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A Study on Influence of Low Density Polyethylene on the Performance of Bituminous Concrete Grade-2 Mix by Dry Process

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***Abstract:** To reuse/recycle the plastic waste in order to reduce its negative impact on environment. Construction material, converting waste plastic into fuel, household goods, fabric and clothing are some of the sectors where waste plastic is emerging as a viable option. Out of these, construction material modified with plastic waste has garnered lot of attention.Plastic waste serves as a dual purpose. It reduces the amount of plastic waste going to landfills or litter and secondly lessens the use of mined construction materials, thereby mitigating the negative impact of construction industry on environment.Inclusion of plastic waste as a binder, coarse aggregate, fine aggregate, modifier or substitute of cement and sand in the manufacturing of bricks, tiles, concrete and roads has been comprehensively reviewed.*

The addition of plastic waste shows influence on strength properties, water absorption, durability, etc. Thus disposal of plastic waste is a menace and becomes a serious problem globally due to their non biodegradability and unaesthetic view .on the basis of the experimental results ,The addition of plastic with aggregate will results in improving the Marshall stability and resistance to water damage, as well as they can contribute to relieve some of the environmental problems caused by classical plastic waste disposal means.

***Keywords:** coarse aggregate, fine aggregate, modifier or substitute of cement*

I. INTRODUCTION

According to a report by the United Nations Environment Programme (UNEP) , around 300 million tonnes of plastic waste is generated every year globally, whereas plastic waste ever recycled merely counts to 9%. The COVID-19 pandemic has further thrashed the efforts for reducing plastic pollution, where the disposal of used PPE kits, gloves, masks, sanitizer dispensers, etc. has created a scenario of 'pandemic of plastic pollution' the problematic issue is that most of the plastic waste is going to the landfills or clogging our water bodies which leads to plastic pollution. the beneficial properties such as longevity, lightweight, water resistant, high elasticity, strength, durability, resistant to corrosion, easy to transport and economical, plastics are otherwise highly useful materialThe plastic waste employ as binder, aggregate, fine aggregate, modifier or substitute of cement and sand in the manufacturing of bricks, tiles and concrete.

In the dry process, the processed waste plastic is shredded and added to the hot aggregate.The Indian Road Congress (2013) and National Rural Roads Development Agency (2019) indicates that the shredded waste plastic size should preferably be 2-3 mm for better spread and coating on the aggregate. Dust and other impurities should not exceed 1%. The shredded waste plastic is then added to the aggregates that are heated to 170ºC. The shredded waste plastic softens and melts to form a coating around the aggregates (Sahu and Singh, 2016). The bitumen is also heated to 160ºC and the plastic-coated aggregates are then mixed with bitumen and used for road construction. Laboratory tests indicate that the percentage of shredded waste plastic in bituminous mixes to be between 5% to 10% of the weight of bitumen, with 8% recommended to be the optimum percentage. The marked improvement in various parameters such as Marshall stability and indirect tensile strength for the outputs from dry process in comparison with that of wet process. This shows higher resistance to withstand at higher loads and to resist deformation.

In the wet process, the processed waste plastic in powder form is added to the hot bitumen. The powdered waste plastic is directly mixed with bitumen before adding them to the aggregates. It has to be ensured that there is an even mix of plastic and bitumen, and the temperature range for this method is 155ºC to 165ºC.

Out of these two methods dry process is the better one for the construction of roads. In dry process the fuel consumption and time of process is less mixing of raw material in dry state in blenders using compression air.the process is simple and the equipment is compact,the critical limitation is less required and liquid waste treatment is not necessary.

