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

Ahlam K. Razzaq Nibras Ali Hussain Asaad Mohammed Baqer
Lecturer in Civil Eng .Dept. , College of Engineering , University of Kufa
Ahlam.alzerjawi@uokufa.edu.iq Nibrasa.alsahhaf@uokufa.edu.iq asaad.algharrawi@uokufa.edu.iq

Abstract

As being exposed to water that 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^{o} 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 .

الخلاصة :

تصنع الخلطات الاسفلتية الحارة HMA من مواد معينة ذات حساسية لوجود المياه في التبليط الاسفلتي الذي يمنع العجينة من الالتصاق بالركام . ولكون العجينة هي الغراء الذي تمسك الخلطة مع بعضها ، لذا فان الفشل الانشائي المتوقع بالتبليط سيكون سريع من جراء ضعف الالتصاق بين العجينة والركام او ما يسمى بالانفصال stripping الذي يوجب استخدام مضافات معينة لتجنبه ك الجير المطفأ او أي مواد كيمياوية مضادة للانفصال anti-stripping.

وعليه اجريت هذه الدراسة لفحص وقياس مقاومة انواع مختلفة من الخلطات الاسفلتية ذات ركام معاد تدويره عند تعريضها لفترات تشبع بالرطوبة بالإضافة الى فحص مغزى استخدام المضادات للانفصال كمضافات .

تم في هذا البحث تعريض ثلاثة انواع من الخلطات الاسفلتية ، واحدة 60% من ركامها معاد من خلطة اسفلتية واخرى 60% من ركامها معاد من خلطة خرسانية والخلطة الثالثة مستخدمة الشمع كمضاف وبنسبة 10% من وزن الاسفلت ، للتغريق بالماء بمدد مختلفة تمثلت ب(3، 7، 15، 28) يوم ، كما اجريت فحوصات مختبرية متعددة عليها ومقارنة النتائج مع خلطة اسفلتية قياسية عرضت لنفس الظروف .

تم اجراء(فحص مارشال للثبات والزحف)، الكثافة ، مقاومة الشد الغير مباشرة ، مقاومة الانضغاط ، فحص التحسس للحرارة ، فحص قوة المرونة .

كان التحري موفقا حيث اعطى نتائج قيمة تبين تحسن الخلطة الاسفلتية في مقاومتها للرطوبة عند استخدام ركام معاد من خلطات سابقة واثبات دور الشمع الفعال في زيادة تللك المقاومة وتحسين خواص الخلطة الاسفلتية.

الكلمات المفتاحية: الخلطة الاسفلتية الحارة، ثبات مارشال، التشبع، الانفصال.

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 the

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 a 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 ˚C) 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):

$$IDT = 2\,P_{ult} / \pi\, t\, D \quad \text{.....} \quad (1)$$

Whereas:

P_{ult} represents the final burden till reaching failure (N).

t represents the Thickness of sample (mm), and

D represents the Diameter of sample (mm).

The heating degree affectability is measured, as explained underneath:

$$IDT = [(IDT)_{to} - (IDT)_{tl}] / (t_1 - t_o) \quad (2)$$

Where:

$(IDT)_{to}$ is the Indirect tensile strength at t_o (°C), $t_0 = 25°C$

$(IDT)_{tl}$ is the Indirect tensile strength at t_1 (°C), $t_1 = 40$ °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)

