

“Use of Waste Engine Oil as a Rejuvenating Agent in Reclaimed Asphalt Binder to Improve Pavement Recyclability: A Research”

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Abstract— Asphalt pavement Recycling is a typical practice in Transportation part. Waste Engine Oil as a rejuvenator has picked up a considerable measure of enthusiasm for pavement recyclability however there is as yet a huge absence of research in its application. Ecological, financial, and social advantages are the empowering factors for pavement reusing. Issues, for example, transfer of reclaimed asphalt material from clearing ventures, high generation cost of asphalt and transportation cost of virgin material are tended to by reusing of RAP. Reusing or Rejuvenating agents are natural materials which enhance asphalt consistency by reestablishing the synthetic structure of aged asphalt. For the most part, a reusing specialist is added with RAP to reestablish the synthetic properties of aged asphalt binder. Thickness attributes are the deciding variables in choosing the reusing specialist for the aged asphalt binder. The worldwide goal of economic improvement can be accomplished by making use RAP in roadway ventures. This paper expects to feature past research works led on RAP and Waste engine oil as a Recycling operator.

Keywords— Reclaimed Asphalt Pavement, Rejuvenating Agents, Aged Asphalt binder, Waste Engine Oil.

I. INTRODUCTION

Bitumen is fundamentally utilized in street making industry for development and upkeep reason. Bitumen is a side-effect acquired from oil refining. The most widely recognized strategy includes a procedure in which RAP is joined with virgin bitumen and virgin total in a focal blending plant to deliver new hot blend clearing blend. Hot set up reusing is another strategy in which softening of the current surface is finished with warmth, by mechanically expelling the aged asphalt pavement, including a reusing or rejuvenating specialist, potentially including virgin total and additionally bitumen accordingly amending the asphalt pavement surface trouble. Remembering the warming limit of hot blend plants and vaporous hydrocarbons outflows up to 50 percent of RAP amount is broadly considered in hot blend asphalt plants. . Because of less waste created the utilization of reclaimed asphalt pavement (RAP) is viewed as a feasible alternative. Reusing of asphalt pavements is one of the compelling and demonstrated restoration forms. Asphalt ventures are constrained to locate another elective source to build conservative and maintainable streets without bargaining on their quality because of quick exhaustion of common material sources Aging and decrease in the execution of binder will happen following quite a while of introduction to environmental change and activity loads. Pavement's surfaces can be expelled and reused into reclaimed asphalt pavement which is an impossible to miss highlight of a pavement after the finish of its plan life. Maturing of Pavement makes the binder stiffer and weaker than virgin binder. Which makes streets more vulnerable to breaking cleared with unmodified reclaimed asphalt pavement (RAP). Waste engine oil got from vehicles, for example, trucks and autos can be utilized as a rejuvenating operator in RAP. Decrease of firmness and change of physical properties of asphalt binder can be accomplished by mixing waste engine oil with aged asphalt binder. Waste engine oil without hampering the moisture helplessness can undoubtedly relax the asphalt pavements.

II. LITERATURE REVIEW

Mishra Brajesh (2015) has studied Reclaimed Asphalt Pavement (RAP) materials were collected and their characteristics including gradation, California Bearing Ratio (CBR), Aggregate Impact value, Aggregate Crushing value, Specific gravity, Flakiness & Elongation Index, Loss Angles Abrasion value, Water absorption and soundness were determined and compared to the MORTH specifications. From the study it was found that the rap material can be effectively used in the soil sub-grade, sub-base and base of the flexible pavement resulting in reduction of the construction cost.

Hussain Arshad and Yanjun Qiu (2012) studied that the performance of pavements with properly prepared recycled asphalt in terms of fatigue, rutting, thermal resistance and durability proved to be satisfactory. Using Superpave system they evaluate the rheological properties of binder with various RAP percentage. Their DSR and RV tests indicated that by increasing the RAP binder percentages increases the stiffness, viscosity and critical temperature of the blend.

Dedene Christopher and You Zhanping (2014) tested the interactions between RAB and Waste engine oil. This testing reveal a decrease in two aging indices of the blended asphalt binder indicating that waste engine oil has the ability to chemically restore aged asphalt binder. Asphalt Mixture testing as then performed with mixture of virgin asphalt, virgin binder, RAP and waste engine oil in quantities similar to binder testing to see if the rejuvenation show a Fourier transform infrared spectroscopy led to an improvement in the performance of pavement specimens. Finally, the results from FT-IR testing show potential for waste engine oil as a rejuvenator, the fact that it was shown to reduce pavement performance presents a challenge. They concluded that further research will be necessary to find a balance between adding enough rejuvenator to restore the binder contained in the RAP, but not too much as to where the rejuvenator becomes detrimental on the performance of the pavement.

