PROJECTION ON PAVEMENT LIFE TIME FOR FR 222 ACCESS ROAD TO GAMBANG TOLL

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ABSTRACT

Flexible pavements in Malaysia are designed until 10 to 15 years design life to support load from the vehicles. Sometimes these roads are not able to carry the load with the specified design life. The proposed study area that is looking at is FR 222 access road to Gambang Toll. From the observation, the condition of pavement of FR 222 (access road to Gambang Toll & UMP) is sub-standard. It is because the road was gazette as industrial access prior to the opening of Gambang Toll Plaza and UMP and these resulted in uneven pavement surface that inconvenient to road users. The objectives of this study are to estimate the thickness of pavement on FR 222 access road to Gambang Toll using Arahan Teknik (Jalan) 5/85, Manual on Pavement Design, Jabatan Kerja Raya and to formulate pavement lifetime based on failure analysis of flexible pavement. Traffic volume count, interview survey and visual inspection are conducted on this study to accomplish and achieved the study objectives.

ABSTRAK

Di Malaysia, turapan fleksible telah direka bentuk dalam jangka hayat 10 hingga 15 tahun. Kadang-kala, jalan raya tidak dapat menampung beban yang diterima dalam jangka hayatnya. Kawasan kajian ini terletak di Jalan Persekutuan 222 menghala masuk ke Tol Gambang. Daripada pemerhatian yang dibuat,keadaan turapan di Jalan Persekutuan 222 menghala masuk ke Tol Gambang dan UMP adalah sub-standard. Hal ini kerana jalan tersebut telah digazetkan di bawah kawasan perindustrian dan jalan masuk utama ke Tol Gambang dan UMP. Hal ini berlaku kerana ketidaksamarataan permukaan turapan yang boleh menyebabkan ketidakselesaan kepada pengguna. Objektif untuk kajian ini adalah untuk menggangarkan ketebalan turapan di Jalan Persekutuan 222 menghala masuk ke Toll Gambang menggunakan Arahan Teknik (Jalan) 5/85, Manual untuk Reka Bentuk Turapan, Jabatan Kerja Raya dan untuk merumuskan jangka hayat turapan berdasarkan kadar kegagalan turapan fleksible.

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AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
CBR	California Bearing Ratio
ESAL	Equivalent Single Axle Load
FHWA	Federal Highway Administration
FR	Federal Road
HMA	Hot Mix Asphalt
HOV	High-Occupancy Vehicle
JKR	Jabatan Kerja Raya
KK4	Kolej Kediaman 4
LEF	Life Extension Foundation
Pc	Percentage of Commercial Vehicles
PMA	Polymer Modified Asphaltic
R5	Rural 5
T5	Trunk 5
UMP	University Malaysia Pahang

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND STUDY

Road has played an important role in the trade and transportation system throughout the world, and it become rapid increase in the pavement infrastructure development in Malaysia. Gazette under Federal Roads Ordinance is usually roads linking the state capitals, airports, railway stations and ports. Currently, Malaysia has more than 80,300km roads. The road is divided into three main categories namely toll expressway (1,700km), federal roads (17,500km) and state roads (61,100km) and the life spans are between 10 to 15 years (Zakaria and Hassan, 2005). Local authority road (city mall, municipal or local council) or kampong (district office) road is depending upon jurisdiction and normally maintained by the responsibility local authority (Haron, 2004).

The road pavement is the actual surface on which the vehicles will travel. Its purpose is twofold, to provide friction for the vehicles and to transfer normal stresses to the underlying soils. The purpose of a pavement is to carry traffic safely, conveniently and economically over its extended life. The pavement must provide smooth riding quality with adequate skid resistance and have adequate thickness to ensure that traffic loads are distributed over an area. The performance of the pavement therefore related to its ability to serve traffic over a period of time (Hernadi T. Cahyanto, 2005).

Federal road at Malaysia almost used the flexible pavement compare to rigid pavement because flexible pavement more comfortable to the user. Furthermore, flexible pavement can be use by users once ready (Nurul Elma Kordi, 2010).

