A Structural Model for the Rapid Analysis of Concrete Pavement Systems

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ABSTRACT

Pavement design is a decision making process which uses pertinent information available to make required judgments. One of the tools used in the design process is analysis of the pavement system. To be of value, it may be necessary to make many analyses of several pavement systems with different loading conditions. With the more complicated models, such as the finite element models (FEM), this may require considerable time on the part of the designer. Furthermore, many consulting firms and designers do not have the necessary background and/or computational tools needed to make many of the required analyses. This paper specifically focuses on the rapid analyses of Portland Cement Concrete (PCC) pavements using artificial neural network (ANN) models.

As part of the research activities of the Federal Aviation Administration Center of Excellence (FAA-COE) at the University of Illinois, artificial neural networks (ANNs) have been successfully used to develop structural models to predict the critical concrete pavement responses (maximum strains, deflections and stresses) for various slab thicknesses, load locations on the slab, subgrade support conditions, and load transfer efficiencies of the joints. These ANN models based on factorials of finite element solutions offer an attractive alternative to the direct use of finite element analysis for determining the critical pavement responses needed for mechanistic based concrete pavement design.

The development and validation of the neural network model for the rapid analysis of the concrete pavement systems will be discussed in this paper. This valuable tool is intended to aid pavement engineers in the investigation of "what if" scenarios before making a final design decision in a relatively very short amount of time (several thousand analyses can be performed in one second using today's typically available personal computers). Potential benefits of using an ANN-based analysis tool and design methodology in concrete pavement design will also be discussed. Examples of pavement analyses using the ANN based tool will be given. Important findings of this application will be outlined in the paper.

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Key words: artificial neural networks—dimensional analysis—elastic layered programs—finite element analysis—jointed concrete pavements—mechanistic-empirical pavement design—principle of superposition

Note: Preparation of this paper was still in progress at the time of publication; final results will be presented at the symposium.