Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Volume 13, Issue 03 March 2024

A Study on Partially Replacement of Bitumen with Waste Engine Oil in Bituminous Concrete

Nakka Venkata Naga Narasimha, Pagidipalli Hema Latha, Pallapu Charan,
Vaka Gayathri, Vanaparla Sanjay, Kaza Raga Sai
UG Students–Final Year, Assistant Professor
Department of Civil Engineering,
NRI Institute of Technology, Agiripalli, India

***Abstract*–Pavements have mainly two types i.e. rigid pavement and flexible pavement. Flexible pavements constructed with bituminous as binder and aggregate materials. This research is about to reduce the load on environment by the use of waste material i.e. waste engine oil (WEO). This research will help to find out the optimum percentage of waste material (WEO) to bituminous pavement mix and a way towards sustainable environment. were prepared by partial replacement of bitumen with the waste engine oil (WEO) and were tested for various bituminous properties is penetration, Softening point, Viscosity, Flash and Fire point and ductility and Marshall stability test. The percentages of replacement by weight of bitumen considered for the study were 0%, 8% ,12% ,16% ,20% and 24% (partial being that of waste oil). This project work will provide an alternative or modified binder as well as will serve with the better way for safe disposal of waste oils.**

Key Words: Pavements, bitumen, waste engine oil (WEO), Aggregates.

1.INTRODUCTION

Pavements have mainly two type's i.e. rigid pavement and flexible pavement. Flexible pavements constructed with bituminous as binder and aggregate materials. It is a key challenge in highway industry to reduce the dependence on fossil fuels & to recycle the highway waste. This research work is used VG 30 grade bitumen. And also study on partially replacement of bitumen with waste engine oil (WEO).

The bitumen was replaced from the engine oil of the vehicle by the mechanic repairing shop. The environmental impacts of engine oil lubricant waste include pollution of land, water, and air, as well as increased dependence on crude oil. The use of waste oil in asphalt pavement production and rejuvenation has also been explored, with improvements observed in the reclaimed asphalt pavement. This research was inspired by two concepts i.e. to reduce the use of bitumen and to achieve the beneficial disposal of waste oils.

2. LITERATURE REVIEW

Irtiza And Neeraj (2021) These conclusions indicated that WCO or WEO in suitable contents could be used as modifier or to rejuvenate aged bitumen to achieve the properties of original bitumen and meet all physical requirements.

Hussein et al. (2020) The penetration value increased by 27%, 69%, and 110% as the maltene percentage was 5%, 10%, and 15%, respectively. Penetration was indirectly correlated with the softening point values of the control mix.

Hake et al.(2020) Thus, the analysis results presented above shows that plastic obtained from plastic waste, proved to be a better binder for permanent than normal bitumen.

Sandhiya et al.(2018) The result shows that with increase of waste plastic in bitumen increases the properties of aggregate . The optimum use of plastic can be 10% and 15% of bitumen based on Marshal Stability test.

Herrington et al.(2017) The best results were given by air blowing blends to produce 80/100 binders for use in asphalt manufacture. The research also showed that 10% and in some cases 20% blends of 180/200 bitumen.

Rahman et al. (2017) Result was very promising as the successful application of waste cooking oil with bitumen as revivifying agent for used or aged bitumen lead to an economic and environment friendly solution.

Mahalakshmi and Priyanka (2014) They infer from the results that the optimum percentage of plastic to be added is 7% The waste plastic bitumen has 20% better results. This project is also a waste plastic management.

Vasudeyan (2012) Stated that the polymer bitumen blend is a better binder compared to plain bitumen Blend has increased softening point and decreased Penetration value with a suitable ductility.

Asli et al. (2012) The ageing process was continued for 7 h at a speed of 350 rpm to produce aged bitumen 40/50 penetration group. After the ageing process was completed, the aged bitumen was tested using the

penetration test to determine the group of aged bitumen.

Ravi et al. (2009) used stone dust as well as cement as the filler material for SMA mixes. They used a filler content of 10% by dividing it into 8% stone dust and 2% cement and for their studies used conventional 80/100 penetration bitumen in their performance study of SMA mixtures using waste plastics as modifier.

