THE DOCTORAL RESEARCH ABSTRACTS

Volume: 13, Issue 13  April 2018

13th ISSUE
Streambank erosion is commonly associated with river meandering initiation and development, through width adjustment and planform evolution. It consists of two types of erosion mechanism; basal erosion due to fluvial hydraulic force and bank failure under the influence of gravity. These processes require an integration between soil-water interactions to properly understand the factors constitutes to streambank erosion and its impact to major scouring. A study was undertaken to explore the rates of streambank erosion and the factors of streambank erosion. Fieldwork investigation technique was conducted in the quantification of streambank erosion rates. Field data has been extracted from two streams which have been identified as the area susceptible to streambank erosion, namely, Sg. Bernam and Sg. Lui, both located in states of Selangor, Malaysia. Measurement of streambank erosion rates has been conducted using short-time scale field technique. Conventional erosion pin arrays, repeated cross-profiling and vertical streambank profiling were employed in order to obtain the streambank erosion rates. The fieldwork data obtained from fieldwork erosion monitoring served as a pilot inventory streambank erosion data for both site areas. Dimensional analysis is performed to establish the factors governing streambank erosion. Two functional relationships addressing streambank erosion rates incorporating factors of hydraulic characteristics, resistance to the soil, streambank geometry, grain and sediment resistance were established using Buckingham PI theorem using two sets of repeating variables. Selection of the most significant parameters constitutes to streambank erosion rates is obtained from the analysis. Results from the analysis concluded eleven dimensionless parameters as factors governing streambank erosion rates. Further objective focused on the development of newly streambank erosion expression using empirical approach. A total of 318 data were used in the model development. Three methods have been employed in the model development, namely, (i) Statistical approach using multiple linear, nonlinear regressions, and logarithmic transformation function; (ii) Linear Least Squares (LLS) solution for Nonlinear Autoregressive Exogenous (NARX) using QR factorization parameter estimator; and, (iii) Artificial Neural Network (ANN) method. The established models were validated to assess their performances in predicting the rates of streambank erosion. 176 data were used in the model validation. The performance of the developed equations was assessed using three criteria, namely, (i) discrepancy ratio (ratio of predicted values to the measured values); (ii) statistical test analysis; and, (iii) graphical analysis. Validation of the developed equations confirmed that ANN model gave very good prediction where all data lie within the line of perfect agreement of the discrepancy ratio limit of 0.5 to 2.0, for both Model no. 1 and 2. Other models (statistical and NARX model) predicted equally good performance ranging from 70% - 90% accuracy. Further analysis is required to test the developed model specifically for different river characteristics. However, the availability of data is a hindrance and to draw these findings, further recommendations are summarized for the validity of the derived equations.

Porous asphalt (PA) is a flexible pavement layer with high interconnected air voids and constructed using open-graded aggregates. Due to high temperature environment and increased traffic volume in Malaysia, PA may have deficiencies particularly in rutting and stiffness of the mix. A possible way to improve these deficiencies is to improve the asphalt binder used. Binder is normally modified using polymer materials to improve its properties. However, nanotechnology presently is being gradually used for asphalt modification. Nanosilica (NS), a by product of rice husk and palm oil fuel ash was used as additive in this study. The aim of this study was to enhance the rutting resistance and stiffness performance of PA using NS. This study focused on the performance of PA with NS-modified binder (NS-MB) to produce better and more durable PA. The involved experimental work which was divided into three phases. Asphalt binder evaluation and performance of the NS-PA mixture was carried out in the first and second phase. Physical tests using Penetration, Softening Point, Ductility, Storage Stability and Rotational Viscosity showed that NS modified binder (NS-MB) can resist high temperature susceptibility. Rheological test using Dynamic Shear Rheometer also showed that NS-MB was capable in enhancing its performance under various temperatures and stresses. Morphological test using Atomic Force Microscopy, Scanning Electron Microscopy and X-ray Diffraction showed that NS was dispersed well in the asphalt binder. Chemical properties using Fourier Transform Infrared analysis showed that NS-MB was capable in reducing the oxidation process (ageing) of asphalt binder. Mechanical properties tests such as Permeameter, Cantabro Loss, Binder Draindown, Resilient Modulus, Indirect Tensile Strength, Dynamic Creep, Dynamic Modulus and Wheel Tracking showed that NS was capable in enhancing the abrasion resistance, binder draindown resistance, stripping resistance, stiffness and rutting resistance of PA. Based on these results of these phases, the addition of NS is capable in enhancing the overall performance of PA. Then, three statistical models were developed in phase three of this study to evaluate the performance of PA in terms of rutting and dynamic modulus. The first model relates the rut depth of PA with rutting parameters of asphalt binder. Then, the second model relates dynamic modulus of PA with temperature, frequency, amount of NS and nominal maximum aggregate size. The last model relates dynamic modulus of PA with rutting parameters of asphalt binder. It is recommended that a study is carried out in the future to evaluate and verify the field performance of NS-PA mix in flexible pavement.