UNIVERSITI PUTRA MALAYSIA

COST COMPARISON BETWEEN STONE MASTIC ASPAHLT (SMA) AND ASPHALT CONCRETE WEARING COURSE (ACW20)

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Chairman: **Ir. Salihudin Hassim**

Faculty: **Engineering**

Stone Mastic Asphalt (SMA) technology has been introduced to Malaysian construction industry since the 1990s. Since then, several trial lay projects were carried out to study the performance of the mix. However the acceptability of SMA among local road agency is quite discouraging due to previous reports on the high cost of SMA. However a Malaysian study reported that the construction cost of SMA is actually 10 % to 15% less than the conventional mix. Hence, the study aims to clarify this matter by comparing the construction cost of SMA and ACW20 by using significant cost elements identified by a multiple regression analysis. The analysis covered 27 SMA and ACW20 projects in Selangor. Cost data was collected via a standardized questionnaire. The result indicates that the construction cost of SMA can be comparable to ACW20 if the material cost does not exceed RM 102/ton and the thickness does not exceed 35 mm. Finally, the study revealed that the construction cost of a thinner SMA layer can be made compatible with the conventional mix. Furthermore a thin SMA layer performs much better than thicker asphalt concrete surfacing as indicated by various local and overseas studies.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PERBANDINGAN KOS DI ANTARA STONE MASTIC ASPAHLT (SMA) DAN ASPHALT CONCRETE WEARING COURSE (ACW20)

Oleh

ROHIMAH KHOIRIYAH BT MOHD. ARIFIN HARAHAP
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Teknologi Stone Mastic Asphalt (SMA) telah diperkenalkan dalam industri pembinaan Malaysia semenjak tahun 1990an. Namun ia kurang mendapat sambutan daripada pihak berkuasa tempatan disebabkan banyak kajian menyatakan harga kosnya sangat tinggi. Namun satu kajian di Malaysia melaporan bahawa kos pembinaan SMA adalah 10% ke 15% lebih rendah daripada premix konvensional. Maka tujuan utama kajian ini adalah untuk membandingkan semula kos pembinaan SMA dengan ACW20. Ini dilakukan dengan mengambilkira kos signifikan yang dikenalpasti melalui satu analisa regresi berganda. Sebanyak 27 maklumat kos SMA dan ACW20 telah berjaya diperolehi daripada kuari-kuari yang menghasilkan bahan ini di Selangor. Data dikutip melalui temuduga persendirian menggunakan borang soalselidik yang seragam. Hasil kajian menunjukkan kos pembinaan SMA adalah setanding dengan ACW20 sekiranya kos bahan mentahnya tidak melelebihi RM 102/ton dan ketebalan lapisannya tidak melebihi 35 mm.

Akhir sekali kajian ini mendapati kos pembinaan bagi lapisan SMA yang nipis adalah setanding dengan kos pembinaan asphalt konkrit biasa. Malah banyak kajian terdahulu menyatakan bahawa keupayaan lapisan SMA yang nipis adalah jauh lebih baik daripan lapisan konvensional yang tebal.

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ACB28	Asphalt Concrete Binder Course (28 mm nominal aggregate size)
ACWC	Asphalt Concrete Wearing Course
ACW20	Asphalt Concrete Wearing Course (20 mm nominal aggregate size)
CIMA	Chartered Institute of Management
EDA	Exploratory Data Analysis
LCC	Life Cycle Cost
LCCA	Life Cycle Cost Analysis
MLR	Multiple Linear Regression
PC	Personal Computer
SMA	Stone Mastic Asphalt
SPSS	Statistical Package for Social Science
TDCPMS	Total Direct Cost per Meter Square
TDCPT	Total Direct Cost per Ton
WBS	Work Breakdown Structure

CHAPTER 1

INTRODUCTION

1.1 Problem Statement

The concept of Stone Mastic Asphalt (SMA) has been introduced to Malaysia road authorities as early as the 1990's. Since then, several trial lay projects had been initiated for purpose of studying the durability and stability of SMA in Malaysian traffic condition (UPM, 2000). However up until today, the acceptability of SMA is quite discouraging among the road authorities. As a result Malaysia road authorities have yet to publish any standard specification for the design mix of SMA.

The main reason why SMA is not accepted in Malaysia is probably due to the high cost of the mix. A United States study reported that the initial cost of SMA is 20% to 25% more than the conventional mix (Yu, 2000). This statement is also supported by a local researcher that the cost of a German-mix SMA constructed in Malaysia is 20% higher than the conventional mix (RSRC, 2000). However, researchers of Auburn University believed that the extra cost of SMA is providing good performance in high volume traffic roads (Brown et. al., 1997).

