ROAD MAINTENANCE AND REHABILITATION IN TROPICAL CLIMATE

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A project report submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Science (Construction Management)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JANUARY 2013

Especially dedicated to:

My parents & my family

Who give motivation and loves...

My beloved supervisor, Mr Bachan Singh a/l Besawa Jagar Singh

Who give the guidance with continuously in finishing this thesis...

All my friends

For their helping and loyalty of this friendship...

ACKNOWLEDGEMENT

First, I would like to thank to my beloved supervisor, Mr Bachan Singh a/l Besawa Jagar Singh who inspired me in making good thesis. In order to make me producing the good thesis, he always lends his hand with his advices, guidance and patience to give the exposion towards new world of construction management.

Not forgetting to my family who never declined in giving me courage for my education and keep inspiring me in finishes my journey. Without their support, I would never being here.

Lastly, I would like to say thank you to all construction management friends, lectures and for those who have contributed in completing this thesis. I am would like to thankful to my UTM friends for their support and gives their view in doing this thesis.

Thank you.

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ABSTRACT

Currently, there are about 92,000 kilometers of road in Malaysia which is more than 80% percent of which are paved. This network can be categorised into the Federal and State roads. The majority of the network is maintained by the State Authorities either by direct labour or under relatively small contracts. The primary mode of failure of this type of road pavement is often reflection cracking. The aim of this study is to investigate the road defects and the root cause of the problem. The objectives of the study to examine the different types of road construction, to examine the types and root cause of the road defects; to identify the problem faced by Public Work Department, and to assess the client's budget allocation for road maintenance and rehabilitation. The study is carried out in District of Tampin, Negeri Sembilan. The data is collected through questionnaire and interview. The data is analysed using Statistical analysis and Average Index. From the study, the different types of road construction are Porous Asphalt and Stone Mastic Asphalt. The types of road defects are crocodile cracks and shoving. The problems faced by the Public Work Department are budget and repetitive of road defects. The budget allocation is mainly channeled to resurfacing work.

ABSTRAK

Malaysia kini mempunyai 92,000 kilometer jalan raya dimana lebih daripada 80 peratus adalah jalan berturap. Jalan perhubungan ini boleh diklasifikasikan kepada jalan Persekutuan dan jalan Negeri. Kebanyakan jalan diuruskan oleh pihak berkuasa negeri yang menggunakan buruh secara langsung atau diberikan dalam bentuk kontrak yang kecil. Punca utama kerosakan jalan adalah disebabkan oleh keretakan refleksi. Tujuan kajian ini adalah untuk menyiasat kecacatan jalan raya dan punca masalah kepada perkara ini berlaku. Objektif kajian pula adalah untuk meneliti pelbagai jenis pembinaan jalan raya yang diaplikasi di Malaysia, untuk memeriksa jenis dan punca kecacatan jalan raya, untuk mengenal pasti masalah yang dihadapi oleh Jabatan Kerja Raya, dan untuk menilai peruntukan bajet pelanggan untuk penyelenggaraan jalan dan pemulihan. Kajian ini dijalankan di Daerah Tampin, Negeri Sembilan. Data dikumpul melalui soal selidik dan temu bual. Data yang diperolehi dianalisis menggunakan analisis statistik dan Indeks Purata. Dari kajian tersebut, jenis pembinaan jalan adalah sepertis Porous Asphalt dan Stone Mastic Asphalt. Jenis kecacatan jalan pula adalah crocodile crack dan shoving. Masalah-masalah yang dihadapi oleh Jabatan Kerja Raya adalah kurang peruntukan bajet dan kecacatan jalan raya berlaku berulang-ulang selepas jalan dibaiki. Selalunya, peruntukan bajet disalurkan untuk pelapisan kerja.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

As cities grew up rapidly, road play the most important role to connect a place to another place. Besides, it also leads to the increasing number of vehicles due to modernization of the country. The consequences from this were the level of road condition rapidly deteriorates. It also increases the number of injuries in the road traffic accidents to the users. As been known, Malaysia is one of the countries that recorded the highest number of accidents in the world. The government spends billions of dollars annually for doing road maintenance and rehabilitation to meet public and other expectations. The effectiveness of pavement rehabilitation treatments in term of their impact in service life is needed for cost effective planning and pavement maintenance, preservation and rehabilitation projects. Pavement maintenance can be described as doing repairs on good roads to keep them good. The major things to be success in pavement maintenance is to know what are the proper repair is needed to be done which is from doing nothing until reconstructing the entire road. It needs to be repaired even though it was not the best choice. In such a case, it is clearly needed to highlight what the problem occurred and how to reduce the chances of road failures from repeated. There are some other issues such

as pavement deterioration rates, truck traffic volumes; environment and other factors have effects on the expected life of pavement rehabilitation treatments.

