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TO EVALUATE THE SELF-HEALING OF ASPHALT MATERIALS AT DIFFERENT TEMPERATURES

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Abstract- It is common for asphalt pavement to develop micro cracks over time, largely owing to weather and traffic conditions. Pavement fatigue life is shortened as a result of these fissures. When the temperature of an asphalt mixture rises, cracks that previously appeared begin to close. The purpose of this study is to use microwave induction to determine the effect of temperature on the self-healing ability of asphalt pavement material. Asphalt's fatigue resistance was measured using a four-point beam fatigue apparatus. This experiment required a certain amount of condition time and temperature. Before and after conditioning, the specimens were tested. The first recovery cycle results in a significant loss of fatigue resistance, however the loss of fatigue resistance from the second healing cycle to the third healing cycle was minimal. Asphalt's self-healing properties improved with temperature, too. Temperature was shown to be the most important determinant in asphalt's ability to self-heal. Temperatures ranging from 37 to 40 degrees Celsius had the highest healing index.

Keywords-. Four-point beam test, Microwave oven heating, Self-Healing,

1 Introduction

The pleasant operating experience and low cost of asphalt pavement make it an attractive option for highway construction. However, degradation occurs quickly once the road is put into service because to traffic volumes, bitumen ageing, and environmental factors such as moisture damage, temperature influence, and UV radiation. Meanwhile, minor cracks emerge in the asphalt pavement, which gradually deepen and produce more major problems including travel, potholes, and fracturing [1]. Road safety is jeopardised by these deteriorations, which also necessitate costly maintenance. Fractures in asphalt mixtures start out as micrometer-sized cracks, but they can quickly grow due to traffic and environmental factors.As a result, preventive maintenance programme measures must always be used to extend the life of asphalt pavements. Additionally, asphalt mixtures can self-heal without the need for human intervention. Blacktop can also self-heal if they are not subjected to traffic forces that can worsen fractures. As a result, complete healing could lay hold of a handful of months, which is impossible to achieve in practice due to the constant drift of Lorries. Asphalt is a stuff that can mend itself. According to Bazin and Saunier [2], and the role of temperature in self-healing is critical. Although bitumen's viscosity is proportional to temperature, at a certain temperature threshold (i.e., 30–70 °C), it tends to flow into cracks by capillary and gravity and seal the fissure [3]. During the summer, cracks in asphalt pavement that are evident in the winter will disappear, but it is necessary to heat asphalt concrete so that it will heal faster due to temperature. [4]. the high temperature created by microwave heating is very difficult to control; it can exceed asphalt's flash temperature limit, damaging its chemical structure. Consequently, the time spent in the heating process should be closely survived [5].

Out of three types of metallic waste examined by Bowen et al., (HBSS) had the best microwave absorption performance [6]. It is common practice to employ lubricating and extender oils rich in maltene components (also known as "rejuvenators") in pavement repair since these oils may be used to reconstitute the asphalt binder's chemical makeup in order to utilize rejuvenators in asphalt pavements, they must fulfil the following five requirements. Bitumen compatibility, high temperature stability, capacity to endure mixing and construction circumstances, healing temperatures between 30

and 40 degrees Celsius, and the ability to heal continuously or several times are all important considerations [7]. Asphalt concrete's thermal capacity and solar radiation would have no extra thermal impact. A decrease in composite viscosity and an increase in rutting resistance were both achieved by using microwave-preprocessed ground tire rubber, as shown by Xu et al. Gallego et al. looked at the efficiency of a new thermo mechanical treatment for enhancing the healing capacity of hot asphalt mixes. A self-healing asphalt mixture including waste metals was studied by Yalcin using induction warming and microwave heating [8]. The aim of this paper is to evaluate and compare the self-healing properties of asphalt material by using Microwave induction Method.

2 Experimental Procedures

Asphaltic pavement materials may be tested for stiffness modulus and fatigue resistance using bending tests. In CEN, AASHTO, and Chinese test requirements, four-point bending tests are included. Controlled strain or regulated stress techniques of loading are possible for the prismatic beam specimen. Servo pneumatics, an increased digital data collection and control system, and user-friendly software make up the CRT-SA4PT-BB Standing Alone Four Point Bend Beam Machine. Microsoft ExcelTM-compatible format test data is saved to the disc during testing, which includes both graphs and tables. Beam height and breadth may be adjusted to meet AASHTO specifications despite the fact that the clamps are spaced at 118.5mm centers (the distance between outer ends is 335.6mm (fourteen inches). Mixing aggregates and bitumen, we created asphalt material slabs before dividing them into 4 beams of asphalt mixture. Beam measured 12 inches in length, 2 inches in breadth, and 2 inches in depth when estimated over its whole surface area. There were a total of twenty asphalt material beams constructed. Asphalt beams were subjected to a Fatigue test using a four-point Beam test device. The device's frequency ranged from 0.1 to 30 Hz. Temperatures and frequencies were varied throughout the testing process to see what effects were seen. The initial fatigue cycle is the number of times before fractures appear.