The claims on high cost of SMA contradicted with a Malaysian study conducted by University Putra Malaysia (2000). According to UPM their SMA's design mix is able to reduce the construction cost by 10% to 15%. This is due to the reduction in the overlay thickness by 12% to 37% as compared to the conventional overlay (Marzita Abdullah, 2000).

Previous US study also recorded that the user cost of conventional surfacing with design life of 7.5 years, is more expensive than its SMA counterpart of 10 years design life (Yu, 2000). In other words, SMA surfacing gives an extended life of 2.5 years as well as cost saving in road user and maintenance costs. This claim is also supported by UPM which reported that SMA surfacing is able to extend pavement to 1.5 times longer than the normal mix. The US study also reported that the maintenance cost of a 15 years SMA road is particularly low at US$ 41,410 per mile (Yu, 2000). Thus in term of life cycle cost analysis, SMA pavements need to last only 2 years longer than the conventional pavements in order to pay for themselves (Yu, 2000).

From the discussion above, it is clear that the ambiguous cost of SMA must be resolved through scientific research.

1.2 Significance of Study

The cost of maintaining road has increased over the years. In year 2003 alone, the Public Works Department of Malaysia (JKR) reported a road maintenance expenditure of *RM 585, 440,400 (Mohamad Razali and Zulakmal, 2004). Aside from that, the road sector has to compete with other economic sector for adequate funds. In addition to the budget constraint, increased public expectations have encouraged the road authorities to delicately balance the functional and structural requirement of roads (Mohamad Razali and Zulakmal, 2004).

Furthermore, 77.1% (or 66,190 kilometers) of Malaysian roads are paved making it the major transportation route for economic activities of the country (JKR, 1999). Hence it is just logical to provide a high performance road surfacing material that maintains the durability, riding comfort as well as safety to the road user.

Most importantly, one of the strategies of the 8th Malaysian Plan (2001 to 2005) for the infrastructure development aims to improve the road service quality through thorough checking on the performance and the technical specification as well as the implementation of new or modified road technology (Abdullah Badawi, 2004). Another important strategy is to develop reliable and affordable road networks.

* US$ 1.00 is approximately equivalent to RM 3.80

Aside from that, the 8th Malaysian Plan also stressed on increasing the quality and the safety aspects of road network. Hence, the government planned to allocate an amount of RM 5.1 billion for building new roads and an amount of *RM 8.9 billion for maintaining and upgrading existing road network (Abdullah Badawi, 2004). A bigger budget will be allocated for road maintenance in order to increase road safety, riding comfort, travel time as well as constructing new motorist lane on selected dangerous road.

In short there is an increase of more than RM 1.7 billion in the development budget for year 2001 to 2005 where RM 14 billion or approximately 51.9% of the total infrastructure development will be spend on constructing and maintaining road network (Abdullah Badawi, 2004). Thus, it is just right to reconsider the application of new surfacing technology such as Stone Mastic Asphalt for upgrading and maintaining the tropical road pavement in Malaysia.

1.3 Research Questions

In order to generate the research objectives, it is best to brainstorm all the possible questions and doubts arise from the earlier discussion in Section 1.1 and 1.2.

Thus, the main research question asked is: 'Why the construction cost of SMA surface course is more expensive than the conventional ACW20?', as claimed by previous Stone Mastic Asphalt studies recorded by Yu (2000).

Other questions and issues generated by this research are as follows:

i. What are the significant cost elements, which can represent the construction cost of SMA and ACW20?
ii. How to estimate the construction cost of SMA and ACW20 using the significant cost elements?
iii. In terms of economy, when is the best time to implement SMA instead of the conventional mix?
iv. Who should be interested in the prediction of the construction cost of SMA and ACW20?

1.4 Research Objective

This study was initiated for purpose of comparing the cost of SMA with a conventional surface course mix. Hence, the dominant objectives of this research are:

i. To compare the construction cost of Stone Mastic Asphalt (SMA) with the conventional asphalt concrete wearing course (ACW20).

ii. To identify the significant cost elements for estimating the prime cost of the two comparable premixes.

iii. To propose a decision-making guideline for the selection of SMA over the conventional mix.

1.5 Scope and Limitation

The scope and limitation in the study of cost analysis of SMA and ACW20 are as follows:

i. The design mixes studied for cost comparison purpose are Stone Mastic Asphalt (SMA) with and without fiber stabilizer and Asphalt Concrete Wearing Course (ACW20) with aggregate nominal size of 20mm. These materials are chosen because SMA is the alternative premix to be studied while ACW20 is the conventional mix used in Malaysia (JKR, 1994). Aside from that, both of these materials are applicable in high speed expressway making them viable for comparison.

ii. **The study focused on the wearing course and not other pavement layers such as base course, road base, sub base and sub grade. The significance behind this is because the price of the wearing course layer varies based on the type of material used (JKR, 1995) while the prices of other pavement layers are usually constant as there is less variation in the types of material available.**