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A REVIEW ON USE OF PLASTIC WASTE AND RECYCLED AGGREGATES IN BITUMINUOUS ROAD CONSTRUCTION

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Abstract: In this project we are attempting to solve problems related to environment concerning about the plastic waste generated and its disposal and also about the reuse of aggregates obtained from demolished structures. Plastic as we all know has become a global environmental threat and measures should be taken to control it. In our project what we have used waste plastic and aggregates obtained from demolished structures in construction of a polymer mixed bituminous road. This gives us two-way benefits of saving the environment and also achieving good economic road construction. This also facilitates the reuse of aggregates thus in a way decreasing the load from supply chain of aggregate.

Keywords: *waste plastic, reuse of aggregates, environment, economy*

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I INTRODUCTION

Plastic is widely used in our day-to-day life. It is common site in both urban and rural areas to find empty plastic bags and other type of plastic packing material littering the roads as well as drains. As Plastic is non-biodegradable, harmful chemical, causes ocean pollution and so many. As per a study by the Central Pollution Control Board, 60 large cities in India generate over 15,000 tonne of plastic waste every day. In an observation earlier this year, the Supreme Court had said that the country is sitting on a plastic time bomb.

Natural materials use in road construction being exhaustible in nature, its quantity is declining gradually while use of Plastic in Roads are found to perform better compared to those constructed with conventional bitumen. If these materials can be suitably utilized in highway road construction, the pollution and disposal problems may be partly reduced. Further it has been found that such roads were not subjected to stripping when come in contact with water. Also, cost of extracting good quality of natural material is increasing. On heating at 100-160°C, plastics such as polyethylene, polypropylene and polystyrene, soften and exhibit good binding properties. Blending of the softened plastic with bitumen results in a mixed that is good for road laying. The process is easy and does not need any new machinery. Plastic increases the aggregate impact value and improves the quality of flexible pavements and also wear and tear of the roads has decreased to a large extent.

Natural resources used for road construction are depleting. Consequently, the haulage cost for acquiring good quality stone aggregates is increasing. The environmental costs of quarrying are also substantial. The project involves design of a road structure using the aggregates of the demolished structures as recycled material. Recycled materials will be used either in unbound form or in lightly cemented form.This use of recycled aggregates in construction of bituminous road construction will have a major positive impact on the environment as the need for supply of new aggregates will be lessened. This will also help in cutting the construction cost of the bituminous road and also will help in proper disposal of the waste generated from the demolished structure.

The debate on the use and abuse of plastic related to environmental protection can go on, without yielding result until practical steps are initiated at grassroot levels by everyone who is in a position to do something about it. The plastic wastes could be used in road construction and would help to enhance the life of the road and also solve environmental problems. The rapid rate of urbanization and development has led to increase in plastic waste generation. As plastic is non-biodegradable in nature it remains in environment for several years and disposing plastic waste at landfills is unsafe as toxic chemicals leech out into the soil and pollute the underground water bodies. Disposal of plastic waste in a vast country like India needs high level of waste management system and at the same time India needs a large network of roads for its smooth economic and social development. Also depleting supplies of aggregates needs deep thinking to ensure fast road construction and also the disposal of material remaining from demolished structures also needs to be properly carried out.

II.LITERATURE REVIEW

Johnson Kwabena Appiah, Victor Nana Berko-Boateng, Trinity Ama Tagbor in their paper entitled “USE OF WASTE PLASTIC MATERIALS FOR ROAD CONSTRUCTION IN GHANA”, Case Studies in Construction Materials 6 (2017) PP1-7:This paper forms part of research to solve two main problems in Ghana: firstly, the management of municipal solid waste (MSW), particularly with regards to used plastics which have overwhelmed major cities and towns; secondly, the formation of potholes on roads due to excessive traffic and axle weight. This study examines the effect of blending waste thermoplastic polymers, namely High-density polyethylene (HDPE) and Polypropylene (PP) in Conventional AC-20 graded bitumen, at various plastic compositions. The plastics

