UNIVERSITI PUTRA MALAYSIA

PERFORMANCE OF CELLULOSE OIL PALM FIBRE (COPF) IN STONE MASTIC ASPHALT (SMA) MIX

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By

JEYAN A/L VASUDEVAN

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Dedicated to my beloved family:

Dad, Mum,

Brother, Sisters, Sister-in-law

And Brother-in-laws

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman : Mr. Ratnasamy Muniandy

Faculty : Engineering

A large amount of money is allocated annually to reduce skid-related accidents due to pavement failures. It seems that the current Hot Mix Asphalt (HMA) could no longer cater for heavy loading vehicles. This indicates that an alternative asphalt technology has to be looked into seriously. As such, Stone Mastic Asphalt (SMA) technology with Cellulose Oil Palm Fibre (COPF) was developed. It is a gap-graded mix with high percentage of coarse aggregate. This mix was found to be performing very well for heavy loading traffic with the use of COPF.

Fibre in SMA plays an important role to stabilise the mix and to minimise the draindown phenomena. This research aims to study the production and processing of the fibre and their performance in the SMA. The fibre production and processing was done using different types of pulping methods such as mechanical and chemical pulping. Each type of pulp products was analysed for its suitability as an anti-draindown agent by using the fibre-oil draindown test. In this study, the standard production and processing methods

would be adjusted or modified if the pulp product failed the oil draindown test or otherwise. When the produced pulp is found to be suitable as an anti-draindown agent, it was then added to the SMA mix to check its performance. Complete mechanical and chemical analyses were also performed on the fibre to check its ability to form micromesh netting.

Material selection of aggregate and asphalt was carried out in accordance with the specified standards. It was found that the selected material complied with SMA mix requirement. Besides that, determination of Optimum Asphalt Content (OAC) was carried out in accordance with the UPM in-house method. From the study OAC of 5.5% was obtained. In addition, a new method of determination of Optimum Fibre Content (OFC) was developed in the study. The OFC of Smartcel obtained through this method was 0.3%.

A detailed comparative performance study of SMA mix was carried out with different types of fibres and without any fibres. The performance was determined by using Density and Void Analysis, Resilient Modulus Test, Marshall Stability Test, Indirect Tensile Test, Moisture Induced Damage Test, Fatigue Test, Static Creep Test, Cantabro and Draindown Test. Results from the analysis revealed that SMA with fibre was performing well.

The entire analysis indicated that the performance of SMA with COPF fibre was far superior as compared to the other SMA with international fibres and SMA without any

fibre. This shows that SMA with COPF fibre can used as a heavy duty, durable and high skid resistance road pavement in Malaysia.

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

PERILAKU SELULOSA SERABUT KELAPA SAWIT DALAM TURAPAN CAMPURAN ASPHALT MAMAH

Oleh

JEYAN VASUDEVAN

April 2001

Pengerusi : En. Ratnasamy Muniandy

Fakulti : Kejuruteraan

Kos pemuliharaan jalan terutamanya bagi mengurangkan kemalangan yang disebabkan permukaan jalan, memerlukan perbelanjaan yang tinggi setiap tahun. Ini mungkin disebabkan oleh turapan campuran asphalt tradisional yang digunakan semasa ini tidak lagi mampu menampung beban gandar kenderaan. Oleh itu, satu teknologi turapan alternatif perlu ditinjau. Jesteru itu, turapan campuran asphalt mamah dengan selulosa serabut kelapa sawit (dikenali sebagai COPF dalam kajian ini) telah dihasilkan. Ia merupakan satu campuran gradiasi terbuka dengan peratusan batuan kasar yang tinggi. Campuran dengan COPF ini juga didapati mampu menampung beban gandar yang tinggi.

Serabut dalam campuran asphalt mamah memainkan peranan yang penting dalam menstabil dan mengurangkan pengaliran keluar asphalt dari campuran berkenaan. Fokus kajian ialah menghasilkan dan memproses serabut kelapa sawit, dan juga perilaku selulosa serabut ini dalam campuran asphalt mamah. Penghasilan selulosa serabut kelapa

sawit dijalankan dengan kaedah pulpa mekanikal dan kimia. Setiap produk pulpa berkenaan dikaji peranannya sebagai agen penghalang pengaliran keluar dengan menggunakan ujian pengaliran keluar minyak – serabut. Dalam kajian ini, jika produk yang dihasilkan didapati kurang memuaskan, cara penghasilannya akan diubahsuai. Jika produk yang dihasilkan didapati sesuai, ia seterusnya dimasukkan dalam campuran asphalt mamah bagi mengkaji perilakunya. Satu analisa menyeluruh bagi sifat mekanikal dan kimia serabut juga dijalankan untuk meramal kebolehannya membentuk jaringan mikro dalam turapan.

Pemilihan batuan dan asphalt dilakukan berasaskan spesifikasi yang disyorkan. Dari kajian yang dijalankan ke atas batuan dan asphalt yang dipilih, didapati bahawa ia adalah sesuai digunakan sebagai bahan dalam turapan campuran asphalt mamah. Selain itu, kajian penentuan asphalt optima yang dijalankan berasaskan keadah UPM menunjukan nilai optima sebanyak 5.5%. Selanjutnya, satu kaedah penentuan serabut optima dibentuk dalam kajian ini. Melalui kaedah baru ini, nilai optima 0.3% diperolehi bagi COPF.

Satu kajian perbandingan mendalam telah dijalankan ke atas campuran asphalt dengan pelbagai jenis serabut dan tanpa sebarang serabut. Kajian perbandingan ini dijalankan dengan Ujian Modulus Keanjalan, Ujian Kekuatan Marshall, Ujian Terikan, Ujian Tusukan Air, Ujian Kelesuan, Ujian Rayapan Static, Ujian Cantabro dan Ujian pengaliran keluar asphalt. Keputusan analisis ini menunjukan campuran asphalt mamah dengan serabut adalah lebih baik.

Keseluruhan analisis yang dijalankan menunjukan turapan campuran asphalt mamah dengan COPF mempamerkan keputusan yang lebih baik berbanding dengan campuran asphalt mamah dengan serabut lain dan campuran asphalt mamah tanpa sebarang serabut. Oleh itu, campuran asphalt mamah dengan COPF disyorkan bagi menangani masalah beban gandar berlebihan. Ia juga berkesan untuk mengurangkan gelinciran di jalanraya di Malaysia.

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