EVALUATION OF HOT MIX ASPHALT (HMA) PROPERTIES COMPACTED AT VARIOUS TEMPERATURES

LARRY AK SILAS TIRAU

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Faculty of Civil Engineering
Universiti Teknologi Malaysia

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My beloved family.....mother and father.....brother and sister

May god bless be upon them, and last but not least, Irene Gabriel

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ABSTRACT

Hot mix asphalt (HMA) mixture compacted at various temperature has always been a concern to researcher. Compaction below the standard compaction temperature may bring reverse effect on HMA properties. Moisture damage of HMA with low temperature referred as striping and this problem become prevalent in recent years. This project is to determine the Marshall properties of compacted mix and moisture susceptibility of mix. In this study asphaltic concrete of wearing course with 14mm nominal maximum aggregate size (ACW14) and 20mm (ACW20) were used and test involved were Marshall Test and AASHTO T283 for moisture susceptibility. Samples were compacted at various temperature namely 85ºC, 100ºC, 115ºC, 130ºC, 145ºC, and 160ºC. Result shown that most samples have low density, low flow value and very stiff when compacted at lower temperature. Tensile strength ratio (TSR) for mixes compacted above 115ºC is more than 80% and this shown that mix still stable at minimum temperature of 115ºC for ACW14. ACW20 has TSR more than 80% when compacted at 130ºC and above. This suggests that as mixes get coarser the minimum compaction should be higher. For Marshall Stability, the result indicates that as the compaction temperature increases, the stability increase. However for compaction temperature above 145ºC, the stability slightly drops. This could indicates that 145ºC is the optimum compaction temperature.

ABSTRAK

Konkrit asfal campuran panas dipadatkan pada suhu yang sesuai untuk menghasilkan turapan jalan yang berkualiti. Pemadatan pada suhu dibawah spesifikasi akan memberi kesan negatif terhadap parameter campuran. Masalah ancaman kelembapan terhadap asfal campuran panas banyak dikaji oleh pakar jalan raya dan jurutera. Masalah kelembapan juga menyebabkan masalah lain akan timbul seperti penjujuhan dan keretakan. Projek ini dijalankan untuk mengkaji parameter Marshall bagi asfal campuran panas yang dipadatkan pada suhu tertentu. Dua jenis bancuhan digunakan iaitu lapisan asfal haus dengan saiz nominal aggregat 14mm (ACW14) dan 20mm (ACW20). Antara ujian makmal yang terlibat ialah seperti ujian Marshall dan ujian AASHTO T283. Sampel ACW14 dan ACW20 akan dipadatkan pada suhu 85ºC, 100ºC, 115ºC, 130ºC, 145ºC, dan 160ºC. Keputusan ujikaji menunjukkan bahawa campuran akan berketumpatan rendah, mempunyai nilai aliran rendah, dan agak keras apabila dipadatkan pada suhu yang rendah. Nilai nisbah tegasan (TSR) bagi sampel ACW14 adalah melebihi 80% apabila ia dipadatkan pada suhu 115ºC, manakala sampel ACW20 memerlukan suhu setinggi 130ºC untuk mencapai 80% nilai nisbah tegasan. Kajian ini juga menunjukkan bahawa semakin kasar aggregat yang digunakan, semakin tinggi suhu pemadatan yang diperlukan. Nilai kestabilan Marshall akan meningkat seiring dengan peningkatan suhu pemadatan bancuhan. Terdapat penurunan nilai nisbah tegasan bagi kedua-dua sampel apabila suhu pemadatan melepasi 145ºC. Ini menunjukkan bahawa 145 ºC adalah suhu pemadatan optimum bagi kedua-dua sampel.

