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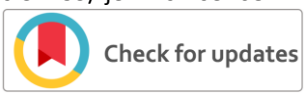

Comparing the Properties of Virgin & Aged Bitumen by the addition of Rejuvenators

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***Abstract*—** Environmental and economic demands prompt to transportation agencies to increase in the use of Reclaimed Asphalt Pavement (RAP) in asphalt pavements. The use of RAP in pavements often require a rejuvenator to reduce the cracking. Estimating a best rejuvenator dosage is crucial to increase its advantages. Large quantity of waste oils from automobiles and restaurants can inflict adverse impact if it is not properly disposed. Recycling of these waste oils can be a suitable option, to reduce the use of natural resources and economic benefits. In this study, three rejuvenators were explored such as Waste Engine Oil (WEO), Waste Vegetable Oil (WVO) and Waste Brown Grease (WBG) with dosages of 5%, 10% and 15%. Physical testing (i.e. penetration, softening point, flash & fire point and ductility) were conducted in the lab on virgin and RAP binder with rejuvenators. WEO and WVO helps in softening when mixed with RAP binder. According to the results, both WEO and WVO can improve the properties of the RAP binder but WBG gives a little bit improvement.

***Keywords*—** reclaimed asphalt pavement, rejuvenators, physical testing.

I. Introduction

An Increase in the risk of crack formation is due to exposure to different temperatures, asphalt binders shift from ductile to brittle behavior [6]. This is even more damaging with reclaimed asphalt pavement (RAP) which is easily susceptible to cracking than virgin binders [8]. Reduction of brittleness, viscosity and stiffness of RAP binders can be done by adding rejuvenators that are available from natural resources [14]. Due to aging in asphalt, cracking resistance expected to have the worst impact on the asphalt because RAP becomes stiffer than virgin asphalt. The addition of rejuvenators helps in improving the mechanical properties of RAP [8]. The quality and effectiveness of rejuvenators can be compared with reference values of the virgin binders by comparing the standard tests such as softening point and penetration of the rejuvenator-aged bitumen [11]. In Pakistan, a large number of used engine oils from various sources are disposed into the rivers, lakes and Arabian Sea which not only contaminate water but are also harmful to marine life [12]. Approximately, one gallon of waste engine oil would pollute one million gallons of water [10]. From crude oil and derivatives, engine oils are prepared by the mixing process of other additives to gain certain properties. Essentially, engine oil is used to lubricate the engine parts. Waste Engine Oil (WEO) is capable of recycling RAP, protecting the environment, saving and reducing the resources as well as the cost of the project which can be signed for the road maintenance [13]. In order to minimize the use of bitumen in the binder content, the use of WEO has been studied with different compositions and resulted in promising performance by using the rejuvenators [9]. Due to the loss of high oil contents such as saturates aromatics resins and asphaltenes the process of asphalt aging started. So to reverse the asphalt aging process asphalt recycling is done in which rejuvenators are introduced to restore the properties of asphalt. As the increase in the dosage of WEO in aged asphalt, resulted in an increase in the ductility and decrease in the viscosity which has important significance in road maintenance [13]. Exposure to atmosphere asphalt aging takes place due to weathering and oxidation, which leads to cracking such as thermal and fatigue. Rejuvenating the aged asphalt by using Waste Cooking Oil (WCO) can have good results in enhancing the properties of RAP [7].

A. *Problem Statement:*

Aging of asphalt starts after the completion of its useful life. But after that, it is considered a worthless material which is a wasted resource. Loss of many essential components due to subjection of HMA to traffic and environmental conditions, stiffness occurs and which resulted in rutting and stripping of asphaltic roads and then which further leads to aging of asphalt. To enhance the properties of RAP and to recycle it, rejuvenation is done

B. *Objectives:*

Several rejuvenators such as WEO, WVO and WBG have been introduced in different proportions of 5%, 10% and 15% to evaluate and compared the properties of RAP binder.

II. METHODOLOGY

Extraction of bitumen is done according to [2] by using centrifuge method. Extraction bitumen was then collected and was compared with the properties of virgin bitumen as well rejuvenators were added in aged bitumen. Following are the physical tests performed on the samples.

A. Penetration Test:

Penetration test shows the grading index of asphalt. According to [5] the sample is kept in water bath at 25 °C temperature and test is done on penetrometer having a needle to penetrate in the sample.

Figure 1 Penetrometer

B. Softening Point Test:

According [4] asphalt's high temperature stability is reflect by softening point test in which two steel balls are placed on disk containing bitumen in it. It is an average temperature at which softening of bitumen take place and steel ball touches the surface.

Figure 2. Softening Point test

C. Ductility Test:

Elasticity of bitumen is measured by ductility test. This test is used to measure the stretching length of bitumen sample under standard testing condition before breaking (50mm/min stretching speed at 25 °C) according to [1].

