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PLASTIC USE IN BITUMINOUS

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Abstract — *Bottles, containers and packing strips etc. is increasing day by day. As a result amount of waste plastic also increases. This leads to various environmental problems. Many of the wastes produced today will remain in the environment for many years leading to various environmental concerns. Therefore it is necessary to utilize the wastes effectively with technical development in each field. Many by-products are being produced using the plastic wastes. Our present work is helping to take care of these aspects. Plastic waste, consisting of carry bags, cups and other utilized plastic can be used as a coating over aggregate and this coated stone can be used for road construction. The mix polymer coated aggregate and tyre modified bitumen have shown higher strength. Use of this mix for road construction helps to use plastics waste. Once the plastic waste is separated from municipal solid waste, the organic matter can be converted into manure and used. Our paper will discuss in detail the process and its successful applications.*

Keywords :- *Plastic Waste, Modified Bitumen, Bitumen, Aggregates, Plastic Roads.*

I. INTRODUCTION

Plastic are user friendly but not eco-friendly as they are non-biodegradable. Today in INDIA nearly more than 12 million tones of plastics are used. There visibility has been perceived as a serious problem and made plastic a arget in the management of solid waste. They also have a very long lifetime and burning of plastics waste under uncontrolled conditions could also lead to generation of many hazardous air pollutant(HAPs) depending upon the type of polymers and additives used. Polymer modified bitumen is emerging as one of the important construction of flexible pavement. The polymer modified bitumen show better properties for road construction and plastic waste can find its use in this process and this can help solving problem of pollution. The better binding property of plastic in its molten state has helped in finding out a method of safe disposal of waste plastic. Roads surface with neat bitumen can cause bleeding in hot climate, may develop cracks in cold climate posses fewer loads bearing capacity and can cause serious damages because of higher axial load in present conditions due to rapid infrastructure development. India has to raise transportation system to a higher level both in terms of length and quality .The use of waste in hot bituminous mixes too enhance pavement performance, protect environment and provide low cost roads.

Use of plastic waste in flexible pavement (R. Vasudevan method)

This is one of the most ecofriendly way to dispose various types of waste plastics like poly ethylene (PE), polystyrene (PP), Poly propylene, Laminated plastics and others in road construction, in this process plastic is coated on the stone aggregate, Dr. R. Vasudevan originated this technique where polymer coated aggregate acts as a raw material for the road construction and later on it will mixed either with stone aggregate or bitumen, it possess different results. In this method, characteristics of plastic coated aggregate is found to be better than the conventional aggregate, the results obtained from the research tells us some .interesting facts about like most of the plastics have a softening about 130 – 140 ^{0}C without any gaseous evolution, so we can easily use the plastics in flexible pavement, binding property of coated aggregate with higher percentage of plastic shows compressive strength of almost 130 tones, and it clearly indicates that PCA has good adhesion property, and it also validation of the material to act as binder. The PCA shows better resistance towards the greater wear and tear load, the brittleness is measured by impact value, and in this research due to the coating of polymer it reduces the air cavities and voids and results into the lesser impact value as compared to plain aggregate. The PCA has also possessed low crushing strength. As the moisture absorption in PCA is almost negligible as compare to 4%-5% in the aggregate without plastic coating, with the property of Soundness is also not found in the PCA. The above mentioned waste plastics is also better in the bonding between bitumen and PCA, which makes this road and method greater resistance from water and increased the durability and performance of the roads. Significant test of Marshall Stability is conducted on PCA and very encouraging results came out as the use of PCA increases the Marshall stability of the mix as compared to PMB mix. It is noted that the PCA bitumen mixes have 50-60 % higher valued instead of PMB which shows that the binding strength is higher in PCA mixes. These all above values coming from various test proves that the PCA mix is superior than that of conventional one, the another approach is environmental aspect as the waste plastic when burned produces greenhouse gases, and as in this process plastic is only softened not burnt which does not produce any evolution of gases, in one kilometer single lane road minimum of one ton of waste plastic is utilized which means it also restrict harmful gases like carbon dioxide to evolve in the atmosphere.