LIST OF CONTENT

CHAPTER 2 LITERATURE REVIEW **PAGE**

CHAPTER 3 RESEARCH METHODOLOGY **PAGE**

CHAPTER 3 RESEARCH METHODLOGY **PAGE**

CHAPTER 4 RESULT AND ANALYSIS

LIST OF TABLES

LIST OF FIGURES

LIST OF GRAPHS

LIST OF SYMBOLS

ºC	-	Celsius
ºF		Fahrenheit
%	-	percent
µ	-	micron
mm	-	milimeter
m	-	meter
G*mb*	-	bulk specific gravity
G*ma*	-	apparent specific gravity
V*a*	-	air void
P*be*	-	effective asphalt
Π	-	pi
P	-	maximum load
t	-	thickness
kg	-	kilogram
g	-	gram
cc	-	cubic centimeter
in	-	inches
kpa	-	kilopascal
N	-	newton

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background study

Hot mix asphalt (HMA) is one type of premix widely used in road construction worldwide. It is considered by many highway engineers as premier paving product available anywhere at any cost and the most popular as paving material with high skid resistance, high comfort ability and low maintenance cost. HMA paving consist of a combination of aggregate uniformly mixed and coated with asphalt cement. Term of “hot mix” comes from aggregate and asphalt cement dried and heated for proper mixing and workability and mix together with desired temperature.

The aggregate and asphalt will be combined in an asphalt mixing plant in which it will be proportioned, heated, and mixed to produce the desired paving mixture. After the plant mixing is complete, the mix will be transported to site and spread with paving machine in loosely compacted layer to uniform , smooth surface. Then the mix will be compacted by heavy roller to produce smooth and well consolidated course.

Compaction is one of major issue in HMA and important criteria in process to produce good quality of hot mix asphalt. Temperature controls asphalt cement viscosity which affect its ability to coat and provide adequate lubrication for aggregates and slides with each other and pack into dense mass during compaction.

The effects of compaction temperature can be subdivided with respect to density and engineering properties. In procedure of pavement construction the compaction is done when temperature reach 110ºC (refer to JKR specification) and in laboratory HMA normally compacted when temperature reach 145 ºC.

However, there is a trend nowadays to operate asphalt plant at lower mixing temperature. Mixing at lower temperature result primarily for one major reason to conserve energy required producing the mixture. Lower mixing temperature means lower operating cost. These lower temperatures commonly result of the introduction of drum mixer that requires less energy for the production of asphalt mixtures.

At site the lower compaction temperature caused by transportation of mix, weather and other factor that cannot be minimized. Many studies have been conducted abroad but it covers small range of temperature and it cannot be related to Malaysia.

Besides compaction, the other major concern is the moisture especially water presence in the mix that may cause tremendous problem to the asphalt performance. The moisture damage will reduce the adhesion between aggregate and asphalt cement. This problem called stripping and normally it cause the HMA to have another deterioration problem such as raveling, rutting and segregation.

There are many type of test to determine the moisture susceptibility of HMA. It can be divided into two groups namely test on compacted and test on loose

mixture. The modified Loftman was among the most reliable test used by many researchers in process of predicting the moisture damage of compacted mix.

The other important criterion of hot mix asphalt is design methodology. The early design of asphalt mixture was performed without any sense related to performance such as strength and durability. Things change as the revolutions of effort to improve performance by developing new principles and concept with careful attention to material and function in the mixture.

This study has its major contribution to the problem related to the various compaction temperatures in the field and presence of moisture in mix. So from this study, relevant countermeasures to the problem arise from HMA compacted at different temperature can be made.

1.2 Objective of the study

The purpose of this study is to determine the Marshall properties of HMA compacted at various compacting temperature. This study also focuses on moisture susceptibility in term of moisture damage to the HMA when it is subjected to the presence.

1.3 Scope of the study.

The HMA used in this study were asphalt concrete wearing course with nominal maximum size of aggregate is 14mm (ACW14) and ACW 20. Hot mix asphalt was compacted at varied temperature to determine its effect on stability and durability. Samples were compacted using 75 blow/face and design by using Marshall Design mix. Samples were analyzed in terms of density, flow, stiffness, VMA (Void in mineral), VFA (void filled with Asphalt) and stability.

Besides that this study also aims at predicting the durability of the mixes. This can be determined by finding the indirect tensile strength of compacted samples at different conditions. This test is accordance with AASHTO T283 (Resistance of compacted asphalt mixtures to moisture- induced damage). All testing were conducted at Makmal Pengangkutan, Universiti Teknologi Malaysia, Skudai, Johor.

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