Veeraragavan A. (2012) conducted an Investigation on Laboratory Performance of Bituminous Mixes with Reclaimed Asphalt Pavement Materials. His Primary objectives were to estimate the bitumen and aggregate demand to fulfill the gradation and volumetric requirements of recycled mix, for a typical highway project, to carry out mix design with recycled and virgin materials and compare the mix properties and finally to investigate the influence of recycled materials on the mechanical behavior, tensile strength, durability and performance of bituminous mixes through laboratory experiments. After carrying out the investigations he concluded that the use of recycled materials brings about 78% reductions in the optimum bitumen content required for air voids level of 4% for a typical road project considered in the present investigation, Indirect tensile strength results confirm that the use of recycled materials in bituminous mix offers high fatigue cracking resistance similar to that of virgin mixes, The bituminous mixes with recycled materials are found to offer higher resistance to rutting when compared with virgin materials.

Jain P.K., Mittal Abhishek & Pradyumna T.Anil (2013) accomplish the Characterization of Reclaimed Asphalt Pavement (RAP) for Use in Bituminous Road Construction Their objectives were 1) to carry out the Laboratory studies on asphalt mixes with RAP material and rejuvenating agent and their performance has been compared with virgin asphalt mixes. 2) Various performance tests such as Retained Stability, Indirect Tensile Strength (ITS), Creep test, beam fatigue test, resilient modulus and wheel tracking test has been carried out to compare the performance properties. The studies concluded that the a) laboratory testing work which was carried out on virgin mixes and mixes with 20 % RAP, found that addition of RAP improves all the properties of the bituminous mixes. This indicates that mixes with 20 % RAP would perform better than the virgin mixes under similar conditions. B) It is possible to design

acceptable-quality bituminous mixes with RAP that meets the required volumetric, mechanical properties and desired performance criteria. However, for actual field performance evaluation of RAP mixes, Accelerated Pavement Testing Facility (APTF) available at CSIR-CRRI may be put to use to get the results in a shorter time period.

Chandrasekaraiah T., Mallesh K.M. & Sunil S (2014) carried out the Experimental Investigations on the Laboratory Performance of Bituminous Mixes with Reclaimed Asphalt Pavement [RAP] Materials. Their objective was to carry out the Marshall Mix design with conventional materials added by controlled RAP and Evaluation of the mechanical properties of the bituminous mix with various proportions of the RAP. They concluded that a] the aged bitumen has shown the available paving material at different percentages of the virgin binder and there has been consistent increase in the physical properties (Penetration, Ductility, softening point etc) of the old bitumen when rejuvenated with Virgin VG-30. B] The proportioning of the aggregates with reclaimed aggregates at all specified percentages of 10,20,30 and 40 have given correct blending of the aggregates meeting the specification Requirements. C] More than 10% and less than 40% RAP can be suitable adopted in making the new roads with the RAP.

Kamaruddin Nurul Hidayah Mohd, Hainin Mohd Rosli, Hassan Norhidayah Abdul, Abdullah Mohd Ezree, Yaacob Haryati (2014) studied the Evaluation of Pavement Mixture Incorporating Waste Oil. They studied the various categories of waste oil that included waste engine oil and waste cooking oil. Later, they studied physical and chemical properties of both types of waste oil. The physical properties studied by them were specific gravity, viscosity and flash point. Different chemical properties such as ash content, iron content and fatty acids were also found out. The methods to incorporate waste oil into pavement were also discussed. The binder performance after addition of the waste oil was critically examined. Lastly, the performance of asphalt mixture was carried out. The conclusions obtained by them were a] effects of WEO and WCO are generally produced both of the adverse and good effects to the pavement b] In cold mix, it was reported that the performance was affected such as stability, strength and weakening the bonding between aggregate and binder. C] in hot mix asphalt where the oil was integrated with RAP, it offered the stiffness reduction and therefore improved resistance to cracking.

III. PURPOSE OF USING RAP

Reused Asphalt Pavement alludes to reclaimed and reprocessed pavement material containing asphalt binder and totals. Assembling of asphalt requires a lot of unrefined petroleum. As the characteristic assets like unrefined petroleum are non-sustainable, it is important to reuse and reuse the old asphalt. The prevailing advantage of utilizing Reclaimed Asphalt Pavement is an immediate cost sparing because of the decrease of virgin materials. Additionally the aged binder connected to the totals in RAP is expected to supplant a segment of virgin binder required for new street development. A portion of the exploration have inferred that a pavement containing reused material ages all the more gradually when contrasted with that of pavements developed from virgin materials.

Following table shows the percentage of RAP used in each project and their dates of construction:

Table – 1

<i>Location</i>	<i>% RAP</i>	<i>Dates of Construction</i>
<i>North Carolina</i>	<i>40 %</i>	<i>September 2007</i>
<i>South Carolina</i>	<i>30 and 50 %</i>	<i>October 2007</i>
<i>Wisconsin</i>	<i>25 %</i>	<i>November 2007</i>
<i>Florida</i>	<i>45 %</i>	<i>December 2007</i>
<i>Kansas</i>	<i>30 to 40 %</i>	<i>May 2008</i>
<i>Delaware</i>	<i>35 %</i>	<i>Summer 2008</i>
<i>Minnesota</i>	<i>30 %</i>	<i>2008</i>
<i>Illinois</i>	<i>10 to 50 % allowed</i>	<i>2008</i>

IV. BENEFITS AND ECONOMIC CONSIDERATIONS OF RAP

Some of the environmental and economic benefits of using RAP as a sustainable construction material are as follows:

- The use of already existing materials.
- The elimination of disposal problems.
- Conservation of Natural Resources.
- Sustainable development.
- Reduction in material cost, energy cost and total job cost.

