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ENHANCED MODIFIED BITUMEN WITH POLYMERS & WASTE OIL PRODUCTS

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Abstract - The reduction in use of natural and finite resources and reuse of waste materials are current concern of different research areas. Therefore the main aim of this study is to develop enhanced modified bitumen with waste engine oil and recycle engine oil bottoms combined with waste polymers (plastic), in order to minimize use of bitumen. After thermochemical characterization, different compositions were studied with penetration, softening point and viscosity tests. The bitumen modified with polymers (2%, 3%, 4%, 5%) and waste oils (0.5%, 1%, 1.5%) with the help of Marshall stability value and check the stability, flow, VFB, percentage of voids in bitumen. To compare the normal sample and modified sample and result include at conclusion.

Key Words: Polymers, Waste oils, Bitumen test, Marshall Stability.

1. INTRODUCTION

The focus in construction has recently shifted toward sustainability and environmentally friendly practices because of global awareness and strict environmental regulations are actively being implemented to prevent the worsening effects of climate changes and depletion of fossil fuel reserves and also the reduction of finite materials which are used in pavements. It is also necessary to reduce cost of constructing pavement by Appling adopting new technologies.

2. LITERATURE SURVEY

2.1 **Mehmet Bayazi et.al(2014)** studied moisture susceptibility characteristics of the mix modified with Fischer Tropsch wax, Montan wax and Polyethylene wax and concluded that modified mixes showed better rutting resistance.

2.2 **John et. al (2019)** modification the asphalt mixture become more moisture susceptible which correlates with the surface energy characterization. Interestingly, polyethylene wax modification shows positive moisture performance.

3. METHODOLOGY AND AGGREGATES PROPERTIES

This methodology describes the different materials used in this study, the employed to accomplish the objectives of research. For preparation of warm mixes, Bituminous Concrete type of aggregate grading as per code IRC-111-2009 Design of Bituminous mixes has been adopted. Methodology adopted is shown in figure 3.1experimental plan to complete proposed research and the experimental procedure

