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A Review on Usage of Waste Plastic in Bitumen Mixes in Cold Climate Areas

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Abstract— Plastic waste is considered as harmful and hazardous in nature. If it's not given proper consideration, it can turn into a disaster very quickly. The major problem related to plastic is its proper disposal. In today's word plastic is being used everywhere from households, to shopping malls and even hospitals in the form of plastic cups, water bottles, for packaging materials etc. Various methods have been tried for the safe disposal of plastic to reduce its harmful effects on the environment. One such method of disposal is the utilization of waste plastic in bituminous mixes. Plastic waste is being utilized in the bituminous mixes in the form of HDPE, LDPE and EVA, PET etc. By utilization of plastic waste in the mixes, permanent strain gets lowered .Also the optimum percentage of bitumen is cut down by the utilization of Plastic waste in the mixes .The mixes having plastic exhibit better retained stability as compared to the normal mixes. Plastic wastes not only enhance the life span of a road but also reduces the cost of construction as well. In general, the optimum dosage of plastic for addition to bituminous concrete is kept as 6-8%.This paper draws attention to the parameters which affect the performance of mixes when modified with Plastic.

Keywords— High density polyethylene, Low density polyethylene, Ethylene Vinyl Acetate, Plastic, Bituminous Mixes, Plastic disposal, Optimum percentage.

I. INTRODUCTION

The plastic waste is available in today's world in huge abundance. There has been a constant increase in the utilization of plastic in the form of plastic cups, bottles etc. It has been observed that the majority of plastic (around 60%) is utilized in the process of packaging. This Plastic is the main source of waste since it has high durability and is not biodegradable. This plastic waste is not properly disposed and may result in health problems such as cancer, genital problems in both humans and animals. This plastic waste on coming in contact with water bodies breaks down. The aquatic animals mistake this for food resulting in deaths of a large number of fish and thus highly disturbing the aquatic life. Plastic waste in the form of municipal waste also contaminates the land and renders it useless for cultivation and other purposes. Many a times , this plastic waste is burned ,which results in harmful toxics getting discharged into the atmosphere thus causing harm to the environment. Thus plastic is highly harmful to land, air as well as to the water bodies of earth. It is thus highly recommendable to find the alternatives of plastic and also a proper method for its disposal. One such method of disposal can be in the form of construction processes. This use of Plastic for construction process is not new. Polyvinyl chloride pipes and high density polyethylene pipes already employ this idea of addition of plastic in the construction processes. The Bituminous pavements made by incorporating plastic help in prevention of Rutting by easing the tyre pressures and also by distribution of activity loads throughout the surface. Scientists have been working towards the use of plastic waste , And the recently concluded studies towards this work has provided a huge scope for use of waste plastic in the construction of roads..

II. LITERATURE REVIEW

[1] **Ahmadinia E., Zargar M., Karim M. R., Abdelaziz M.** completed a test inquire about on the utilization of waste plastic containers (Polyethylene Terephthalate (PET)) as an added substance in stone mastic asphalt (SMA). Wheel tracking, dampness weakness, bulk modulus and drain down tests were completed in their examination on the blends that included different rates of waste PET as 0%, 2%, 4%, 6%, 8% and 10% by weight of bitumen content. Their outcomes demonstrate that the adding of waste PET into the blend has a huge constructive outcome on the properties of SMA which could enhance the blend's protection against perpetual misshaping (rutting), increment the strength of the blend, give low binder drain down and advancement of re-utilize and reusing of waste materials in an all the more ecologically and efficient way.

[2] Awwad M.T. and Shbeeb L.demonstrated that the modified mixture has a higher stability and VMA rate as compared with the non-modified blends and in this way decidedly impact the rutting protection of these mixtures. As indicated by them altering asphalt blend with HDPE polyethylene improves its properties significantly more than the upgrades acknowledged by using LDPE polyethylene.

[3] **Bindu C.S and Beana K.S** considered how Waste plastic goes about as a an added substance working as a stabilizer in Stone Mastic Asphalt when the blends were subjected to tests counting Marshall Stability, rigidity, compressive strength tests and Tri-axial tests. There out comes demonstrated that flexible pavement of high durability and greater performance can be acquired with addition of 10% shredded plastic.

