

USE OF BIO-BINDERS TO REDUCE THE PERCENTAGE OF BITUMEN FOR FLEXIBLE PAVEMENT

¹Reshma shende, ²Sagar hedau, ³Mayur warghude, ⁴Akash agrawal

¹M.E civil, ^{2,3,4}B.E Civil
Civil engineering Department,
RMD sinhgad institute of technical campus, Warje, Pune, India.

Abstract: In order to explore the applicability of waste engine oil and waste cooking oil used in bitumen, the effect of waste engine oil and waste cooking oil on aged bitumen recycling was studied through the analysis of the improvement of its physical, chemical. Three proportions on bitumen were carried out aged by indoor test simulation. Then, waste engine oil and waste cooking oil with proportion dosages were added to investigate improvement performances. The results clearly demonstrated that waste engine oil and waste cooking oil could soften and recover the work ability of aged bitumen effectively. Researchers have found some positive result with these materials. Further research is needed to make these satisfactory replacements of bitumen in industrial scale which will lead to a sustainable source of binder for flexible pavement.

Keywords: Waste engine oil, Waste cooking oil, Improvement, sustainable source.

I. INTRODUCTION

The world is now taking actions to set up an economy which is bio-based and where renewable organic matter is the source of energy rather than natural fossil. Biogases source of energy is renewable, efficient, cost effective and environment friendly which can be a great economical asset to any country.

Bitumen is a viscoelastic material composed of heavy hydrocarbons and soluble in carbon disulfide which is a low loss material. It needs to be heated at 165°-200° Celsius (C) temperature to get enough liquidity to coat all the aggregates in road construction. Bitumen fume consists of minute hazardous particles which are formed by the condensation from the vapor stage after volatilization of bitumen. This vapor mixes with the air consumed by the pavers and at the same time it mixes with the other environmental elements and pollutes them.

WASTE COOKING OIL

In general, the dumping activity of untreated waste cooking oil into the landfill or river cause the negative effect towards an environmental aspect. The responsibility to overcome the high construction cost and minimize the waste dumping issues has initiated the recycling practice of waste oil as an option and alternative method in preventing these problems.

Use of this waste cooking oil can lower down the percentage of usage of bitumen into the flexible pavement. This oil is used as modifier into the bitumen which can enhance the properties of bitumen whether it is taken as old asphalt for reclaimed asphalt pavement

WASTE ENGINE OIL

Waste engine oil is typically petroleum and is often typically contaminated by impurities during physical and/or chemical processes. As a result, the oil is no longer suitable for its original purpose and needs to be replaced by virgin or re-refined oil. If improperly disposed, the pollution of used engine oil may cause irreparable damage to the environment. Waste engine oil contains higher percentages of polycyclic aromatic hydrocarbons (PAHs) which are very dangerous to health.

2 MATERIALS AND METHODS

2.1 Materials

The virgin bitumen with a 40/60 penetration grade obtained from Thakkar constructions, vitthalwadi plant was used in this study. In order to characterize the properties of the virgin bitumen, conventional test such as: penetration test, softening point test and ductility test were performed.

Table 1: Properties of virgin bitumen.

| Sr no | Test name | Results |
|-------|----------------------|-------------|
| 1 | Penetration test | 44mm |
| 2 | Softening point test | 46.8°C |
| 3 | Ductility test | 100cm above |

2.1. Methodology

Within the scope of this study, the effect of two different kinds of waste oils (WCO, WEO) was evaluated on bitumen. These rejuvenators were used to increase the applicable amount of RAP in bituminous mixture.

Typically, modified bitumen binder is produced when the oily form of waste cooking oil is mixed together with neat binder. Accordingly, WCO can also be directly poured into the heated aggregate and apply as a rejuvenator in Reclaimed Asphalt Pavement (RAP). The properties of binder will be changed when the WCO is added into the mixture. Binder evaluation can be performed by conducting, softening point test, ductility test and penetration test to identify different properties of binder. When the amount of oil added into the mixture and the temperature is increased, it will affect the reduction of the viscosity of the samples besides; the high penetration value is achieved with the increasing amount of WCO due to low viscosity property.

3. Experimental Sections

The various test were carried out on bitumen with proportion using IS CODE as reference Test conducted namely as

- 1) Penetration test (Is 1203-1978)
- 2) Softening point test (Is 1205-1978)
- 3) Ductility test(Is 1208-1978)

Test were conducted in standard lab as well as few test were conducted in college laboratory with IS specification and collaborated equipment's.