From the day it is opened to traffic, a pavement will suffer progressive structural deterioration. It is possible that the pavement may not fulfill its intended function of carrying a projected amount of traffic during its design life, because the degree of deterioration is such that reconstruction or major structural repair is necessitated before the end of the design life.

1.2 PROBLEM STATEMENT

Flexible pavements in Malaysia are designed until 10 to 15 years design life to support load from the vehicles. Sometimes these roads are not able to carry the load with the specified design life. The proposed study area that is looking at is FR 222 access road to Gambang Toll. From the observation, the condition of pavement of FR 222 access road to Gambang Toll and UMP is sub-standard. It is because the road was gazette as industrial access prior to the opening of Gambang Toll Plaza and UMP and these resulted in uneven pavement surface that inconvenient to road users.

On this access road, the condition of pavement is not very good because the area is having development in building construction. Heavy trucks always using the road to moves their goods. A lot of distress on the flexible pavement and it become uncomfortable feelings to the driver. Besides, the road also is the main entrance for bus to enter the East-Coast Highway. The road is bumping, indicating that pavement not maintain properly. It may leads to traffic accidents.

Therefore, this study will estimate the thickness of pavement on FR 222 access road to Gambang Toll by using Arahan Teknik (Jalan) 5/85, Manual on Pavement Design, Jabatan Kerja Raya.

As major result of the study by study, this paper will discuss on failure of flexible pavement and source failure of flexible pavement.

1.3 OBJECTIVE OF STUDY

The objectives of this study are:

1. To estimate the thickness of pavement on FR 222 access road to Gambang Toll using Arahan Teknik (Jalan) 5/85, Manual on Pavement Design, Jabatan Kerja Raya.

2. To formulate pavement lifetime based on failure analysis of flexible pavement.

1.4 RESEARCH QUESTION

In order to achieve the objectives of this study, the research questions were designed based on the criteria needed.

1. Does the thickness pavement design is satisfy the using Arahan Teknik (Jalan) 5/85, Manual on Pavement Design, Jabatan Kerja Raya?

2. Is pavement maintenance work carried out according to expected design life of the pavement?

1.4 SCOPE OF STUDY

Scopes of this research include the following procedures:

1. Traffic estimation or count on FR 222 access road to Gambang Toll.

2. Design the thickness of pavement using Arahan Teknik (Jalan) 5/85, Manual on Pavement Design, Jabatan Kerja Raya.

3. Getting information on the failure of flexible pavement and source failure of flexible pavement.

1.6 EXPECTED OUTCOMES

The expected outcomes from this study are to get the pavement thickness structure layer on FR 222 access road to Gambang Toll. Besides, it will also come out with cause of failure flexible pavement and source on flexible pavement on Malaysia road.

1.7 SIGNIFICANCE OF STUDY

This study will serve a good application of highway engineering into practice by giving the opportunity for the student to conduct field research such as traffic volume study and expose to the design of thickness of road pavement for FR 222 access road to Gambang Toll. Besides, the finding of this study also will be useful to the road authorities such as Public Department Work for further maintenance works.

CHAPTER 2

LITERATURE REVIEW

2.1 FLEXIBLE PAVEMENT

Flexible pavements are so named because the total pavement structure deflects or flexes and under loading. In Malaysia, Federal road use the flexible pavement that constructed with asphaltic cement and aggregates and consist of several of layers with the lowest called the sub-grade which natural soil itself. The next layer is the sub-base, which consist of crushed aggregate. The next layer is called road base (base course), which can be made of crushed aggregates with a cementing material. The top layer is called surfacing layer. It is usually made of asphaltic concrete. The structural strength depends on individual material strength characteristic and thickness layer. Some form of deflection within the elastic limit is allowed. Surface readability is good but relatively less durable or susceptible to high temperature (Haron, 2004).