II. LITERATURE REVIEW

Prof.C.E.G. Justo States that addition of 8.0 % by weight of processed plastic for the preparation of modified bitumen results in a saving of 0.4 % bitumen by weight of the mix or about 9.6 kg bitumen per cubic meter (m 3) of BC mix. Modified Bitumen improves the stability or strength, life and other desirable properties of bituminous concrete mix.
Dr. R. Vasudevan states 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. When it used for road construction it can withstand higher temperature and load. The coating of plastics reduces the porosity, absorption of moisture and improves soundness. The polymer coated aggregate bitumen mix forms better material for flexible pavement construction as the mix shows higher Marshall Stability value and suitable Marshall Coefficient. Hence the use of waste plastics for flexible pavement is one of the best methods for easy disposal of waste plastics. Use of plastic bags in road help in many ways like Easy disposal of waste, better road and prevention of pollution and so on.
According to V.S**. Punith,** (2001), Some encouraging results were reported in this study that there is possibility to improve the performance of bituminous mixes of road pavements. Waste plastics (polythene carry bags, etc.) on heating soften at around 130°C. Thermo gravimetric analysis has shown that there is no gas evolution in the temperature range of 130-180°C. Softened plastics have a binding property. Hence, it can be used as a binder for road construction.
Mohd.Imtiyaz(2002) concluded that the mix prepared with modifiers shows:-Higher resistance to permanent deformation at higher temperature.
Sabinaetal (2001) studied the comparative performance of properties of bituminous mixes containing plastic/polymer (PP) (8% and 15% by wt of bitumen) with conventional bituminous concrete mix (prepared with 60/70 penetration grade bitumen). Improvement in properties like Marshall Stability, retained stability, indirect tensile strength and rutting was observed in Plastic modified bituminous concrete mixes.

III. OBJECTIVES OF THE STUDY

Basic intention is to efficiently utilize the waste plastic in constructive way so that it can be beneficial to society.
Main objectives of current project work are:
1) To identify the optimum proportion of waste plastic to be added in the bitumen mix for getting the required strength.
2) To compare the experimented results with the conventional pavement details and perform the economic analysis.
3) To prepare statistical model for optimum utilisation of plastic waste.

IV. COMPOSITION OF VARIOUS SAMPLES

Sample Type	Plastic (PE)	Bitumen	% of PE
A	2.1 g	39.9g	5
B	2.94g	2.94g	7
C	3.78g	38.22g	9
D	4.66g	37.34g	11
E	0.00	42.00g	0

Table 1 : Composition of various samples.

Analytical Methods

In the Marshall test method of mix design, compacted mold samples were prepared in triplicate for each binder content (a total of twelve samples) to determine the optimum binder content. All these molds were subjected to the following tests:
Bulk Specific Gravityof compacted material The bulk specific gravity of the sample was determined by weighing the sample in air and in water. The specific gravity of the bulk compacted material (G_{mm}) of the specimen was determined by
$G_{mm} = W_a / W_a - W_w$

WhereW_a= weight of sample in air (g), W_w=weight of sample in water (g).

Marshal Stability

The Marsha stability of a test specimen is the maximum load resistance that the standard test specimen will develop at 60₀C when tested. In the stability test the specimen was immersed in a bath of water at 60₀ C for a period of 30 minutes. After this it was placed in the Marshall stability testing machine and loaded. The total maximum load taken in kg (that causes failure of the specimen) was taken as Marshall Stability. The minimum requirement is 1200kgaccording to the MOTC standard .

Flow

The flow value is a measure of the total movement or strain in units of 0.25mm occurring in the specimen between the conditions of no load and the point of maximum load during the stability test. The total amount of deformation that occurred at maximum load was recorded as flow value, and tabulated in Table 3. The required range was between 2.0 to 3.5mm according to the MOTC standard (Table 2).

