

ADHESION ON DIFFERENT RATE OF BINDER AND AGGREGATE FOR  
CHIP SEAL

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“SPECIALLY DEDICATED TO MY BELOVED FATHER AND MOTHER, HAJI  
KHALID ABDULLAH AND HAJAH SALIAH ABD. RAHMAN, MY SIBLINGS  
ZAPARIN, SHAKLIZA, AMINURIJAL, ZAINURDIN AND SHAFIK AFFANDI AND  
ALL MY FRIENDS FOR THEIR ENCOURAGE, SUPPORT AND CONCERN”

“TILL DEATH DO US APART...”

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## ABSTRACT

Chip seal is a frequently used as preventive maintenance treatment on flexible pavements. The construction of chip seal should be monitored and the technique must be used correctly especially when spreading the binder and the aggregate. The objective of this study is to investigate and to determine the best adhesion of chip seal based on the rate of aggregate and binder. Three different size of aggregate with the different rate are used in this study which are (12, 14, 16 and 18 kg/m<sup>2</sup>) for 14mm size; (8, 10, 11 and 12 kg/m<sup>2</sup>) for 10mm size and (5, 6, 7 and 8 kg/m<sup>2</sup>) for 6mm size. The penetration grade 80/100 pen bitumen is used as the binder with different rate for every size of aggregate which are (1.50, 1.60 and 1.70 l/m<sup>2</sup>) for 14mm ; (1.30, 1.40 and 1.50 l/m<sup>2</sup>) for 10mm and (1.10, 1.20 and 1.30 l/m<sup>2</sup>) for 6mm aggregate size. Vialit test and pull out test are conducted on every sample to investigate and determine the best adhesion of chip seal. From vialit test result, the percentage of aggregate retained is increases as the binder rate increases. The difference percentage of aggregate retained is around 0% to 0.85%. Besides that, at the same rate of binder shows that percentage of aggregate retained decreases when aggregate rate increases around 1.10% to 2.87%. The combination between smallest aggregate rate and highest binder rate provide the great adhesion between aggregate and binder. The pull out test result shows that highest binder rate gave the highest average maximum load. The highest average maximum load is about 41.970 N for 14 mm, 25.515 N for 10 mm and 15.409 N for 6 mm aggregate size. The best adhesion between aggregate rate and binder rate are (12 kg/m<sup>2</sup> and 1.70 l/m<sup>2</sup>) for 14mm, (8 kg/m<sup>2</sup> and 1.50 l/m<sup>2</sup>) for 10mm and (5 kg/m<sup>2</sup> and 1.10 l/m<sup>2</sup>) for 6mm aggregate size.

## ABSTRAK

Dandanan permukaan sering digunakan dalam kerja penyelenggaraan adalah rawatan untuk turapan anjal. Kerja pembinaan dandanan permukaan haruslah dipantau dan teknik pembinaan yang betul hendaklah digunakan terutamanya ketika penyemburan pengikat dan penaburan agregat. Objektif untuk kajian ini adalah untuk menyiasat dan menentukan lekatan yang terbaik berdasarkan kadar semburan pengikat dan taburan agregat. Tiga saiz agregat digunakan dalam kajian ini iaitu (12, 14, 16 dan 18 kg/m<sup>2</sup>) untuk 14mm; (8, 10, 11 dan 12 kg/m<sup>2</sup>) 10mm dan (5, 6 dan 8 kg/m<sup>2</sup>) untuk 6mm saiz agregat. Bitumen penusukan bergred 80/100 digunakan sebagai pengikat untuk penyediaan sampel dengan kadar penyemburan yang berbeza iaitu (1.50, 1.60 dan 1.70 l/m<sup>2</sup>) untuk 14mm; (1.30, 1.40 dan 1.50 l/m<sup>2</sup>) untuk 10mm, dan (1.10, 1.20 dan 1.30 l/m<sup>2</sup>) untuk 6mm saiz agregat. Ujian vialit dan ujian tarik keluar dijalankan pada setiap sampel untuk menyiasat dan menentukan lekatan bagi dandanan permukaan. Hasil daripada ujian vialit menunjukkan peratusan agregat tertahan meningkat apabila kadar penyemburan pengikat meningkat dengan perbezaan sebanyak 0% hingga 0.85%. Selain itu, peratusan agregat tertahan menurun dengan kenaikan kadar penaburan agregat sekitar 1.10% hingga 2.87%. Kombinasi antara kadar penaburan agregat yg rendah dengan kadar penyemburan pengikat yg tinggi memberikan hasil yang terbaik. Ujian tarik keluar pula menunjukkan bahawa kadar pengikat yang tinggi memberikan nilai purata beban maksimum yang tinggi. Nilai purata beban maksimum adalah 41.970 N untuk 14mm, 25.515 N untuk 10mm dan 15.409 N untuk 6mm saiz agregat. Lekatan yang terbaik antara kadar penaburan agregat dan kadar penyemburan pengikat adalah (12 kg/m<sup>2</sup> and 1.70 l/m<sup>2</sup>) untuk 14mm, (8 kg/m<sup>2</sup> and 1.50 l/m<sup>2</sup>) untuk 10mm dan (5 kg/m<sup>2</sup> and 1.10 l/m<sup>2</sup>) untuk 6mm saiz agregat.

