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Review on Effect on addition of Plastic Waste in Bituminous Mixes prepared with CRMB

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Abstract: ***The need of a improving durability of Bituminous roads is need of the hour to reduce life cycle cost as India has large network of roads to maintain. Modified Bitumen has been found to improve the performance of bituminous mixes. Effect of addition of plastic waste in controlled manner also yields in certain improvement. However a combination has not yet been tried. In this study the addition of plastic has been done by replacing CRMB-55 by percentage by weight in varying percentage (2%, 4%, 6% and 8%). Marshall Stability test was carried out over bituminous mix namely DBM and BC. The aim is to study the effect of addition of plastic by its addition in bituminous mixes prepared with CRMB. It will reduce volume of plastic waste to be disposed of, by incineration or land filling and also improve durability of road which will have positive impact on environment. While on other side, performance of bituminous mixes will also improve with CRMB as ordinary bitumen have early distress symptoms due to heavy loads.***

Keywords: Plastic Waste, Marshall Stability Method, Poly-ethylene Terepthalate (PET), CRMB-55.

I. INTRODUCTION

For the economic growth and development of the country a good connectivity is required between state and national highways. A Steady increase is observed in vehicular density and areas like tyre pressure, change in climatic conditions, wheel load and daily wear and tear which affects the performance of the pavement. Study has revealed that the properties of bitumen pavement can be improved to meet the requirement of strength and durability. Therefore there is a scope and a need as well, to improve the property of bitumen pavement in India. While striving to achieve this goal environment should also be kept in focus as the construction, maintenance and development of roads consume a lot of energy and resources. Modified bitumen is needed to sustain the stress of heavy vehicles, so CRMB-55 is used. CRMB is type of binder whose properties have been improved by recycling of rubber tyres & special types of additives. Comparison has been drawn between the properties of CRMB-55 and on addition of plastic in varying percentage like 2%, 4%, 6% and 8% in CRMB-55.

II. RESEARCH AND STUDIES ON USE OF PLASTIC WASTE

Relevant research work and studies are reviewed here:
[1] Rasel H. M., Rahman M. N. and Ahmed T. U. studied the property of binder mixed with waste PVC (2.5%, 5%, 7.5%, 10%, 12.5%, 15% and 20% by weight of bitumen) at optimum content and checked the design criteria of bitumen mixes using bitumen-PVC waste. They concluded on the basis of experimental result that:

i. Dense grade bitumen mix with bitumen containing PVC upto 10% can be used for bituminous pavement construction in warm areas from the view point of stiffness, stability and void characteristics
ii. Scrap PVC available from waste can be used to modify bitumen to obtain better property of bitumen and high strength of bituminous mix.

[2] Shivani Thakur and Ajay Kumar Duggal studied on reutilization of plastic waste in paving mixes. They concluded that effect of addition of waste plastic bag and PET in paving mix shows good result on various properties of mix such as VMA, VFB, air voids and stability with 7% WPB and 6% PET, also shows 28% and 35% increase in stability in PET and WPB respectively compare to control mix i.e. DBM.

[3] S Shankar, Prasad, observed that modified bitumen (CRMB 55) was blended at particular temperatures and Marshall Stability test was carried out by changing the crumb rubber modified bitumen content at constant optimum rubber content and successive tests have been performed to determine the change in mix design characteristics and for virgin bitumen (60/70) also. This has resulted in improved property and characteristics when compared with bitumen and that too at reduced optimum modified binder content (5.67%).

[4] Mohammad T. Awwad, used polyethylene to investigate the potential possibility to enhance bituminous mixes property. The study also aimed at determining the suitable type of polyethylene to be used and its proportion. Two different types of polyethylene High Density Polyethylene (HDPE) and Low Density Polyethylene (LDPE) were added to coat the aggregate. The result shows that HDPE polyethylene modifier provides better engineering property such as

better stability, flow. The suitable proportion of the modifier is 12% by the weight of bitumen binder content. It also found that there is reduce in the density, increase in the stability and slightly increase in the air voids and the voids in mineral aggregate.

[5] C. Prasanna kumar and Dr. Shashishankar discussed on use of waste for the purpose of road instead of conventional bitumen and can be used as mixture along with bitumen. The study also focused on to reduce the usage of bitumen and also involves the characteristics of the crumb rubber used along with conventional bitumen. They concluded that

1) Crumb Rubber use in Bituminous road will increase Marshall Stability by 9% for Warm Mix Asphalt and 8% for Hot Mix Asphalt.
2) The Optimum content of Crumb Rubber was 12% to the weight of the Bitumen.
3) Hot Mix Asphalt mixed with Crumb Rubber attain maximum load of 1397kg.
4) Warm Mix Asphalt mixed with Crumb Rubber attain maximum load of 1418kg

[6] Nishant Vora, Rutvij Desai, M.H.Lunagaria studied the comparison on physical property of Crumb Rubber Modified Bitumen (CRMB-60) and virgin bitumen (60/70 grade). Study included the test such as Marshall Stability, Flow, Air Voids in Mineral Aggregates (VMA), Marshall Density, Air Voids, Voids filled with Bitumen(VFB). Different conclusions had been drawn based on observation. Use of Modified Bitumen in bituminous mixes shows better properties of mixes. Higher life Bituminous Concrete (BC) surface of 40mm with the use of CRMB compared to 60/70 grade bitumen indicated by performance trends.

