

CHARACTERIZATION OF SOIL MIXED WITH
RECLAIMED ASPHALT PAVEMENT WASTE FOR ROAD SHOULDER

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A project report submitted in partial fulfilment of the
requirements of award of the degree of
Master of Engineering (Civil)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JUNE 2017

*Dedicated to Allah S.W.T,
my beloved husband Mohd Rafiqan Bin Zainal Abidin
and my lovely daughter,
Nur Hanis Afiqah Binti Mohd Rafiqan
Thanks for your valuable sacrifice and love.*

*To my beloved parents and in laws,
Ab Rashid Bin Awang – Rohani Binti Mohamed
Zainal Abidin Bin Jaafar –Meriam Binti Awang.
Thanks for your support and always being there for me in happiness and sadness.*

~~~~~ Love you all ~~~~~

## **ACKNOWLEDGEMENT**

I would like to thank Allah S.W.T for blessing me with excellent health and ability during the process of completing my thesis. Special thanks to my supervisor Dr. Azman Bin Mohamed who have given me the opportunity to learn a great deal knowledge, and guiding me towards fulfilling this achievement.

My gratitude is also extended to the Highway and Transportation Laboratory, Geotechnics Laboratory, Lecturer and Laboratory staff. Thank you for the support and friendship showered upon me throughout the experimental periods.

Finally, I would like to thank my husband Mohd Rafiqan Bin Zainal Abidin for his unconditional support and assistance on various occasions. All your kindness will not be forgotten.

## ABSTRACT

The usage of fresh bitumen and aggregates in pavement construction and rehabilitation can be minimised by utilising reclaimed asphalt pavement (RAP). RAP is a waste material generated from the old or damaged pavement surface. Although it has been practiced since the 1970s while several suggestions on the usage of RAP in the new mixture have been introduced, there are a limited number of studies found. It is also cost-effective and sustainable for the environment because the materials used are recycled materials. This research is about the characterization of soil mixed with reclaimed asphalt pavement (RAP) for the local road shoulder. RAP is one of the rehabilitation methods to replace the existing surface of deterioration where the upper pavement was later removed and replaced with the new pavement. From previous research, if soil is mixed with the other materials, it will improve the finding. In this research, the objectives are to determine the material properties of soil and RAP, investigate the optimum moisture content of material and degree of compaction for road shoulder and investigate the optimum mix proportion of soil and RAP under the California Bearing Ratio (CBR) test for road shoulder. The sample of soil and RAP has been tested Atterberg limit, liquid limit and plastic limit for soil. Sieve analysis for soil and RAP. Compaction test for soil and CBR test for soil and RAP were conducted with mixed proportion of 10S, 2S8RAP, 4S6RAP, 6S4RAP, 8S2RAP and 10RAP. The finding from the laboratory test, 20% of RAP (8S2RAP) showed the better mixed proportion for road shoulder. Therefore reuse material such as RAP can be used as a road shoulder material for road construction.

## ABSTRAK

Penggunaan bitumen segar dan agregat dalam pembinaan turapan dan pemulihan boleh dikurangkan dengan menggunakan semula turapan asfalt (RAP). RAP adalah bahan sisa yang dihasilkan dari permukaan turapan lama atau yang telah rosak. Inovasi RAP telah diamalkan sejak tahun 1970-an dan beberapa cadangan daripada sebilangan penyelidik telah menemui penggunaan RAP dalam campuran tertentu diperkenalkan. Dengan menggunakan bahan RAP ini ianya akan menjimatkan kos dan menjadi bahan kitar semula. Kajian ini adalah merupakan kajian untuk menentukan campuran yang sesuai dengan tanah yang ada dengan RAP untuk bahu jalan kawasan tempatan. RAP adalah salah satu kaedah pemulihan untuk menggantikan permukaan yang sedia ada kemerosotan di mana turapan atas kemudian telah dibuang dan digantikan dengan turapan yang baru. Daripada penyelidikan sebelum ini, tanah jika campuran dengan bahan-bahan lain akan meningkatkan hasil dapatan. Dalam kajian ini, terdapat beberapa objektif yang akan dilaksanakan untuk menentukan campuran yang sesuai diantara tanah dan RAP. Objektif yang pertama adalah untuk menentukan kandungan lembapan optimum serta tahap pemadatan untuk bahu jalan. Objektif yang ke dua adalah untuk menentukan campuran kadar campuran optimum tanah dan RAP bawah ujian California Bearing Ratio (CBR) untuk bahu jalan. Sampel tanah dan RAP akan diujian dimakmal seperti ujian had Atterberg, had cecair dan had plastik untuk tanah. analisis ayak untuk tanah dan RAP. Ujian pemadatan untuk tanah dan ujian CBR untuk 100% tanah dan 100% RAP serta kadar campuran yang sesuai diantara tanah dan RAP mengikut peratus 10S, 2S8RAP, 4S6RAP, 6S4RAP, 8S2RAP dan 10RAP. Berdasarkan beberapa ujian yang telah dijalankan peratus campuran yang sesuai adalah 8S2RAP, jumlah RAP yang disyorkan di dalam campuran adalah 20 %.