Figure 1: Experimental Setup

3 Research Methodology

To meet the goals of the research, a three-phase procedure was devised. The initial step was to narrow down the options for raw materials. A single aggregate supply and three local asphalt binder were chosen. Bitumen from the Attock Oil refinery's 80/100 penetration grade and 60/70 penetration aggregates were utilized. Second, several binder tests on asphalt binder were done in order to discover binder requirements. Phase 2. It was tested for penetration, ductility, viscosity and softening point. Third, the self-healing of asphalt mix was performed utilizing microwave induction. i.e. asphalt mixture design specimens were made. This phase's primary test was a four-point beam fatigue test. Tests were performed during self-healing to compare the asphalt material beam's fatigue resistance. This was the era in which the Healing Index was discovered. Analyzing the data was the last step in the study technique. Asphalt 60/70 and 80/100 mixture healing indices were studied. In first phase two different local asphalt binders and Margalla aggregates were chosen to make preparation of the asphalt mixture. In Second phase specimens were made ready for both qualitative as well as quantitative tests. To check the qualities of the chosen asphalt, both conventional and rheological experiments were carried out. In the third phase of research methodology, Self-Healing of asphalt mixture was accomplished by using Microwave oven. The flowchart of research Methodology is given below in Figure 2.

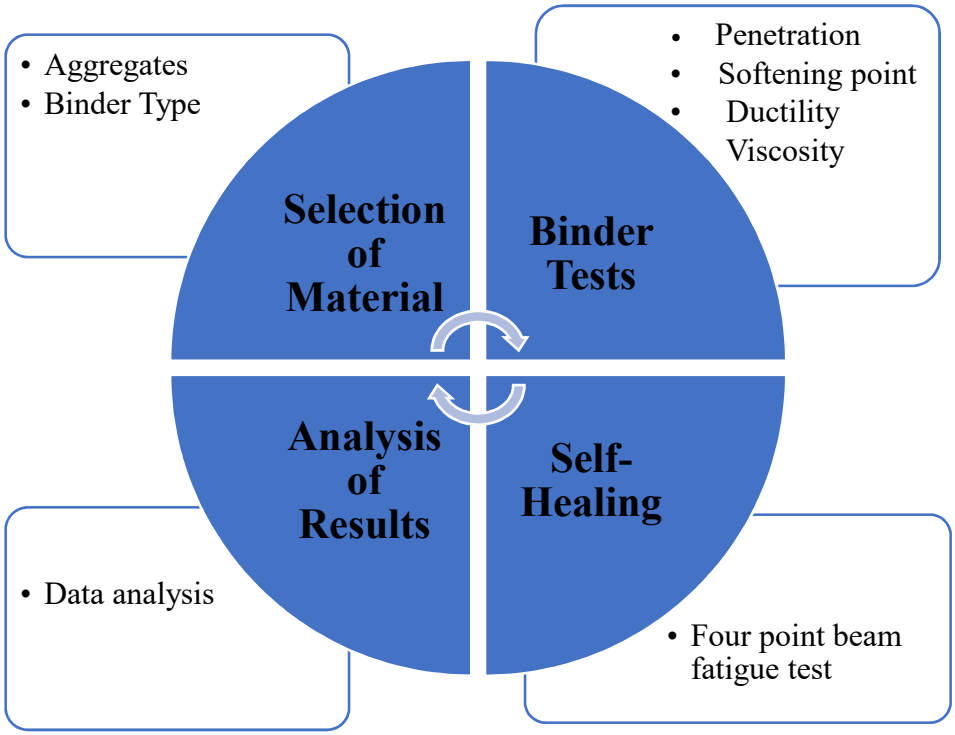

Figure 2; Flowchart of Research Methodology

4 Results

4.1 Fatigue resistance of healed specimen

.A considerable decrease in fatigue resistance was seen after the first healing cycle, however there was no such decrease between the second and third healing cycles, as shown by the results of cyclic loading. Because certain aggregate grains were shattered during the initial 4 PB test, they were unable to completely restore their strength when microwave treatment was applied. When it came to the third and final measure of fatigue resistance, however, the two were almost tied. Broken aggregates, in other words, impede healing to a certain extent. Figure 2 shows the results of cyclic loading when 60/70