V. PURPOSE OF USING WASTE ENGINE OIL

With a specific end goal to enhance the properties of aged binder some concoction added substances, known as reusing agents are converge into the asphalt blend. . For the most part, there are two kinds of reusing agents that are rejuvenating agents and softening agents. Reusing Agents are normally made out of an oil based good made out of either very polar or sweet-smelling oils The reason for utilizing reusing agents is to reestablish asphalt consistency. The reason for rejuvenating specialist is that it will attempt to reestablish the compound structure of aged asphalt while a softening operator mixes into a blend to diminish the general consistency of the binder. There are different suppositions with respect to the utilization of greasing up oil as an added substance in asphalt binder since the greater part of the exploration done by the creators have concentrated on enhancing the low temperature properties of asphalt. Some examination has demonstrated that utilization of engine oil can enhance the low temperature properties of asphalt and furthermore waste engine oil can be utilized as a reusing operator for reducing the solidifying impact of RAP in asphalt clearing blends. Waste oil that is dumped into landfill without earlier medicines expedites negative effect nature. Spilled oil tends to collect in the earth. This current reason's soil and water contamination. It decreases the broke down oxygen substance of the water bodies. A thin layer of oil shows up on the surface of a stream or a lake because of the eutrophication procedure. This thin layer of oil can obstruct the daylight and along these lines thwart photosynthesis in the end disturbing the oxygen supply to the sea-going life. Burning of utilized oil creates high grouping of chromium, lead, metal particles, zinc and copper in utilized oil can be harmful to biology and human wellbeing. An eutrophication procedure prompts over the top development of small scale creature, phytoplankton and green growth all of which utilize the waste oil as a nourishment source. So as to defeat such issues, it ends up basic to reuse the utilized engine oil as a reusing operator to keep its contamination.

VI. RESULTS AND DISCUSSION

- This think about gives the harmony between including waste engine oil as a rejuvenator to reestablish the binder properties contained in the Reclaimed Asphalt Pavement.
- The above investigation demonstrated steady increment in the physical properties (Penetration, Ductility, softening point and so on.) of the aged bitumen when revived with waste engine oil and Virgin Bitumen.
- The Stability and Flow Value of tests containing Reclaimed Asphalt Binder +Waste Engine Oil (REB + WEO) in extents of half and 20% indicated similar great outcomes when contrasted and the virgin asphalt.
- Waste Engine Oil can be effectively utilized as rejuvenating operator in bituminous solid blend for street development.
- Based on the lab thinks about it very well may be presumed that Reclaimed Asphalt Pavement content as high as half can be appropriately received in Pavement Construction.

- Based on the research facility thinks about it can likewise be done for over half of the RAB as for decreasing the Virgin Bitumen and their Marshall Properties, Dynamic stacking and Rutting and Fatigue test conduct can be assessed.
- Comparison of results between Virgin Bitumen and different extent of Virgin Bitumen, Reclaimed Asphalt Binder and Waste Engine Oil as appeared in Table 2.

Table 2: Comparison of results between Virgin Bitumen and various proportion of Virgin Bitumen + RAP + WEO

TEST	RESULT OF VIRGIN BITUMEN	RESULT OF VIRGIN BITUMEN + RAP + WEO	SPECIFICATION IS : 73 – 2006
PENETRATION TEST (mm)	65 mm	64 mm	50 -70
DUCTILITY TEST (cm)	70 cm	68 cm	MIN 40
SOFTENING POINT TEST (°C)	52.4°C	50.2 °C	MIN 47 °C
VISCOSITY TEST (poise)	2432	2646	MIN 2400 Poise

VII. CONCLUSION

Following conclusions can be made:

- Asphalt Recycling benefits the environment in many ways. In particular, it reduces quarrying, mining and oil consumption.
- Recycling asphalt also dramatically reduces the consumption of resources such as fuel, machinery, transportation and labor when compared with producing virgin asphalt materials. By increasing the percentage of RAP binder there is significant increase in the stiffness, viscosity and critical temperature of the blend.
- Use of RAP brings about 78% reductions in the optimum binder content used for the road projects.
- Use of Engine oil as a recycling agent in RAP assist to improve its low temperature properties and physical properties (Ductility, Softening Point, Viscosity etc)
- RAP reduces the cost of construction as its addition with the bituminous mixes shows better results as that of the virgin mixes.
- According to the Federal Highway Administration 73 million tons of reclaimed asphalt pavement is reused every year. This is nearly twice as much as paper, glass, aluminum and plastics combined.
- There is a profit/savings potential of \$30.00-\$80.00/ton recycled. The wide savings range relates directly to the range in asphalt costs.

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