

PERFORMANCE OF MODIFIED COLD DENSE GRADED ASPHALT MIX  
USING OIL PALM FRUIT ASH (OPFAsh)

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Dedicated to:

*“ My beloved father, Abdullah Bin Abu Bakar and my lovely mother , Rosiah Binti Hussain,*

*my family, Aida n Iqbal, Ebab n Baby n Jojie*

*To all lectures especially Assoc. Prof Dr Mohd Rosli Bin Hainin,*

*for their love, support and patience”*

*Also not forgotten to all my friends,*

*for their helping and encouraging towards the success of this study”*

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## ABSTRACT

A lot of research has been conducted in order to investigate other alternative material as a modifier in asphalt mixtures whether for hot mix asphalt or cold mix asphalt. This thesis presents a study of laboratory evaluation on the performance of modified cold dense asphalt mix by incorporating the kerosene, diesel and fine oil palm fruit ash. The aggregates gradation considered in this investigation is dense graded (asphaltic concrete with 14 mm nominal maximum aggregate size- AC14). Laboratory trials were conducted to investigate the performance of modified cold dense graded asphalt mix using OPFAsh in modifying the asphalt binder. The Marshall properties of asphaltic concrete pavement were determined by carried out a series of test to the prepared samples with or without OPFAsh. The performances of resilient modulus also was conducted. Samples have been divided into two types which are controlled samples and modified samples (consist OPFAsh). For each modified samples the percentages of OPFAsh were varied from 5, 10 and 15 %. The parameter value results for each samples will compared with the specification SPJ/JKR/2008. The results show that the strength of resilient modulus will increase with increasing of the percentage of bitumen content. Nether less, the result for the Marshall test full fill all the specification except for the stability parameter.

## ABSTRAK

Banyak penyelidikan telah dijalankan bagi mencari bahan tambah alternative di dalam campuran asphalt sama ada untuk asphalt campuran panas atau asphalt campuran sejuk. Projek ini dilaksanakan bagi mengkaji kesan penggunaan ubahsuai campuran asphalt sejuk dengan menggabungkan minyak tanah, diesel dan abu kelapa sawit. Rekabentuk campuran yang diambil kira di dalam kajian ini ialah 'dense graded (AC14)'. Ujian makmal telah dijalankan untuk mengkaji prestasi ubahsuai campuran asphalt sejuk menggunakan abu kelapa sawit sebagai pengikat asphalt. Ciri-ciri Marshall bagi konkrit berasfalt telah dikaji dengan menjalankan ujikaji bagi sampel yang mengandungi OPFAsh dan juga sampel kawalan iaitu tidak mengandungi OPFAsh. Perlaksanaan 'resilient modulus' juga dilakukan. Sampel telah dibahagikan kepada dua bahagian iaitu sampel kawalan dan sampel ubahsuai termasuk abu kelapa sawit. Setiap sampel ubahsuai kandungan peratusan abu kelapa sawit dalam lingkungan 5, 10 dan 15%. Keputusan ujikaji setiap sampel akan dibandingkan dengan spesifikasi SPJ/JKR/2008. Keputusan menunjukkan kekuatan resilient modulus akan bertambah dengan pertambahan peratusan kandungan bitumen. Bagaimanapun, keputusan untuk ujian Marshall telah memenuhi semua spesifikasi kecuai untuk parameter kestabilan.

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**LIST OF ABBREVIATIONS**

OPFAsh	Oil palm fruit ash
JKR	Jabatan Kerja Raya
AC14	Asphaltic Concrete with Nominal Maximum Aggregate Size of 14mm
HMA	Hot Mix Asphalt
ASTM	American Society for Testing and Materials
JKR	Jabatan Kerja Raya
VTM	Voids in Total Mix
VMA	Voids in Mineral Aggregate
VFB	Voids Filled with Bitumen
OBC	Optimum Bitumen Content
SSD	Saturated-surface-dry
TMD	Theoretical Maximum Density
$G_{mb}$	Bulk specific gravity of compacted mix
$G_{sb}$	Combined bulk specific gravity of total aggregate
$G_{mm}$	Theoretical maximum density

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 BACKGROUND**

A lot of research has been conducted in order to investigate other alternative material as a modifier in asphalt mixtures whether for hot mix asphalt or cold mix asphalt. Asphalt cold mix design is a method of designing pavement structure. The process of designing including selecting appropriate graded aggregate materials and optimum bitumen content, so that the most suitable combination of composition and properties will give required strength or stability to withstand repeated load applications and get the most economic of pavement structure.

Asphalt cold mix is almost same with hot mix asphalt, however cold mix does not require to heat the aggregate compare to hot mix. Most of asphalt mixes were designed using Marshall and Superpave method, but in Malaysia method still be used for cold mix design. Some states used both methods on the same materials to get a better understanding of the characteristics of the mixtures.

Classified by the method of mixing, there are two type of cold mix, plant-mix and mixed-in-placed. Plant-mixed cold mixes are produce in stationary plants that

permit close control of the production process from materials proportioning through mixing, spreading and compacting is done with conventional paving equipment. Mixed-in-place cold mixes are produced at the paving site by means of travel plants, motor graders, or special in-place mixing equipment.

The design for cold mix is based on research conducted at the University of Illinois using a modified Marshall method of mix design and a moisture durability test. The design involved the following:

- Aggregate selection and quality test
- Asphalt selection and quality test
- Type and approximate amount of asphalt
- Water content at mixing and at compaction
- Variation of residual asphalt content
- Selection of optimum asphalt content

## **1.2 PROBLEM STATEMENT**

In general, Malaysia has not widely use cold mix premix, except in some rural area and patching work. Furthermore, the usage of hot mix asphalt quite expensive compare to the cold mix. Cold mix is economical because it needs low investment in equipment and locally available aggregate can be used. Additionally, cold mix easy to produce, it is a mixture of mineral aggregate and emulsified or cutback asphalt without heating the aggregate.

### **1.3 OBJECTIVE OF THE STUDY**

The objective of this study was to investigate the effect of adding fine oil palm fruit ash on the performance of the cold dense graded asphalt.

### **1.4 SCOPE OF THE STUDY**

The scope of the study focused on mix AC14 (dense graded). The bitumen of 80-100 Pen was used by weight of mixture of 12.5% kerosene, 1% diesel and fine OPFASH as the modified cold mix. The percentage of OPFASH used were 5%, 10% and 15% by the total weight of bitumen. The oil palm fruit ash was added in the mixes by using 'Wet Process' method. The performance of modified mixes was compared with unmodified mixer AC14.

### **1.5 SIGNIFICANT OF STUDY**

From the result of the study, the performance of different mixes with varied percentage of oil palm fruit ash can be obtained. Then, Marshall samples that meet the best performances were determine by comparing with the value suggested according to the JKR specifications. If the performance of mixes were found to be affected by the addition of oil palm fruit ash, the optimum content of oil palm fruit ash that most improves the characteristics of cold mixes was determined. Based on findings, if it is found beneficial, it can be proposed that oil palm fruit ash should be taken into consideration for further studies in the future. Besides, it really hopes that by using modified cold mix asphalt it will also can contributed to a lot of advantages



for highway engineering such as less economy by using modified cold mix asphalt compare to unmodified asphalt and also can solve the problem of waste material issue.