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A REVIEW PAPER ON USABILITY OF DIFFERENT WASTE PLASTIC TYPES ON BITUMIOUS CONCRETE MIX

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Abstract - *The continuous increase in road traffic in combination with insufficient maintenance due to paucity of funds has resulted in deterioration of road network in India. To improve this proper maintenance, effective and improved roadway design, use of better quality materials and use of effective and modern construction techniques should be put into practice. During last three decades in many countries around the world it has been tested that modification of the bituminous binder with polymer additives enhances the properties and life of bituminous concrete pavements. This paper reviews the use of plastic waste materials in improving the properties of bituminous mix. This review helps in the management of plastic waste and proper disposal or use of plastic waste for road construction.*

Key Words: *modern construction techniques, bituminous mix*

1.INTRODUCTION

Plastic usage has become part of our today's lifestyle. As a result, amount of waste plastic also increases. This leads to various environmental problems. Plastics are user friendly but not eco-friendly as they are non –biodegradable. Generally, it is disposed by way of land filling or incinerations which are hazardous the former prevent intrusion of water in to ground whereas the later causes air pollution. Many of the wastes produced today will remain in the environment for many years leading to various environmental concerns. Subjected to recent studies, plastics can stay for as long as 4200 years. Therefore, it is necessary to utilize the wastes effectively with help of technological development in each field.

Now-a-days, waste plastics is being widely used in construction sector. Research emerged in late 90's in India for the use of plastic wastes in pavement construction. Thousands of kilometres were constructed successfully using waste plastics in our country. However, these waste materials were used mainly for low volume road construction. The use of these materials in road construction is totally based on economic, technical and ecological point of view also. Many highway agencies are doing various studies on environmental suitability and performance of recycled products in high construction. Use of these waste plastic in bituminous road construction will help in disposal of vast quantities of plastic.

IRC: SP: 98-20013, Guidelines for the use of waste plastic in hot bituminous mixes (dry process) in wearing courses. The scope of the present guidelines is manufacturing of bituminous mix using waste plastic. These guidelines deal with the specifications and use of waste plastic in wearing course using dry process. It requires waste plastic modified design and open graded mixes. Studies have revealed that waste plastics have great potential for use in bituminous construction as its addition in small doses, about 5-10%, by weight of bitumen helps in substantially improving the Marshall stability, strength, fatigue life and other desirable properties of bituminous mix, leading to improved longevity and pavement performance. The use of waste plastic thus contributes to construction of green roads. There are two processes namely dry process and wet process for manufacturing bituminous mixes using waste plastic. In the dry process, processed waste plastic is added after shredding in hot aggregates where as in the wet process, processed waste plastic in the form of powder is added in the hot bitumen. The bitumen for bituminous mixes for wearing course with waste plastic is based on the Indian Standard Specifications for viscosity grade. The size waste plastic used in this code passing 2.36 mm sieve and retained on 600-micron sieve. Dry process and wet process are used for the manufacturing of bituminous mixes using waste plastic. In the dry process, shredded waste plastic is added in hot aggregates where as in the wet process, powdered waste plastic is added in the hot bitumen. The plastics consist of LDPE, HDPE, PU and PET. The aggregate mix is heated to 140-175°C in Central mixing plant. Central mixing plant helps to have better control of temperature and better mixing of this material thus helping to have a uniform coating and heated bitumen is also sprayed. The road laying temperature is between 110°C to 120°C for waste plastic bituminous mix.

2. LITERATURE REVIEW

Shubham Bansal, utilize waste materials as partial replacement of bitumen to develop a modified binder for making bituminous concrete mix. In this project, Shredded plastic and rubber were mixed with bitumen at a temperature range between 200°C and 220°C in pre-determined proportions. Plastic replacement in the binder

was in the order of 4%, 6%, 8%, 10%, and the rubber replacement was 5%, 10%, 15% and aggregates from four different sources were taken to prepare the sample then Marshall Stability Analysis' was performed on this samples. Shubham Bansal used discarded waste materials like crushed plastic bottles, thrown away polythene bags and used rubber tyres were the minor constituents of the binder along with bitumen as major constituent. Shredded plastic waste, having particle size around 650 mm with specific gravity 1.18 was used in the binder mix. Penetration test, Ductility test, Softening Point test and Specific gravity test were performed to analyse the physicochemical properties of various binders. Experimental results demonstrate that partial substitution of bitumen with waste plastic results up to 16% increment in strength whereas with rubber material, about 50% increment in strength was observed as compared to the conventional mix. He concluded that by using waste materials, bituminous concrete of required strength and density can be obtained and an environment friendly green pavement can be prepared with less material cost.