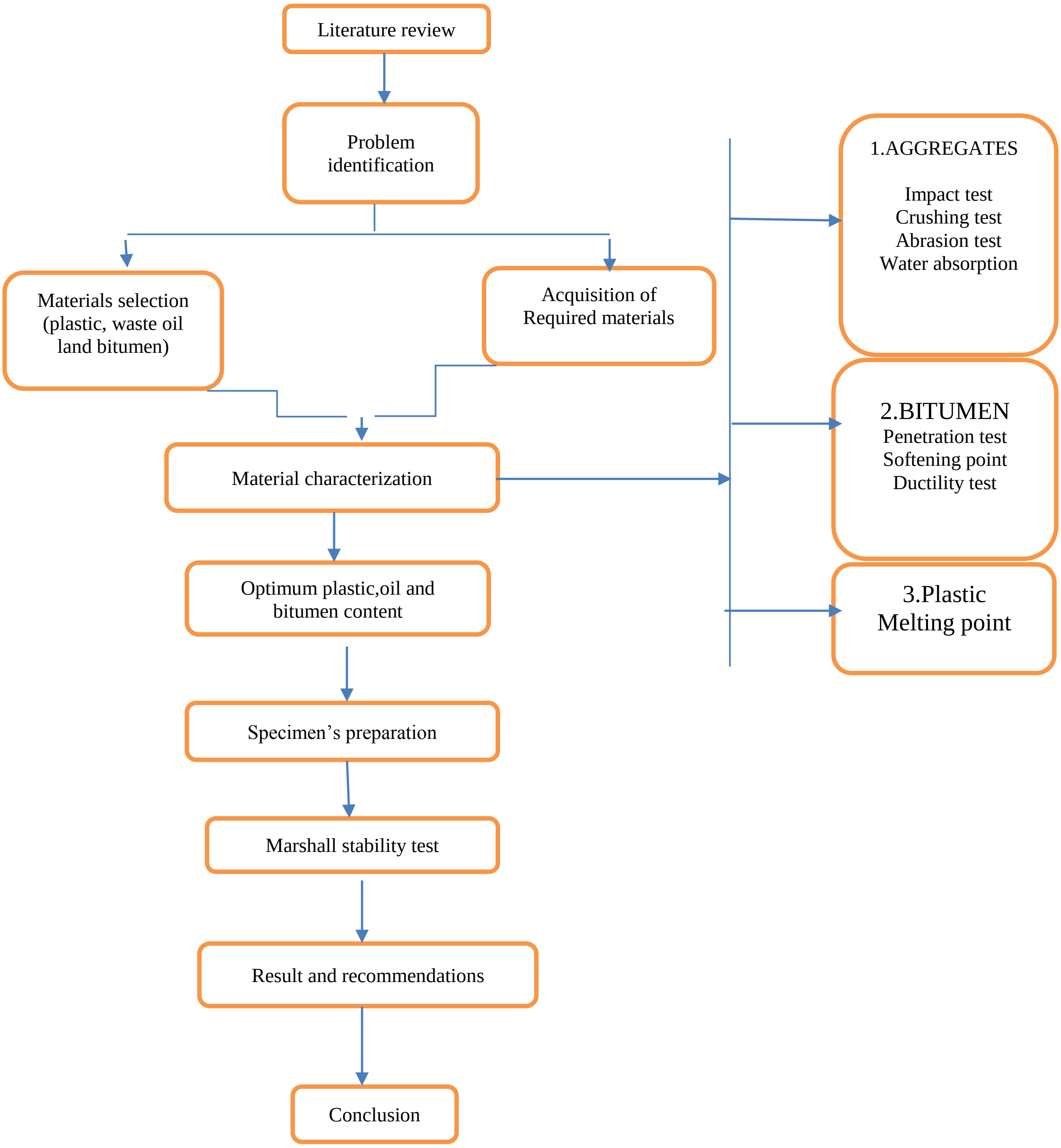


Fig 1. Methodology

Type of Crude Oil	Saturates	Aromatics	Resins	Asphaltenes
Light Crude[a]	92	8	1	0
Medium Crude[b]	78	15	6	1
Heavy Crude[c]	38	29	20	13
Diluted Bitumen[d]	25	22	33	20

Table 3.1 Major Classes of Compounds in Crude Oils, Percentages by Weight

Property	Test	Result	Recommendations as per IRC 111-2009	Test Method
Particle shape	Flakiness and elongation index(combined)	**16.77%**	Max 35%	IS:2386 Part 1
Strength	Los Angeles Abrasion Test	**27.24%**	Max 30% For bituminous concrete	IS:2386 Part 4
	Aggregate Impact	**20.23%**	Max 24% for bituminous concrete	IS:2386 Part 4
Water Absorption	Water Absorption	**0.5%**	Max 2%	IS:2386 Part 3
Specific Gravity	Specific Gravity	**2.67**	2.6-2.9	IS:2386 Part 3

Table 3.2 Properties of Aggregates

S.NO	IS sieve size (mm)	Cumulative % by wt of total Agr. passing	Mid range for percentage of passing (P)	% Of Retained 100-P	W=(R/100)*1200 Wt. of Agr. In grams
1	26.5	100	100	0	0
2	19	90-100	95	5	60
3	13.2	59-79	69	26	312
4	9.5	52-72	62	7	84
5	4.75	35-55	45	17	204
6	2.36	28-44	36	9	108
7	1.18	20-34	27	12	144
8	0.6	15-27	21	3	36
9	0.3	10-20	15	6	72
11	0.075	2-8	5	4	48
12	<0.075	-	0	5	60
					Total=1200 g

Table 3.3 Gradation of Aggregates

4. RESULTS AND DISCUSSION

4.1 Introduction: According to the Methodology and Experimental work described in the 3rd chapter, test results are presented, analyzed and discussed. For the ease of reporting the results, the nomenclature as given in Table 4.1 is used for mix identification

Table 4.1: Identification of Different Mixes

Binder Type	Additive	Mix Identification (ID)
VG 30	Plain mix(No Additive)	VP
VG 30	Polyethylene (plastic)	VPE
VG 30	Crude oil	VC

4.2 Mixing and compaction Temperature:

As bitumen mix is produced at a lower temperature reduction in mixing and compaction temperatures of 30 to 50°C. There are no previous specifications available regarding the mixing and compaction temperatures for bitumen mixture the mixing and compaction temperatures are adopted as per the table 4.2[9].