[4] **Chavan M.** concluded that Plastic covering on aggregates is utilized for the better performance of roads. This helps in superior binding of bitumen with plastic waste covered aggregate because of increased bonding and expanded zone of contact amongst polymers and bitumen. The polymer covering additionally decreases the voids. This prevents the dampness absorption and oxidation of bitumen by captured air. In short we can presume that, utilizing plastic waste in blend will help decrease consumption of bitumen by around 10%, increase the quality and performance of street, avoid utilization of anti-stripping agent, and eventually build up an innovation, which is eco well disposed.

[5] **Gawande A., Zamare G., Renge V. C., Tayde S., and Bharsakale G.**gave a review on waste plastic usage in asphalting road by utilizing both wet and dry technique. They said that utilization of modified bitumen prepared by adding waste plastic of around 5-10% by weight of bitumen helps in enhancing the life span and performance of pavement with minor saving in bitumen utilization and as indicated by them utilization of waste plastics in the making of roads and laminated roofing likewise help to utilize vast amount of waste plastics. In this way, these forms are socially profoundly applicable, providing us with better infrastructure.

[6] **Ghorpade M. R.** arrived at conclusion that high movement and traffic intensity of commercial vehicles, over-burdening of trucks and varieties in daily temperature of the pavement have been responsible for early advancement of trouble like rutting, cracking, bleeding, shoving and potholing of bituminous surfacing. Under these conditions the bituminous surfacing has a tendency to end up delicate in summer and weak in winter. Flexible pavements containing ordinary bitumen don't continuously perform as required. The polymer modified emulsion innovation can be used to enhance the physical properties, performance, and durability of bitumen emulsion. It shows the utilization and advantages of polymer modified emulsion as more noteworthy protection from rutting and thermal cracking and diminishes fatigue stripping. Generally speaking, the advantages of polymer modified asphalt emulsions over unmodified asphalt emulsions can be outlined as: more impervious to rutting and thermal cracking, more impervious to flushing or bleeding, increment in traffic induced stress resistance, increment in stone retention, faster setting (minimizes land closures and traffic delay*)*, and longer lifecycle with same comparable cost.

[7] **Gundaliya P. J.** expressed that the procedure of modifying of bitumen with waste polythene improves protection from splitting, pothole arrangement and rutting by improving softening point, hardness and diminishing stripping because of water, in this manner enhancing the general execution and performance of roads over a drawn out stretch of time. As indicated by them the waste polythene used in the blend shapes covering over aggregates of the blend which lessens porosity, ingestion of dampness and enhances binding property.

[8] **Herndon D.** examined dampness vulnerability of asphalt blend utilizing phosphorylated reused polythene. They demonstrated that there is a huge decrease in dampness susceptibility by addition of reused unmodified polyethylene to asphalt concrete mixtures in both the Wet Procedure and the Dry Process.

[9] **Karim R., Islam N., Sajjad M. and Habib A.** gave a potential answer for quality loss of bituminous pavement under water. They analyzed performance of bituminous blend submerged with and without polyethylene admixture and came to reason that bitumen blends with polyethylene performed well when submerged under water and indicated much superior Marshall Stability than typical bituminous blend under typical condition. Also protecting the earth from contamination will be a special reward.

[10] **Moghaddam T .B, Karim M. R., and Soltani M.** revealed that the use of waste material in asphalt pavement would be gainful keeping in mind the end goal to locate an answer for increment in benefit life of asphalt pavement and diminish ecological contamination also. From their examination it is reasoned that Polyethylene Terephthalate (PET) fortified blends have higher stability value, flow, and weariness life in correlation with the mixtures without PET.

[11] **Rajasekaran S., Vasudevan R., Samuvel P.** has explained the Reuse of Waste Plastics Coated Aggregates-Bitumen Mix Composite for Road Application by Green Method. Their softening varies between 1100C – 1400C and they do not produce any toxic gases during heating but the softened plastics have tendency to form a film like structure over the aggregate, when it is sprayed over the hot aggregate at 160C.The sample showed higher Marshall Stability value in the range of 18-20KN and the load bearing capacity of the road is increased as well. 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.

