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Structural Response Analysis and Verification of Multi-Slab Jointed Concrete Pavements

Key word: Jointed Concrete Pavement, Rigid Pavement, Load Transfer, Thermal Curling, Finite Element Method, Dimensional Analysis, Regression Analysis.

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Abstract:

Determination of critical structural responses in terms of stresses and deflections in a jointed concrete pavement is essential to mechanistic-based design and structural evaluation procedures. Various Artificial Neural Networks (ANN) models developed based on the ISLAB2000 finite element (F.E.) model have been utilized to compute critical stresses and deflections in the recommended Mechanistic-Empirical Pavement Design Guide (NCHRP 1-37A). Tremendous amount of time and efforts are often required in generating the databases and conducting network training and testing using original pertinent input parameters. Thus, the main objective of this study is to develop alternative prediction models for critical structural responses of multi-slab jointed concrete pavements using the principles of dimensional analysis and modern regression techniques.

The applicability of ISLAB2000 program was first validated through a series of factorial F.E. runs by reproducing almost identical results using the well-known ILLI-SLAB F.E. program. To expand the applicability of existing edge stress prediction models, various factors including the effects of finite slab sizes, gear configurations, adjacent slabs, and thermal curling were considered. Many series of F.E. factorial runs over a wide range of pavement designs under edge loading conditions have been conducted. Accordingly, various prediction models were separately developed using Projection Pursuit Regression (PPR) together with spline regression as well as local regression (LOESS) techniques. Favorable agreements were achieved when comparing the newly developed versus the existing edge stress prediction models.

To increase the prediction accuracy, more complicated models have also been developed for direct prediction using local regression techniques. In such an approach, the principle of superposition is no longer adopted to avoid possible magnification effects of prediction errors when multiplying two or more prediction models together. Furthermore, the proposed approach has been implemented in the Insightful Miner software program to facilitate critical edge stress prediction. Several case studies were provided to illustrate and validate the proposed critical edge stress analysis procedure.