Table 4.2: Mixing and compaction temperatures

Mix Type	Mixing Temperature		Compaction Temperature(°C)
	Aggregate(°C)	Binder(°C)	
VP	145-150	145-150	132-137
VPE	127-121	127-121	121-115
VC	127-121	127-121	121-115

4.3 Optimum additives Content:

The modification of the VG 30 was carried out by adding additives between 1 to 5% of dry weight of bitumen. As additives was added to bitumen viscosity decreases the optimum content was selected based on the viscosity values. The additives content which provides the highest viscosity to the binder was selected as an optimum percentage. This process led to an optimal percentage of 3.5% for polyethylene wax and below 3% for crude oil.

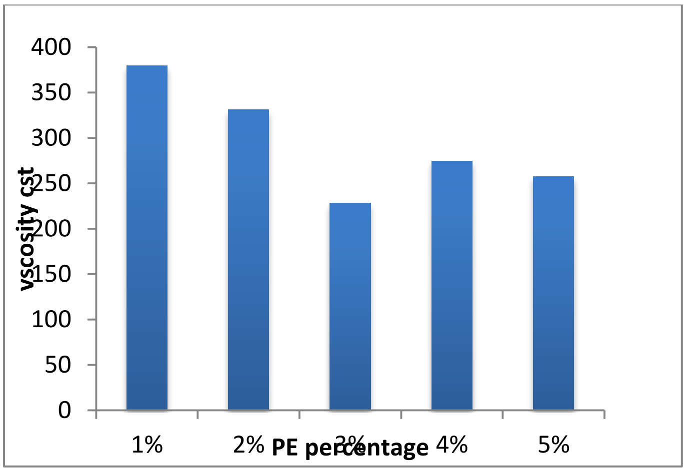


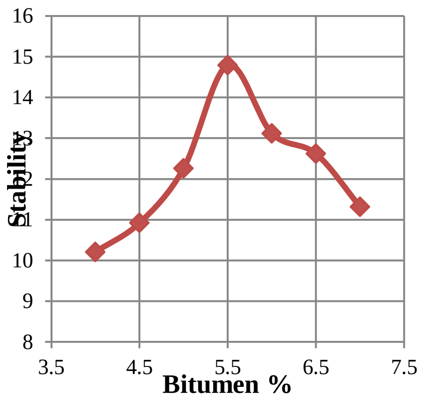
Fig 4.1 Optimum percentage of Polyethylene (PE) Fig 4.2 Bitumen sample

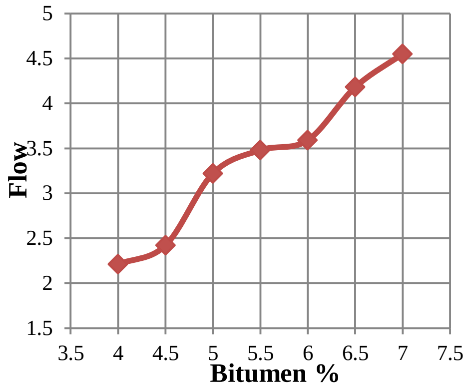
4.4 Marshall Stability Test

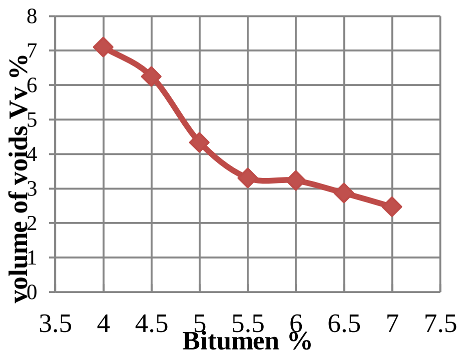
4.4.1Conventional Bituminous Mix: To determine the optimum bitumen content for a particular blend of aggregates and bitumen, different percentages of the bitumen with an increment of 0.5% are adopted in the range of 4-7 like 4%, 4.5%, 5%, 5.5%, 6%, 6.5 and 7% .OBC is selected to get 4% of the air void in the mix and satisfying all the other requirements in accordance with code IRC 111-2009. From the tests 5.2% of bitumen satisfying 4% air voids in the mix and it is adopted as OBC. The results of the tests are given below in table 7correspondingly Marshall Mix Design Curves for VG30 Conventional Bituminous mix are shown in figur.4.3