II. LITERATURE SURVEY

By incorporating this waste improve the stability and stiffness of the mix and it is environmentally friendly. as percentage WPB replacement increases, result of Marshall stability is greater than the control specimen. Asphalt mix modified with WPB replacement shows lower bulk density & VFA; and higher flow, air void & VMA. But the stiffness of the modified mix is increased by approximately up to 15% replacement. This decrease in bulk density can be explained to be a result of the low density of added plastic material. From Marshall Hot Mix Design, the optimum WPB replacement content of 17, 13, and 7% got for 9.5, 12.5 & 19 mm NMAS respectively. Therefore, the modified mix having 9.5 & 12.5 mm size of aggregate are suitable for wearing coarse and 19 mm for binder coarse layer. For all NMAS, TSR result at the optimum WPB replacement are greater than 80%, which indicates the modified mix is not vulnerable to moisture damage [1]. Additive of plastic waste at different content gives effect on the temperature susceptibility of the bitumen. As the content of plastic waste increase from 1.5% to 6%, the penetration number decreases gradually and softening point of modified bitumen increase.The addition of plastic waste content increases the viscosity of the bitumen at high temperature i.e. 135 °C. (High viscosity means less chances of rutting.) Plastic waste improves the performance of bitumen when it was added into bitumen. The higher plastic waste percentage give the higher $G^*/\sin\delta$ which is rutting factor. Thus, the modified bitumen able to reduce the rutting effect. The usage of 6% of plastic waste is found to be the optimum percentage for modification of bitumen. This percentage could make the pavement able to resist the heavy vehicles and hot climate[2]. to research how adding low-density polyethylene LDPE affects the ability of asphalt concrete mixtures to fracture. At 160 °C, LDPE was blended into a mixture of asphalt. A modified LDPE percentage by weight of asphalt of 1.5, 3, and 4.5% was used. The J-integral approach served as the foundation for evaluating fracture toughness. For the measurement of fracture toughness, a novel semicircular specimen shape with a 76-mm radius and a 57-mm thickness is used. On the flat surface of each specimen, notches were added with various depth-to-radius ratios. The two surfaces could separate thanks to tensile strains at the fracture tip thanks to three-point bend loading.The J-integral concept was applied to demonstrate the superior fracture toughness of the LDPE-modified asphalt concrete mixtures over the unmodified mixture. The concentration of LDPE affects the fracture toughness. The mixtures with the highest fracture toughness were those adjusted with 4.5% LDPE. The physical qualities of asphalt cement have also been improved by the modification of LDPE. Both the indirect tensile and compressive strengths of the asphalt concrete mixture treated with LDPE increased significantly[3]. the need for road maintenance and assist in reducing plastic waste by employing non-biodegradable garbage. In addition to LDPE (PW), the air also constricts air vessels, preventing bitumen from being absorbed by and oxidizing in the air. This raises Marshall's stability cost. In comparison to the combination prepared with plain bitumen, it has been found that the value of the stability of the blends modified with plastic waste has improved by 14% to 12% in the rubbish. The mixture's strength has increased as a result of the addition of plastic garbage, indicating that the mixture's density has increased as well. The addition of plastic waste has increased the mixture's strength, which suggests that the mixture's density has also increased. The outcomes shown that the Marshall characteristics of the AC-BC mixture were improved by the inclusion of LDPE plastic waste. The Marshall quotient and the value of stability have both increased with the addition of LDPE plastic trash (MQ) [4]. By the literature we can say that the describes By adding plastic garbage to bitumen waste, the pavement was enhanced by increasing qualities like moisture absorption and bitumen content reduction.With this, we might indirectly lessen the amount of plastic garbage that would otherwise burn up and contribute to global warming and ozone layer depletion.Plastic has the sticky nature that increases the Binding properties, which is useful for rapid setting of the pavements typically used in heavy traffic regions. By adding this plastic to the bitumen, we can increase the life span of the pavement when compared to the BT Pavement without Polymer usage. By doing this, the amount of bitumen used decreased and was replaced by polymer waste, which resulted in a 15% decrease in the price of the pavement.

III. EXPERIMENTAL WORK AND RESULTS DISCUSSION

A. Introduction

The aggregate is heated upto the temperature of 160 C.Later,Various Percentages of Low Density Polyethylene Plastic (LDPE) like shredded milk plastic is mixed to the heatedaggregate and heated this mix up to the temperature of 180C.The bitumen is heated upto the temperature of 121-125C.the mixture of aggregate with plastic is added to the hot bitumen at 170C.After that mix the specimen with spatula.Later,the nix is placed in a preheated mould and compacted by a rammer with about 75 blows on each side. the weight of rammer is 4.54kg and the weight of fall is 45.7cm.The compacted specimen should have a thickness 63.5+3cm.Movement of the proving ring in the opposite direction is a sign of failure. Ringdivision proof is noted down at this time. This provides us with a stability value, measured in kilograms.We also record the reading from the strain dial gauge, which provides us with the flow value, which is expressed in deformation units.1 unit = 0.25 mmThe compacted Specimens are extracted using a sample extractor after Curing time.

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B. Materials Used

1) Hammer
2) MST load application machine,
3) Cylinder:
4) Weighing apparatus,
5) Specimen extractor

C. Marshall Test

Varying percentages of waste plastic by weight of bitumen was added into the heated aggregates Marshall specimen with varying waste plastic content was tested for bulk density and stability Maximum value of stability was considered as criteria for optimum waste plastic content .The Bituminous mixes using 60/70 grade bitumen having average Marshall Stability Value (MSV) of 1200 kg at optimum bitumen content of 5.0 % by weight of the mix. the mix prepared with the above-modified bitumen to withstand adverse heating condition under oven, Marshall Stability tests were conducted after heating in oven at 60 Co for 4 hours. The Specimen is cooled outside for the period of 30 minutes after heated in oven.

