UNIVERSITI TEKNOLOGI MARA

DEVELOPMENT OF MECHANISTIC FLEXIBLE PAVEMENT DESIGN METHOD FOR MALAYSIAN CONDITIONS

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Thesis submitted in fulfillment of the requirements
for the degree of
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ABSTRACT

Malaysia currently utilises an empirically-based pavement design procedure which is adopted from the AASHTO 1972 Design Guide. Elsewhere, pavement design approach is shifting towards mechanistic-based procedures that are based on the mechanics of materials. The purpose of this study is to develop a framework for mechanistic design of flexible pavement suitable for Malaysian conditions. In this study, resilient modulus characterisation of flexible pavement materials (asphaltic concrete wearing and binder course, base and subbase) used in Malaysia, according to the Public Works Department of Malaysia's (PWD) Specification for Road Works (JKR/SPJ/1988), were carried out so that these can be used as inputs into a mechanistic-based procedure. Granite-type aggregates were used as it is produced by most quarries in Malaysia, and it is representative of the flexible pavement materials locally used. The repeated load indirect tensile test method (ASTM D4123-82) was used to investigate the effects of variations at different temperatures, gradation, bitumen content and penetration type and to determine the resilient modulus values of asphaltic concrete (ACW20 and ACB 28). Regression models of ACW20 and ACB28 were developed and recommended for use as predictive models. Base (Type II) and subbase (Type E) were tested at different gradations and moisture contents using the repeated load triaxial test in accordance with AASHTO T307-99. From the test, the k-θ constitutive model was used to characterise the base and subbase materials. Field work data derived from the Falling Weight Deflectometer tests were compared to the values obtained from laboratory testing of asphaltic concrete, base and subbase materials and were found to be consistent for those sites where the thickness of the pavement materials were consistent and uniformly layered. The proposed mechanistic design procedure for Malaysian conditions consist of input (layer thickness, material properties and traffic loadings), pavement response model (to calculate stress, strain and deflection) and a distress model to relate the pavement responses to the number of traffic load repetitions to failure. For Malaysian conditions, it is imperative that environmental correction/modification factors (temperature and moisture) be incorporated into the regression models (for asphaltic concrete) and constitutive models (for base and subbase materials) to determine their resilient modulus values which will then used as inputs in the pavement analysis. The mechanistic analysis of pavement structures was carried out using a multi-layered elastic analysis software, KENLAYER. An example using the proposed method was then illustrated and a mechanistic-based pavement design table using the regression and constitutive models obtained in the laboratory tests was then deduced for a tyre pressure of 690 kPa (100 psi). It is recommended that for future research in this area, the proposed design process be verified by full-scale tests of actual pavement performance throughout their design life.

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