

THE DETERMINATION OF THE TEXTURE DEPTH, SKIDDING
RESISTANCE AND ROUGHNESS INDEX OF VARIOUS
BITUMINOUS ROAD SURFACES.

BY

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This Project Report Submitted in Partial Fulfillment of the requirement for the
Award of the Degree of Master of Engineering (Civil – Transportation and Highway)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

MAY 2008

This Work is dedicated to my Late father Ambassador Suleiman Yero and my Late mother Hajia Fatima BabaGana.

ACKNOWLEDGEMENT

In the name of the most Gracious and Compassionate I will like to express my appreciation for the support and assistance I received throughout the research process from my able supervisors, Prof. Madya Dr. Rosli Mohammad Hainin and Dr.Haryati Yacoob. I wish to thank Prof. Madya Dr. Aziz Chik, Prof. Madya AbdulAziz Mufti and Che Ros Ismail for providing constructive opinions and critics in the process. My great appreciation also goes to the Highway Laboratory Technicians for their patience and guidance in the process, especially Suhaimi and Permad. Thanks to many friends and colleagues, such as Wardati, Azeerana, Esarwi, Bany, Tiong and Ricky. Besides the Undergraduate team in the research like Zamani, Romi, Bakhtia, Eja and Ummi. I appreciate my Wifes Jamila efforts and our kids Patience and moral support despite my absence.

ABSTRAK

Penentuan rintangan gelinciran sesuatu permukaan turapan berbitumen adalah bergantung kepada kedalaman tekstur permukaan jalan tersebut. Kedalaman tekstur adalah ukuran makrotekstur permukaan turapan iaitu komponen kasar bagi permukaan aggregate dan ditentukan melalui ujian *Sand Patch* (SPT). Manakala mikrotekstur, iaitu ukuran bagi celah aggregate yang berfungsi sebagai rintangan terhadap kesan pelicinan (PSV) oleh aggregate, ditentukan melalui ujian *British Pendulum* (PTV). Tahap kekasaran sesuatu permukaan jalan adalah faktor penentu kelancaran permukaan jalan tersebut dan ia ditentukan dengan menggunakan alat *Walking Profilometer*. Kajian ini telah dilaksanakan di Jalan Tebrau, Jalan Pontian dan Batu Pahat. Sebanyak 180 titik ujian dipilih untuk ketiga-tiga ujian tersebut. Kajian ini dilaksanakan dengan objektif untuk menentukan nilai minimum rintangan gelinciran, kedalaman tekstur dan indeks kekasaran terhadap pelbagai jenis permukaan jalan berbitumen serta mendapatkan korelasi antara setiap ujian. Keputusan yang didapati daripada ujian menunjukkan korelasi yang sederhana di antara nilai kedalaman tekstur dan indeks kekasaran sesuatu permukaan jalan. Namun begitu keputusan yang didapati masih memberikan aliran umum iaitu semakin tinggi kedalaman tekstur (TD), semakin tinggi nilai indeks kekasaran (IRI) dan nilai rintangan gelinciran (SR), kecuali pada jenis turapan ACW 14 yang baru di mana semakin tinggi nilai SR, semakin rendah nilai IRI kerana nilai SR bergantung pada mikrotekstur.

ABSTRACT

The determination of the skidding resistance of a bituminous pavement surface depends on the texture depth of the road surface. The texture depth is a measure of the macrotexture of the pavement surface, which is the coarse component of the surface aggregate and determined by sand patch test (SPT). While the microtexture, which is the measure of the aggregate interstices referred to as the resistance to polishing (PSV) of the aggregate, is determined by the British pendulum test (PTV). The roughness of the road surface is a determining factor for the smoothness of the road surface, and was determined by using the walking profilometer. The study was conducted on jalan Tebrau, jalan Pontian and Batu pahad, 180 test points were investigated for the three tests. This study is aimed at determining the minimum skidding resistance, texture depth, and roughness index of various bituminous road surfaces, and their correlation. The results obtained from the study show a fair correlation between the texture depth and the roughness index of the chipseal road surfaces. But the general trend is that the higher the texture depth (TD), the higher the roughness index (IRI) and the skid resistance (SR), except with the new ACW 14 where at high SR the IRI is low, as the SR depends on the microtexture.