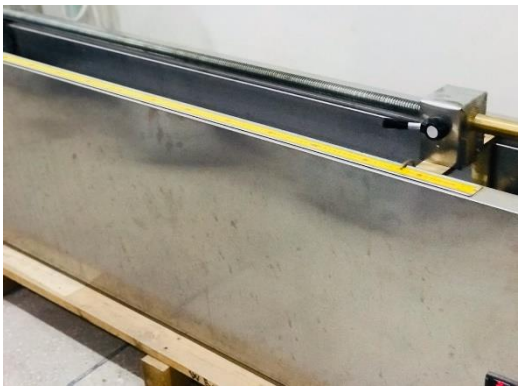

Figure 3. Ductility test

D. Flash and Fire Point Test:

According to [3] safety of asphalt can be measured by one of the test called flash and fire point test in which sample is heated and test flame is passed across the centre of the test cup. Test result are recorded when the sample at certain temperature distinct flash in the test cup.

Figure 4. Flash & Fire Point test

III. RESULTS

Table 1 shows the overall results of properites of rejuvenators in which it includes different physical testings. In which the values of penetration and Duciltiy of virgin and aged bitumen with different rejuvenators increases with the increase in the percentage of rejuvenators while softening point and flash and fire point test results shows the decrease in the values as the percentage increases.

Table 1. Physical Testing Results of Virgin and Aged Bitumen with Rejuvenators

Properties	Sample Type									
	Virgin	Aged Bitumen	WEO + Aged Bitumen			WVO + Aged Bitumen			WBG + Aged Bitumen		
			5%	10%	15%	5%	10%	15%	5%	10%	15%
Penetration (mm) @ 25˚C	64	33	46	57	62	44	56	65	41	49	54
Softening point, °C	55	59	64	61	57	68	64	56	62	59	56
Flash point, °C	305	277	272	269	266	288	270	261	256	251	239
Fire point, °C	312	282	280	278	273	298	279	272	265	260	248
Ductility (25°C, 50mm/min)	103	21	31	44	53	35	49	61	25	32	36

