DEVELOPMENT OF SOFTWARE FOR RIGID PAVEMENT THICKNESS DESIGN

MOHD KHAIRUL IDHAM BIN MOHD SATAR

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Dedicated to

my dad Mohd Satar bin Sa'ad, my mum Rosmiah bte Abd Samad, my family and to a special person... for their love, support and patience are awesome

also not forgotten to all my colleagues...., for their assistance and encouragements towards the success of this study

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ABSTRACT

Rigid pavement is frequently misunderstood form of construction. Many people assume that rigid pavement is costly and not effective. However, it has been proven that it is good in term of the strength and durability to cater high traffic load compare to flexible pavement. However, in order to have good rigid pavement, the design procedures of the pavement should be properly applied. The vital issue in pavement design is thickness. There are two main approaches of design the rigid pavement thickness which are Portland Cement Association (PCA) method and American Association of States Highway and Transportation Officials (AASHTO) method. However, both methods are difficult to conduct manually and may produce inaccurate result. The difficulties can be expressed in term of time consuming and tedious calculation. Hence, it is very important to computerize the methods in order to make it more accurate and quicker. Although there are available software in the market but the software may not be user-friendly enough. It also does not allow the user to compare between methods. Generally, both methods have their own concept but there are still several same parameters considered. Therefore, the significance comparison between both methods can be done to select most economical pavement thickness design. Microsoft Visual Basic 6.0 was the tools used to develop the new software. Software named as AnP Pave was successfully developed. Moreover, based on the verification result there are only small difference between the software and manual calculation. However, an improvement needs to be applied to make the software capable to design pavement reinforcement and produce printable design report.

ABSTRAK

Turapan tegar sering disalaherti dari segi pembinaan dan penggunaanya. Ramai beranggapan turapan tegar menelan kos yang tinggi berbanding peranannya. Walau bagaimanapun, telah terbukti turapan ini mempunyai kekuatan dan berkeupayaan menanggung beban trafik yang lebih tinggi berbanding turapan lentur. Dalam mengahasilkan turapan tegar yang baik, proses rekabentuk hendaklah dilaksanakan dengan kemas dan teratur. Ketebalan turapan merupakan perkara pokok dalam proses ini. Terdapat dua kaedah utama dalam merekabentuk ketebalan jalan iaitu kaedah Portland Cement Association (PCA) dan kaedah American Association of State Highway and Transportation Officials (AASHTO). Namun, kedua-dua kaedah ini agak rumit untuk dilaksanakan secara manual dan berkemungkinan boleh menghasilkan keputusan yang kurang tepat. Maka, adalah penting pengiraan ini dijalankan dengan bantuan perisian komputer untuk menghasilkan keputusan yang lebih tepat dan cepat. Walaupun sudah terdapat perisian komputer terjual di pasaran, tetapi ia agak sukar digunakan kerana kurang mesra pengguna. Selain itu, pengguna tidak dapat membandingkan keputusan antara kedua-dua kaedah tersebut. Umumnya, konsep kedua-dua kaedah adalah berbeza, tetapi terdapat beberapa parameter yang sama yang diambilkira dalam kaedah-kaedah tersebut. Oleh itu, kedua-duanya boleh dibandingkan dalam memilih ketebalan turapan yang lebih ekonomi. Microsoft Visual Basic 6.0 digunakan untuk membangunkan perisian ini. Perisian baru ini dinamakan AnP Pave. Berdasarkan ujian pengesahan, keputusan menunjukkan hanya terdapat sedikit perbezaan antara kiraan secara manual dengan kiraan perisian ini. Penambahbaikan atas perisian ini boleh dijalankan dengan memasukkan pengiraan tetulang turapan dan menghasilkan laporan rekabentuk yang boleh dicetak.