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

In Malaysia, the street development has started from the time before Independence. After 1957, there has been a street framework connecting Johor Bahru in the south with Kangar in the north and Kota Bharu in the East Coast, associating the principle with alternate urban areas. After the nation gained Independence in 1957, the endeavours to enhance the street framework have been done appropriately and through the fast improvement arrangement, particularly the Malaysia Plan at regular intervals which were propelled by the federal government.

The development of streets in Malaysia is completed chiefly by the federal and state government in concurrence with the necessities and advancement arranging and street solidness period that rely upon many variables. In asphalt plan, the adaptable asphalt is commonly intended use for around ten to fifteen years. The recovery and support exercises are extremely vital with a specific end goal to guarantee quality and enhance serviceability of the specific street.

These days, development industry gives a more noteworthy consideration on maintainability perspective. There are many components adding to the economic

development, for example, development techniques, plan procedures, hardware and materials utilised for the development. The interest for bitumen and the total cost of material development continue to ascend as fast as the advancement and consumption of regular recourses.

The reusing of asphalt pavement has turned into a typical practice in the transportation business. The inspirations for reusing normally incorporate the natural, financial, and social advantages. Using the Reclaimed Asphalt Pavement (RAP) in the roadway advancement meets with the overall objective of sensible change by the astute usage of typical resources (Hoppe *et al.*, 2015).

Recycling a bituminous pavement is not a new idea but one of the solutions that supports sustainability aspect and at the same time reduce the construction and material costs. Progressions in recycling technology and equipment arisen in the 1970s. It conserved energy and non-renewable natural resources, preserved environment, reduced the routine landfill, made smaller cost for construction and enhanced the overall pavement effectiveness (Asphalt Recycling and Reclaiming Association, 2001).

One of the common methods in bituminous recycling is by using reclaimed asphalt pavement (RAP). RAP is an old asphalt pavement that has been removed from the roadway by either milling or full-depth removal. Using RAP has been favoured over virgin materials in the light of the increasing cost of asphalt and needs to preserve the environment. The use of reclaimed asphalt also decreases the amount of waste produced and helps to resolve the disposal problems of highway construction materials.

## 1.2 Background of Study

The growth of the road construction and rehabilitation in improving the workability of road that increases the socio-economic development are now an important factor in the high demand of road construction, new road and upgrade the existing road to meet the needs of road users. Road development has made significant contributions to economic growth and poverty reduction (Fan and Chan-Kang, 2005)

However, pavement deterioration is a common problem that occurred in road construction that needs to be replaced or make rehabilitated. This means that the sustainable construction, maintenance, and rehabilitation of road pavements are a matter of ever increasing importance in Slovenia, and elsewhere in the world. Besides the intensity of traffic loads, some other factors such as road design and construction, the quality and performance characteristics of input materials, and local weather conditions, are crucial for road durability, and also the lifespan of roads (Ossa *et al.*, 2016).

