UNIVERSITI TEKNOLOGI MARA

THE EFFECT OF RECLAIMED ASPHALT PAVEMENT (RAP) PROPORTION ON STRENGTH PROPERTIES OF A FULL DEPTH RECYCLING PAVEMENT

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MSc

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Candidate's Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of University Teknology MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as reference work. This thesis has not been submitted to any other academic or non academic institutions for any other degree qualification.

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ABSTRACT

Reclaimed Asphalt Pavement (RAP) is the term given to the removed and/or reprocessed pavement materials containing asphaltic concrete. Cold in-place recycling (CIPR) is the processing and treatment with bituminous and/or chemical additives of existing Reclaimed Asphalt Pavement (RAP) without heating to produce a restored pavement layer. The pavement recycling using CIPR technique may either full depth recycling or partial recycling depending on the use of base materials. Full depth recycling may involved the use of base material as a part of recycled pavement layer and partial recycling only used RAP material to rebuild the new road.

One of the advantages of the Cold in Place Recycling (CIPR) is cost savings of up to 40 percent over conventional techniques and also environmentally responsible method of asphalt pavement reconstruction. Pavement recycling was first introduced about half a century ago in the most of west country (e.g. United State America, South Africa etc). but the technology is relatively new in Malaysia. Currently in Malaysia, there is no documented guidelines/specification on the optimum RAP portion in stabilized recycled pavement mixes. The Road Engineering Association of Malaysia (REAM) had developed the Specification for Cold in Place Recycling but does not specify the requirement of RAP content for full depth pavement recycling. This study aims are to evaluate the strength properties of a full depth recycling pavement with different RAP proportions, and hence deduce the optimum reclaimed asphalt pavement proportion content in recycled mix design.

There were four (4) RAP proportions and crush stone aggregate combinations which were 0% RAP, 25% RAP, 50% RAP and 75% RAP from the total sample weight using one single grading. Proctor Test method was first carried out to determine the optimum moisture content at every RAP contents. In order to determine the optimum cement and binder content and binder content, similarly, 1.5%, 2.0% and 2.5% cement and 2%,3%, 4%, 5% and 6% bitumen emulsion by total weight were prepared at every RAP content. The samples were then tested for Marshall Stability, Density and Flow test for determination of the optimum bitumen emulsion and cement content of the recycled mixes at every RAP contents. The result of maximum stability, flow and density versus bitumen emulsion content were plotted to determine the optimum bitumen emulsion and cement content for every RAP contents. Samples were prepared at the optimum moisture content, optimum bitumen emulsion and cement content and tested for Unconfined Compressive Strength, Indirect Tensile Strength and Resilient Modulus at every RAP proportions to determine the performance of the recycled mixes.

The experimental results from this study had shown that the various RAP proportions in full depth recycle layer had resulted significant differences in strength performance to the recycled mixtures. The effectiveness of recycled mix also depends on the amount of the stabilising agent used in the mix. The additional of cement was able to enhance the performance of recycled mix with bitumen emulsion. The result showed that the used of different RAP content in the full depth pavement recycling effect the overall performance in recycled pavement mix design.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The total extend of Malaysia roads network is approximately 73,418.95 kilometers of pave road, 15,663.52 kilometers of gravel road and 2,929 kilometers of earth road and with that its about 58 % was federal roads and it was maintained by Public Works Department of Malaysia [1]. Malaysia spent about RM950 million for road maintenance program in year 2005 [2]. The total expenditure for road maintenance program had increase to 2.16 billion in year 2008 [1]. A desire to maintain a safe, efficient and cost effective roadway system has led to a significant increase in demand to rehabilitate the existing pavement. Malaysia was adopting the various type of pavement rehabilitation technique such as overlay, mill and pave, reconstruction, recycling etc.

In Malaysia, pavement recycling is quite new but has grown dramatically over the last few years as the preferred way to rehabilitation an existing pavement. The pavement could be recycled partially or fully depending on the existing road defect. Normally, recycling agent is used to rejuvenate the old pavement during the pavement recycling process. There are many types of recycling agent such as, fly ash, lime, cement, foamed bitumen and bitumen emulsion. The recycling agent was introduced while the existing pavement layer was milled and mixed using the milling machine. The material is then laid and compacted to form a stabilised base which is usually stronger than the previously existing base material. The exposed surface can be used temporarily as a driving surface but in most cases the recycled layer was overlaid with new surface material because the recycled layer typically has an open texture, poor surface durability and an unknown moisture susceptibility [3].