Studying the Physical Properties of Hma with Recycled Aggregate Subjected to Moisture

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Abstract

As being exposed to water exists on asphalt road, HMA that is created by utilizing a certain resources may require to be made strong due to the capability of that water to stop the covering to be attached to the aggregate, consequently, asphalt road layers will not be held jointly, this will have a negative influence on the asphalt that will be damaged quickly. Such phenomenon is known as "the erosion", which requires to be dealt with by, for example, improving asphalt layers by means of specific resources that assist in existence of water.

Different ways in this work are employed to calculate the strength of various mixes via using used aggregate that is exposed to saturation times, similarly, the importance of exploiting the anti-stripping as chemical addition is determined.

Three kinds of HMA were exposed in the current study, 60% of the first kind were made of used aggregate taking from crushed pavement, and 60% of the second kind were taking from using aggregate that is part of concrete mix, while the third mixture has 10% of wax used as an addition by pavement weight. These mixtures were soaked in water bath of 25°C for various intervals of time that are (3, 7, 15, 28) days. Many investigations examinations had been as well executed, and then the outcomes were contrasted against standard pavement blend subjected to similar circumstances. Number of examinations were adopted in this study, these are (Marshall Stability and flow), mass thickness, roundabout elasticity, compressive quality, affectability to temperature, flexible modulus.

The study achieved a good success as it makes important outcomes, the enhanced pavement showed strength against moisture damage while taking advantage of used aggregate of preceding blends, on other hand, the wax has affective role in raising these strengths in addition to develop the characteristics of HMA.

Key words: HMA, Marshall stability, saturation, Antistripping .

Introduction

The premature failure of flexible asphalt pavements may be achieved from the presence water at surface course which leads to segregate the gel contents (Mills et. al., 2009). The flexural sprains are built up by binder course saturation results in...
wearing of coat of asphaltic, whereas deteriorated rut wills cause crack in the coat of the outside part. Laboratory testing equipment is needed to obtain a material and quantity comprehension of the distortion attributes for soaked outside part course substances and the related disappointment components of the asphalt construction, the lab testing gear was produced involving Marshall constancy and run, mass thickness, roundabout elasticity, compressive quality, affectability to temperature, flexible modulus which be completed on 250 mm width compacted tests of a reused total having a most extreme molecule size of 19.5 mm. All tests were performed on both unsaturated and saturated samples (Hanter, 2002).

Comparative analyses were demonstrated in order to assess the response of varying saturated periods with different conditioned mixtures by using the results from the utilizing test methods.

Materials and Methodology

Recycled aggregates employed in this research were provided by collecting concrete and flexible pavement from the construction and highways debris of Al-Najaf city, transferring them to the crushing and breaking them into the size of natural aggregates. Firstly the characteristics of the aggregates were evaluated Al Najaf city which is located at south of Iraq. 5% asphalt cement has gradation of 40-50 penetration of Al-Nasiriya factory. Wax and limestone filler brought from the local market in Al-Najaf city.

Virgin aggregate is warmed to a heating degree of (175 – 190)˚C, whilst the compaction template gathering and mallet are remained pre-warmed to a heating degree of (100-145)˚C. The bitumen is warmed to a heating degree of (121-138)˚C.

In the event of making the blend utilized reused black-top asphalt RAP, the RAP is warmed before blending with virgin aggregate and new black-top cement, in extraordinary stove at 120˚C for an hour and the aggregate blend then be put in blending dish and blend quickly until the virgin totals are completely covered to be then put in the standard template and compacted at the device of Marshall compactor.

The prepared samples are divided into two groups, the first group was submerged in water at 25˚C while the other samples were submerged in water at 40˚C. Both of grouped were subjected to different days (3, 7, 15, 28) to present saturation condition as it was in the field without accelerated vacuum condition.

Indirect tensile strength test

As per ASTM (D 4123) (ASTM, 2003), specimens samples are set up by Marshall approach and tried for indirect elastic strength. The readied examples are made cold at the temperature of room (25 oC for 24 hours) then submerged in a shower of water at various testing heating degree (25, and 40 oC) for half hour, utilizing a stainless steel stacking strip on both the top and base of side long outside part of tried example, running parallel to the hub of the barrel shaped example that are stacked oppositely at a consistent rate of 2 in/min. (50.8 mm/min.) until a definitive stacking resistance is achieved.

Three samples for each blend mix are tried and the normal outcomes are recorded. The aberrant rigidity (IDT) is computed, as takes after (Yo et al., 2008):

\[
IDT = 2 \frac{P_{ult}}{\pi t D}
\]  

(1)
Whereas:

- $P_{\text{eff}}$ represents the final burden till reaching failure (N).
- $t$ represents the Thickness of sample (mm), and
- $D$ represents the Diameter of sample (mm).

The healing degree affectability is measured, as explained underneath:

$$ \text{IDT} = \frac{[(\text{IDT})_{t=25} - (\text{IDT})_{t=40}]}{(t_1 - t_0)} $$

Where:

- $(\text{IDT})_{t=25}$ is the Indirect tensile strength at $t_0 = 25^\circ C$
- $(\text{IDT})_{t=40}$ is the Indirect tensile strength at $t_1 = 40^\circ C$

**Ultrasonic Device**

Non-Contact Ultrasound, the overwhelming strategy for bringing wave engendering into a specimen, is done by putting the transducer onto the material along with utilizing a coupling medium such as a gel [Wong and sun, 2007]. This system is a contact mode for which the utilization in development examination or testing is exceptionally dreary. Non-contact methods of transducer situation are more viable and the strategy utilized in this examination (Dunning et al., 2004).

The Ultrasonic pulse velocity method had been employed for the purpose of probing the period time of travel of an ultrasonic pulse going via the checked samples. Two modes of wave travel were detected, compression or longitudinal wave and plate wave. The latter is a type of surface waves; when a surface wave is launched on a plate and if the thickness of the plate is reduced until it approaches the wave length or if the wave length is increased (Shen, 2005).

**Results and Discussion**

The results of stability recorded unaffected for merging into water for each modified mixture is while the mixture with recycled asphalt has made improvement in resistance to water as shown in Figure (1).

In Figure (2) the best results appeared when the mixture of recycled asphalt, followed by recycled concrete mix that showing improved tensile strength in spite of their sensitivity duration imposed to water compared to the virgin mixture and this modified with wax.

So the results of Marshall flow and Marshall stiffness have been no variation values, but there were generally realized US Specification which demonstrated in Figures (3) and (4), respectively.

Figure (5) demonstrated another steady case obvious in sensitivity to temperature for mixtures have recycled asphalt and concrete compared with the both of virgin and this which modified with wax.

The period of merging has a significant effect on the surface layer strength at all mixtures, else high resistance to moisture in the mixture with recycled concrete followed by these modified with wax, either in respect to the mixture of reused asphalt is still good resistance to limit 4 days which obvious in Figure (6).
Figure (1) Marshall stability test

Figure (2) Indirect tensile strength test

Figure (3) Marshall Flow test
Figure (4) Marshall Stiffness test

Figure (5) Temperature sensitivity test

Figure (6) Ultrasonic test

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