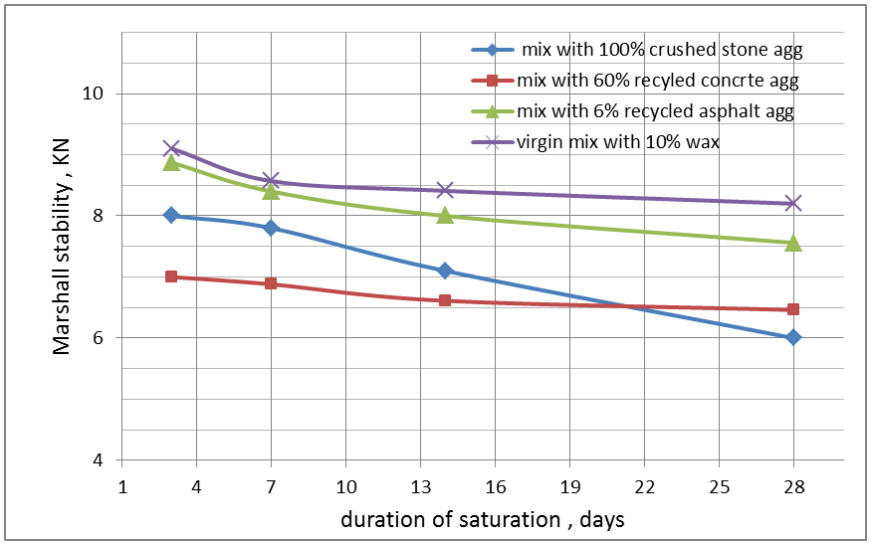

Figure (1) Marshall stability test

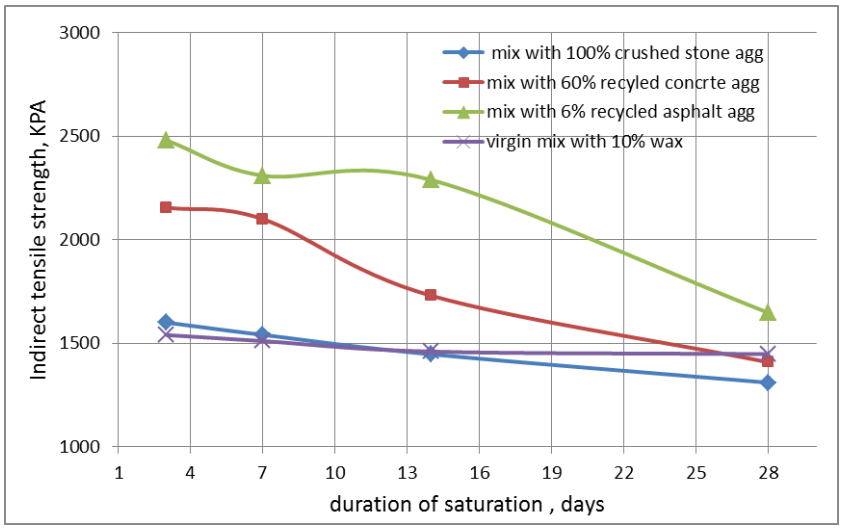

Figure (2) Indirect tensile strength test

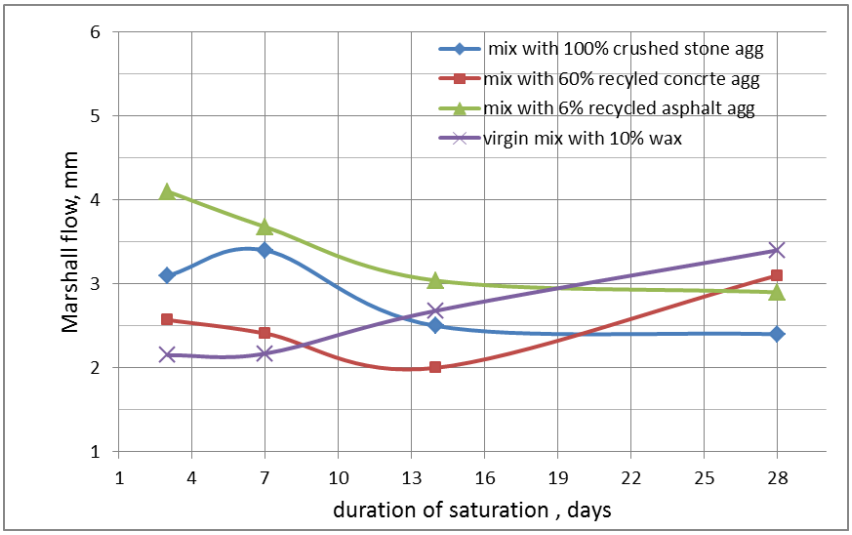

Figure (3) Marshall Flow test

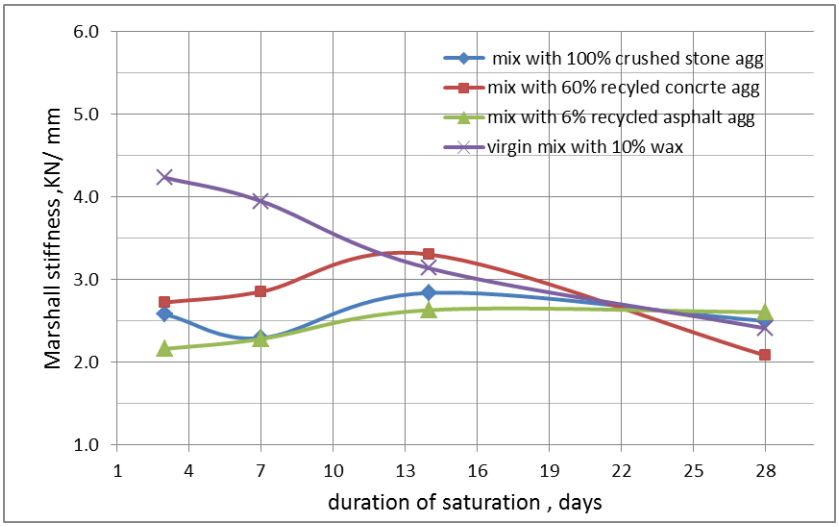

Figure (4) Marshall Stiffness test

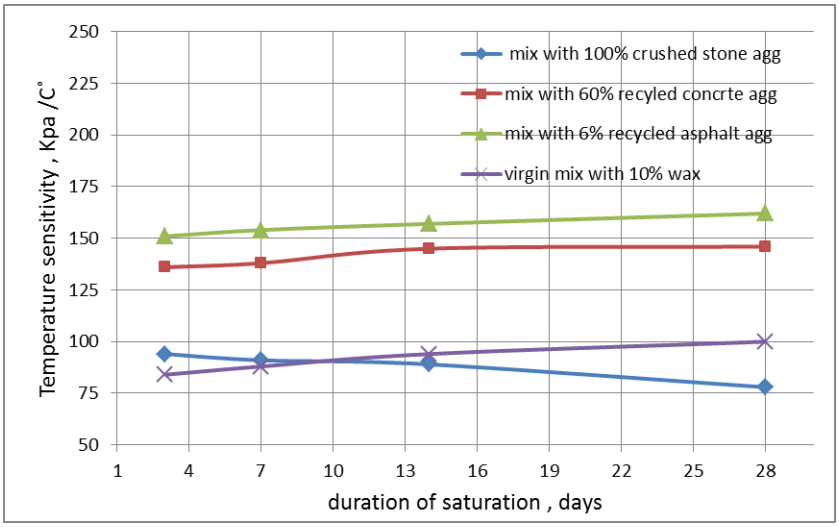