1.2 Definition

The Organisation for Economic Co-operation and Development (OECD) defines road a travelled way that using stabilized base open to public traffic which is for the use of road mother vehicle on own wheel. It includes bridges, tunnels, supporting structures, junctions, crossings, interchanges, and toll roads, but it not involves cycle paths. Basically, maintenance been done to preserve the asset and not to upgrade it. Road maintenance consist the activities to keep the pavement, shoulders, slope, drainage facilities and other structure in good condition and or like renewed condition(B. Sally et al, 2005). It includes some of minor repairs to reduce and eliminate the cause of defects. Besides, it needs to be done to avoid from repetition of maintenance efforts.

For management, road maintenance is categorized as routine, periodic, and urgent. Routine maintenance can be described as small-scale work conduct regularly. It is to ensure the safety and smoothness of the existing road to prevent preliminary deterioration of the roads. The activity is varies and been done once or more in a week or month. It includes some activities such as clearing and grass cutting at roadside, cleaning the culvert, patching and repair the pothole. But, it took every six months for gravel road (B. Sally et al, 2005).

Periodic maintenance is for the activities on a section of road at regular and long intervals. It aims to preserve the structural of the integrity of road. These activities been done in large scale and need to specialized the equipment and the skilled worker. It more costly compared to the routine maintenance works and need

some specific identification and planning for road maintenance. Sometime, it needs to do the design. There are several activities for the periodic maintenance such a resurfacing, overlay and reconstruction of pavement. For measurement of deterioration in road conditions, the activities been done like resealing and overlay works. The maintenance been done for paving road is every eight year and three year for gravel road. Emergency maintenance operations is needed where have immediate actions been required to ensure the road user safety. The activities include the removal of debris/obstacles and landslides that block a road. Maintenance not includes rehabilitation, building shoulders, or widening roads. If the sections to be reconstruct more than 25 percent of the road's length, the work is rehabilitation, not maintenance (B. Sally et al, 2005).

Pavement rehabilitation been defined as a structural of enhancement of a pavement which produce a long time of service life by improving the pavement condition and ride quality. Rehabilitation treatment can be categorized to restoration, resurfacing, recycling or reconstruction. Restoration is a set of one or more activities that repair existing distress and improve the serviceability which is remain the service life of the pavement without increasing the structural capacity of the pavement. Recycling is the process of removing pavement materials for reuse in resurfacing or reconstructing a pavement (or constructing some other pavement). For asphalt pavements this process started from in-place recycling of the surface layer until recycling material from all pavement layers through a hot mix plant. Reconstruction defines as the removal and replacement of all asphalt and concrete layers and the base and sub base layers. Due to its high cost, reconstruction is rarely been done (T.H. Kathleen et al, 2001).

1.3 Background of Study

Paved roads in tropical climates often deteriorate in different ways which is more temperate regions of the world due to harsh climatic condition and less quality of materials for pavement. Basically, many countries suffer a lot of problem regarding road deterioration because of accelerated failures. It is happen from variable problems such as quality control during construction, high axle load and inadequate fund for doing road maintenance.

