechanical characteristics for particular road mix. In conventional road making process bitumen is used as binder. Such bitumen can be modified with waste plastic pieces and bitumen mix is made which can be used as a top layer coat of flexible pavement. This waste plastic modified bitumen mix shows better binding property, stability, density and more resistance to water.

6. **V. Patel, et al., (2014) [6]** studied the phenomenon of utilizing the waste such as Polypropylene, Low Density Polyethylene and High-Density Polyethylene in the construction of roads. Various tests were performed like Aggregate Impact value, Los Angles Abrasion, and the Crushing values of the aggregates with composition of one, two and three percentage of plastic waste. On the basis of test performed it was observed that values are increased with the addition of 1% of the plastic. Also, the construction cost of a road made with help of this plastic was analyzed it was found that plastic roads are more economical than other roads. At last it was concluded that the material used for the construction of flexible pavement is made better with the help of coating of bitumen mix with the polymer as it provides us superior Marshall Stability value and suitable Marshall Coefficient.

7. **Khodary, et al., (2015) [8]** did a study in which crumb rubber was used as a modifier in the bituminous concrete mix in his research with the inclusion of 10% of the weight of bitumen. CaCO3 was also included in the crumb rubber modified bitumen sample with 5%, 10%, 15%, 20% and 25% modification. Various tests such as Penetration test, Softening Point test, Compression test and Static three-point flexural tests were performed. It was observed that there were improvements in both softening point and penetration value for every modified bitumen samples from the view of fracture resistance and mechanical properties of modified bitumen mix. It was also observed that with 15% crumb rubber/CaCO3 nano-compounds were superior to that of the normal mix by almost thirty-four percent. It was concluded in the research that modified mixtures with fifteen percent crumb rubber/CaCo3 nano-compounds had twice higher Critical Energy Release Rate than that of unmodified mixtures which means that modified bitumen mixtures are superior in fraction resistance.

8. **Rajput, et al., (2016) [9]** studied utilization of waste plastic in bituminous mixes and proved that the properties of mix are improved. Disposal problems also solved to some extent. The cleaned Plastic waste was cut into a size such that it passes through 2.36 mm sieve using shredding machine. The aggregate mix was heated and the plastic was effectively coated over the aggregates. These plastic waste coated aggregates were mixed with hot bitumen to prepare mix. The use of the innovative technology will not only strengthen the road construction but also increase the road life as well as will help to reduce the environment pollution. The study investigated the use of waste plastic as a modifier for semi dense bituminous concrete. In this study the shredded plastic waste was mixed in hot aggregate and the plastic modified mix is prepared using 6%,8%,10%,12%, and 14%plastic by weight of bitumen .It was found that the Marshall stability value is maximum when 12% plastic waste is added to the mix. The other Marshall parameters were also improved with the addition of plastic waste into the bituminous mix.

9. **R. Manju, et al., (2017) [10]** did research in which the main focus was to minimize the global warming, pollution, and greenhouse gases, to increase the lifespan of the roads and to minimize the potholes. In the research various tests, conducted on normal aggregates and plastic-coated aggregates which were prepared with the help of dry process, were performed. About 10% of bitumen was replaced for the modification with plastic. It was observed that there is about 40% decrease in aggregate crushing value of modified bitumen, also the los abrasion value of plastic-coated aggregates were 21%less and there is about 10°C decrease in softening point. It was also observed that the polymer-coated aggregates reduced the voids and

moisture absorption. Due to this, there is no potholes formation and reduction in ruts. The plastic pavement can tolerate heavy traffic and are durable than those of flexible pavement. In this study researcher concluded that the use of plastic mix will reduce the bitumen content up to 10% and increases the strength and performance of the road. Also, this new technique is eco-friendly. The use of material which is smog absorbent such as titanium dioxide by ten percentage of polymer content can reduce vehicular pollution.

10. **Kumar, et al., (2019) [11]** used waste polyethylene in bituminous paying mixes. Various tests were conducted and from those tests following conclusions were drawn. It was observed that Marshall Stability value increases with polyethylene content up to 9% and thereafter decreases. A regular road requires 10 tonnes of bitumen for each kilometer. A plastic road however, requires only nine tonnes of bitumen and one tonne of waste plastic for coating. So, for every km, the plastic roads save as much as one tonne of bitumen.

11. **Hake, et al., (2020) [12]** studied procedure to utilize plastic waste. In Regular Street making process bitumen is utilized as folio. Such bitumen was adjusted with squander plastic pieces and bitumen blend was made which could be utilized as a best layer of adaptable asphalt. The plastic from PET jugs was utilized in blends for examine work. The measurements of plastic of 5 %, 7.5%, 10 %, 12.5% and 15 % was utilized as substitution of bitumen. The advance plastics content was kept 10% with 5.25 % of bitumen content. In this examination work it was explored that the general cost of plastic blends bitumen spared 5.18 % cost as contrast with customary bitumen. Subsequently it was efficient and earth advantageous for development of plastic blend bituminous streets.

Various studies on the performance of plastic road conclusively proves that it is good for heavy traffic due to better binding, increased strength and better surface condition for a prolonged period of exposure to variation in climatic changes Above all, the process helps to dispose waste plastics usefully and easily. A lot of work has been done and there is a huge scope for future research on this topic.

METHODOLOGY

In the process of laying plastic roads, firstly we collect the plastic waste material from different areas like landfills or dump yards. After that waste plastic material is washed or cleaned with any appropriate method and then dried for some time. Then we use the shredding machine to shred plastic waste into appropriate size. Then we select the appropriate size of aggregates for road construction.