Figure (5) Temperature sensitivity test

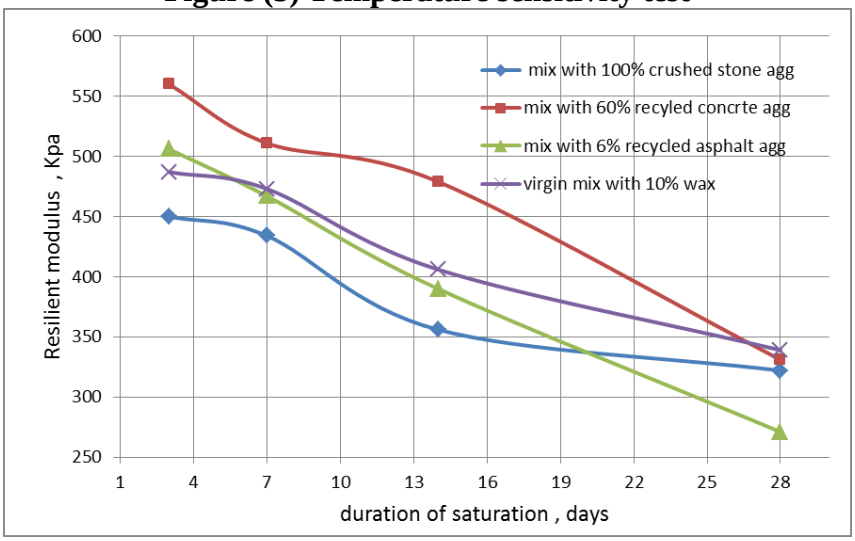

Figure (6) Ultrasonic test

References

Choubane B., G. Page, and J. Musselman, 2001 :" **Effects of Water Saturation Level on Resistance of Compacted Hot-Mix Asphalt Samples To Moisture-**

Induced Damage", Transportation Research Record 1723, National Research Council, TRB, Washington, D.C., pp. 97-106.