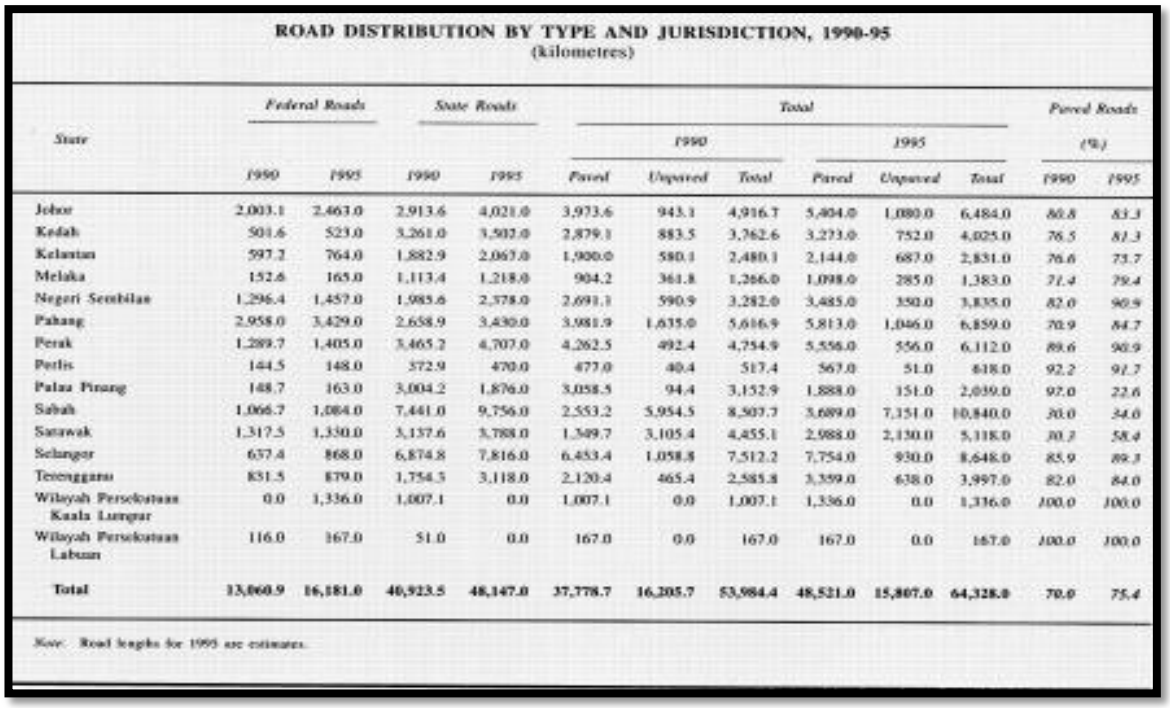
Nowadays, it needs to find the effective way to maintain, protect and sustain the pavement. Not only safety for the user, but it needs to do maintenance effectively to become last longer. In Malaysia, this maintenance and rehabilitation of road been done by Public Works Department (PWD). The people who performed construction-engineering services will know the problem during construction that makes the road not long lasting. A road can be described as the movement of transportation from one point to another point in all type of weather and traffic condition. The road was constructing to reduce the stress on the native material such as sub grade under the pavement. So, it needs to use good materials on the sub grade to spread the load. (David P. Orr, 2006).

The construction of asphalt concrete is complex due to involve with many critical stages. It need some specific requirements during the construction process can be very high which is can give impact to the performance of the road (A.A Bubshait, 2001). This is important to make sure the movement of traffic flow is smooth. Basically, the asphalt pavement rehabilitation involve with milling and resurfacing of the existing the asphalt pavement to reduce the effects of rutting, cracking and distresses. For resurfacing thickness, it needs to depend on the condition of the existing pavement, available funding and others. The service life of the rehabilitated pavement under heavy truck traffic been expected about 8 to 12 years (SD Tayabji et al, 2000).

Road maintenance needs to be planning and manage properly. On time maintenance is very important to avoid some problem occurred later. Refer to the (K.Stefan et al, 1991), developing countries has lost a lot of dollars due to the deterioration of roads. It effects the economic because of lack adequate of road maintenance. It could be avoided by improve the maintenance practice.

1.4 Problem Statements

The road construction has been started in Malaysia before 1957 where there has been road system. The road system linking started from Kangar in the north with Johor Bahru in the south while Kota Bharu in the East Cost that connect the main cities to other cities. After Malaysia got the independent, a lot of efforts in improving the road system through the development planning. It can be seen especially during Malaysia Plan which is launched by the Federal Government. In the 10^{th} Malaysia Plan, the Federal Government announced that the government wills adding in build 6300 km paved roads in Penisular Malaysia while 2500 km in Sabah and Sarawak. It expected to give benefits to the 3.3 million people. Besides, seven highway projects around RM15 billion costs will be constructed. Among the project that involve are the West Coast Expressway, Guthrie-Damansara Expressway, Sungai Juru Expressway and Paroi-Senawang-KLIA Expressway (The Star, Thu, June 10, 2010).