grade bitumen was used. Figure 4 shows that 1st fatigue resistance of asphalt material 80/100 was less than that of 60/70. Healing performance of 80/100 asphalt mixture was greater than that of 60/70. Results of cyclic loading for both grades of bitumen are shown in Figure 3 and Figure 4. Because 80/100 grade binder is softer than 60/70, so healing performance of 80/100 is greater than that of 60/70. Different vehicles load apply, remove and reapply on road which is an example of cyclic loading. Self-healing of asphalt mixture occurs in periods without traffic and under high temperatures, starting between 30oC and 70oC depending on the type of bitumen used. The main healing mechanism of asphalt mixture is the capillary flow of the bitumen through the cracks at high temperatures. This is a very slow process and cracks may need many days to fully self-heal. By increasing temperature, Healing capability can be increased as shown in fig.

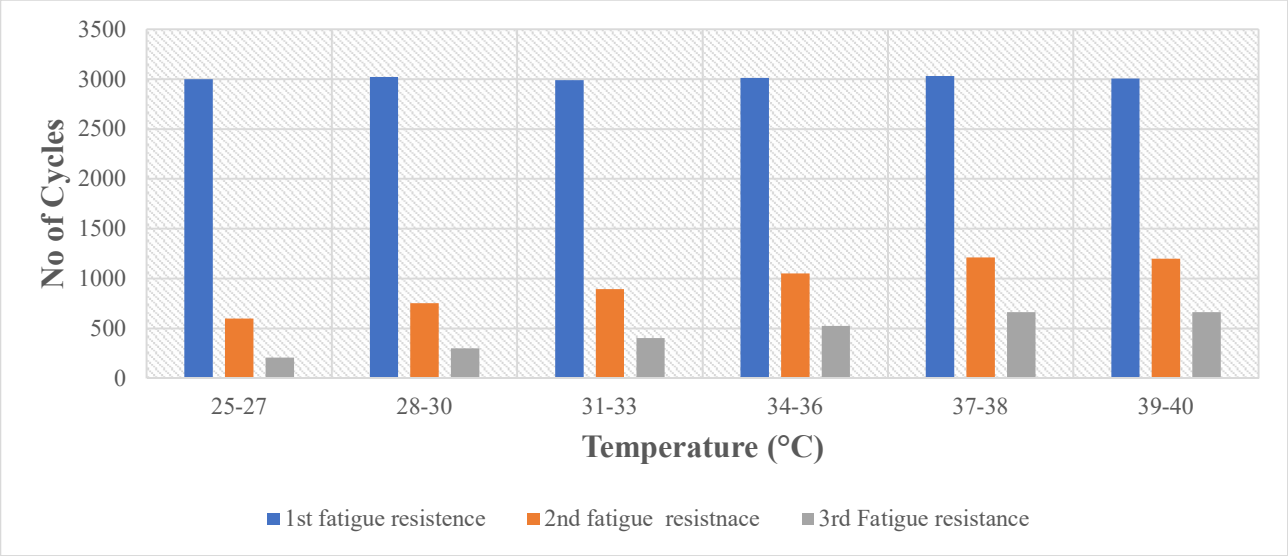

Figure 3: Effect of temperature on fatigue resistance (60/70)