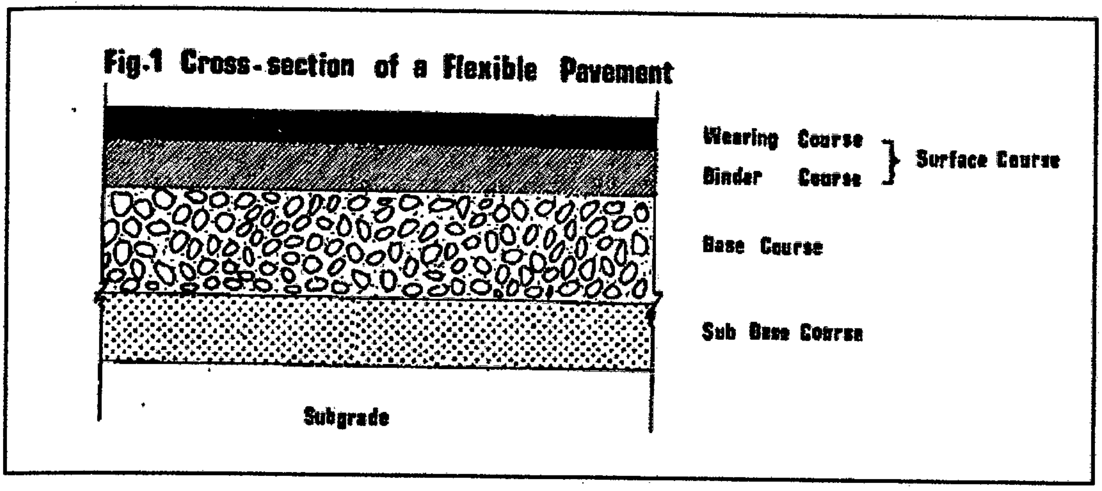

Figure 2.1: Cross Section of a Flexible Pavement

Source: Arahan Teknik (Jalan) 5/85, Manual on Pavement Design, Jabatan Kerja Raya

In order to take maximum advantage of this property, material layers are usually arranged in order of descending load bearing capacity with the highest load bearing capacity material (and most expensive) on the top and the lowest load bearing capacity material (and least expensive) on the bottom.

2.2 BASIC STRUCTURAL ELEMENT OF FLEXIBLE PAVEMENT

2.2.1 Surface Course

The surface course is the layer in contact with traffic loads and normally contains the highest quality materials. It provides characteristics such as friction, smoothness, noise control, rut and shoving resistance and drainage. In addition, it serves to prevent the entrance of excessive quantities of surface water into the underlying base, sub-base and sub-grade (NAPA, 2001). This top structural layer of material is sometimes subdivided into two layers (NAPA, 2001):

1. **Wearing Course.** This is the layer in direct contact with traffic loads. It is meant to take the brunt of traffic wear and can be removed and replaced as it becomes worn. A properly designed and funded preservation program should be able to identify pavement surface distress while it is still confined to the wearing course. This way, the wearing course can be rehabilitated before distress propagates into the underlying intermediate/binder course.

2. **Intermediate or Binder Course.** This layer provides the bulk of the HMA structure. Its chief purpose is to distribute load.

2.2.2 Base Course

The base course is immediately beneath the surface course. It provides additional load distribution and contributes to drainage and frost resistance. Base courses are usually constructed out of (NAPA, 2001):

1. **Aggregate.** Base courses are most typically constructed from durable aggregates that will not be damaged by moisture or frost action. Aggregates can be either stabilized or unsterilized.

2. **HMA.** In certain situations where high base stiffness is desired, base courses can be constructed using a variety of HMA mixes. In relation to surface course HMA mixes, base course mixes usually contain larger maximum aggregate sizes, are more open graded and are subject to more lenient specifications.

2.2.3 Sub-Base Course

The sub-base course is between the base course and the sub-grade. It functions primarily as structural support but it can also:

1. Minimize the intrusion of fines from the sub-grade into the pavement structure.
2. Improve drainage.
3. Minimize frost action damage.
4. Provide a working platform for construction.

The sub-base generally consists of lower quality materials than the base course but better than the sub-grade soils. A sub-base course is not always needed or used. For example, a pavement constructed over a high quality, stiff sub-grade may not need the additional features offered by a sub-base course so it may be omitted from design. However, a pavement constructed over a low quality soil such as swelling clay may require the additional load distribution characteristic that a sub-base course can offer. In this scenario the sub-base course may consist of high quality fill used to replace poor quality sub-grade (NAPA, 2001).