ROAD DISTRIBUTION BY TYPE AND JURISDICTION, 1990-95
(kilometres)

State	Federal Roads		State Roads		Total						Paved Roads (%)	
					1990			1995				
	1990	1995	1990	1995	Paved	Unpaved	Total	Paved	Unpaved	Total	1990	1995
Johor	2,003.1	2,463.0	2,913.6	4,021.0	3,973.6	943.1	4,916.7	5,404.0	1,080.0	6,484.0	80.8	83.3
Kedah	501.6	523.0	3,261.0	3,502.0	2,879.1	883.5	3,762.6	3,273.0	752.0	4,025.0	76.5	81.3
Kelantan	597.2	764.0	1,882.9	2,067.0	1,900.0	580.1	2,480.1	2,144.0	687.0	2,831.0	76.6	75.7
Melaka	152.6	165.0	1,113.4	1,218.0	904.2	361.8	1,266.0	1,098.0	285.0	1,383.0	71.4	79.4
Negeri Sembilan	1,296.4	1,457.0	1,985.6	2,378.0	2,691.1	590.9	3,282.0	3,485.0	350.0	3,835.0	82.0	90.9
Pahang	2,958.0	3,429.0	2,658.9	3,430.0	3,981.9	1,635.0	5,616.9	5,813.0	1,046.0	6,859.0	70.9	84.7
Perak	1,289.7	1,405.0	3,465.2	4,707.0	4,262.5	492.4	4,754.9	5,556.0	556.0	6,112.0	89.6	90.9
Perlis	144.5	148.0	372.9	470.0	477.0	40.4	517.4	567.0	51.0	618.0	92.2	91.7
Pulau Pinang	148.7	163.0	3,004.2	1,876.0	3,058.5	94.4	3,152.9	1,888.0	151.0	2,039.0	97.0	22.6
Sabah	1,066.7	1,084.0	7,441.0	9,756.0	2,553.2	5,954.5	8,507.7	3,689.0	7,151.0	10,840.0	30.0	34.0
Sarawak	1,317.5	1,330.0	3,137.6	3,788.0	1,349.7	3,105.4	4,455.1	2,988.0	2,130.0	5,118.0	30.3	58.4
Selangor	657.4	868.0	6,874.8	7,816.0	6,453.4	1,058.8	7,512.2	7,754.0	930.0	8,648.0	85.9	89.3
Terengganu	851.5	879.0	1,754.5	3,118.0	2,120.4	465.4	2,585.8	3,359.0	638.0	3,997.0	82.0	84.0
Wilayah Persekutuan Kuala Lumpur	0.0	1,336.0	1,007.1	0.0	1,007.1	0.0	1,007.1	1,336.0	0.0	1,336.0	100.0	100.0
Wilayah Persekutuan Labuan	116.0	167.0	51.0	0.0	167.0	0.0	167.0	167.0	0.0	167.0	100.0	100.0
Total	**13,060.9**	**16,181.0**	**40,923.5**	**48,147.0**	**37,778.7**	**16,205.7**	**53,984.4**	**48,521.0**	**15,807.0**	**64,328.0**	**70.0**	**75.4**

Note: Road lengths for 1995 are estimates.

Figure 1.0: Road Distribution by Type and Jurisdiction (source by: //http: www.epu.gov.my, May 10,2012)

Although a lot of money was spend in order to improve the level of service for the roads, but it still facing with the deterioration problems. A lot of defection occurred because of not adequate maintenance progressively deteriorate with time travel. Besides, because of not proper construction lead to this problem. Defection has been occurred such as potholes, cracking and other that are easily been seen on the road surface. For example the Senai Desaru Highway that cost RM 1.37 billion is been grossed under unsatisfactory. Malaysia Highway Authority (MHA) that the highway was been found not following the specification which is resulting damage to the road surface and endangering the road users (The Star, Tue, Oct 25, 2011)

Studies have proved that if implement preventative maintenance actions on pavement can be more cost effective compare trying to rehabilitate the pavement later. Premature periodic maintenance is 20 times costlier compare to proper routine maintenance while 3 times costly to strengthen the pavement rather than properly maintain it (Robinson, 1988) It is also been stated that the timely maintenance can

increase the pavement's service life by 5 to 10 years (OECD, 1990a). The maintenance is important for the highway user as it is can avoid from unsafe conditions rather than to rectify the defect after accident was occurred. Poor maintenance can increase the vehicle operating costs by 15% and no maintenance is 50% (Robinson, 1988).