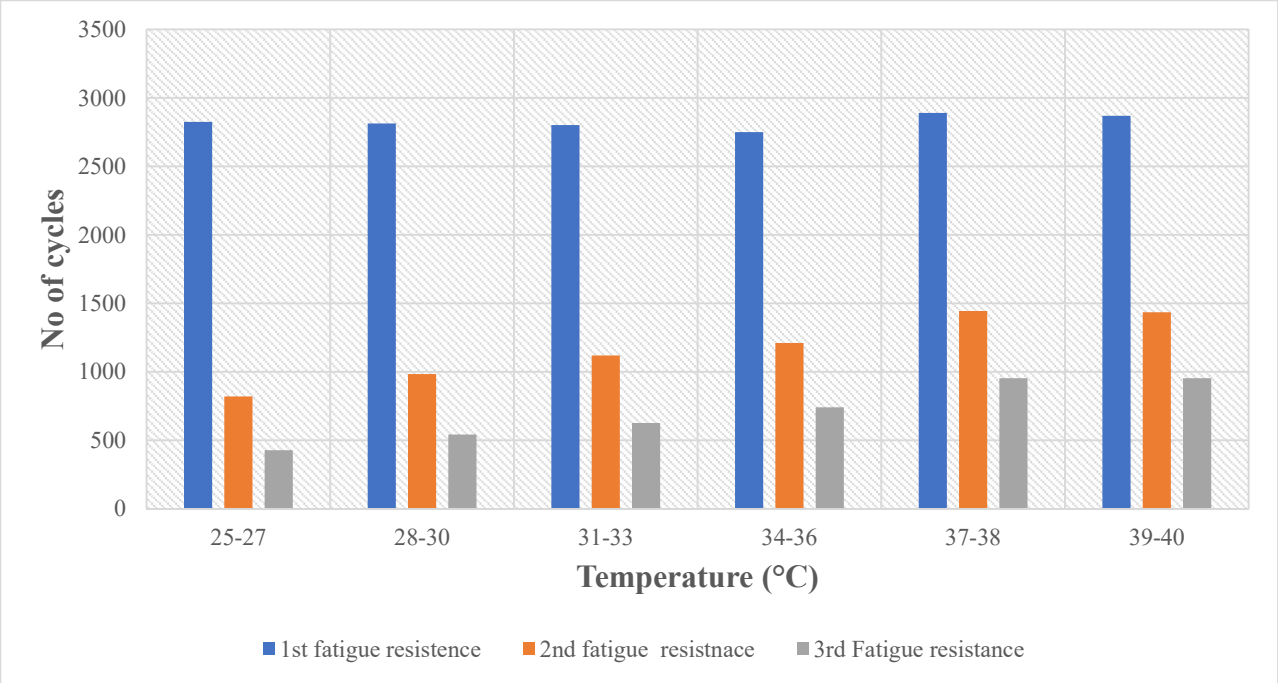

Figure 4: Effect of temperature on fatigue resistance (80/100)

5 Practical Implementation

Fig 5 shows the working mechanism of the microwave heating vehicle. While moving, the automobile heats the pavement via the microwave unit. Additional equipment, because the crusher and the shovel, are set up for mincing the ice layer and pushing the ice to the road side. The authors 'purpose turned into the deicing of the pavement, however plainly comparable systems may be used for different heating pavement applications.

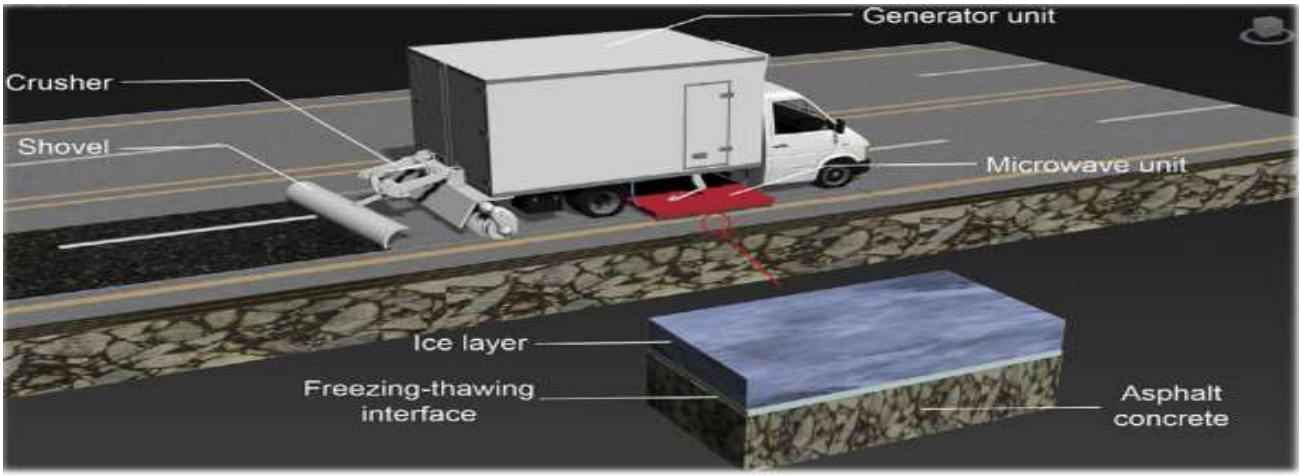

Figure 5: Working mechanism of the microwave heating vehicle

6 Conclusion

In the light of results attained, conclusions are summarized as:

1 High temperatures improve pavement fatigue life because asphalt material fractures mend faster at high temperatures. It is reported that cracks seen within the asphalt pavement in winter disappear in summer, however to enhance temperature related healing performance, it's necessary to heat asphalt concrete artificially. Self-healing of asphalt material also enhanced with increasing time up to some extent and then decreases.

2 Based on experimental data, healing performance of 80/100 grade bitumen was higher than that of 60/70 grade bitumen.

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