Johnson KwabenaAppiaha, conducted a case study on the Use of waste plastic materials for road construction in Ghana. This paper solved two main problems in Ghana. Firstly, the management of municipal solid waste and secondly, the formation of potholes on roads due to excessive traffic and axle weight. This study examines the effect of 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 at a temperature range of 160℃ –170℃. The plastic used was waste plastic bottles, bags, wrappers, etc collected from the Department of Chemistry, KNUST and from residential areas on the campus. In this paper wet process was employed and samples were prepared, using melt-blending technique. Bitumen (400 g) was heated in oven till fluid condition and polymer was slowly added. The speed of the mixer was kept above 120 rpm and temperature, between 160℃ –170℃. The concentration of PP and HDPE, ranged from 0.5% - 3% by weight of blend with an increment of 0.5%. Mixing was continued for 30mins-1hr to produce homogenous mixtures. He concluded that the addition of thermoplastic modifiers to conventional bitumen is known to improve the visco-elastic behaviour of the bitumen and change its rheological properties. Two types of modifiers display different amount of influence i.e. increasing the softening point, decreasing penetration value whilst enhancing the overall dynamic and absolute viscosities of the binder. This study has also shown that waste plastic modified bitumen carries great promise as an alternative recycling method for plastic waste management in Ghana, as well as a non-traditional, modified binder for road construction. Further studies should be done to investigate long term performance of field test sections with PMB so as to evaluate the effect on storage, rutting, cracking resistance under various traffic conditions.

Dr.V.Tare used dry process for waste plastic modified bituminous concrete mix and wet process is used for crumb rubber modified BC mix. In this project crushed coarse aggregate and fine aggregate are used. Were the filler material is cement.VG30 grade bitumen is used as a binder. The Marshall method of mix design is adopted to find the optimum bitumen content. In crumb rubber used in hot mix asphalt normally has 100 percent of the particles finer than 4.75 mm. Some crumb rubber particles may be as fine as 0.075 mm. The specific gravity of crumb rubber is approximately 1.15, and the product must be free of fabric, wire, or other contaminants. In the present study Crumb rubber passing sieve IS 425µ is used as modifier for BC mix. Rutting in conventional BC mix at optimum binder content and in both modified BC mix by adding 10% crumb rubber and 10% waste plastic is determined at 40,50 and 60 ℃ beyond optimum has effect on rutting. However waste plastic modified mix appears He observed minimum rutting in waste plastic modified mix. He concluded that binder content limit to perform better compared to other bituminous mixes. The processed waste plastic bags (mostly LDPE) for garbage of local area in the shredded form are used as modifier for bituminous concrete mix. The size of shredded waste plastic is taken for the present study passing through 4.75 mm IS sieve and retained on 300 µ IS sieve & thickness between 10 µ to 30 µ. The specific gravity of waste plastic is approximately 0.95.

Amar Kumar Das, The Optimal Utilization of Waste Plastics Added With Bitumen plastic. In this study, the properties of bituminous mix when modified with shredded waste plastic waste were investigated. The scope of this study is limited to the use of syringe plastic waste only. This work is carried out by mixing shredded autoclaved waste plastics with heated aggregates by dry process. It helps to improve the strength of the road. Here, Anti-stripping agents are being used. The present work involves using waste plastic bottles as a secondary material in civil construction work provides a better solution to overcome the threat of producing large amount of waste plastics and reinforcing the strength of material. Here, the molten plastics materials were used as a binder because they can be mixed with binder like bitumen to enhance their binding property. Laboratory performance studies were conducted Waste plastics on heating soften at around on bituminous mixes. This study intended to find the effective ways to reutilize the waste plastic waste particles as replacement of aggregate. He concluded that development of modified asphalt materials to improve the overall performance of pavements.

Jalal J. Jafar, utilised waste Plastic in Bituminous mix for improved performance of roads. He explained that the use of waste plastic in bituminous mix products often suffers from weak bonding between the plastic surface and the bitumen. The selected recycled waste plastics were used as partial aggregate replacement in bituminous mix product. The plastics were treated using a strong oxidising mixture of dichromate and sulphuric acid while the bitumen was treated with a cross linking agent, polyethyleneimine. Three modified bituminous mixtures were prepared and the stiffness results were compared with the control bituminous

mixture. Over the ten measurement cycles it was observed that the stiffness increased by 10% for the chemically modified bituminous mixtures. This improvement is attributed to an increase in the bonding forces between the aggregates and the bitumen. Furthermore, a mechanism is proposed in order to explain the effect of the chemical additives on the increase in the stiffness of the bituminous mixture.