[12] **Sabina, Khan Tabrez A, Sangita, Sharma DK and Sharma BM** studied the comparative performance of properties of bituminous mixes containing plastic/polymer (PP) (8% and 15% by the weight of bitumen) with conventional bituminous mix. Significant improvement in properties like Marshall Stability, Retained Stability, Indirect Tensile Strength and Rutting was observed in PP modified bituminous concrete mixes. Thus waste PP modified bituminous concrete mixes are expected to be more durable, less susceptible to moisture in actual field conditions and improved performance.

[13] **Sangita, Reena, and Verinder .K** proposed a method to deal with improving road quality by using plastic waste in street development. As indicated by her India spends Rs 35,000 crores a year on road development and repairs, including Rs 100,000 crores every year only to upkeep serviceability and only by bitumen roads keeps going 2-3 times longer, which will spare us Rs 33,000 crores a year in repairs, in addition to diminished vehicle breakdowns and repairs.

[14] **Soni K. and Punjabi K. K** has discovered that with the utilization of waste plastic enhancing the performance of bituminous concrete mixture, this waste plastic modified bitumen mixture demonstrate better binding property, stability, stiffness, thickness and additional impervious to water. The outcomes demonstrated that the waste polythene used in the blend will get covered over aggregates of the blend and lessens porosity, retention of moisture and enhances binding property. The bitumen adjusted with 4.5 % Polythene waste is indicating better execution when contrasted with different blends. Marshall Stability value increases with polythene content up to 4.5 % and from that point diminishes.

[15] **Sreedevi B.G., Salini P.N** studied that on roads surfaced using bituminous mix with plastic coated aggregates. Laboratory studies conducted on Semi Dense Bituminous Concrete (SDBC), Bituminous Concrete (BC) and Dense Bituminous Macadam (DBM) show that the Marshall Stability value of bituminous mixes increase by 1.5 to 2 times by using Plastic Coated Aggregates. Also bitumen consumption can be reduced by more than 10% by weight. Better strength parameters and road condition indicate increase in life of pavement and delayed and slow deterioration, improved performance in terms of better surface condition, delayed pot hole and crack initiation and progression, desirable skid resistance and surface texture.

[16] **Thakur Shivani and Duggal A. K.**came to the conclusion that Plastic waste was utilized as a part of the type of high thickness polyethylene, low thickness polyethylene (LDPE), Ethylene Vinyl Acetic acid derivation (EVA), plastic, Polypropylene (PP), polymer, polymeric poly packs, plastic sacks, water bottles, funnels, electrical fittings, PET. Permanent strain is diminished by the addition of plastic waste in bituminous mixture. Optimum bitumen content was utilized about as 5% and the huge measure of plastic waste was utilized as a part of bituminous mixture. The optimum level of plastic waste utilized was 8% by the weight of bitumen. Range for plastic waste was utilized 2%-20% by the weight of bitumen and as covered aggregates. By replacing with reused material, the cost of road development was lowered in light of the fact that this reused material is less expensive than bitumen and easy to get.It additionally enhances the level of performance and the service life of the road.Also higher Marshall Stability value was acquired in the scope of 18-20 KN and increased the loadbearing limit of the road by 100%.

[17] **Verma S .S.** considered that plastic expands the point of melting of the bitumen and makes the road flexible amid winters bringing about its long life. As indicated by creator while an ordinary "roadway quality" street keeps going four to five years, plastic-bitumen streets can last up to 10 years and it would be a boon for India's hot and greatly muggy atmosphere, where temperatures much of the time cross 50°C and heavy rains make devastation, leaving a large portion of the streets with huge potholes.

III. CONCLUSIONS

The durability and performance of bituminous pavements with plastic gets increased to a good extent. A significant decrease in moisture absorption and also to stripping and rutting is achieved by the addition of plastic in bitumen mixes. Binding property of the mix gets increased by mixing plastic leading to better life span of roads. By the addition of plastic, the oxidation of bitumen and moisture absorption caused due to entrapped air is lowered significantly. HDPE polythene provides slightly better results as compared to LDPE polythene. Plastic content between 5-10% by weight of bitumen is considered optimum and produce desirable results. Plastic waste is required to be added in only shredded form to achieve desired results. The cost of road construction is also reduced due to the addition of plastic to mix. Retained Stability of waste plastic roads is increased to 90% as compared to 70% of the normal mixes.

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