Yongjie Xue et al. (2008) utilized municipal solid waste incinerator (MSWI) fly ash as a partial replacement of fine aggregate or mineral filler in stone matrix asphalt mixtures. They made a comparative study of the performance of the design mixes using Super pavements and Marshall Mix design procedures.

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Xue et al. (2008) utilized solid waste incinerator fly ash as a partial replacement of fine aggregate or mineral filler in SMA mixes. They made a comparative study on the performance of the design mixes using Super-pave and Marshall mix design procedures. They concluded that nearly 8-16% of the incinerated fly ash substitution in replacement for aggregates and filler meets the SMA specifications.

Kumar et al.(2008) used 60/70 penetration grade bitumen and Crumb Rubber Modified Binder- CRMB without any stabilizing additives to study the performance and results onSMA mixes. They concluded that the use of CRMB without fibers in SMA mixes has a performance similar to or better than the conventional SMA.

Mustafa et al.(2006) used waste marble dust obtained from shaping process ofmarble blocks and lime stone as filler and optimum binder content was determined by Marshall Test and showed good result.

Hake et al.(2006) Use of waste plastic in construction of bituminous roads. The addition of plastic increases the hardness of the bitumen. The waste plastic to be used is between 5% to 10%. The problems like bleeding are reduced in the hot temperature region by the plastic bitumen blend. Plastic has a property of absorbing sound which helps in reducing the sound pollution of heavy traffic. Load carrying capacity is increased and can resist water.

Praveen et al.(2005) Recycled Plastics as Coarse Agropate for Structural Concrete (2013) The percentage substitution that gave higher compressive strength was used for determining the other properties such as modulus of elasticity, split tensile strength and flexural strength. Higher compressive strength was found with 20% NCA replaced concrete.

Nemade and Thorat et al. (2002) Use of Plastic Waste in Road Construction Plastic will increase the melting point of the bitumen. This innovative technology not only strengthened the need construction but also increased the road life. Strength of the road increased, better resistance to water & water stagnation. No stripping & have no potholes Increased binding & better bonding of the mix.

Justo and Veeraraghavan (2002) After the experiment results shows that the ductility and penetration values of modified bitumen decreased with the increase in the percentage of added plastic modifier up to 12% by weight.

3. MATERIALS

The various materials used for carrying out the project work with their particular type used and Samples were prepared from the mixture of Bitumen, Coarse Aggregates, waste engine oil (WEO).

3.1 Bitumen: Bituminous binders such as (bitumen and tar) used in pavement construction work. This research work is used vg 30 grade bitumen because of having good thermal susceptibility. Bitumen of vg30 grade confirming to requirements of as per IS 73-2013.

Table -1 Physical properties of Bitumen

S.NO	Properties	Obtained Values
1	Penetration Test	58 mm
2	Ductility Test	35 (cm)
3	Flash and Fire Point Test	200°C And 260°C
4	Softening Point Test	50°C

3.2 Coarse Aggregate: As per IS 2386: 1963, Coarse aggregates are particulates that are greater than 4.75mm. The usual range employed is between 9.5mm and 37.5mm in diameter. Improved workability, energy efficiency, environmental sustainability, versatility in application, and cost-effectiveness.

Table -2 Physical properties of coarse aggregate

S.NO	Properties	Obtained Values
1	Specific gravity	3.05
2	Aggregate Impact values	11.97 %
3	Aggregate Crushing strength	21 %
4	Fineness modulus	7.20

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3.3 Waste engine oil: The bitumen was replaced from the engine oil of the car by the car repairing shop. It was black and brown. Waste engine oil depending on their type and performance.

Table -3 Physical properties of Waste engine oil

S.NO	Properties	Obtained Values
1	Specific gravity	0.94
2	Viscosity (Pa·s)	50

3.4 Fillers: Fillers play the role of filling the voids, they help in stiffening the binder and offer higher permeability. Examples for this type of fillers are stone dust and fly ash.