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LIST OF SYMBOLS

h - Height of measuring Cylinder

D - Diameter of Sand Patch

π - Pie

v - Volume of Sand

V - Test values

IRI - International Roughness Index

MTD – Mean Texture Depth

PTV – Pendulum Test Value

SR - Skid Resistance

CHAPTER I

INTRODUCTION

1.1 Background

A lot of research work has been conducted with the aim of investigating, and establishing the mean texture depth, skid resistance, the roughness index of various asphalt surfaces and their correlation. The surface texture depth is an important factor used to determine the resistance of skidding of a road surface. The surface texture depth is a measure of the macrotexture of a bituminous pavement surface. The assessment of the skid resistance and macrotexture of various types of bituminous road surface became of utmost importance as it relates to the safety of the road.

The roughness index is a function of the smoothness of the pavement, comfort and its safety to the road user. The surface texture depth as a measure of the macrotexture of the road surface and skid resistance, are often mentioned as possible contributory factors towards the incidences of road accidents. The macrotexture is the coarse component of texture due to the shape of aggregate particle on road surface, and it is a determining factor for skid resistance on bituminous road surface. It is pertinent to note that in bituminous surface is characterized by the resistance to polishing (PSV) of the aggregates or microtexture. The measurement of the macrotexture is most commonly estimated by

the use of the sand patch tester. The skidding resistance is a measure of the friction generated between a pavement surface and vehicle tire.

Skidding occurs when the available friction is insufficient to counter the forces imposed by a moving vehicle. The available friction depends upon the microtexture and macrotexture of the road surface, the properties of the tire, vehicle speed and weather conditions. In U.K good aggregate with resistance to polishing and polish stone value PSV of 55 or more are used on road surface (Hunter, 2000).

Although research on texture depth and its relationship to skidding resistance on a bituminous road surface, had being a case of study to researchers on the safety of road. Various Research work had been conducted on the Safety of bituminous pavement surfaces, and very few countries like U.S.A, Australia and U.K are able to come up with mean texture depth, skid resistance and roughness index for different wearing courses.

However, in Malaysia some research work has been conducted by the jabatan kerja raya (JKR) and the Transport and Road Research Laboratory (TRRL) of the United Kingdom in 1992, to assess the skid resistance and macrotexture of aged bituminous road surfacings in Malaysia, of between 6-24 months of age in use. In the study conducted by JKR of Malaysia and the TRRL of the United Kingdom 81 road surfaces in Malaysia were investigated and an average skid resistance value, texture depth for Asphaltic concrete wearing (ACW), dense bitumen macadam (DBM), and surface dressed roads (SD) was obtained. The Study recommended a minimum texture depth of 0.33mm-0.39mm, for ACW, 0.55mm for DBM, and 1.5mm-1.9mm for SD surfaces respectively. The study also recommended a PSV of 55 standardized to 58, because of temperature variance (Kwang H.J, Emby J, and Morosiuk G, 1992).

The JKR in Malaysia had adopted International roughness index (IRI) of 1.6m/km for four lane highways, 2.5m/km for two way highways and 8m/km for minor roads (Design of flexible pavements, JKR). The measurements of the Roughness Index (IRI) for a completed pavement surface to be measured in terms of its lane IRI, using the Australian Road Research Board (ARRB) walking profiler (WP).The road surface often

used by motorist has some frictional properties that is relatively associated with performance, of the road and its safety to the road user. They include microtexture and macrotexture depths which are often mentioned as contributory factors to road accident. The microtexture is the interstices of the aggregate that is characterized by the resistance to polishing, while macrotexture is the coarse component of the texture due to the aggregate particle on the road surface.

The study on texture depth and its relationship to skidding resistance and occurrence of accident on bituminous road surfaces has been a course of study upto date, as it is yet to be clearly understood. That is why this study was initiated to investigate the condition of some various bituminous road surfaces in Johor Bahru and determine the mean texture depth, skid resistance, the roughness index and there relationship, which is to be compared with the JKR , TRRL , and the Australian road research board (ARRB) standards.

As the road system of transportation becomes the leading means of transporting people, goods and services in Malaysia. There has been considerable publicity on the safety of these roads as there is significant increase in the occurrence of road accidents. In Malaysia there has been an increase in the rate of accident occurrence, with an accident record of 215,632 in 1997 to 363,314 in 2007. (Miros, 2007).