2.3 PAVEMENT THICKNESS DESIGN

The thickness design of the pavement is the determination of the overall thickness of the road and the thickness of the individual layers. The thickness design of pavement shall be based on the design CBR (California Bearing Ratio) of the sub-grade and total number of 8.16 tone standard axle application for a specific design period. The design CBR of the sub-grade and the total equivalent standard axle are the main factor in the structural design of the pavement.

The design chart is based on the AASHO Road Test Relationship at terminal serviceability of 18-kip single axle for sub grade of 3%. The thickness for other sub-grade CBR is obtained through the use of Chevron, a multi layer elastic theory computer program. The input for the computer program is based on the following material properties (Arahan Teknik (Jalan) 5/85, Manual on Pavement Design, Jabatan Kerja Raya).

2.4 CALIFORNIA BEARING RATIO

The California Bearing Ratio (CBR) test is a simple strength test that compares the bearing capacity of a material with that of a well-graded crushed stone (thus, a high quality crushed stone material should have a CBR at 100%). It is primarily intended for, but not limited to, evaluating the strength of cohesive materials having maximum particle sizes less than 19 mm or 0.75 in. (AASHTO, 2000).

A minimum CBR of 5% is recommended for pavements that have to support traffic volumes corresponding to Traffic Classes T 2 through T 5. If the sub-grade (cut or fill) does not meet this minimum CBR requirement, at least 0.3 m of unsuitable sub-grade soil shall be replaced or stabilized to ensure that the selected minimum CBR value is obtained under due consideration of applicable moisture conditions and probability of meeting the design input value. For road pavements designed for large volumes of traffic (Traffic Classes T 4 and T 5), a minimum sub-grade strength corresponding to CBR of 12% is recommended. For pavement design purposes, the use of average CBR or sub-grade modulus test results is not recommended; it would signify that there is only a 50% probability that the design input value is met (Harun. M. H, 2005).

2.5 DESIGN PERIOD OF PAVEMENT

The design period refers to the span of time between the initial passings of user traffic until the fatigue limit of the pavement whereby a strengthening overlay is required. The design period should not be confused with the pavement lifetime can be extended by strengthening overlays. Currently, a design period of twenty years is stipulated. A design period of only ten years is to be specified. However, as an initial study has indicated that it would be economical in terms of initial capital outlay and also with respect to the total cost (Arahan Teknik (Jalan) 5/85, Manual on Pavement Design, Jabatan Kerja Raya).

Pavement design life, also referred to as performance period, is the period of time that a newly constructed or rehabilitated pavement is engineered to perform before reaching its terminal serviceability or a condition that requires pavement rehabilitation. The selected pavement design life varies depending on the characteristics of the highway facility, the objective of the project, and projected traffic volume and loading (Highway Design Manual, 2009).

2.6 TRAFFIC VOLUME

Traffic volume studies are conducted to determine the number, movements, and classifications of roadway vehicles at a given location. These data can help identify critical flow time periods, determine the influence of large vehicles or pedestrians on vehicular traffic flow, or document traffic volume trends. The length of the sampling period depends on the type of count being taken and the intended use of the data recorded. For example, an intersection count may be conducted during the peak flow period. If so, manual count with 30-minute intervals could be used to obtain the traffic volume data (Mohidudin. M, 2009).

A traffic study is conducted to evaluate the transportation system serving an area and to identify any improvements necessary to accommodate existing or projected traffic volumes. The study consists of data collection, including existing traffic volumes and turning movement's counts, projected traffic volumes, and the identification of required improvements such as traffic calming devices. Any identified improvements may include a feasibility analysis, including identification of impacted properties, impacted structures, alternate alignments, physical constraint and roadway design criteria to be used (Mohidudin. M, 2009).

2.7 ESTIMATING EQUIVALENT SINGLE AXLE LOAD (ESAL)

The information obtained from traffic projections and Truck Weight Studies is used to develop 18-kip Equivalent Single Axle Load (ESAL) constants that represent the estimated total accumulated traffic loading for each heavy vehicle (trucks and buses) and each of the four truck types during the pavement design life. Typically, buses are assumed to be included in the truck counts due to their relatively low number in comparison to trucks. However, for facilities with high percentage of buses such as high-occupancy vehicle (HOV) lanes and exclusive bus lanes, projected bus volumes need to be included in the projection used to determine ESALs (Highway Manual, 2008).