V. PROCESS FLOW DIAGRAM

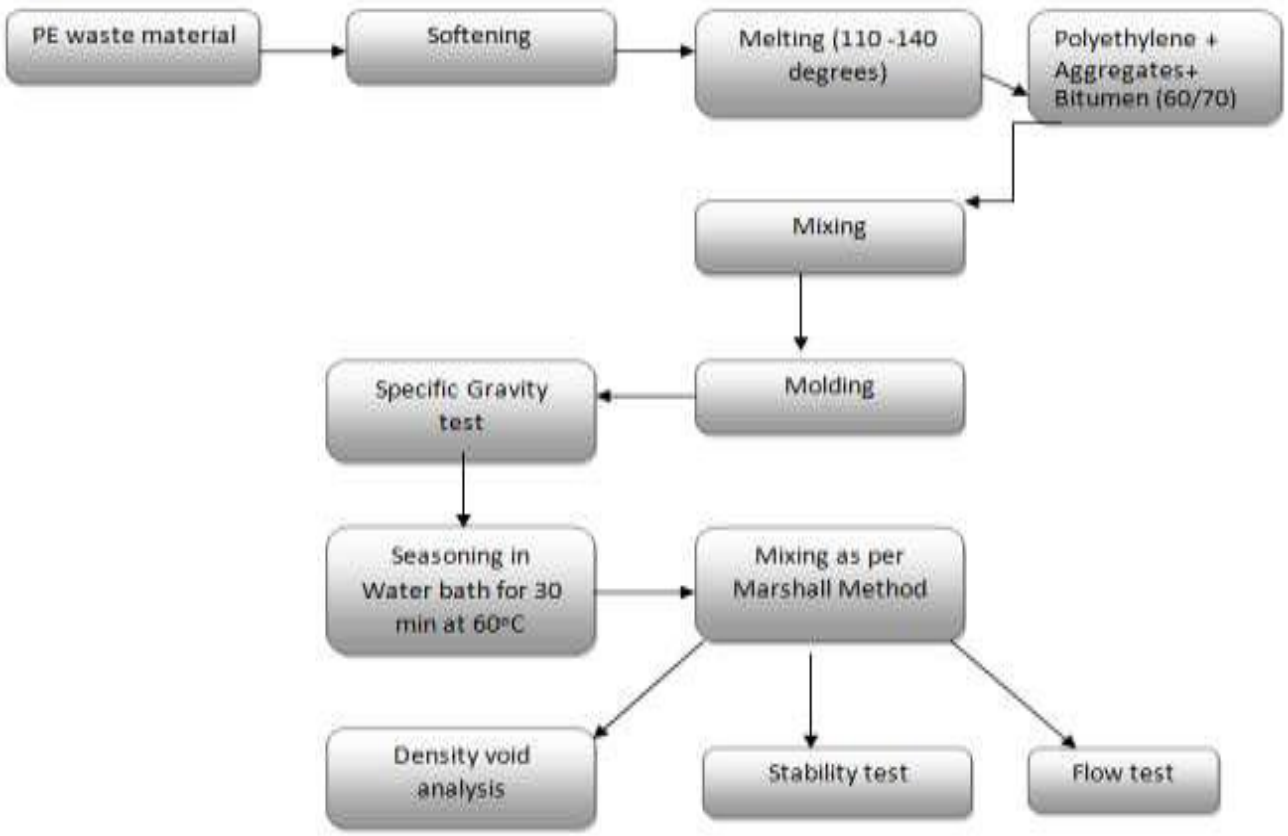

Fig No 1 : Process Flow Diagram

Experimental Procedure

The experimental flow sheet is shown in Fig 2. The coarse aggregate, fine aggregate, as well as the filler material were taken in the proportion in order to adhere to the requirements of the standards of the MOTC of Oman. On mixing plastic with asphalt, polymerized bitumen was formed. The collected plastic waste products (plastic bags) made out of olyethylene were separated and cleaned. The plastic bags were shredded into small pieces and were passed through a 4.5 mm sieve. The aggregate (Dolerite; cent percent blasted quarry material) was heated to 170°C, and the shredded plastic waste was added. Since the plastic usually softens at 130₀ C, it softens and coats the aggregate. The melted plastic was then added to the heated Bitumen at160°C and mixed well. As the polymer and the bitumen were in the molten state, they got mixed, and the blend was formed at the surface of the aggregate material in different proportions (5/95, 7/93, 9/91,11/89). Mixing temperature was 160-165₀C. Marshall mold compaction was made at the temperature of 145₀C by using 75 blows on each side. **Table 1** showed the lab trial specimen preparation with the amount of polyethylene and bitumen used in grams as per the respective percentages.

VI. CONCLUSIONS

Since bitumen grade of 60/70 guidelines match with the general specification of MOTC, the same has been adapted in the present work for using in Marshall Stability Method. The studies conclusively showed that that the waste plastic materials could be incorporated as a binding agent for the construction of roads. Low density polyethylene (LDPE) to an extent of 9% Sample C) was found to be the most effective binder proportion. Previous studies have also shown similar results.

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