S.Elango, conducted research on using plastic coated aggregate and eggshell as filler material in bituminous road construction. This study investigates the construction of flexible pavement using waste plastics as the coating over the aggregate. The main intention is to produce the better performance and Stability nature to the road and also made an improvement in the properties of the bituminous mix. . Aggregates of size 20mm & 12mm are used in this project work. Here, Low Density Polyethylene (LDPE) like Carry bags, sacks, milk pouches, bin lining, cosmetics and detergent bottles, Polyethylene Terephthalate (PET) such as drinking water bottles, Polypropylene (PP) includes bottles caps and closures, wrappers of detergent, biscuit, vapours packets, microwave trays for readymade meal are collected, cleaned, shredded into small pieces. Filler material is finally divided substance, which are insoluble in bitumen. Here, specimen were prepared by Dry Process. The result showed that the maximum value obtained at 10 % plastic coating and 15% of Eggshell in its content and it indicates that Plastic Coated Aggregate and Eggshell powder incorporated pavements are better when compared to conventional one. S.Elango concluded that thedeploy of plastics and eggshell proved effective one for the construction flexible pavements and acts as a boon to the society.

Dr. R. Vasudevan, explain on his paper that the roads constructed with PCA –Bitumen mix are shows good performance and this process is eco-friendly and economical. In this work plastics waste like PE, PP and PS is coated over stone aggregates and the PCA was mixed with bitumen and the mix was used for flexible pavement construction. Here, higher percentage of plastic waste of 10-15% can be used without separation. Various tests were carried out to find the characteristics of waste plastics used for coating over the aggregates, Plastics coated aggregate, Plastics coated aggregate mix with bitumen, Plastic coated bituminous road scrap. The aggregate is chosen on the basis of its strength, porosity and moisture absorption capacity. The waste plastics namely films, cups and foams shredded to the required size of 2.5mm – 4.36mm. The aggregate is heated to 170°C. The shredded waste plastic was sprayed over the hot aggregate. Plastics got softened and coated over the aggregate. The extent of coating was varied by using different percentage of plastics. Higher percentage of plastics was used up to 25% to evaluate the binding property, whereas lower percentage of plastics like 1% to 5% to evaluate the properties like moisture absorption and soundness. The hot plastic coated aggregate was mixed with 80/100 bitumen at 1600. The bitumen polymer coated aggregate mix was subjected to tests like Stripping test, Bitumen extraction test and Marshall Value determination test. This study concluded that Coating of polymers on the surface of the aggregate has resulted in many advantages and ultimately helps to improve the quality of flexible pavement. The coating of plastics over aggregate also improves the quality of the aggregate. The use of polymers helps to reduce equivalent quantity of bitumen, thus reducing the cost of the road laying.

Renga Rao Krishnamoorthy carried out to upgrade the standard concrete material with the recycle concrete material that can be applied to within the study area. The recycle concrete materials come from industrial waste. Shredded tyre rubber and grinded plastic bottles (polypropylene, PP) have been reused as coarse aggregate replacement and clean river sand in concrete mixture respectively. Both coarse aggregate and clean river sand were replaced by 10%, 20%, 30%, 40% and 50% of shredded tyre rubber and grinded plastic bottles (polypropylene, PP) respectively. The materials that are involves in this research process will be the common and usual materials in concrete mixture which are portland cement, clean river sand, 12 mm - 14 mm coarse aggregates and water. Besides, 6 mm of shredded tyre rubber and 5 mm of grinded plastic bottles (polypropylene, PP) are also being used during the lab test with different percentages which are 10%, 20%, 30%, 40% and 50% from the weight of coarse aggregates and clean river sand respectively. Portland cement was used for the concrete mixes and also being called as general purposed cements. The coarse aggregates used are usually gravel. These aggregates are being fed into vibrator sieved machine in order to obtain required size of aggregates which is 9 mm - 18 mm. Sand or usually being called as fine aggregates was used in this mixture. This sand has to be in clean condition as it is called clean river sand. We cannot simply take sand from any places just like that because that type of sand is not clean and cannot be used in the mixture. The common size used is 2 mm or less. Water that is safe and suitable for human being to drink is usually good enough for concrete mixture. The water should be cleared from all organic matters and certain chemical substances such as sulphate salts and alkaline. 0.5 is the fixed water cement ratio in this research. It can be conclude that both recycle material can still be used as an alternative material that can be replaced either sand or coarse aggregate in concrete mix design for pavement by using the optimum percentage which is 10% of sand and coarse aggregate being replaced with the recycle materials. Shredded tyre rubber can still be used as a replacement for coarse aggregate by using an optimum percentage of 20% for repair or replace purposed of the existing flexible pavement

3. CONCLUSIONS

There are various methods for design of bituminous mix for road pavements. Plastic wastes have been causing severe damage to the environment. Incorporation of these wastes on the making of bituminous mix helps in reducing the

damages caused by these wastes. Different methods for utilizing the waste materials on bituminous mix are studied by various researchers. Use of the plastic or polymer additives from wastes were found to increase the strength characteristics and durability of bituminous pavements. So plastic wastes can be efficiently used as a better replacement material in bituminous mixes.

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