The Specimens are tested in a marshall Testing Machine. When the load is applied on the specimens, the failure occurs at a certain displacement on the mould. The Flow Values are recorded for Specimens. The Load Values and Displacement Values are recorded on the Marshall Appartus

TABLE I
Test Results Of Marshall Stability

S.NO	Bitumen Content(%)	Weight Of Mix(g)	Stability Of Modified Bitumen(using plastic)	Stability Of BitumenWithout Plastic	Diameter(cm)	Height(cm)	Flow(mm)
1	4.5	1200	17.95	14.7	10	6.3	1.99
2	5	1200	23.44	19.47	10	6.4	2.38
3	5.5	1200	18.21	13.40	10	6.5	2.88
4	6	1200	13.10	8.9	10	6.4	2.59

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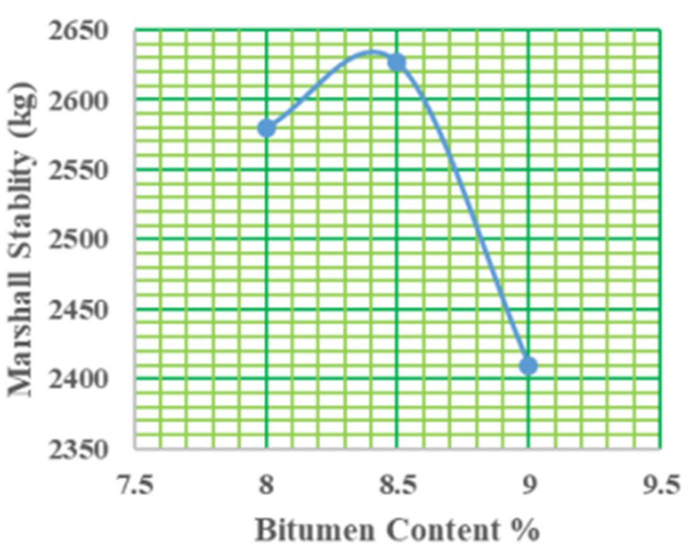
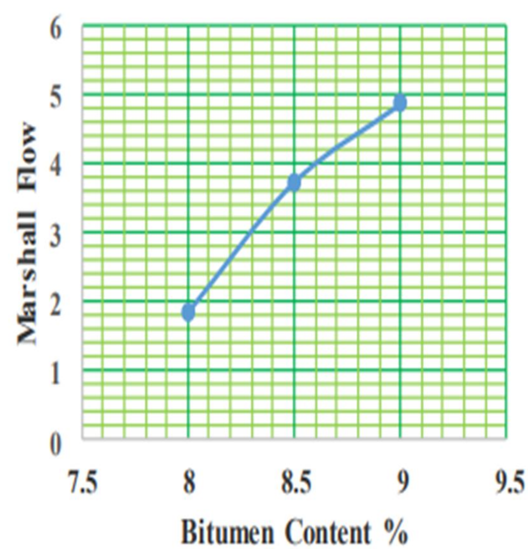


Bitumen Content vs Marshall Stability



Bitumen Content vs Marshall Flow

D. Aggregate Tests

More water Absorption more porous considered unsuitable unless they found to be acceptable based on strength, impact and hardness.Specific Gravity is measure of Strength or Quality of material less specific gravity weaker. specific Gravity is proportional to the Strength. Impact testing is a method used to measure a material's resistance to breaking under repeated impacts or how tough it is. The aggregate impact test, which has been standardized by ISI, is frequently used to gauge aggregate resistance to impact.The resistance to progressively increasing compressive stress has a different effect than the aggregate impact value, which represents a relative measure of aggregate to impact.For aggregate to be employed in the wearing course of the pavements, the aggregate impact value typically shouldn't exceed 30%. The highest value allowed for bituminous macadam is 35%, while for water-bound macadam base course, it is 40%.

