THE EFFECTS OF WASTE POLYETHYLENE TEREPHTHALATE AS AN AGGREGATE COATING ON THE PROPERTIES OF BITUMINOUS MIXTURE FOR ROAD MAKING

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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LIST OF SYMBOLS

A	Area of sample
BC	Bitumen content
CS	Compressive Strength
Fmax	Maximum load at failure
M_1	Initial Weight
M_2	Final Weight
M_3	Weight Loss
MC	Modifier Binder
OBC	Optimum Bitumen Content
OMC	Optimum Modifier Content
Wa	Weight of Aggregate
Wb	Weight of Binder

LIST OF ABBREVIATIONS

ACW	Aggregate Course Wearing
ASTM	American Society for Technology and Material
BS	British Standard
CRAM	Contained Rock Asphalt Mat
EG	Ethylene Glycol
HDPE	High Density Polyethylene
HMA	Hot Mix Asphalt
LA	Los Angeles
LDPE	Low Density Polyethylene
MS	Malaysia Standard
PET	Polyethylene Terephthalate
PMMA	Polymethyl Methacrylate
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl Chloride
SSRW	Standard Specification of Road Work
VMA	Voids in Mineral Aggregate
VFB	Voids Filled With Bitumen
VTM	Voids In Total Mix

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ABSTRAK

Penggunaan sisa plastik dalam pembuatan jalan raya pada masa kini dianggap sebagai salah satu pilihan positif untuk meningkatkan kualiti campuran berbitumen dan juga membantu mengurangkan pencemaran plastik kepada alam sekitar. Botol plastik terdiri daripada bahan polyethylene terephthalate (PET). PET mempunyai pelbagai kegunaan dan ia biasa digunakan untuk membungkus dan melindungi produk. PET dianggap sebagai bahan tidak terbiodegradasikan; akan tetapi, ia mungkin menyumbang kepada masalah alam sekitar apabila dilupuskan dalam kuantiti yang banyak. Oleh itu, peningkatan jumlah sisa ini perlu dikurangkan dengan cara menggunakannya semula bagi tujuan kegunaan lain yang bermanfaat. Melalui kajian ini, PET digunakan dalam pembuatan jalan dan kesan penggunaannya dikaji dari segi potensi bahan ini untuk digunakan bagi memperbaiki sifat-sifat campuran berbitumen. Dengan menggunakan proses kering, penyelidikan ini mengkaji peratus kandungan optimum bagi PET yang perlu ditambah bagi menyaluti permukaan batu dan kesan-kesan penambahannya terhadap campuran berbitumen serta seterusnya membandingkan perbezaan tersebut dengan sifat-sifat campuran konvensional tanpa penambahan PET. PET yang digunakan dalam campuran berbitumen telah dipotong menjadi cebisan-cebisan kecil bersaiz antara 2 mm hingga 5 mm. Dengan menggunakan kaedah Marshall mix design, 15 sampel telah disediakan bagi menentukan kandungan bitumen optimum dan kemudian 25 sampel telah digunakan untuk menguji sifat-sifat campuran yang telah diubahsuai dan untuk mencari kandungan optimum bagi PET. Kandungan bitumen optimum didapati 4.8% mengikut berat campuran bitumen dan ia dianggap sebagai kandungan pengikat yang optimum. PET dengan kandungan 2%, 5%, 10%, 15% dan 20% mengikut berat kandungan pengikat optimum 4.8% telah diuji. Hasil kajian menunjukkan bahawa 10% disyorkan sebagai peratus kandungan PET yang optimum kerana ia menunjukkan ciri kestabilan yang baik dengan 16.824kN, 2.32 g/cm3 ketumpatan pukal, 71.35% daripada ruang yang dipenuhi bitumen atau voids filled with bitumen (VFB), pengaliran berukuran 3.2248mm, 4.53% ruang udara atau air voids (AV) dan 15% ruang agregat mineral atau voids in the mineral aggregate (VMA). Campuran ubahsuai yang optimum mengandungi 10% PET mampu meningkatkan 15.23% kestabiltan dan 21.39% kekuatan mampatan berbanding campuran biasa. Keputusan kajian menunjukkan bahawa PET sebagai pengubahsuai mampu memberikan sifat kejuruteraan yang lebih baik dan semua dapatan kajian telah mengikut Standard Spesifikasi Jabatan Kerja Raya di Malaysia. Oleh yang demikian, penggunaan 10% PET daripada berat kandungan pengikat adalah sangat sesuai digunakan untuk menyaluti permukaan batu agar dapat menambah baik siaft-sifat campuran berbitumen bergantung kepada penambahan PET yang betul. Kajian ini mampu menjimatkan 10% kos pembuatan jalan di samping meningkatkan ketahanan jalan dalam jangka masa panjang.

ABSTRACT

Utilization of waste plastic in road making is nowadays considered as one of the positive options available to improve the quality of the bituminous mixture and also help to reduce plastic pollution in the environment. Plastic bottles are mainly composed of polyethylene terephthalate (PET). PET has many uses and is commonly used in processes such as packing and protecting. PET is considered a non-biodegradable material but it can also contribute to environmental problem when disposed in large quantities. Therefore, the growing quantities of waste should be reduced by reusing them for other useful applications. This research has examined the effects of using PET in a road making application by investigating its potential prospect in improving bituminous mixture properties. By using dry process, this research sought to determine the optimum percent of PET content that should be added to coat the aggregate and its effects on the properties of the bituminous mixture compared to those of the conventional mixture. PET was introduced in bituminous mixture in shredded forms between 2 mm and 5 mm. By using Marshall mix design method, 15 samples were used to determine the optimum bitumen content (OBC) followed by 25 samples to test the modified mixture properties and to find optimum PET content. The OBC was found to be 4.8% by weight of bituminous mixture and it was assumed as optimum binder content. PET of 2%, 5%, 10%, 15% and 20% by weight of the 4.8% OBC were tested. The results showed that 10% of PET would be the recommended optimum PET content because this level indicated good stability with 16.824kN, 2.32g/cm3 bulk density, voids filled with bitumen (VFB) with 71.35%,flow with 3.2248mm, air voids (AV) with 4.53%, and voids in the mineral aggregate (VMA) with 15%. Optimum modified mixture which consist 10% of PET has 15.23% higher stability value and 21.39% higher compressive strength compared to the conventional mixture. The outcomes showed that PET modifier would give better engineering properties and that all results analysed from the data adhered to the specifications of the Standard Specification of Road Work (SSRW) in Malaysia. In conclusion, 10% of PET by the weight of binder content is suitable to be used as aggregate coating to improve the bituminous mixture properties subjected to the right amount of addition. This finding helps to save cost of making pavement about 10% for the future development and to maintain the road in a long run.

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