PERMEABILITY IN MALAYSIAN HOT MIX ASPHALT MIXTURES

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ABSTRACT

Many studies have shown that the air void content affect the permeability of the hot mix asphalt (HMA) mixtures. This study aims to evaluate the characteristic of local HMA mixtures and find a relationship between air void and permeability, and then obtain in-situ minimum density level in order to produce impermeable pavements. Eight types of HMA mixes were produced; ACW14, ACW20, BMW14, BMW20, ACB28, BMB28, BMR28 and BML10. Ten samples for each mix with different compactive efforts; 75, 60, 50, 40 and 30 were prepared. The permeability test was conducted to get the coefficient of permeability. From the test conducted the permeability versus air void content graphs were plotted. The relationship between permeability and air void content is directly related. As the air void content increased the permeability also increased. Therefore, it is suggested that the maximum in-place air void contents for wearing course, ACW14 and ACW20 are 6.4 and 4.2% or 98 and 100% of Marshall density design at 4% air void respectively while the air void contents for wearing course, BMW14 and BMW20 are 5.4 and 6.0% or 99 and 98% of Marshall density. For binder course, ACB28 and BMB28, 6.4 and 6.1% air void contents or 98% of Marshall density are recommended. For levelling, BML10 and bituminous roadbase, BMR28 course, 12.9 and 7.2% air void content or 91 and 97% of Marshall density are proposed respectively.

ABSTRAK

Banyak kajian menunjukkan kandungan lompang mempengaruhi kebolehtelapan sesuatu campuran panas asfal. Kajian ini bertujuan menilai ciri-ciri kebolehtelapan campuran panas asfal dan mendapatkan hubungan antara kandungan lompang dan kebolehtelapan seterusnya mendapatkan nilai tahap ketumpatan minimum in-situ bagi menghasilkan turapan yang tidak telap. Lapan jenis campuran panas disediakan; ACW14, ACW20, BMW14, BMW20, ACB28, BMB28, BMR28 dan BML10. Sepuluh sampel bagi setiap campuran panas dengan usaha pemadatan yang berbeza; 75, 60, 50, 40 and 30 disediakan. Ujian kebolehtelapan dijalankan untuk memperolehi pekali kebolehtelapan turapan. Daripada kajian yang dijalankan graf kebolehtelapan melawan kandungan lompang diplot. Hubungan antara kebolehtelapan dan kandungan lompang adalah berkadar terus. Apabila kandungan lompang meningkat, nilai kebolehtelapan juga turut meningkat. Oleh itu, adalah dicadangkan kandungan lompang bagi lapisan haus, ACW14 dan ACW20 masing-masing adalah 6.4 dan 4.2% atau 98 dan 100% daripada ketumpatan Marshall yang direkabentuk pada 4% kandungan lompang, manakala bagi lapisan haus, BMW14 dan BMW20 pula masing-masing adalah 5.4 dan 6.0% atau 99 dan 98% daripada ketumpatan Marshall. Bagi lapisan pengikat, ACB28 dan BMB28 pula, kandungan lompang yang dicadangkan adalah 6.4 dan 6.1% atau 98% daripada ketumpatan Marshall. Manakala bagi lapisan pelaras, BML10 dan tapak jalan berbitumen, BMR28 adalah 12.9 dan 7.2% kandungan lompang atau 91 dan 97% daripada ketumpatan Marshall dicadangkan.

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LIST OF ABBREVIATIONS

ACB28	Asphaltic Concrete Binder Course with Nominal Maximum Aggregate Size of 28mm
ACW14	Asphaltic Concrete Wearing Course with Nominal Maximum Aggregate Size of 14mm
ACW20	Asphaltic Concrete Wearing Course with Nominal Maximum Aggregate Size of 20mm
BMB28	Bituminous Macadam Binder Course with Nominal Maximum Aggregate of Size 28mm
BML10	Bituminous Macadam Leveling Course with Nominal Maximum Aggregate of Size 28mm
BMR28	Bituminous Macadam Roadbase with Nominal Maximum Aggregate Size of 28mm, BMR28
BMW14	Bituminous Macadam Wearing Course with Nominal Maximum Aggregate Size of 14mm
BMW20	Bituminous Macadam Wearing Course with Nominal Maximum Aggregate Size of 20mm
HMA	Hot Mix Asphalt
NAPA	National Asphalt Pavement Association
VFA	Voids Filled with Asphalt Cement
VMA	Voids in Mineral Aggregate
VTM	Voids in Total Mix

CHAPTER I

INTRODUCTION

1.1 Preamble

The strength and durability of road pavement depends on several factor such as the strength of subgrade, the repeated loading applied from traffic, and the design itself. The amount of voids in a Hot Mix Asphalt (HMA) mixture is probably the single most important factor that affects performance of the mixture throughout the life of the pavement (Roberts *et al.*, 1996). Peterson (1982) stated that the desired air void content for initial in-place voids for dense graded mixtures should not be higher than approximately 8% and should never less than approximately 3% during the life of the pavement.

High air void contents allow water and air to penetrate into the structure resulting in water damage, oxidation, raveling and cracking. Meanwhile low air void contents lead to rutting and shoving of asphalt mixtures. One of the variables that affected by the air void content is permeability. The higher the air voids the higher the permeability, and vice-versa.

1.2 Problem Statement

High in-place air voids have been identified as the cause of cracking and stripping problems of hot mix asphalts (HMA) pavements. It was caused by inadequate compaction which permits the entrance of water and air into the permeable HMA pavement (Kumar and Goetz, 1977). For fine dense graded mixes, pavements with air void contents more than 8% are generally prone to permeability problem (Brown, 1990) and for coarse dense graded mixes air void contents more than 6% could result in permeable pavements (Cooley, Prowell and Brown, 2002).

To date, there has been a limited research conducted to investigate the permeability characteristics of our HMA dense graded mixes. Thus, there is a need to conduct an experiment to evaluate the permeability characteristics and determine the desirable density levels for impermeable pavement.

1.3 Objectives of the Study

This study is conducted to achieve several objectives. The objectives of this study are to:

i. evaluate permeability characteristics of local HMA mixtures;
ii. establish relationships between air void and permeability of local HMA mixtures; and
iii. obtain better minimum in-situ density levels in order to achieve impermeable pavements.

1.4 Scope of the Study

HMA mixtures will be compacted in the laboratory to the in-situ density levels for each mix type as stipulated in the JKR specifications. Laboratory permeability test will be performed on each sample from each mix type. These include ACW14, ACW20, BMW14, BMW20, ACB28, BMB28, BMR28, and BML10. If the samples are found to be permeable, the compactive effort will be increased until the desired density level is achieved. The entire test will be conducted at Makmal Pengangkutan, UTM Skudai.

1.5 Significant of Study

From the result of the study, the relationship between air void and permeability will be established. Then, the maximum air void content will be determined from the relationship according to the suitable permeability values. If the new air void content was found to affect the density levels of the pavement provided in JKR/SPJ/1988 (JKR, 1988), it is propose that the permeability factors should be taken into consideration in designing the road pavement. The density level of the road pavement can be determined by the maximum value of air void content obtained from this study.

From this study, the problem such as rutting, stripping, raveling and cracking will be prevented as result from better design with optimum air void contents. The problem caused by permeability will be reduced thus providing more durable and stronger pavement.

1.6 Summary

This chapter overview the background HMA problem as related to permeability. Next chapter will discuss the background of the HMA materials, mixture design, construction and their properties focuses on permeability in detail.

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