4. RESULTS AND DISCUSSIONS:

4.1 Ductility Test

Ductility of bitumen is its property to elongate under traffic load without getting cracked in road construction works. Ductility test on bitumen measures the distance in centimeter's.

Table-4 Ductility values

% replacement of WEO	0	8	12	16	20	24
Ductility values (cm)	25	49	55	67	79	105

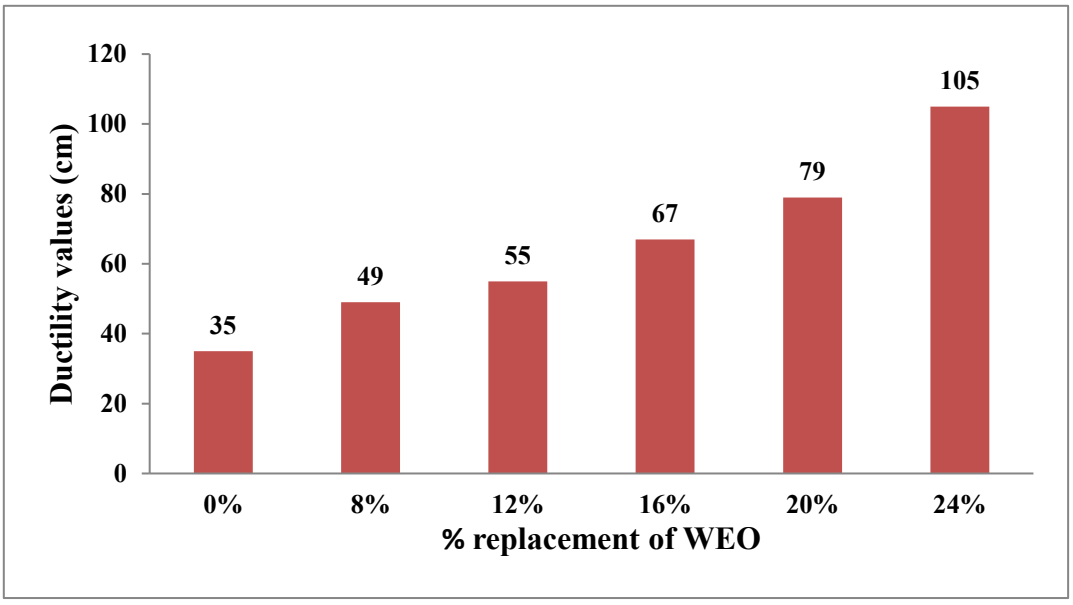

Figure 1: % replacement of WEO vs Ductility values

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4.2 Penetration Test

It measures the hardness or softness of bitumen by measuring the depth in tenths of a millimeter to which a standard loaded needle will penetrate vertically in 5 seconds.

Table-5 Penetration value

% replacement of WEO	0	8	12	16	20	24
Penetration values (mm)	58	64	68	77	80	88

Table:6 Softening point values

% replacement of WEO	0	8	12	16	20	24
Softening Point values (°C)	50	47	44	42	36	34

4.3 Softening Point Test Softening point is measure of viscosity of bitumen. The viscosity of bitumen decreases with decreasing softening point.