It need to arrange a night watchman for the equipment that is left overnight and ensure that correct traffic signs are erected to safeguard any equipment left on the road. For a long term of reconstruction projects on the high volume freeways, the contractor need to find the way to implement traffic control techniques and strategies that can maximize the roadway capacity through the work zone. These are been stated like use the portable concrete and paddle screens; closure of entrance ramps within the work zone or restriction of their high occupancy vehicles. To temporary travel lanes, it need to wide and upgrade the shoulders. Besides, reversible lane can be used to control the peak period traffic and use of service patrol (Ullman et al, 1989).

Federal road at Malaysia mostly used the flexible pavement compare to rigid pavement because flexible pavement is more comfortable to the user. Furthermore, flexible pavement can be use by users once ready. There are three main categories of the road has been divided which are toll expressway (1,700 km), federal roads (17,500 km) and state roads (61,100 km). The life spans of roads been estimated between 10 to 15 years (Zakaria and Hassan, 2005). INDOT Design Manual (INDOT, 2008) stated differentiate between the flexible (asphalt) pavement and rigid (concrete) pavement. With proper design and proper construction method, adequate routine and periodic maintenance are necessary to achieve the determined design life spans and even beyond.

	Composite/Flexible Pavement Distresses	Jointed Concrete Pavements
Distress Category	**Distress Type**	**Distress Type**
Cracking	Alligator Cracks Transverse Cracks Block Cracks Longitudinal Cracks Edge Cracks Widening Cracks	Corner Breaks Durability Cracks Transverse Cracks Longitudinal Cracks
Patching and Potholes	Patching Potholes	
Surface Defects	Raveling	
Surface Deformation	Rutting	
Joint Deficiencies		Transverse Joint Spalling Longitudinal Joint Spalling Transverse Joint Seal Damage
Miscellaneous	Pumping Maintenance actions	Pumping Faulting Maintenance

Figure 1.1: Differences between Flexible and Rigid Pavement

As been known, heavy vehicles also lead to deterioration of the road. There were 19.3 million registered vehicles on the Malaysia road. The government spent around RM 5 billion between 2001 and 2010 to sustain the Federal (New Strait Times, June 2010). Heavy vehicle also been banned during morning peak hours started 2 August 2010 from certain time to avoid traffic congestion on the North-South Expressway. Referred to Tan Sri Mustafa Mansur, Federation of Malaysian Manufacturer president's (2010) there will not give much impact because lorries still can use other alternative roads to their destination. After the investigation was done, it result that the total of heavy vehicle breakdown three times more than light vehicles. It leads to the increasing of traffic congestion (Berita Harian, 2010). However, it gave other perception to the Pan Malaysia Lorry Drivers Association president, Er Sui See because it unfair and absurd to expect them apply for temporary permits each time they need to use the highway during the ban time (The Star, July 2010).

1.5 Aims and objectives

The aim of this study is to investigate the roads defects and the root cause of the problems. To achieve the aim of this study, there are four objectives has been determined such as:

1. To examine the different types of roads construction.
2. To evaluate the types of road defects.
3. To investigate the root cause of the road defects.
4. To assess the clients budget allocation for road maintenance and rehabilitation.

1.6 Scope of Study

The scope of study for this research is focusing the maintenance work that been done by the Public Work Department (PWD) for all Federal Road. Besides, the entire problem occurred with the road maintenance need to get the data from the Public Work Department. Road Maintenance Department is the main focus for this research because this department is doing the maintenance and rehabilitation of road. This study will be conducted at Tampin district. They would be some question and answer with the expertise about the deterioration of road. Literature review was done based of several resources including the problem and requirement to do road maintenance in local authority. Other resources such as journal, books and also articles been used in this project.

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