UNIVERSITI TEKNOLOGI MARA

EFFECT OF NANOPOLYACRYLATE AND NATURAL RUBBER LATEX ON ASPHALT BINDER AND MIXTURE PERFORMANCE

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Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy
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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 22th November 2017 to conduct the final examination of Ekarizan Bt Shaffie on her **Doctor of Philosophy** thesis entitled "Effect of Nanopolyacrylate and Natural Rubber Latex on Asphalt Binder and Mixture Performance" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiner recommends that the student be awarded the relevant degree. The Panel of Examiners was as follows:

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I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

The use of modified asphalt binder for asphalt mixtures is becoming common to provide a more durable and better performance for flexible pavement surfacing. This study presents the viability of nanopolyacrylate (NP) and natural rubber latex (NRL) as a modifier in asphalt binder and asphalt mixture. The objective of this study is to investigate the properties of asphalt binder mixtures containing NP and NC modifiers and their effect on the asphalt mixture performance of densely-graded (AC) and gap graded-stone mastic asphalt (SMA) according to Marshall mix design method. The study investigates fourteen different asphalt mixtures consists of NP and NC modified asphalt binder formulations. NP polymer modified asphalt binder was prepared by mixing penetration grade PEN 80/100 asphalt binder with 2, 4 and 6 percent NP by weight of asphalt binder at mixing temperature 140°C, mixing time 60 minutes, and mixing speed 1650 revolution per minute. While, Nanocomposite (NC) polymer modified asphalt binder was prepared by mixing penetration grade PEN 80/100 asphalt binder with optimum 6 percent NP with NR at several percentages ranging from 0 to 6 percent by weight of asphalt binder. The physical and rheological asphalt binder characterization and mechanical properties of asphalt mixture were assessed and evaluated with the laboratory tests. Physical asphalt binder tests result using penetration, softening point, storage stability and viscosity indicated that both NP and NC polymer modification improved the asphalt binder physical properties and temperature susceptibility. Rheological test using Dynamic Shear Rheometer also showed that addition of NP and NC to the asphalt binder may enhances the properties of modified asphalt binder. It was found that an increase in the percentage of NP and NC causes an increase in rutting factor ($G^*/\sin \delta$) and decrease in fatigue factor ($G^* \sin \delta$) indicating higher resistance against rutting and fatigue cracking. Therefore, it can be concluded that both polymers considerably improve elastic properties and rutting resistance of asphalt binder and thus could be used to enhance the asphalt mixture performance. The asphalt mixture performance of the NP and NC modifiers were investigated by resilient modulus, wheel tracking, dynamic modulus and moisture susceptibility test. The results show that the addition of NP and NC polymer into the mixture has a significant positive effect on the properties of AC14 and SMA14 which could improve the mixture's resistance against permanent deformation (rutting), stripping resistance and increase the stiffness of the mix. It was observed that the addition of NP and NC polymer gave better overall performance in the asphalt mixture. Two statistical models were developed in this study to evaluate a statistical relationship between resilient modulus with viscosity and $G^*/\sin\delta$ of asphalt binder. The tests revealed that the models have been successfully developed and validated thus could be effectively used to predict the asphalt mixture performance according to asphalt binder properties. Therefore, it can be concluded that NP and NC polymer is feasible to be used as asphalt modifier and 6 percent NC is the most effective proportion that could gave better asphalt binders and asphalt mixture performance compared to others.

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