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## LIST OF ABBREVIATIONS/SYMBOLS

AC	-	Asphaltic Concrete
AASHTO	-	American Association of State Highway and Transportation Officials
ASTM	-	American Society for Testing and Materials
BS	-	British Standard
CCSA	-	California Chip Seal Association
JKR	-	Jabatan Kerja Raya
MS	-	Malaysian Standard
M	-	Mass
MBT	-	Modified Binder Test
MC	-	Medium Curing
MRP	-	Malaysian Rock Product
N	-	Newton
NCHRP	-	National Cooperative Highway Research Program
NDOT	-	Nevada Department of Transport
RC	-	Rapid Curing
SC	-	Slow Curing
S.O	-	Safety Officer
UTM	-	Universiti Teknologi Malaysia
kg/m <sup>2</sup>	-	kilogram per meter square
l/m <sup>2</sup>	-	liter per meter square
min	-	minute
mm	-	millimeter
pen	-	penetration
s	-	second

g	-	gram
h	-	hour
%	-	percent
°C	-	Degree of Celsius

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

Road is the most famous alternative for the land transportation system that used by the drivers. A good and systematic of road network can make the short travel time from one destination to other destination. The road condition is one of the important factors that affected the smooth of the traffic on the road. The road pavement can be divided into two categories such as flexible pavement and concrete pavement. There are many types of the flexible pavement such as asphaltic concrete, porous asphalt, and stone mastic asphalt. The road has specific design life based on the traffic loading that has been determined before the road is constructed. The damaged road should be repaired to prevent an accident by road users. The type of maintenance is dependent on the damage of road surface such as surface treatment for the old asphalt pavement. The low skid resistance between tire and old surface pavement can be one of the causes of the road accident, especially during raining weather. One of the best solutions for this problem is chip seal.



A chip seal also known as a surface dressing or a seal coat is most widely used of treatment in highway to provide and a texture surface for wet skid resistance, seals the fine crack underlying pavement and prevent water intrusion. A chip seal is a layer that consist of a single application of binder and a single layer of uniform size of aggregate. The construction of chip seal is simple by spraying a bituminous with distributor truck on the existing road followed by the chip spreader that spreads of aggregate. There are many types of chip seal such as single chip seal, double chip seal, racked in chip seal, sandwich chip seal and etc. Chip seal is not improving the structural capability of pavement but it can extend the service life of the road. The cost of chip seal is effective and cheap compare to the other resurfacing method. The advantages of these seals include rapid construction at a cost which should be approximately one fifth of that for thin AC layers, very good surface texture and a thick durable film of bitumen with an effective thickness of several millimetres.

## **1.2 Problem of Statement**

The problems also occur when applying chip seals as a new pavement surface. The problems happen during construction or after opening to traffic flow. The construction of chip seal must followed the specification to prevent the failure exist during or after construction. The construction of chip seals should be monitored and the construction technique must correct especially during spreading the binder and aggregate. The common type of failure related to the chip seal are striping or loss of cover stone and bleeding or excess asphalt on the road surface.

According to California Chip Seal Association (CCSA, 1987), many industries believe that chip seals fail because binder and aggregate are not suited to each other. The aggregates are striping from the surface because of the degree of compatibility between any emulsion and aggregate so poor that the asphalt will not coat the rocks. If the binder is spreading too little, the aggregate will prevented

embedding properly and the aggregate will be stripped from the surface. The bleeding will cause fatty patches to increase as time goes on, creating a skidding hazard to the road users. If the aggregate spread too little, the surface leads to insufficient cover and will cause picking. It also causes flushing from excess oil due to the shortage of stone.

Excessive usage of material such as binder and aggregate will waste the money since it ends into the ditch. The aggregate are also more easily dislodged if the aggregates are spread too heavily. The stripping aggregate from the surface can cause the hazard to road users. The flying aggregate can cause the damaged to windshield of cars users. This condition will cause the users loses in terms of their money to repair their vehicles. Bleeding can also be dangerous to road users. The bleeding of binder on the surface will make the poor contact between tire and aggregate. An accident can occur to road users especially during braking and cornering.

### **1.3 Objective of Study**

The objectives of the study are:

- i) To study the adhesion of chip seal on different rate of aggregate for every size of aggregate
- ii) To investigate the adhesion of chip seal on different rate of binder for every size of aggregate
- iii) To determine the best binder rate and aggregate rate for chip seal.

#### **1.4 Scope of Study**

All the tests are conducted at Transportation Laboratory at UTM. The scopes of the study are:

- i) This study only focuses on the adhesion between the binder and aggregate of chip seal.
- ii) There are three sizes of aggregates using in this study which are 14mm, 10mm and 6mm. The rate of aggregate for every size has been shown in the objective. The moisture and cleanliness of the aggregate is used in this study.
- iii) The dry and clean aggregate are used in this study.
- iv) The aggregates are obtained from Malaysia Rock Product (MRP) Quarry located at Ulu Choh, Pulau.
- v) The type of bitumen that has been used for this study is penetration bitumen 80/100 grade. The rate of binder for every size had been shown in the objective.
- vi) There are about 36 samples are prepared for Vialit test and 9 samples for Pull-Out test. There are only two test are conducted in this study which are Vialit test and Pull-Out test.
- vii) This study only involved the top layer of pavement which assume the strength of the sub base and subgred layer are followed the Standard Specification for Road Works of JKR (JKR/SPJ/rev2008).

### **1.5 Significant of Study**

The road that is constructed should follow the specification to control the quality of the road. The monitoring and supervising work during construction is important to make sure that the road was fulfilling the standard. This study is conducted to determine the best adhesion between binder rate and aggregate rate. The best adhesion of chip seal will affect the quality of the chip seal. The quality of chip seal construction is very important to prevent any bad possibility occur on the road such as bleeding and stripping of aggregates. The finding of this study is very important in order to improve the road safety as well as to prevent excessive usage materials.