Standard laboratory name: IR solutions, sinhgad road, pune

In order to evaluate the physical properties of WEO- and WCO-rejuvenated asphalts, the basic tests, such as penetration at 25 °C, softening point at 25°C, ductility test at °C were carried out



(a) Penetration test



(b) Softening point test



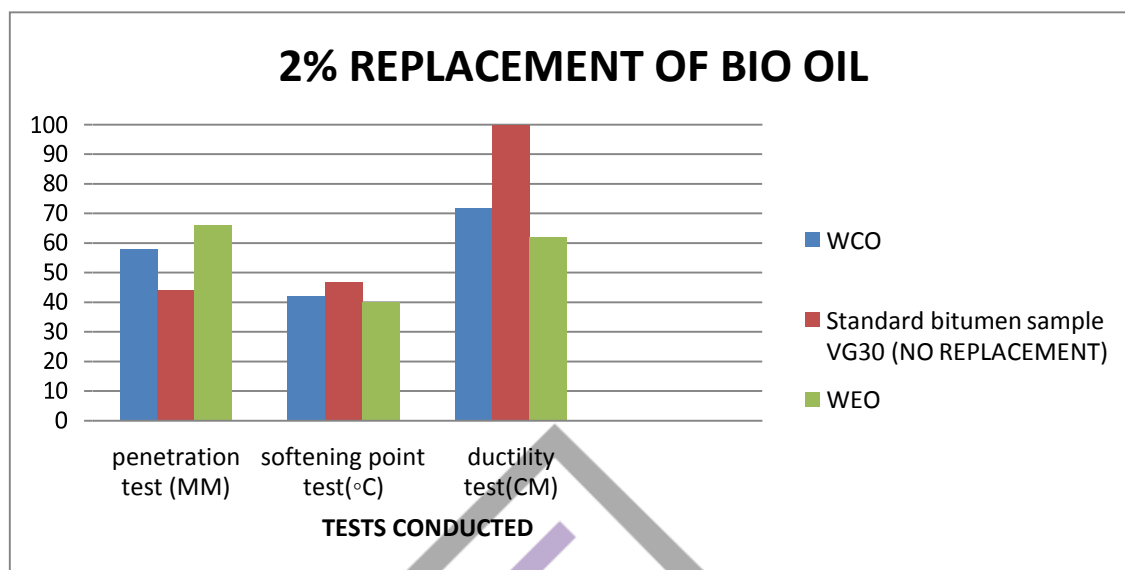
(c) Ductility test

4. Results and Discussion

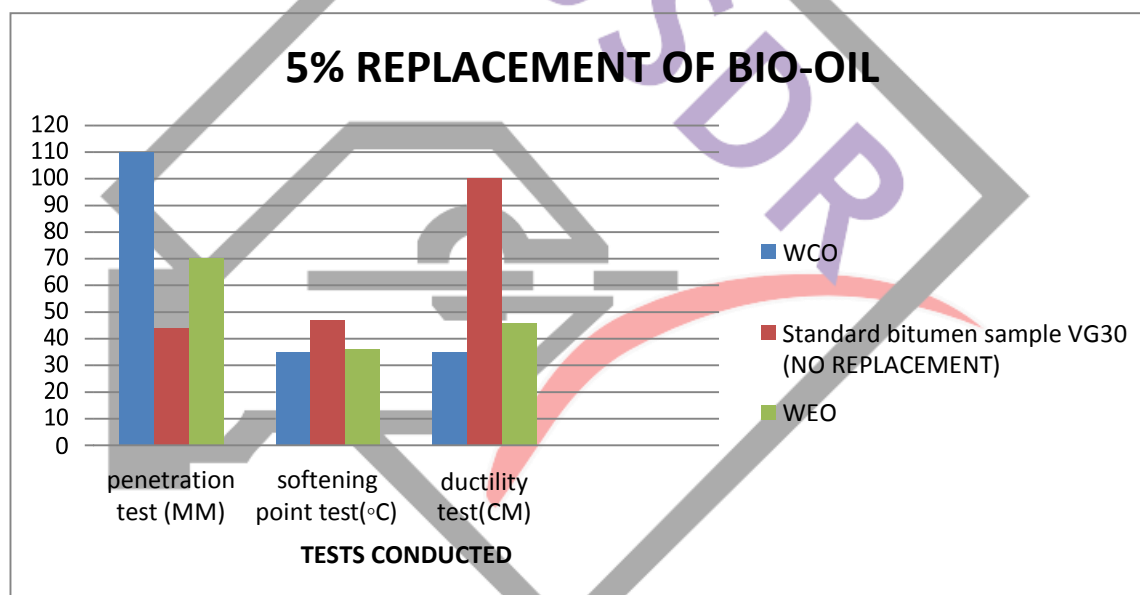
The results of bitumen test with various proportions carried out are as follows in a comparative chart