From this situation, road repair and reconstruction of road industry has encouraged the waste of road disposal and consumed large amounts of raw material and generated enormous amounts of waste during the construction and demolition of the roads, sidewalks and bridges. This waste primarily consists of mortar, aggregate, and bitumen milling as well.



### 1.3 Problem Statement

In recent years, the construction industry has depleted our natural resources which naturally followed by environmental degradation. Without environmental awareness, contractors have caused irreversible damage to the environment by disposing of waste materials if there is continuous demand on the construction materials that lead to the depletion of natural resources and increase of the waste materials.

Pavements are designed specifically for the expected load conditions throughout the design life of the road. Pavement types vary from flexible pavements through semi-rigid to rigid concrete pavements. After several years of services, the pavement will deteriorate and surface damage will occur. To overcome this situation, rehabilitation and maintenance can slow the deterioration of the pavement but it cannot stop it.

Recycling of bituminous pavement materials is found to be the best method to minimise the usage of natural resources and solve the material disposal issues. Many studies have proven that RAP could be incorporated into the pavement mixture for the first time. For example, few places in the US have successfully used RAP in the pavement mixture on site (Federal Highway 4 Administration, 2016).

However, there are still mixed findings on the performance of RAP discovered among the researchers especially on the suitable amount of RAP to be incorporated in the mixture. For example, Yang and Lee (2016) suggested that RAP should be less than 25% from the total mixture, but other researcher claimed that the higher RAP content with proper handling is still capable of performing as good as the conventional mixture (Poulikakos *et al.*, 2014).

The effects of deterioration are needed to be rectified by adding or replacing materials in the existing pavement structure by rehabilitation. Resurfacing is one of rehabilitation method for pavement, which it involved the placement of fresh materials on an existing surface to increase its structural strength and improve the riding quality of the surface.

The waste of resurfacing of pavement or wearing course is called milling waste. By doing this resurfacing new problem will arise that is milling waste is considered the waste product from rehabilitation works from the old pavement. Disposal of milling waste is the issue for road construction and rehabilitation because milling waste cannot be eliminated and is one of hazardous wastes. The other problems of milling are dumping at the roadside and a lot of stockpile at the certain construction industry. From this study, the reusing of milling waste for road shoulder will decrease the dumping at the roadside and reduce the milling waste stockpile.

#### **1.4 Aim and Objectives**

The aim of this study was to determine the bituminous mixture for the following purposes:

- i. To determine materials properties of soil and RAP.
- ii. To determine the optimum moisture content of material and degree of compaction for road shoulder.
- iii. To determine the optimum mix proportion under California Bearing Ratio (CBR) test for road shoulder.

## 1.5 Scope of the Study

The scopes of this study were to achieve the objectives mainly through experimental works. The testing methods and procedures were specified according to those recommended by the British Standard Institution and some were proposed by previous researchers. Table 1.1 shows the scope of study of this research.

**Table 1.1:** Scope of study

| <b>Description</b>         | <b>Limitation</b>                                                                   |
|----------------------------|-------------------------------------------------------------------------------------|
| Material for road shoulder | Soil and Milling Waste                                                              |
| Testing for Materials      | Soil: sieve, PL, LL, soil classification<br>Milling Waste : Sieve (Extraction test) |
| Method of drying           | Surface dried                                                                       |
| Compaction                 | Fully replacement, For Soil only.                                                   |
| CBR                        | Fully replacement, partial replacement<br>For soil and milling waste                |

## 1.6 Significance of the Study

The significant of this study is to focus more on using reclaimed asphalt pavement (RAP) as the material for road shoulder and also the significant capability of RAP in order to enhance its properties. Besides that, this study also provides reliable data from experimental work since fewer studies were conducted on RAP for road shoulder. The information and data from this study can be used for future study and might help another researcher to establish the requirement and specification on the road shoulder construction.

In addition, the cost of constructing the road shoulder can be reduced since RAP is used as a material in road shoulder and can solve the milling waste dumping at the roadside. Furthermore, by using RAP as materials in road shoulder will reduce the demand of using the natural source such as aggregate and sand that are widely used in construction industry.

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