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Experimental Analysis of HDPE Percentage in Bitumen Samples Using IDT Test

Akshay Mhatre[1], Avinash Walunj[2], Atish Pichake[3], Ankit Torane[4], Vinayak Agawane[5], Dr. Apeksha Mendhe[6]
[1, 2, 3, 4, 5]*B.R. Harne College of Engineering and Technology, Karav, Vangani, Dis:-Thane, Maharashtra*
[6]*Guide*

***Abstract:** The main objective of this research is to evaluate the ability of using recycled plastic waste as a binder material with asphaltic concrete to improve the performance and service life of the road. As bitumen is used as a binder material in asphaltic concrete which is very costly.*
We can reducethis cost by replacing bitumen (up to some extent) with plastic. There are many types of plastic but here we used only High Density Polyethylene (HDPE) plastic. NHA class B aggregates were used in this research with varying admixture (2, 4, and 6%) and bitumen content (3, 3.5, 4, 4.5, 5,5.5, and 6%). For this purpose Marsha Stability and Flow test and ITS test was carried out whichshowed different results for different percentages of admixture.

I. INTRODUCTION

Good road infrastructure is a vital requirement for the social and economic development of any country. The goal of roads is to provide durable and long lasting pavements to improve riding comfort and safety, as well as to reduce maintenance costs. This can be achieved by providing good structural pavement design as well as good asphalt mixture design. Throughout the years, numerous studies have been conducted to improve asphalt mixture design for better performing pavements. Significant improvement on asphalt mixture quality has been made by the addition of modifiers. Modifiers can enhance asphalt binder's stiffness at normal temperature which has the capacity to reduce shoving and rutting, while decreasing its stiffness at low temperatures to improve its resistance to fatigue cracking.

Also, modifiers can increase adhesion between asphalt binder and aggregates in the presence of moisture, this will reduce the probability of aggregate stripping.

The modification of bitumen with polymers can improve the properties of asphalt mixtures. Researches shows that the use of recycled plastic may also show a similar result with additional environmental advantages.

This work aims to evaluate the possible advantages of modifying the bitumen with different plastic wastes, namely polyethylene (high density HDPE), in order to improve the properties of the resulting binders for use in high performance asphalt mixtures. The performance of modified binders with recycled polymers was compared with that of the conventional bitumen and the one of a commercial modified binder.

The results of the laboratorytests was used in the selection of the best plastic waste materials and production conditions. That was used in the modification of bitumen in order to optimize its behavior, emphasized the study aims to promote the reuse of plastic waste in a more environmental and economic way.

The most common asphalt mixture modifiers are filer, extender, fiber, oxidant, antioxidant, hydrocarbon, crumb rubber and polymers. Crumb rubber can be obtained from tiers whilepolymers can be obtained from waste disposal plastic such as plastic bags and bottles.

Disposal ofplastic waste materials has become a serious environmental problem. In highway engineering it has been considered to use the different waste materials produced by various processes instead ofdischarging them openly into environment which results in high level pollution and environmentaldegradation. Such waste includes industrial, municipal and agricultural waste

II. DIFFERENT TESTS ON COLLECTED MATERIALS

A. Asphalt Consistency Properties

Table a. shows the propertied of Asphalt consistency. Also (IS 1201-20)1978 are mentioned.These results of bitumen are without plastic admixtures.

S.no	Property	Bitumen Type	Unit	IS 1205-1978	Result	Test Method
1	Softening Point	60/70	°C	49-57	56	IS1205-1978
2	Penetration	60/70	mm/10	60-70	63	IS1203-1978
3	Flash	60/70	°C	230 min	240	IS1209-1978
4	Fire Point	60/70	°C	235 min	250	IS1209-1978
5	Ductility	60/70	cm	100 min	120	IS1208-1978

