

EFFECT OF AGGREGATE MOISTURE ON ADHESION OF CHIP SEAL

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**A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Civil – Transportation and Highway)**

**Faculty of Civil Engineering
Universiti Teknologi Malaysia**

JANUARY 2012

DEDICATED TO

My Parents:

Che Ajid and Rasidah.

My Sisters and Brothers:

Nur Ainihayati & Fendy, Nurul Izah & Mohamad Faizal, Nur Hakimi,
Nur Afiqah and Arbiah.

My Nieces:

Nur Farah Natasha and Zara Nur Humaira.

My Fiancee:

Dr. Wan Norashikin.

Transportation and Highway Engineering Relevant Parties.

Who always been so supportive and guide me throughout my academic
career.

ACKNOWLEDGEMENT

“In the name of God, the most gracious, the most compassionate”

First and foremost, I would like to express my grateful to Allah S.W.T. for given me good health to finish up my Masters Project.

I would like to express my utmost gratitude to my project supervisor, Dr. Haryati Binti Yaacob for her guidance, support, helpful assistance and valuable advice that enable this project to run smoothly. I am very lucky that she patiently guide me through my work.

My appreciation also goes to my family who has been so tolerant and supports me all these years. Very special thanks for their love, support and encouragement they had given to me. They were there with me throughout the course of this study.

Last but not least, I would like to express my sincerest gratitude to my friends for their helps, constant support and encouragement throughout the entire duration of this project.

ABSTRACT

Chip seal involves the application of a thin layer of bituminous binder to the pavement surface followed by the spreading and rolling into it of single sized aggregates. There are several problems when using chip seal. One of the problems is moisture content on aggregate in chip seal. This will lead to the problem of aggregate easily dislodged and can reduce the adhesion between aggregate and bitumen. The objectives of this study are to determine the percentage of moisture content on different condition of aggregate and to determine the adhesion of chip seal at different condition of moisture content on aggregate. 80/100 penetration grade bitumen is used as a binder. There were three sizes of aggregate that have been used in this study namely, 6 mm, 10 mm and 14 mm. For each aggregate size, the percentage of moisture content are determined in four conditions of aggregate which are dry aggregate, partially dry aggregate, saturated surface dry aggregate and fully wet aggregate. Then, the vialit test and pull out test are conducted to determine the adhesion between aggregate and bitumen. From moisture percentage determination test, increasing the size of aggregate will increase the percentage of moisture content of aggregate. For vialit test, the percentage of aggregate retained will decrease when increasing the percentage of moisture content on aggregate. For pull out test, the average of maximum load increases when the percentage of moisture content of aggregate decreases.

Keywords: *Chip seal, adhesion, moisture content, vialit test, pull out test.*

ABSTRAK

Dandanan permukaan terdiri daripada penggunaan lapisan nipis berbitumen pengikat ke permukaan turapan jalan diikuti dengan penyemburan dan pemadatan ke atas agregat bersaiz tunggal. Terdapat beberapa masalah yang timbul apabila menggunakan dandanan permukaan. Salah satu masalahnya ialah kandungan lembapan yang terdapat pada agregat. Ini akan membawa kepada masalah di mana agregat akan mudah tertanggal dan boleh mengurangkan rekatan di antara agregat dan bitumen. Objektif kajian ini dijalankan adalah untuk menentukan peratusan kandungan lembapan pada keadaan agregat yang berbeza dan menentukan rekatan dandanan permukaan pada keadaan kandungan lembapan yang berbeza pada agregat. Bitumen penusukan bergred 80/100 digunakan sebagai pengikat. Terdapat tiga saiz agregat yang digunakan dalam kajian ini iaitu 6 mm, 10 mm dan 14 mm. Untuk setiap saiz agregat, peratusan kandungan lembapan ditentukan dalam empat keadaan iaitu agregat kering, agregat separa kering, agregat permukaan tepu kering dan agregat basah sepenuhnya. Kemudian, ujian vialit dan ujian tarik keluar dijalankan untuk menentukan rekatan di antara agregat dan bitumen. Daripada ujian penentuan peratusan kelembapan, peningkatan saiz agregat akan meningkatkan peratusan kandungan lembapan agregat. Bagi ujian vialit, peratusan agregat tertahan akan berkurangan apabila peratusan kandungan lembapan agregat meningkat. Manakala bagi ujian tarik keluar, purata beban maksimum meningkat apabila peratusan kandungan lembapan agregat berkurangan.