There are two different types of process which we can use for purpose:-

[1] Dry process for bitumen mix

[2] Wet processes for bitumen mix

1. DRY PROCESS: In Dry process waste plastics are used as coating materials by softening the plastic and not by burning. For a flexible pavement hot stone aggregate (170'C) is mixed with hot bitumen (160'C) and the mix is used for road laying. The aggregate when coated with plastics improved its quality with respect to voids, soundness and moisture absorption and decreases porosity and thus the performance of the pavement is increased.

2. WET PROCESS: Plastic waste is ground and made into powder. 6 to 8% plastic is added to the bitumen at 160'C. The process does not yield a homogenous mix and have prominently separated solid deposits therefore wet process is not usually adopted.

Here, in this project work dry process is used.

OBJECTIVES OF STUDY

The objectives of proposed work are:

• To conduct a series of laboratory tests on conventional bituminous mix and modified bituminous mix to find out its suitable use for flexible pavements.

• To safer use of non biodegradable waste materials (HDPE) in flexible pavements.

• To propose an effective and economical method of disposal of plastic waste by using them in flexible pavements.

• To find out the positive effects of waste material, it may be lesser formation of pot holes, cracking and durability in flexible pavements.

IMPORTANCE OF STUDY

As per the previous works conducted on the proposed topic the importance of the study includes reduction of bitumen by around 10%. It proves to be a technology which is eco-friendly and can improve fatigue life of roads, increases the strength and performance of the road.

REFERENCES

1. Erich Strommer, "Process For Preparing A Bituminous Binder Modified With Plastics For Building Materials", United States Patent, January 1991.

2. J. E. Patrick and T. C. Logan, "Use Of Tyre Rubber In Bituminous Pavements In New Zealand", Transit New Zealand Reseaech Report, 1996.

3. R. Vasudevan , "A Technique To Dispose Waste Plastics In An Eco-Friendly Way– Application In Construction Of Flexible Pavements", Construction and Building Materials, volume 28, Department of Chemistry, Thiagarajar College of Engineering, Madurai, Tamil Nadu, India., 2011.

4. Zahra Niloofar Kalantar, Mohamed Rehan Karim, and Abdelaziz Mahrez "A Review Of Using Waste And Virgin Polymer In Pavement" , Construction and Building Materials, 2012.

5. Amit Gawande, G. Zamare, V.C. Renge, Saurabh Tayde, and G. Bharsakale "An Overview On Waste Plastic Utilization In Asphalting Of Roads", Journal of Engineering Research and Studies, Volume 3, May 2012.

6. V.Patel, Snehal Popli, and Drashti Bhatt. "Utilization of Plastic Waste In The Construction Of Roads", International Journal of Scientific Research, 2014.

7. Anzar Hamid Mir, "Use of Plastic Waste in Pavement Construction: An Example of Creative Waste Management", IOSR Journal of Engineering (IOSRJEN) Volume 05, Issue 2, February 2015.

8. Khodary Farag, Y. Mohammed, and A. Wazeri. "Damage Analysis Of Asphalt Concrete Mixtures Modified With Crumb Rubber/Caco3 Nano-Composite", International Journal of Scientific & Engineering Research, 2015.

9. Pratiksha Singh Rajput and R.K. Yadav. "Use Of Plastic Waste In Bituminous Road Construction", International Journal of Science Technology & Engineering**,** Volume 2, Issue 10, April 2016.

10. Manju, R., S. Sathya, and K. Sheema. "Use of Plastic Waste in the Bituminous Pavement", International Journal of ChemTech Research, Volume 10, 2017.

11. Ayush Kant Gupta and Er. Neeraj Kumar. "Experimental Study On Use Of Waste Polyethylene In Bituminous Paving Mixes." International Journal for Research in Applied Science & Engineering Technology, Volume 7, Issue 3, March 2019.

12. Dr. S. L. Hake, Dr. R. M. Dangir, and P. R. Awsarmal. "Utilization of Plastic waste in Bitumen Mixes for Flexible Pavement", Transportation Research Procedia, 48, May 2020.

13. A. B. Khan and S. S. Jain. "Assessment Of Strength Characteristics Of Bituminous Concrete Modified Using HDPE", Transportation Research Procedia, 48, May 2020.

14. Dr. Maninder Singh and Sachin Kamboj**. "**Review On Usage Of Waste Plastic In Bituminous Roads", Journal of University of Shanghai for Science and Technology, Volume 22, Issue 11, November 2020.

15. Arjita Biswas, Amit Goel, and Sandeep Potnis. "Performance Comparison Of Waste Plastic Modified Versus Conventional Bituminous Road In Pune City; A Case Study", Case Studies In Construction Materials, 2020

16. PMGSY "Guidelines for the Use of Plastic Waste in Rural Roads Construction."

17. Indian Road Congress IRC, SP. 53, 2002: Guidelines on Use of Polymer and Rubber Modified Bitumen in Road Construction, New Delhi.

18. IS: 15462. , 2004: Polymer and Rubber Modified Bitumen–Specification. Bureau of Indian Standards. New Delhi.

19. Indian Roads Congress IRC: 37, 2012: Guidelines For The Design Of Flexible Pavements, New Delhi.

20. IRC: SP 98, 2013: Guidelines on Use of Plastic Waste In Road Construction, New Delhi.