TABLE II
Aggregate Test Results

TYPE OF TESTS	WITHOUT COATED PLASTIC	WITH COATED PLASTIC
Abrasion Test	19.4%	16.8%
Impact Test	30.61%	7.35%
Specific Gravity	2.6	-
Flakiness Test	30%	-
Elongation Test	13.34%	-

IV. CONCLUSIONS

In this study, By varying plastic fixations from 0% to 2.5% at an addition of 1.0%, the effects of the expansion of waste plastic in the type of locally accessible counterfeit milk with brand OMFED packets in the bituminous mixes have been considered. The ideal bitumen content (OBC) and ideal plastic substance (OPC) for various types of blends have been determined using the Marshall Method of blend structure. When stone residue is used as filler, it has been observed that expansion of 2% plastic for SMA and DBM mixes and 1.5% plastic for BC blends produces optimal Marshall properties. As a result, ruts are diminished and potholes are prevented from forming. Plastic pavement is more durable than flexible pavement and can resist heavy traffic. The usage of plastic mix will boost the strength and functionality of the road while reducing the bitumen concentration by 10%. Environmentally friendly is this new technology. Vehicle pollution can be decreased by using smoke-absorbing material (titanium dioxide) in polymer blends with a 10% percentage..

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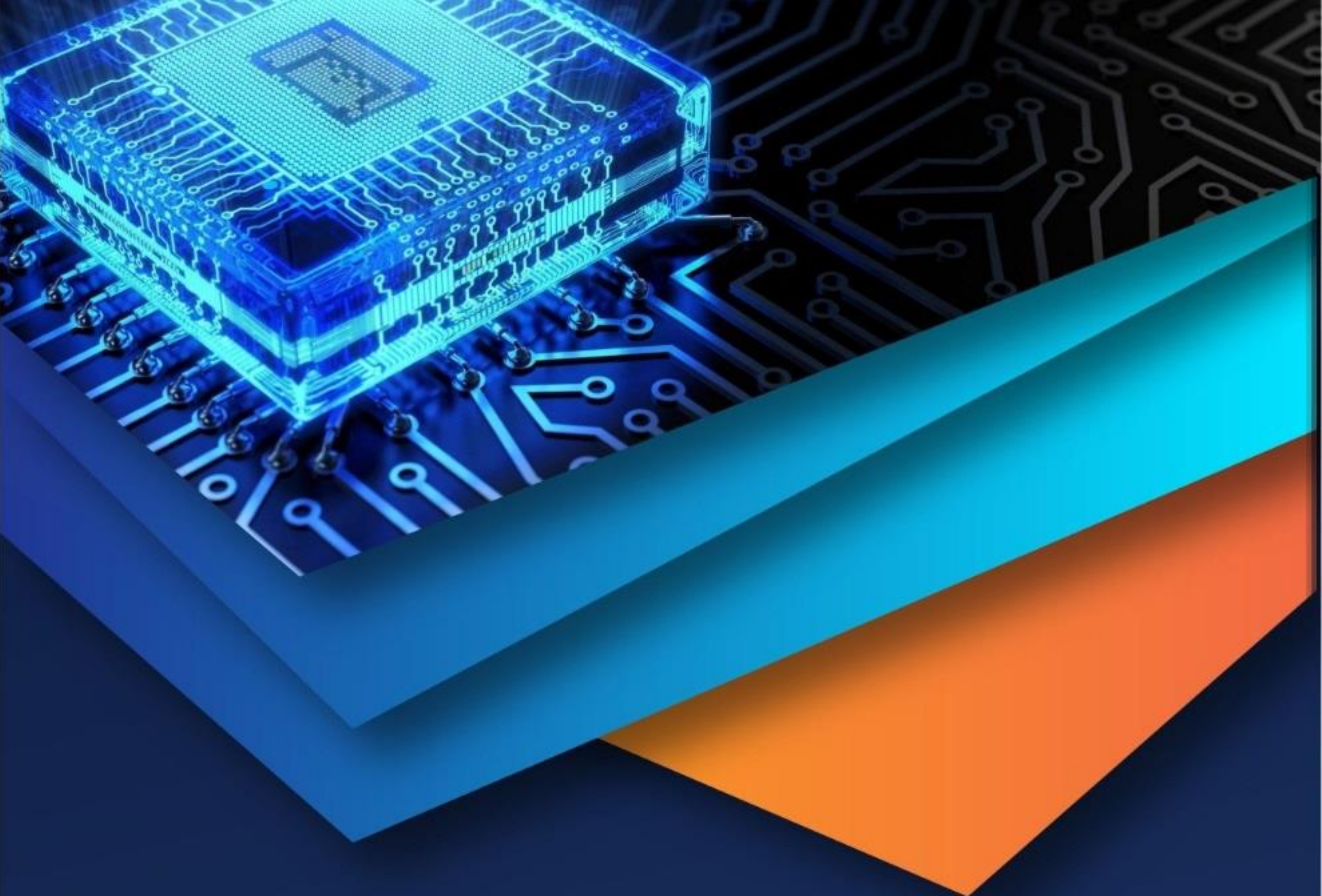

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