Asphalt Consistency Properties

III. RESULTS AND ANALYSIS

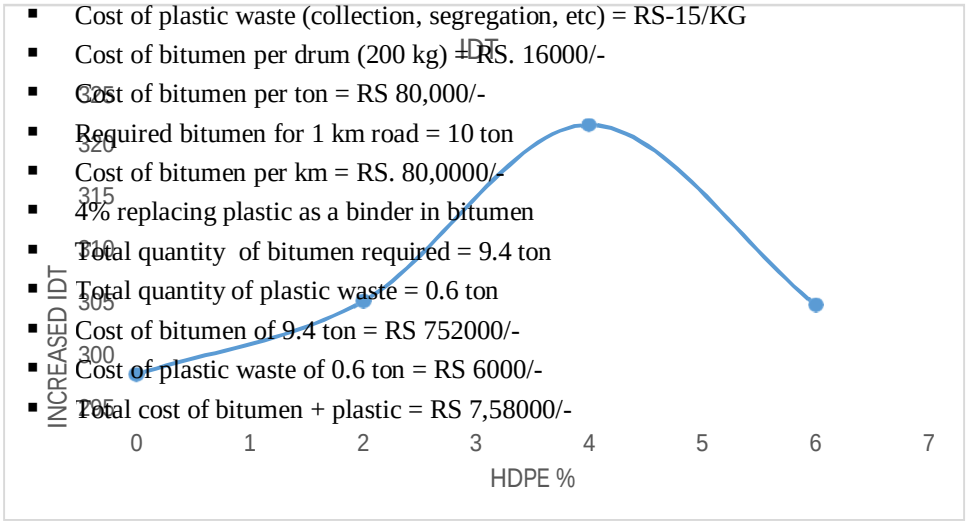
IDT apparatus

Crack after IDT testing

Polymer (HDPE %)	0%	2%	4%	6%
Average IDT (KN)	281.18	292.58	320.12	292.02
Increased (%)	0	2.24	9.62	2.14

Analysis For The Road Of 1000m and 3.75m Wide WithAdmixtures

- Cost of plastic waste (collection, segregation, etc) = RS-15/KG
- Cost of bitumen per drum (200 kg) = RS. 16000/-
- Cost of bitumen per ton = RS 80,000/-
- Required bitumen for 1 km road = 10 ton
- Cost of bitumen per km = RS. 80,0000/-
- 4% replacing plastic as a binder in bitumen
- Total quantity of bitumen required = 9.4 ton
- Total quantity of plastic waste = 0.6 ton
- Cost of bitumen of 9.4 ton = RS 752000/-
- Cost of plastic waste of 0.6 ton = RS 6000/-
- Total cost of bitumen + plastic = RS 7,58000/-



TOTAL SAVING
80,000-75,000 = 42,000 RS
RS – 42,000/KM SAVING 4% PLASTIC.