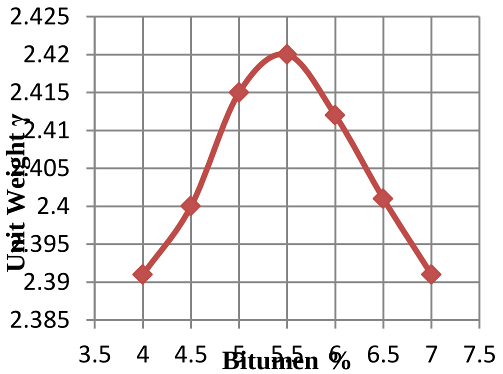
Table 4.3 Properties of Conventional Marshall Mix Design

S.No	Bitumen (%)	Stability KN	Flow Mm	Volume of voids(Vv)%	Voids In mineral Aggregates(VMA) %	Voids filled with bitumen(VFB) %
1	4	11.21	2.21	7.10	16.48	57.00
2	4.5	11.42	2.42	6.25	16.84	62.89
3	5	12.62	3.22	4.34	16.18	73.18
4	5.5	14.11	3.48	3.31	16.36	79.76
5	6	13.31	3.59	3.23	17.42	81.46
6	6.5	12.31	4.18	2.87	18.17	84.25
7	7	12.02	4.55	2.47	18.88	86.92









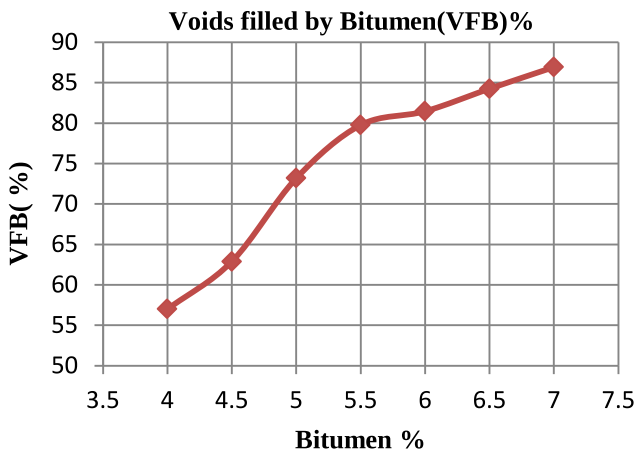


Fig 4.3 Marshall Mix Design Curves for VG30 Conventional Bituminous mix. Fig 4.4 Bitumen failure

***4.4.2 Bitumen Modified with Polyethylene and crude oil**:* Marshall Stability tests were conducted for the binder modified with the optimum wax contents of 3% of PE and below 3%of oil.. Marshall Stability and Marshall Quotient (MQ) values were obtained by averaging of three specimens and the obtained results are given in Table 4.4. Marshall Stability of modified mixtures show better stability than unmodified mixes, PE modified mix offered better stability than crude oil. Flow values of the additives modified mixes are lower than that of unmodified mixes. Marshall Quotient of the modified mixes increased 26% for PE and less than10%crude oil as compared with the unmodified mix. Among of them, PE showed more positive effect.

Table 4.4: Marshall Properties With and Without Additives

Bituminous Mix	Blows	Marshall Stability (Kn)	Flow in mm	Marshall Quotient (MQ)
VP	75	13.23	4.16	3.18
VPE	75	14.57	3.63	4.01
VRB	75	12.57	4.60	2.73

5. CONCLUSIONS

1. According to conventional bitumen test results, the addition of polyethylene 3%and oil in 1.5%the bitumen decreased viscosity and increased softening point and ductility. This indicates PE wax and oil modification reduced the mixing and compaction temperature. Thus, PE wax and waste oil usage as an additive can be beneficial.
2. In the Marshall Stability test, it was obtained that stability values of the modified mixes are higher than the unmodified mixes. Marshall Quotient is also higher for the modified mixes increased approximately 37% which show more rutting resistance. Among mixes, modified mix showed higher MQ value.
3. Indirect Tensile Strength test results showed that the tensile strength of the modified mixes is higher than the unmodified irrespective of the conditioned of the specimen. TSR (%) values of the modified mixes were less than unmodified thus shows modified mixes are moisture susceptible.
4. From all these results it can be concluded that PE (plastic)showed all positive effects of behavior of bitumen and mixes by improving mechanical properties except moisture susceptibility, so this can be improved either by using anti-stripping additive or using lime as filler material and future research should be performed to improve the moisture susceptibility of the WMA mixtures.

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