Di Benedetto H, Olard F, Sauzeat C, Delaporte B. , Des 2004 , Linear viscoelastic behavior of bituminous materials: from binders to mixes. Int J Road Mater Pave;5(special issue):163–202 [European Asphalt Technology Association, Nottingham].

Dunning M. ,M. Karakouzian, R. Vun and M. Bhardwaj ,2004 : "**Non-Contact Ultrasonic Characterization of Hot Mix Asphalt (HMA)**", Las Vegas, Nevada, University of Nevada, The Ultran Group, Inc. Boalsburg, Pennsylvania, Unites States.

Epps J. A., P. E. Sebaaly, J. Penaranda, M. R. Maher, M. B. McCann, and A. J. Hand 2000 :" **Compatibility of a Test for Moisture-Induced Damage with Superpave Volumetric Mix Design**", Transportation Research Board, NCHRP Report 444, TRB, Washington D.C.

Gibbs A.G., 1998 :" **Water-proofing properties of cuticular hydrocarbons**", Amer Zool, vol. 38, pp. 471-482.

Hall K. D. ,and S. G. Williams, 2000 :" **Effects of Specimen Configuration and Compaction Method on Rutting and Stripping Behavior in Asphalt Concrete Wheel-Tracking Tests",** Presented at the 7th , Annual Meeting of the Transportation Research Board , TRB, Washington, D.C. January.

Hunter E. R. and K. Ksaibati, 2002 :" **Evaluating Moisture Susceptibility of Asphalt Mixes**", Department of Civil and Architectural Engineering, University of Wyoming, Laramie, Wyoming, November.

Mahmoud AFF , 2004, Bahia H. Using the gyratory compactor to measure the mechanical stability of asphalt mixtures. Wisconsin Highway Research Program. WHRP 05-02 (0092-01-02);.

Mills-Beale J, You Z, Williams RC, Dai Q., 2009 , Determining the specific gravities of coarse aggregates utilizing vacuum saturation approach. Construct Build Mater;23(3):1316–22.

Mills-Beale J, You Z. Measuring the specific gravity and absorption of steel slag and crushed concrete coarse aggregates: a preliminary study. In: Proceedings of the ASCE airfield and highway pavements conference held in Bellevue,

Olard F, Di Benedetto H. General 2S2P1D model and relation between the linear viscoelastic behaviors of bituminous binders and mixes. Int J Road Mater Pave Des 2003;4(2):185–224.

Paranavithana S, Mohajerani A., 2006 , Effects of recycled concrete aggregates on properties of asphalt concrete. Resour Conserv Recycl;48(009):1–12.

Saed A. , 2008 , Performance-related tests of recycled concrete aggregates for use in unbound pavement layers. NCHRP Report 598. Transportation Research Board of the National Academies;. p. 1–53.

Shen D-H, Du J-C. 2005 , Application of gray relational analysis to evaluate HMA with reclaimed building materials. J Mater Civ Eng;17(4):400 – 6.

Washington , 2008, October 15–18. American Society of Civil Engineers;.p. 111–21. ISBN 13 No. 9780784410059.

Wong YD, Sun DD, Lai D., 2007 , Value-added utilization of recycled concrete in hot-mix asphalt. Waste Manage;27:294–301.

You Z, Mills-Beale J, Williams RC, Dai Q. , 2009 , Measuring the specific gravities of fine aggregates in Michigan: an automated procedure. Int J Pave Res Technol;2(1):1996–6814. ISSN.

You Z, Mills-Beale J, Williams RC, Dai Q., 2008, Investigation of a new test procedure for measuring the specific gravities of fine aggregates in Michigan. In: Proceedings of 2008 annual transportation research board meeting (DVD).Washington, DC: National Research Council, National Academy of Sciences;2008. January 13–17.