were shredded and blended with the bitumen 'in-situ', with a shear mixer at a temperature range of 160°C– 170°C. Basic rheological parameters such as penetration, ring & ball softening point and viscosity tests were employed to determine the resulting changes from base bitumen. FTIR spectroscopy was also employed to study the chemical functionalities present in the bitumen composite. The properties of the unmodified bitumen were found to be enhanced with the changes recorded in the rheological properties of the polymer modified bitumen (PMB). It was observed that polypropylene polymer, showed profound effect on homogeneity and compatibility with slight linear increment in the viscosity, softening and penetration values as against relatively high changes for modified bitumen.

Amit Gawande, G. Zamare, V.C. Rengea, Saurabh Tayde, G. Bharsakale, in their paper entitled "AN OVERVIEW ON WASTE PLASTIC UTILIZATION IN ASPHALTING OF ROADS" Journal of Engineering Research and StudiesEISSN0976-7916Vol. III/ Issue II/AprilJune,2012/01-05: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 leading 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 replaced the conventional material to improve desired mechanical characteristics for particular road mix. In the present paper developed techniques to use plastic waste for construction purpose of roads and flexible pavements has reviewed. 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 show better binding property, stability, density and more resistant to water.

Imran M. Khan, Shahid Kabir, Majed A. Alhussain, Feras F. Almansoor in their paper entitled "ASPHALT DESIGN USING RECYCLED PLASTIC AND CRUMBRUBBER WASTE FOR SUSTAINABLE PAVEMENT CONSTRUCTION", Procedia Engineering 145(2016):The seasonal change in temperature and loading nature has a significant effect on asphalt behavior because of its viscoelastic nature. Several types of flexible pavement failure/distress occur due to this behavior of asphalt binder, among which rutting and fatigue cracks are very common. In this study, Low Density and High Density Polyethylene and Crumb rubber were used as additions to base bitumen. Complex modulus (G*) and phase angle (δ) obtained from Dynamic Shear Rheometer (DSR) are the basic perimeters used to evaluate the behavior of the binder in respect to rutting and fatigue cracking. It was concluded that Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), and Crumb Rubber (CR) modified binder showed significant improvement in rheological properties of the binder. Furthermore, recycling these municipal wastes will contribute to solving environmental problems in the Kingdom of Saudi Arabia caused by the piling up of these wastes in dumpsites.

Utibe J. Nkanga, Johnson A. Joseph,Feyisayo V. Adams, Obioma U. Uche in their paper entitled"CHARACTERIZATION OF BITUMEN/PLASTIC BLENDS FOR FLEXIBLE PAVEMENT APPLICATION" ,Procedia Manufacturing 7(2017)PP 490-496:Waste plastic materials including low density polyethylene (LDPE) grocery bags etc. are disposed through landfills: this poses an environmental pollution due to difficult in degradation of polymeric materials by environmental factors. Waste plastic materials can improve desired properties of bituminous mix for repair and construction of flexible pavements. In this project, various proportions of polymeric materials blended with bituminous mix were characterized. Strength and performance of bitumen/plastic blends were tested through marshall stability test, extraction test, sieve analysis, water absorption tests and bulk density. The results showed that bitumen/plastic blend has higher marshall stability of range 14.03 to 14.80 KN compared to conventional bituminous mixcsample which has a value of 11.35 KN. They also showed higher void air, lower bulk density and Marshall flow than the conventional bituminous mix. The results from the proportions of aggregate and quarry dust used in sieve analysis showed ratio 50:50 to be more appropriate for bitumen/plastic blends. This project also proves that waste plastics can be used efficiently for road repairs and construction resulting in more sustainable and better roads with high performance and durability.