In view of this predicament the Government of Malaysia finance a series of research in 1992 and 1996. A joint investigation by JKR and TRRL of the U.K carried out a comprehensive assessment on the skid resistance, texture depth, the microtexture and macrotexture of bituminous surfaces in Malaysia (Morosiuk G, Emby, and Kwang H.J 1992).

Also in 1996 another study was also conducted to adopt alternative surfacing that would provide a better skid resistance to roads in Malaysia (Suffian Z, Smith H R, and Ford W G). There is a serious reason for the concern by the Government, as in 1990 the Total accident recorded for the whole year was 87,999 (Liew T.H, 2002). This record

shows an increase in road accident by over 400% by the year 2007 compared to the previous records in 1990, this necessitates prompt action by the Malaysian authority. The Government had continued to take steps aimed at reducing the incidences of accidents, on roads in Malaysia. This includes road maintenance, the use of Caution sign, and accident campaigns.

Generally the road pavement structure is classified into the sub-grade, sub- base, road base and the surfacing which consist of binding course and wearing course. The wearing course is the exposed topmost layer that provides the travel path, skid resistance, safety and comfort to the road user. In view of this the study investigated specifically the pavement surface frictional characteristics, skid resistance, texture depth and the International roughness index of these categories of bitumen pavements, ACW14, ACW20, SMA14 and surface dressed surfaces.

This study determined the correlation between the texture depth, skid resistance and the International roughness index of various bituminous pavement surfaces in Malaysia. It is expected that good roads should provide an economical, convenient, comfortable and safe path for the road user. The road surface been the top or exposed layer of the road structure also has a function of providing skid resistance and safety to the road user. In view of this the study investigated the road surface characteristics of the various bituminous pavements.

1.2 Problem statement

Road accident can be caused by the poor condition of the road surface, weather condition, vehicle speed and even the driver's behavior. Normally as a result of the polishing of the aggregate in the road surface due to vehicular traffic, and subsequent reduction in surface friction can lead to the occurrence of road accidents. Determining the correlation between the SR, TD, and IRI became of utmost importance. Skidding

continues to be a factor in the tendency for accident to take place, more especially when the road surface is wet.

While the roughness of the road surface also continues to be a problem faced by road users in developing countries, as it is the function of the smoothness of the road surface, and in turn its convenience to the road user. Skidding leading to road accident tends to happen, when the interface friction developed between the tires of the moving vehicle and the surface of the road becomes insufficient to counter the forces generated by the vehicle tires. It is also pertinent to note that wet surfaces are more prone to incidences of accidents on highways, as they make the road surfaces slippery with virtually no friction to resist the skidding. Also despite the numerous researches on the skidding resistance, texture depth and International roughness index, the correlation between these frictional properties of the road surface is also not clearly understood.

1.3 Objective of the study

The objective of the study is to determine the skidding resistance, texture depth, roughness index and their correlation. The study investigated three classes of bituminous pavement surfaces in Johor, these include Jalan Tebrau (SMA) in Johor, section 2 to 3 of Jalan Pontian and Jalan Utama UTM (ACW) at Skudai, Jalan Bulat and Jalan Parit yaani (Surface Dressed) at Batu Pahat.

1.4 Scope of the study

The study investigated the microtexture, macrotexture and the surface roughness of the various bituminous surface in Malaysia these include ACW20, ACW14, SMA14 and surface dressed surfaces. The study involves field survey on these pavement surfaces in Johor Bahru, Malaysia. It also involved carrying out the following tests, sand patch test to determine the macrotexture, the British pendulum test to measure the skid resistance, and

the walking profilometer to determine the roughness index of the road surface. The scope of this study also involves determining the correlation between the road surface frictional properties. The field test was carried out in accordance with the JKR, TRL and ARRB standards.

1.5 Significance of the study

This study shall provide useful data to determine the skidding resistance, texture depth, roughness index and their correlation, for the three types of bituminous pavement surfaces tested. The research shall provide the information on the condition of these roads and the characteristics of the various surfaces. These findings shall provide necessary data to enable the road regulatory organization in Malaysia such as Jabatan kerja raya (JKR) to determine skid resistance, and texture depth of the adopted SMA surfaces as they are yet to be specified. The study also determined the correlation between the texture depth, skid resistance and roughness index of the road surfaces.