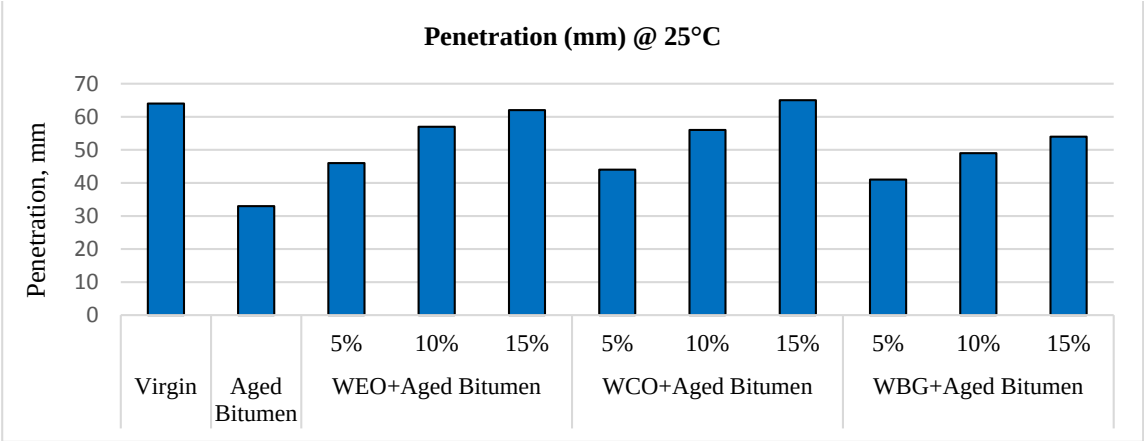

Figure 5. Graphs showing Penetration Test Results

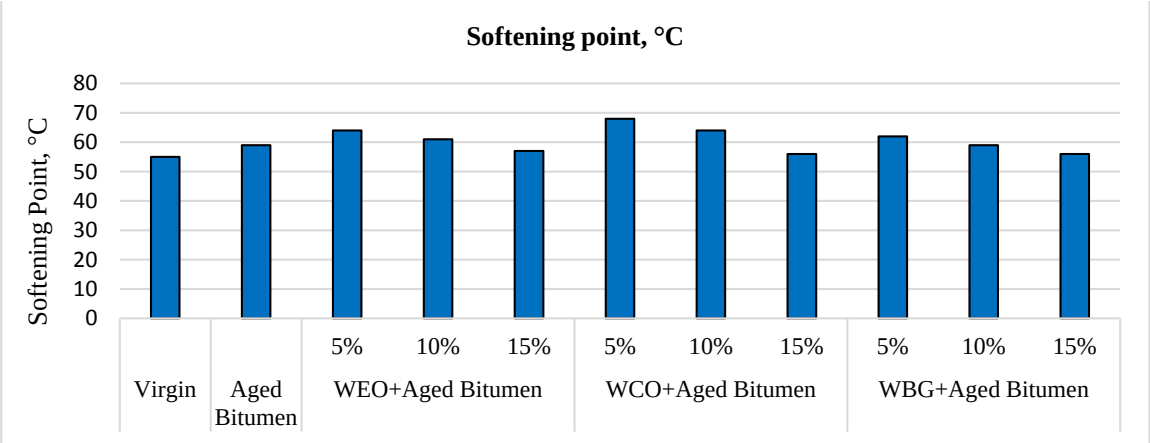

Figure 6. Graphs showing Softening Test Results

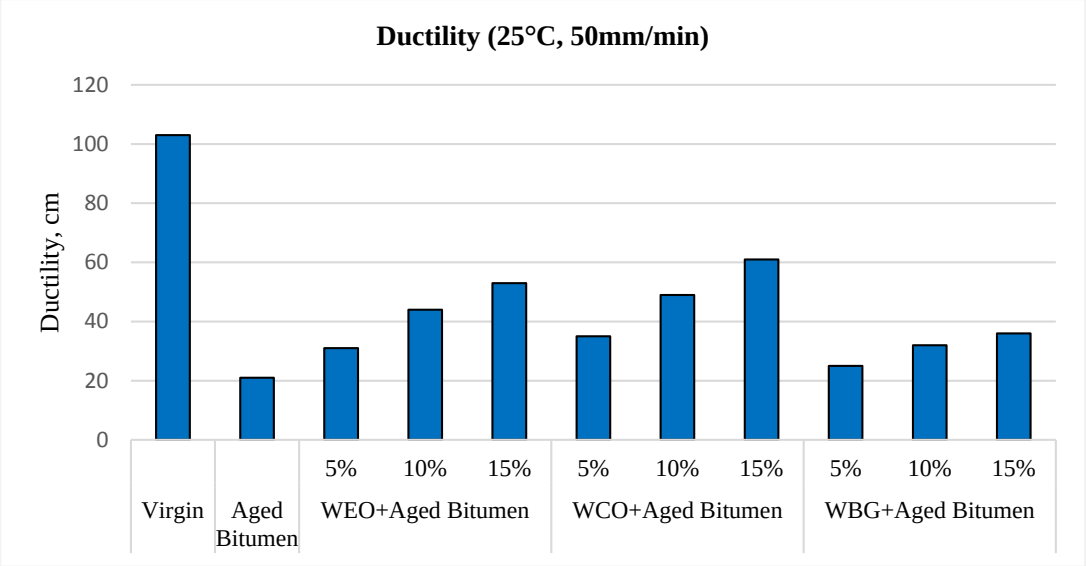

Figure 7. Graphs showing Ductility Test Results

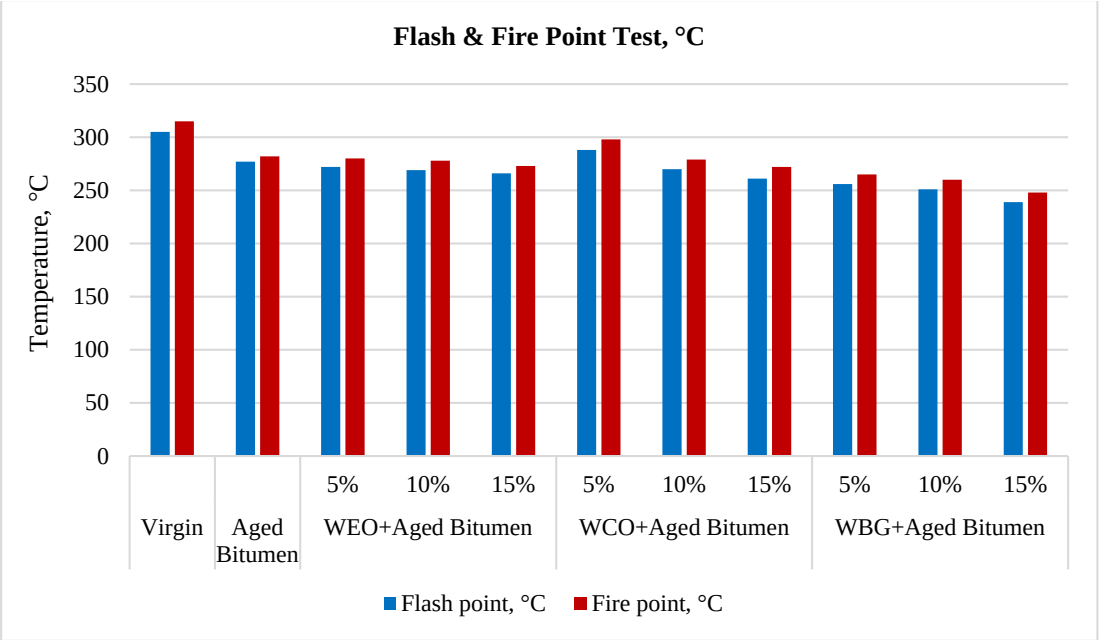

Figure 8. Graphs showing Flash & Fire Point Test Results

CONFLICT OF INTEREST

The contents of this study are free from plagiarism and therefore the study is original and is not copied from anywhere. Previous work of original authors has also been referenced.

CONCUSLION

The effects of WVO, WEO and WBG produced good effects to the binder. The values of penetration and ductility of rejuvenated asphalt increases as in the increase of dosages while the softening point and flash & fire point temperature values decreases.

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