PERFORMANCE OF STONE MASTIC ASPHALT INCORPORATING NANO TITANIUM MODIFIED ASPHALT BINDER

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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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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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ABSTRAK

Batu mastik asfalt (SMA) adalah sejenis turapan fleksibel yang sesuai dengan kawasan lalu lintas tinggi. Oleh karena itu, SMA dapat memenuhi jumlah trafik yang banyak. Selama bertahun-tahun, reka bentuk SMA terus bertambah baik dengan menambahkan penstabil, aditif, atau bahkan pengikat. Namun, pengubahsuaian ini kadang-kadang mahal dan tidak mesra alam. Di samping itu, kerana ciri penggredan jurang SMA di mana penggradan agregat tidak dinilai dengan baik (variasi ukuran agregat minimum), SMA mengalami beberapa kelemahan seperti pengikatan dan pengikatan pengikatan semasa pencampuran dan transportasi. Di antara bahan tambahan mungkin yang dapat meningkatkan kualitas nanomaterial. Nanomaterial dalam campuran aspal sejak kebelakangan ini menarik minat. Nanomaterial menunjukkan potensi pengubah yang dapat menghadapi masalah dalam campuran asfalt seperti ubah bentuk pramatang, busuk, dan keletihan. Oleh itu, titanium Nano digunakan dalam kajian ini dengan julat 1% hingga 5% berat bitumen dara. Bitumen yang diubah dapat diakses oleh sifat fizikalnya melalui ujian titik pelunakan, ujian penembusan dan putaran putaran, sementara untuk sifat kimia, FTIR dan XRD dilakukan, dan SEM-EDX untuk sifat morfologi. Makmal dilakukan lebih jauh dengan menilai prestasi mekanikal SMA yang diubah sesuai nano dengan modulus yang tahan lasak, kerentanan, dan ujian ujian dinamis. Dari hasilnya, pada penambahan 3% nano titanium, modulus berdaya tahan SMA menunjukkan peningkatan kekuatan 50% berbanding dengan sampel yang tidak diubah untuk suhu 20°C dan 50°C. Saluran pengikat juga menunjukkan pada sampel nano titanium 2% yang diubah suai, saliran pengikat turun dikurangkan sebanyak 91.5%. Perkara yang sama berlaku untuk pengikatan yang diubah pada 3% untuk SEM-EDX, yang menentukan pengikatan yang lebih baik tanpa pengikatan pengikatan bahan kimia yang sudah ada. Kesimpulannya, pengubahsuaian pengikat dengan titanium nano telah mempengaruhi komposisi pengikat yang membawa peningkatan dalam semua aspek bitumen yang mendorong prestasi mekanik campuran. Kajian ini dilakukan untuk meningkatkan prestasi mekanikal aspal batu mastik dengan pengikatan dengan nano titanium dengan harapan dapat memperoleh campuran SMA yang lebih baik yang dapat mempengaruhi lebuh raya Malaysia

ABSTRACT

Stone mastic asphalt (SMA) is a type of flexible pavement that suit to high traffic area. Therefore, SMA can cater high volume of traffic loads. Over the years, SMA design keeps improving by adding stabilizers, additives, or even modifying the binder. However, this modification sometimes costly and not environmentally friendly. In addition, due to gap graded characteristic of SMA where the aggregate gradation is not well graded (minimum aggregate size variation), SMA suffers a few drawbacks like bleeding and binder drain off during mixing and transporting. Among the potential additive that may improve the properties is nanomaterials. Nanomaterials in asphalt mixture have pique interest lately. Nanomaterials show a potential modifier that can encounter problems in asphalt mix like premature deformation, rutting, and fatigue. Thus, Nano titanium was used in this study with the range of 1% to 5% by weight of virgin bitumen. The modified bitumen is accessed by its physical properties through softening point test, penetration test and rotational viscosity, while for chemical properties, FTIR and XRD are carried out, and SEM-EDX for morphological properties. The laboratory is further performed by assessing the mechanical performance of nano-modified SMA by its resilient modulus, moisture susceptibility, and dynamic creep test. From the results, at 3% addition of nano titanium, the resilient modulus of SMA shows a 50% increasement in strength compared to the unmodified sample for both 25℃ and 40℃. The binder drain down also shows at 2% nano titanium modified sample, the binder drains down is reduced by 91.5%. The same goes for modified binder at 3% for SEM-EDX, which shows more well-dispersed binder components without eliminating the chemical binder elements that are already present. In conclusion, the modification of the binder with nano titanium has influenced the composition of the binder which brings improvements in all aspect of the bitumen which promotes the mechanical performance of the mix. This study is done to improve the mechanical performance of stone mastic asphalt by modifying the binder with nano titanium in hope to obtain a more well enhanced SMA mixture that could contribute to the expressways of Malaysia.

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