| Sr no. | Sample name | Penetration value (mm) | Softening value(°C) | Ductility value (cm) |
|--------|-------------------------------------|------------------------|---------------------|----------------------|
| 1) | Standard test on VG30 grade bitumen | 44 | 46.8 | 100> |
| 2) | Waste cooking oil | | | |
| a) | 2% replacement | 58 | 42.9 | 72 |
| b) | 5% replacement | 110 | 35.4 | 35 |
| c) | 7% replacement | 130 | 20.8 | 26 |
| 3) | Waste engine oil | | | |
| a) | 2% replacement | 66 | 40.0 | 62 |
| b) | 5% replacement | 70 | 36.6 | 46 |
| c) | 7% replacement | 80 | 30.2 | 33 |

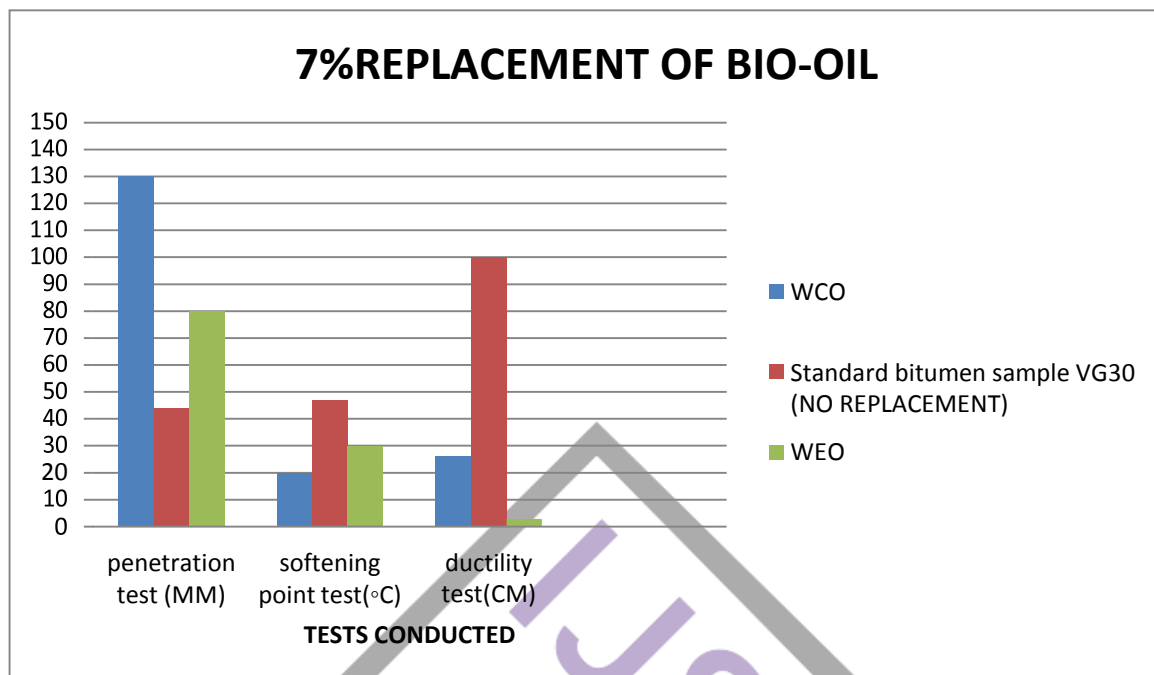
- 1) Graph showing comparative statement regarding 2% replacement of Waste cooking oil and Waste engine oil with standard bitumen sample of grade VG30



- 2) Graph showing comparative statement regarding 5% replacement of Waste cooking oil and Waste engine oil with standard bitumen sample of grade VG30



3) Graph showing comparative statement regarding 7% replacement of Waste cooking oil and Waste engine oil with standard bitumen sample of grade VG30



4.1 Discussions

In comparison, WCO had better function than WEO as a regenerative agent, additive agent as well as easily available material. Addition of WEO and WCO could increase the viscosity and by achieving certain temperature i.e. around 60°C -70°C of bitumen, mobility can be achieved.