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LIST OF ABBREVIATIONS

AASHTO	-	American Association of State Highway and Transportation Officials
APCA	-	American Concrete Pavement Association
PCA	-	Portland Cement Association
JPCP	-	Jointed Plain Concrete Pavement
JRCP	-	Jointed Reinforced Concrete Pavement
CRCP	-	Continuously Reinforced Concrete Pavement
SA	-	Single Axle
TA	-	Tandem Axle
NS	-	No Shoulder
WS	-	With Shoulder
ND	-	No Dowel
WD	-	With Dowel
LSF	-	Load Safety Factor
ADT	-	Average Daily Traffic
ADTT	-	Average Daily Truck Traffic
ESAL	-	Equivalent Single Axle Load

LIST OF SYMBOLS

W_{18}	-	Total 18-kip ESAL Application, AASHTO
E_c	-	Concrete Elastic Modulus,
k	-	Modulus of Subgrade Reaction
S_c	-	Modulus of Rupture
J	-	Load Transfer Coefficient
C_d	-	Drainage Coefficient
ΔPSI	-	Design Serviceability Loss
S_o	-	Overall Standard Deviation
R	-	Reliability
Z_R	-	Standard Normal Deviate

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CHAPTER 1

INTRODUCTION

1.1 Background of the Problem

Road infrastructure is essential in a new development area. New road infrastructure projects constitute of large investments in order to serve to the public for a long time. The investments have to be durable at the lowest life cycle cost and the pavements have to sustain loads from increasing traffic intensity and heavy traffic loads. Road structure encompasses several layers which are subgrade, sub-base, road base and surface layer. From bottom until top of the road structure play an important role to ensure the road is good enough to be serve to the public.

In general, there are two main pavement types which are flexible and rigid pavement. Rigid pavement is more complex to build, which required more specialized equipment. The current preference within the road industry is to flexible and composite road pavement. Flexible pavement bituminous surfacing while rigid pavement consists of a thick concrete top surface. In addition, composite pavement is where a flexible layer has been added on top of the surface of a rigid road, or where a concrete layer exists below a bitumen top surface.

The last major concrete road built in the Malaysia was in the late 1980s [1]. On the other hand, concrete roads are widely used in developed country such as Europe and United States for highway as well as rural roads. High initial cost is the main reason why the usage of concrete pavement is less.

However, with proper design and construction, concrete pavement can cater almost unlimited amounts of any type of traffic with ease, comfort and safely. The surface is smooth, dust-free and provides good skid resistance. Therefore, it is economical such that low in maintenance cost and it relatively permanence.

Consequently, to encourage the competition between different pavements, the tools for designing robust concrete pavements have to be brought forward. In order to emphasize concrete pavements as an alternative in road construction, the design must also be competitive.

1.2 Statement of the Problem

Concrete pavement design has over the years become a more important part for the promoting of concrete roads. High capital cost is balanced by the less cost of pavement maintenance and longer design period. However, proper design of concrete pavement needs to be emphasized in order to avoid lack of performance of concrete pavement. Moreover, time taken during design stage may also increase the capital cost. Although, many software application have been introduced to counter the problems, but it may be expensive, not user-friendly and not allow the users to compare which is more economical in term of the thickness between the design methods. Due to that, this study concentrated on the development of software that may help the design engineer as well as the contractor to choose the best pavement thickness in term of design and cost.

1.3 Objectives of the Study

This study aims to develop software for rigid pavement thickness design. The developed software is expected to achieve the following objectives:

i) To analyze and recognize the difference between Portland Cement Association (PCA) method and (American Association of State Highway and Transportation Officials (AASHTO) method in term of the concept and parameters used.

ii) To develop software that allows the design engineer to compare the results between two methods and select the prefer method.

1.4 Scope of the Study

This study considers all types of concrete pavement consist of jointed plain concrete pavement (JPCP), jointed reinforced concrete pavement (JRCP) and continuously reinforced concrete pavement (CRCP). However, it only focuses on two design methods which are PCA method and AASHTO method. Microsoft Excel and Microsoft Visual Basic 6.0 are tools used in order to achieve the objectives.

1.5 Significance of the Study

The significances of the study are as follows:

i) Manual design may take longer time compared with computerized design. Thus, at the end of the study, the software for rigid pavement design thickness is developed that may minimize the time taken in design process.

ii) Generally, the software also avoids human error made by the engineer during the calculation because it was developed according to the standard method and all calculation is computerized. Consequently, the result can be trusted and unarguable.

iii) Since, the software will comprise two design methods design engineer may select preferred one by comparing both methods.