Kata kunci: *Dandanan permukaan, rekatan, kandungan lembapan, ujian vialit, ujian tarik keluar.*

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LIST OF ABBREVIATIONS/SYMBOLS

AASHTO	-	American Association of State Highway and Transportation Officials
ASTM	-	American Society for Testing and Materials
BS	-	British Standards
DA	-	Dry Aggregate
DOT	-	Department of Transportation
FWA	-	Fully Wet Aggregate
JKR	-	Jabatan Kerja Raya
MRP	-	Malaysian Rock Product
MS	-	Malaysian Standards
N	-	Newton
PDA	-	Partially Dry Aggregate
S.O	-	Safety Officer
SSDA	-	Saturated Surface Dry Aggregate
UTM	-	Universiti Teknologi Malaysia
g	-	gram
kg/m ²	-	kilogram per square metre
mm	-	millimetre
s	-	second
%	-	Percentage
°C	-	Degree of Celsius

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CHAPTER 1

INTRODUCTION

1.1 Background

A chip seal (also called a surface dressing or seal coat) has a history than 90 years and is widely used by state Department of Transportation (DOTs) in many countries. Chip seal involves the application of a thin layer of bituminous binder to the pavement surface followed by the spreading and rolling into it of single sized aggregates (Rogers, 2003). The primary objectives of chip seal are to prevent water intrusion into the base and subgrade layers and to provide a skid resistant with the resultant benefits of reduction in accidents. It is also used to seal the fine cracks in a pavement surface and to maximize the cost effectiveness of limited maintenance funds. A chip seal usually constructed in low volume gravel road.

The use of chip seal as preventive maintenance treatments has been a successful surface treatment on both low volume and high volume pavement. Their popularity owes to their favourable cost in comparison with thin asphalt to extend the life of the underlying pavement structure. The preventive maintenance treatment is a program employing a network level, long-term strategy that enhance function pavement

performance by using an integrated, set of practices that extend pavement life, cost effective and improve safety. It should be recognize that successful chip seals are a function of their application on underlying pavements that have not suffered structural failure. The preventive maintenance can be classified into excellent or failed. Figure 1.1 shows the concepts of preventive maintenance where timely application of preventive maintenance reduces costs. If pavement is treated in good condition at \$1, it defers pavement deterioration. While, delayed application can increase costs from \$6 to \$10 (TRB, 2005).