IV. CONCLUSION

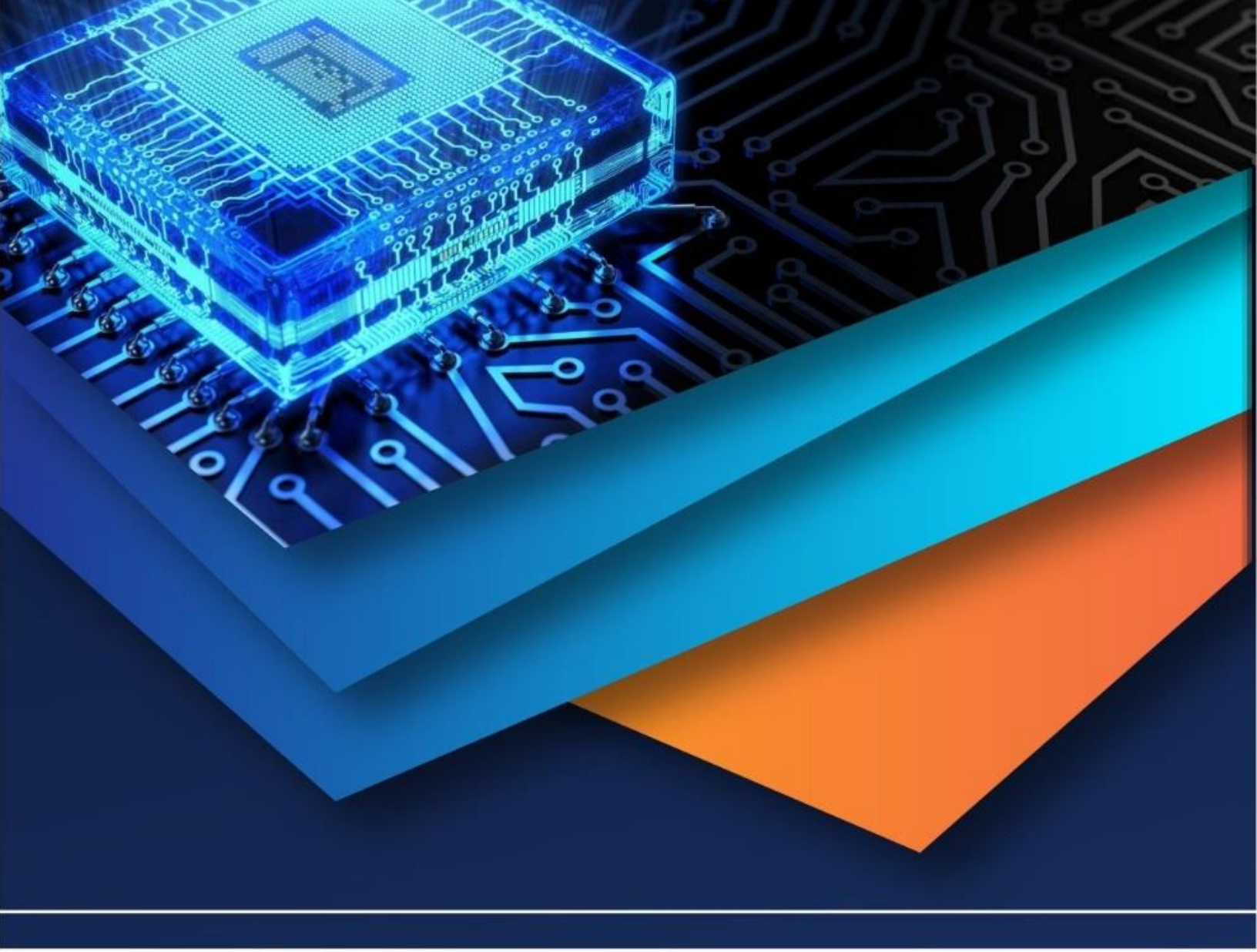
The main objective of this paper is to evaluate the use of plastic waste as a low cost asphalt bindermodifier. HDPE was used to replace bitumen up to some extent. Plastic waste was collected fromhouses and schools. The bottles were cleaned then slashed into small pieces.

Marshall mix design method was used to compare the modified asphalt mix with the conventionalasphalt mix. Marshall mix design procedure seeks to select the OBC to be added to a specific aggregate blend resulting in a mixture that satisfies the desired properties of strength anddurability, so in order to evaluate the modified asphalt mixtures, the OBC for the conventional asphalt mix was identified, then different percentages of crushed plastic waste by weight of OBCwere tested on the PWM asphalt mixtures.

V. RECOMMENDATIONS

Marshall Test results for the modified asphalt mixtures were analyzed to find the optimum PWMcontent. Finally, the static ITS was determined for all mixtures using the splitting test. It was foundthat PWM content of 4% by weight of OBC is recommended as the optimum PWM content neededfor enhancing the performance of asphalt mixtures. Asphalt mix modified with 4% PWM by OBC % would significantly enhance stability by 42.56%, flow by 89.91% and strength by 13.54%. Thisimprovement can be explained by the enhanced adhesion developed between asphalt and plastic waste coated aggregates caused by the intermolecular bonding which improves asphalt mix strength. This would be reflected in the enhanced durability and stability of the asphalt mix whichwould lead to enhancing pavement resistance to fatigue cracking and rutting or permanent deformation.

Recommendations concluded from this project is that by using 4% plastic with 4% bitumen, we can gain the maximum stability with reliable flow. The results of conventional samples without admixture and with 4% of admixtures are compared below.



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