A basic element in pavement design is estimating the ESALs a specific pavement will encounter over its design life. This helps determine the pavement structural design (as well as the HMA mix design in the case of super pave). This done by forecasting the traffic the pavement will be subjected to over its design life then converting the traffic to a specific number of ESALs based on its makeup. A typical ESAL estimate consists of (Pavement Interactive, 2010):

i. **Traffic count**

A traffic count is used as starting point for ESAL estimation. Most urban areas have some amount of historical traffic count records. If not, simple traffic tube counts are relatively inexpensive and quick. In some cases, designers may have to use extremely approximate estimates if no count data can be obtained.

ii. **A count or estimate of the number of heavy vehicles.**

This usually requires some sort of vehicles classification within the traffic count. The simplest classification divides vehicles into two categories

a. Heavy trucks
b. Others

Other more elaborate schemes can also be used such a FHWA's vehicle classification.

iii. **An estimated traffic (and heavy vehicle) growth rate over the design life of the pavement.**

A growth rate estimate is required to convert a single year traffic count into the total traffic experienced over the pavement design life (in years).

iv. **Select appropriate LEFs to convert truck traffic to ESALs.**

Different region may experience different types of loads. For instance, a particular area may experience a high number of trucks but they may be mostly empty thus lowering their LEF.

v. **An ESAL estimate.**

An ESAL estimate can be made based on the preceding steps. Depending upon circumstances these estimates may vary widely. Figure 2.3 shows an example of a pavement that was built for an estimated ESAL loading but experiencing a much higher loading due to a marked increase in bus traffic.

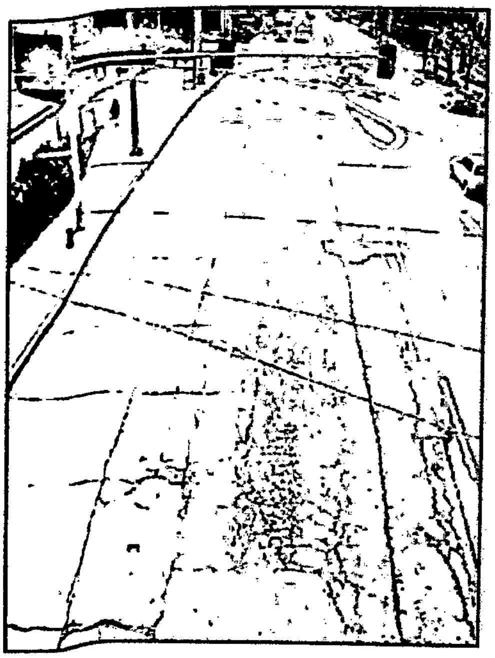

Figure 2.2: Resulting Damage from a Marked Increase in ESAL

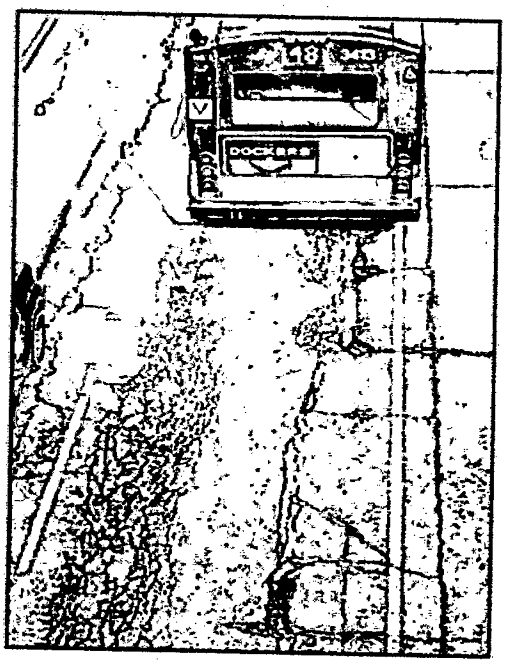

Figure 2.3: Likely caused of increased ESAL

Source: Pavement Interactive, (2010)