Experimental Study on Physical Properties of Bitumen Using Waste Engine oil And Waste Cooking Oil

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***Abstract*— Amount of Waste engine oil (WEO) and Waste cooking oil (WCO) has been increased in large quantities as a result of growth in automobile and increase in today's lifestyle. As waste oil disposal is heavy task in the current society as it leads to many environmental issues. The generic structure of bitumen is similar that of the waste oil, so it can be used in highway construction to decrease the hardening effect of reclaimed flexible pavement materials. Through this experiment, five different ratios of Waste engine oil and Waste cooking oil is blended with VG40 bitumen and bituminous tests like Penetration test, Viscosity test, Softening point test, Ductility test were performed. The physical properties of bitumen is improved when treated with this waste oils. According to this test results, 3% of WEO and WCO gives the optimum results. Mixing of high amount of bitumen shows a varying change of trend in case of bitumen grade.**

Keywords—Waste engine oil; waste cooking oil; Bitumen

I. INTRODUCTION

The development of automobiles and the rise in living standards in society have resulted in massive productions of waste cooking oil (WCO) and waste engine oil (WEO). The amount of WEO being produced globally is rises along with the number of automobiles on the road. Continuous engine operation causes the oil's performance destroy with time, making it harder and harder to recycle used engine oil (WEO) into new vehicle oil. Engine oils are petroleum remains, such as used motor oil from garage, as it reflects many physical and chemical properties of bitumen. Additionally, as food production has increased in response to a rise in population, there is a significant increase in the amount of kitchen waste produced. We are aware that one of the most often used kitchen supplies is cooking oil, which may be made from a variety of materials including plant and vegetable oils, animal fats, and a number of other sources. Waste cooking oil (WCO) can be collected from many sources,mainly from frying shops after frying and cooking process when various eatable vegetable oils, animal oils, and palm oil are utilized. Due to their ability to destroy rivers and other natural resources, WEO and WCO have become significant environmental contaminants.The rightful removal of this waste oil is crucial since it could make existing regional and national environmental issues worse. The waste oil is huge threat to the environment so that it is treated before the disposal into rivers or streams. From the survey done by International Energy Agency, India uses 102 billion liters of fuel annually and uses 23 million tons of edible oil.WEO burning will release lots of pollutants that are airbone in atmosphere and may cause lung related diseases in the society and have detrimental effects on their health. After four batches of frying, food business operators (FBOs) are obligated to dump the cooking oil, because it increases the health issues.

According to research, the comparable molecular structures to bitumen, WEO and WCO have the potential to be employed in road building to reduce the impact of hardening on recycled flexible pavement materials after being reused. Asphaltenes, aromatics, resins, and saturates are the four fractions which make up bitumen, a result of distilling the petroleum product. The most plentiful element is water-soluble, followed by aromatics and resins. The two general groupings that are most frequently observed are maltenes and asphaltenes, which can be used to categorise the compounds. Asphaltenes are made up of resins and saturated and aromatic compounds, whereas maltenes, which are also soluble in n-heptane, are made up of resins and saturated and aromatic compounds. Asphaltenes are the components that are dark in colour, insoluble in n-heptane, and have the highest potential and molecular weight.

Here five different ratios of Waste engine oil and Waste cooking oil is blended with VG40 bitumen and different bituminous tests like Penetration test, Viscosity test, Ductility test, Softening point test were performed. The use of waste oil in bitumen increases the physical properties of the bitumen. Therefore, properly turning waste material qualities into ecologically conscious products can be achieved through the

reuse and recycling of oils in improved asphalt materials. By using waste oil, the suggested procedure has the potential to increase bitumen's characteristics and offer a practical means to make it once again usable.

II. OBJECTIVES

The main objective of the project is to develop sustainable bitumen that may take the place of bitumen in bituminous pavements. Waste materials derived from biological sources must be incorporated. This method improves the bitumen's physical characteristics. It aids in bitumen reduction in bituminous blends.

III. SCOPE

- Bitumen's physical properties can be improved by using residual cooking oil and engine oil.
- To develop sustainable bitumen.
- To reduce the amount of bitumen in bituminous mixtures.

IV. MATERIALS USED

A. BITUMEN

India experiences typical summer heat. Wintertime temperatures are above 10°C, while summertime temperatures range from 35 to 45°C. It is essential to create pavements that are stable in both the winter and summer.