Shivraj Sarojero Patil, in his paper entitled "EXPERIMENTAL STUDY ON BITUMEN WITH SYNTHETIC FIBER", Journal of Information, Knowledge and Research in Civil Engineering, ISSN: 0975 – 6744| Nov 14 to Oct 15 | Volume 3, Issue 2 pp213216:Disposal of waste materials including waste plastic bags has become a serious problem and waste plastics are burnt for apparent disposal which cause environmental pollution. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned is cut into a size such that it passes through 1-2 mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. 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 improve the environment. The study was conducted to study the effects of the use of pieces of rubber as a partial substitute in bitumen. Bitumen is one of the binder materials used in construction of roads and pave has increased prices and costs to

achieve it. As a result of increasing economic and traffic load, road bitumen structure designed should have the durability and capability services play a key role in the communication network, the most important. Objective of this study is to reduce the quantity of bitumen used and replaced with pieces of rubber. Therefore, many efforts have been undertaken to improve the quality of the existing bitumen. In this study, bitumen grade is done with the addition of various pieces of rubber per cent content. Percentage of rubber used is 0%, 2%, 4%, 6%, 8% and 10% of the total amount of bitumen used. Overall analysis will shows, the addition of pieces of rubber in the mixture can enhance the capability of the mixture pave flexible.

Miss Apurva J Chavan, in her paper entitled " USE OF PLASTIC WASTE IN FLEXIBLE PAVEMENTS", International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 2, Issue 4, April 2013 PP 540-551:Disposal of waste materials including waste plastic bags has become a serious problem and waste plastics are burnt for apparent disposal which cause environmental pollution. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned is cut into a size such that it passes through 2-3mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. 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 improve the environment. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes. In my research work I have done a thorough study on the methodology of using plastic waste in bituminous mixes and presented the various tests performed on aggregates and bitumen.

III . RESEARCH METHODOLOGY

•Collection and segregation of plastic waste from garbage dumping area (helps in economic activity for the rag pickers)

•Collection of aggregates obtained from demolished structures

• Cleaning of aggregates and making them free from any unwanted materials

•Testing of aggregates for confirming their suitability for use in bituminous road construction

•Initially plastic wastes are converted into smaller size of range 2.36mm to 4.75mm using shredding machine.

•Plastic is added (@ 8% of bitumen) and this aggregate mix is heated at 165°C and then transferred to mixing chamber.

•The bitumen is heated to a maximum of 160°c for achieving good binding and to prevent weak bonding. (Monitoring the temperature is very important).

• At the mixing chamber, the shredded plastics waste is to be added. It gets coated uniformly over the aggregate within 30 to 60 seconds, giving an oily look.

•The plastics waste coated aggregate is mixed with hot bitumen and this mix is used for road construction. The roller used is 8-ton capacity.

•The temperature during lying of road is kept between 147C to 160 °C. And the rollers are used have capacity 8- ton generally.

IV. ADVANTAGES

•Since plastics come with various chemical and physical properties, roads can be engineered to meet specific requirements (e.g., weather and wear resistance)

•Plastic roads can be built from waste plastic --- the majority of which is usually put into landfill, incinerated, or polluted into the environment. Land-filling and incinerating plastic are both problematic methods of managing plastic waste. Plastics in landfills can leak pollutants into the surrounding soil; incinerating creates gaseous pollutants, such as carbon dioxide.

•Plastic-bitumen composite roads need not be especially discriminating with the plastics used, thus increasing the reuse of plastic. Most plastic waste is not recycled because it is usually mixed with different types of plastic and non-plastic (e.g., paper labels) and, so far, the segregation process is labour-intensive with no easy solution.

•The addition of plastic in asphalt can reduce the viscosity of the mix. This allows a lower working temperature, which lowers VOC and CO emissions.

•Plastic-bitumen composite roads have better wear resistance than standard asphalt concrete roads. They do not absorb water, have better flexibility which results in less rutting and less need for repair. Road surfaces remain smooth, are lower maintenance, and absorb sound better.

•The use of recycled aggregates will also have a positive environment impact and also will give economy to the construction of bituminous road

•Better resistance towards rainwater and stagnation of water

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