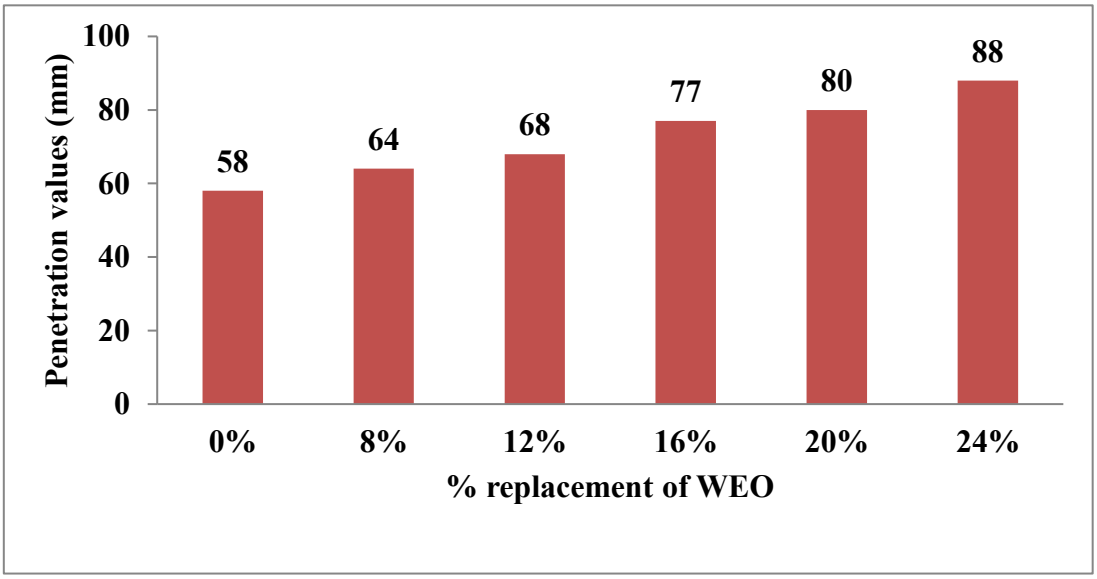

Figure 2: % replacement of WEO vs Penetration value

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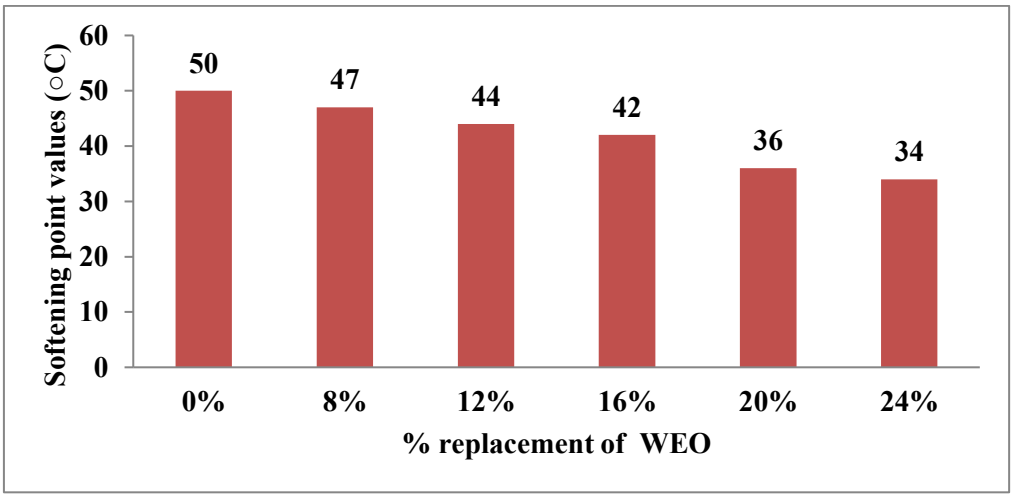

Figure 3: % replacement of WEO vs Softening point values

4.4.1 Marshal Stability

stability of the mix is defined as a maximum load carried by a compacted at a standard test temperature deformation in units of 0.25 mm between no load and maximum load carried by the specimen during stability test.

Table-7 Marshal Stability values

% replacement of WEO	0	8	12	16	20	24
Marshal Stability Values	17.62	16.39	15.60	15.12	14.95	14.54