Addition of WCO or WEO decreases stiffness and increases value of binder at low temperature which indicates good stress relaxation property and also helps to improve thermal cracking resistance of binder.

5. Conclusions

In this study, some conventional and specific experiments were conducted to evaluate regeneration properties of bitumen. Based on experiment result and analysis from different combinations and proportions, following conclusions can be drawn,

1. WEO and WCO could improve basic properties of bitumen to normal level to satisfy better performance of bitumen, dosage of WCO or WEO should be in reasonable range which are different for different bitumen grade.
2. According to different grade ageing property and viscosity criteria recovery of physical properties could be done with addition of 1%-5% of WCO and 1%-4% by WEO.
3. It reduces usage of virgin material and aged bitumen of virgin nature.
4. In cold region, WCO can improve low temperature performance.
5. By using WCO as bitumen rejuvenator in Reclaimed Asphalt Pavement, significantly can be an alternative of waste material in addition to recycled paper, glass, Plastic bottles etc. that can contribute to reduction in environmental degradation.
6. The addition of WCO and WEO decreases softening point and viscosity, increases penetration and ductility of bitumen binder. The separation tendency result of WCO and WEO demonstrate that it has good compatibility under static heated and stored condition.

6. Future scope of study

- 1) Due to ageing property of bitumen, various proportions of WCO and WEO can be worked out.
- 2) Maximum proportions could be worked out to look after the recovery property of bitumen without damaging its basic property and also achieving economy.

Conflicts of Interest: The authors declare no conflicts of interest..

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References

- [1] D. S. V. Prasad¹ and g. V. R. Prasadaraju, performance of waste tyre rubber on model flexible pavement issn 1819- 6608,vol. 4, no. 6, august 2009 page no 89 to 92.
- [2] Diana johns, t.gdeepak raja, m. Karthigadevi, use of waste tyre as subgrade in flexible pavement e-issn: 2395 -0056 volume: 04 issue: 03 mar -2017 page no 1130 to 1132.
- [3] Mdmaniruzzaman a. Aziz¹, md tareq rahman¹, mohd. Rosli hainin¹ and wan azelee wan abu bakar² alternative binders for flexible pavement from <https://www.researchgate.net/publication/269693860> from page no 11868 to page no 11871.
- [4] Mdtareqrahman a, mohdroslihainina, wan azelee wan abubakar b use of waste cooking oil, tire rubber powder and palm oil fuel ash in partial replacement of bitumen www.elsevier.com/locate/conbuildmat science direct page no 95 to 104.
- [5] P. Aghazadeh dokandari¹, d. Kaya², b. Sengoz², a. Topal² implementing waste oils with reclaimed asphalt pavement paper no. Icsenm 142 page no 1 to 12
- [6] R. M. Subramanian¹ and s. P. Jeyapriya, study on waste tyre rubber in flexible pavement page no 19 to 24.
- [7] Sara fernandes, joanaperalta, joel r. M. Oliveira , r. Christopher williams and hugo m. R. D. Silva, improving asphalt mixture performance by partially replacing bitumen with waste motor oil replacing bitumen with waste motor oil and elastomer modifier published on 5 august 2017 appl. Sci. 2017, 7, 7942 page no 1 to 11.
- [8] Wan nuraifa wan azahara, masturabujanga, ramadhansyahputrajayaa,* , mohdroslihainina, azmanmohamed, norzitangadib, dewisrijayantic the potential of waste cooking oil as bio-asphalt for alternative binder – an overview from research gate sit page no 111 to 116.
- [9] Xiaoyangjia, ph.d; baoshanhuang, ph.d., p.e., m.asce; jason a. Moore³; and sheng zhao, ph.d, influence of waste engine oil on asphalt mixtures containing reclaimed asphalt pavement published on 29 september 2015 page no (04015042) 1 to (04015042) 9.
- [10] Zhaojie sun a, junyanyia,b, yudonghuang b, dechengfeng a, chaoyanguo properties of asphalt binder modified by bio-oil derived from waste cooking oil from <https://www.researchgate.net/publication/283738983> from page no 496 to 505.