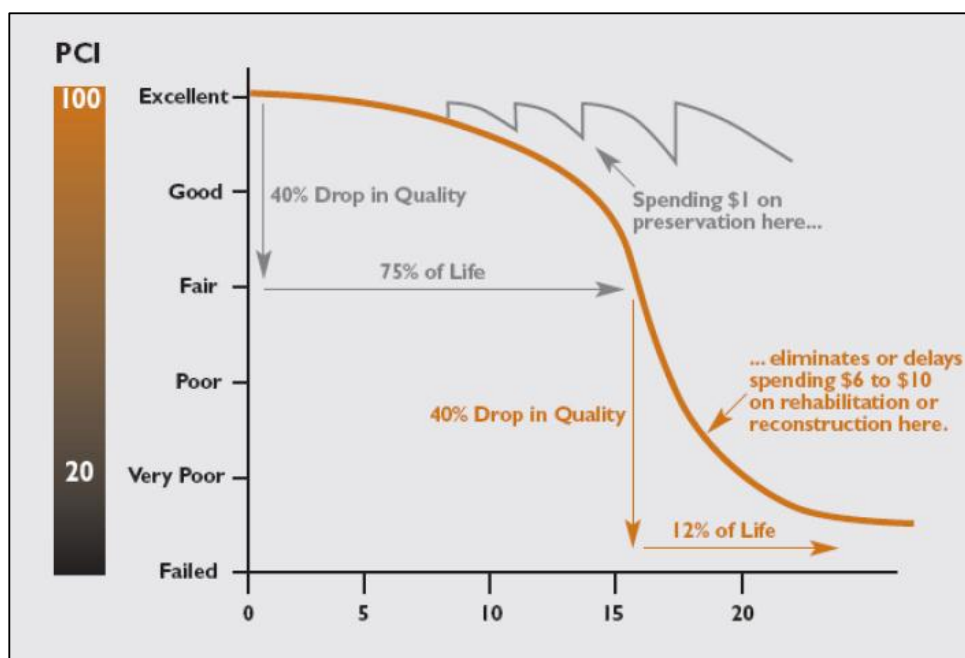


Figure 1.1 : Preventive maintenance concept (TRB, 2005)

Normally, chip seal requires a high quality of materials and workmanship. Good quality of aggregates in term of grading, hardness, cleanliness and shape are applied by a purpose made spreading device. However, chip seal can be done by labour based methods but it quality is not same with the original quality of aggregate. It can be relatively expensive but for suitable gravel can be easily screened, is available locally. Wet aggregates must be prevented because it can reduce the bonding between the

aggregates and bitumen. Dust in the smaller sized aggregates must also be removed by manual segregation. Washing with river water could have been carried out had been necessary.

1.2 Problem Statement

Road development is based on three main strategies which are to reduce capacity constraints, to extend the road network to open new growth areas and to improve interurban linkages. The government of Malaysia has worked hard to ensure that all roads are accessible with adequate level of service. A good road infrastructure and management is very important for national growth and roads that are durable and sustainable. There are many types of road in Malaysia such as flexible pavement and rigid pavement. Road consisted of layers such as subgrade, subbase, road base, binder course and wearing course. Chip seal is the uppermost layer of a road which is exposed to traffic to provide a wearing and waterproof layer.

There are several problems when using chip seal, either during construction or after construction stage. The main cause of this problem arises due to the lack of supervision as required in the specifications. In terms of theory and design, it is not a problem, but when it comes to construction stage, the various problems will arise. The problems are identified due to the process of spraying a binder and spreading the aggregates is not following the specifications and methods. This condition caused by the weaknesses of the workers to operate the plant. The aggregates are also important in determining the performance of chip seal, such as aggregate strength as well as types, sizes, shapes and textures. Another important factor is the moisture in aggregate.

Malaysia is a country with a high degree of humidity of 80-90 %. This means that the moisture content on aggregate is sure to be a problem. The moisture or water film attached to the aggregate will prevent the adhesion of a binder on it. This will lead to the problem of aggregate easily dislodged. The success of a chip seal depends on the adhesion of the aggregates to the road surface, both the aggregates and the road surface must dry. Therefore, this study is needed to determine the effect of aggregate moisture on adhesion of chip seal.

1.3 Aim and Objectives of Study

The aim of this study is to investigate the effect of aggregate moisture on adhesion of chip seal.

The objectives of this study are:

- i. To determine the percentage of moisture content on different condition of aggregate.
- ii. To determine the adhesion of chip seal at different condition of moisture content on aggregate.

1.4 Scope of Study

The scope of this study is focused on the effect of aggregate moisture on adhesion of chip seal. This study is conducted by experiment at Highway and Transportation Laboratory, Universiti Teknologi Malaysia (UTM), which concentrated on:

- i. In this study, single chip seal was used as test specimens.
- ii. The sizes of aggregate that have been used for chip seal specimens are 6 mm, 10 mm and 14 mm.
- iii. 80/100 penetration grade bitumen that has been used as a binder.
- iv. The tests were conducted are vialit test and pull out test.
- v. Standard Specification for Road Works (JKR/SPJ/2008) was used as guidelines in this study.

1.5 Significance of Study

This study provides more understanding about the effect of aggregate moisture on adhesion of chip seal. This understanding can be used to discover the solutions for serious problem of chip seal. This study can also be highlighted as a proposal to JKR and other local authorities in providing a new concept towards the road safety and development in Malaysia.