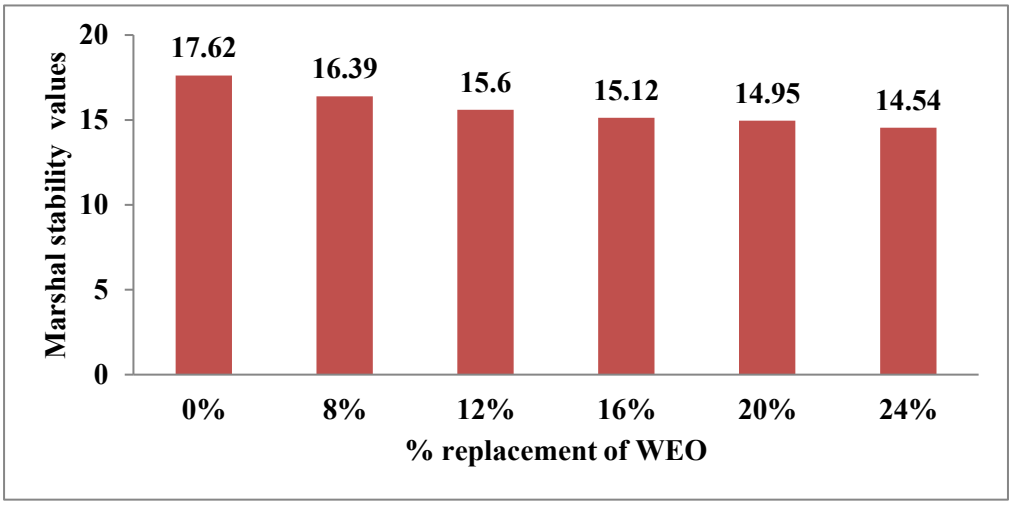

Figure 4: % WEO replacement vs Marshal Stability values

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Table-8 Flow values

% replacement of WEO	0	8	12	16	20	24
Flow Values	3.4	4.27	4.39	4.76	4.92	5.10

4.4.2 FLOW VALUE

This indicates that partial replacement of bitumen with WEO increased the workability of mix.

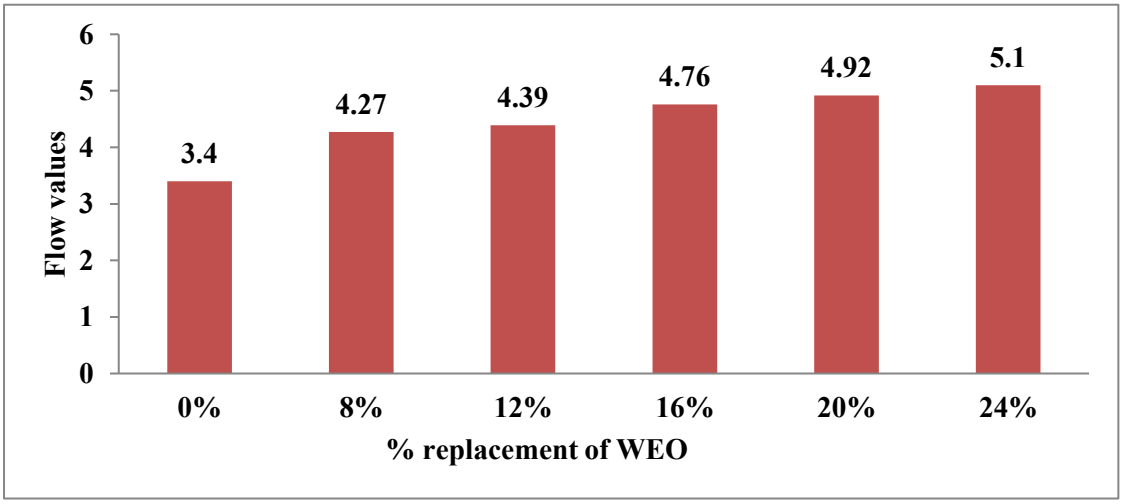

Figure 5: % replacement of WEO vs Flow values

CONCLUSIONS:

- In our experimental study, we observed a decrease in Marshall Stability of samples as the proportion of waste engine oil (WEO) increased in place of bitumen binder. This reduction suggests a decrease in the load-bearing capacity of the mixture.
- Furthermore, as the WEO content increased, the Flow Value of the mixture increased, indicating improved workability.
- Our analysis suggests that if there's flexibility in sacrificing load-bearing capacity, such as in Heavy or Low Volume Roads, Rural Roads, and Cycle tracks, this approach could be viable.
- Implementing this idea could offer a cost-effective and environmentally friendly alternative in the pavement industry, potentially reducing the burden on the environment by utilizing waste engine oil as a resource.
- Properties (Ductility, penetration and flow values) are increased with increase in replacement of WEO up to 24 %.
- Properties (Softening point and marshal stability) are decreased with increase in replacement of WEO up to 24 %.

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