B. Waste Engine oil

The WEO employed in this investigation is a dark oil. Direct collection is made from a nearby garage.

C. Waste Cooking Oil

Palm olein oil, which is gathered from several stores, served as the WCO for the study.

V. EXPERIMENTAL DETAILS

A. Penetration Test

Under standard conditions of temperature, stress, and time length, the penetration of bitumen is its consistency represented as the vertical depth, measured in tenths of millimetres, that a standard needle can pierce into a specimen of material. This test can determine bitumen's consistency and deformation resistance. The material becomes softer if the penetration value is higher. This test is carried out after the bitumen has been treated with WEO and WCO. The best results are obtained by comparing the values before and after the addition of waste oil.

Fig.1. Penetrometer

B. Softening Point Test

It establishes the thermal sensitivity of a material at higher temperatures. This experiment was carried out using a ring and ball setup. It shows whether a substance has a propensity to flow at a greater temperature. This test assists in determining the maximum temperature that a bituminous binder should reach for various road applications. Two balls, each measuring 9.5mm in diameter and weighing 3.5g, are dropped from a depth of 25mm to determine the softening point.

Fig.2. Ring and ball apparatus

C. Viscosity Test

The correlation between the applied shear stress and the rate of shear in a fluid is the foundation for the coefficient of viscosity. The opposition to flow is known as viscosity. Bitumen has both viscous and elastic characteristics. Temperature had a significant impact on bitumen viscosity, which decreased with a rise in temperature. Under the supervision of a viscometer, this test is conducted.

Fig.3. Viscometer

D. *Ductility Test*

This test evaluates the bitumen's ability to stretch as well as its adhesive qualities. In order to provide structural interlocking between aggregates, a binder must create a thin, ductile film surrounding the particles. It is done with conventional briquette elongates. The distance before the bituminous thread breaks is measured in centimetres.

Fig.4. Ductility test apparatus

VI. RESULTS AND DISCUSSIONS

A. *Penetration Test*

VG40 Bitumen has a penetration value of 28mm, after the addition of waste oils it increases. 3% of waste oil gives the best results.

TABLE I. EFFECT OF WEO AND WCO ON PENETRATION VALUE

Percentage	Penetration value (mm)	
	WEO	***WCO***
0%	28	28
1%	33	32
2%	36	39
3%	42	45
4%	48	51
5%	60	63

B. *Softening Point Test*

The values get lower by the addition of WCO and WEO. WCO has more of an impact on softening point value compared to WEO. The appropriate amount to add was 3% waste oil.

TABLE.2. EFFECT OF WEO AND WCO ON SOFTENING POINT

Percentage	Softening point (^{0} C)	
	WEO	*WCO*
0%	63	63
1%	58	56
2%	55	54
3%	50	48
4%	45	44
5%	42	41

C. *Viscosity Test*

This values dropped as WEO and WCO levels in the solution raised. The perfect quantity of waste oil to add is 4%.

TABLE.3. EFFECT OF WEO AND WCO ON VISCOSITY TEST

Percentage	Viscosity (cSt)	
	WEO	***WCO***
0%	540	540
1%	460	490
2%	452	465
3%	401	400
4%	360	350
5%	330	328

D. *Ductility Test*

When more than 4% of waste oil added, the ductility of VG40 bitumen, which was 32 cm, increases to more than 100 cm. The ductility value was unaffected by the addition of waste oil. After 3% of addition, the result remains unchanged. WCO has a better ductility value when compared to WEO.

TABLE 4. EFFECT OF WEO AND WCO ON DUCTILITY TEST

Percentage	Ductility (cm)	
	WEO	*WCO*
0%	32	32
1%	45	50
2%	62	69
3%	75	94
4%	95	100
5%	100	100

VII. CONCLUSION

In comparison to VG 40 bitumen, the modified binders WEO and WCO showed greater penetration and lower softening points in circumstances.

The WEO's effect is more notable than WCO's. The greater changes in bitumen quality are caused by changes in waste oil percentage. The grade of bitumen can be best preserved when up to 4% waste oil is used, and bitumen that has been modified with WCO and WEO has a reduced viscosity.

Up to 4% more waste oil does not modify the ductility value, indicating that WEO and WCO have no impact on the cohesiveness of the bitumen.

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