[7] Sangita, D. K. Sharma and B. M. Sharma (2009) described the comparison in performance of bituminous concrete mix properties which contain plastic polymer in varying rates from 8% and 15% bitumen by weight respectively. The results indicated that waste plastic polymer has thermal stability up to 200^{o}C. Coating of waste plastic over the aggregate improves the performance parameters in term of stability, strength, flow value, flexibility and rutting.

[8] Asim Hassan Ali, Nuha S. Mashaan, Mohamed RehamKarim and MahrezAbdelaziz (2011) studied the physical and rheological properties as well as elastic behaviour of modifier bitumen namely CRMB in bitumen pavement. Laboratory testing was done on modifier bitumen as a function of two blending time (30 min and 60 min) and five crumb rubber contents of varying rates as 4%, 8%, 12%, 16% and 20% by weight of bitumen at mixing temperature of 180^{o}C and the result showed that the increase in blending time did not have significant effect on crumb rubber modifier bitumen binder and elastic recovery could be seen for each crumb rubber, high crumb rubber accounts for increase in elastic recovery and ductility.

[9] Rokade S, concluded that the use of waste plastic, low density polythene (LDPE) and crumb rubber when blended together in different processes such as dry process of LDPE and wet process of CRMB showed an increasing trend in strength by about 25%.

[10] Soni Kapil, Punjabi K. K., have studied the use of plastic waste in bituminous concrete mix. This plastic waste modified bitumen shows better stability, density and resistance to water. Their study indicated that waste polythene consumed in mix will get coated over the aggregate and reduce absorption of moisture, porosity and improve binding property. The binder modified with 4.5% polythene waste is showing better performance as compared to other bitumen mix. Polythene content up to 4.5% increases the Marshall Stability value first and then start decreasing. Thus high percentage of polythene is not recommended and the rutting action can be improved using plastic coating over the aggregates. Considerable increase in Marshall Stability value is observed and optimum binder content is considerably reducing.

[11] Athira R. Prasad, Sowmya N. J, have studied the bitumen modification with waste plastic and crumb rubber. In this study comparison is carried out between use of different waste plastic like carry bag, PET bottles, crumb rubber and all three in varying rates like 3%, 4.5%, 6%, 7.5%, 9% by weight of bitumen in bitumen concrete mixes to examine the better ability to modify bitumen so as to use it for road construction. It is concluded that Optimum content was obtained at 6% in all three cases and Marshall Stability is higher in case of PET bottles as compared to rubber and polythene.

[12] Ajay kumar, Vinay Kumar Singh Chandrakar, P.D. Porey, performed experimental study of modified bitumen in semi dense bitumen concrete. Modified bitumen used is CRMB which has been identified as special type of binder whose property can be improved by addition of crumb rubber, thus improving physical property. Crumb rubber is mixed with 60/70 grade bitumen with varying rates like 3%,6%, 9%, 12%. Following conclusion were made as

1) CRMB increases penetration and ductility decreases while softening point and specific gravity increases
2) Marshall value, flow value increases by addition of CRMB.
3) Optimum binder content reduces to 5% with optimum dose of CRMB (9%) in comparison to ordinary bituminous mix (6%).

[13] Bale Amole S discussed on use of various plastic waste in the construction of roads. Melting point will be raised on adding of plastic. The use of such technology not only strength the road but also increase the road life, it improves the

environment. In areas where there is high temperature, plastic roads are benifical. In this review paper it was explained that use of plastic waste in flexible pavement will give durable, strong and eco-friendly roads which will free our planet from all type of waste plastic.

[14] Gawandea Amit, Zamarea G., Rengea V. C., Taydea Saurabh (2012) have studied on an overview of waste plastic utilization in flexible pavement. The production of waste plastic in municipal solid waste (MSW) is increasing due to increase in population, urbanization and change in lifestyle which is leading a wide spread littering on the landscape. The use of recycled plastic waste in asphalt pavement represents a valuable outlet for such materials. The use of processed waste plastic in modified bitumen by about 5% to 10% by weight of bitumen helps in improving the durability, fatigue life and other properties of bituminous mixes.

3. CONCLUSIONS

i. The durability and performance of bituminous pavement with plastic and also crumb rubber as individual bitumen modifier gets increased to greater extent.
ii. The bulk density of bituminous mix shows increasing and decreasing trends with increase in LDPE content.
iii. Use of plastic together with bitumen provides slightly better results as compared to conventional bitumen.
iv. Crumb Rubber use in Bituminous road will increase Marshall Stability by 9% for Warm Mix Asphalt and 8% for Hot Mix Asphalt while Optimum binder content reduces to 5% with optimum dose of CRMB (9%) in comparison to ordinary bituminous mix (6%).
v. Binding property of the mix gets increased by using plastic and crumb rubber leading to better life span of the road.
vi. Recycling of rubber tyre and plastic are most efficient environment friendly way.
vii. Coating of waste plastic over the aggregate improves the performance parameters in term of stability, strength, flow value, flexibility and rutting.

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