THREE DIMENSIONAL FINITE ELEMENT ANALYSIS OF PAVEMENT RESPONSE TO LOADING

H. Yin*, S. Stoffels & M. Solaimanian

*Dept. of Civil and Environmental Engineering
The Pennsylvania State University
University Park, PA 16802, USA
hxy153@psu.edu

The mechanistic-based response parameters of pavements, such as stresses and strains, require that computationally intensive finite element models be used. This paper demonstrates a utilization of three dimensional (3-D) finite element analysis (FEA) techniques to determine pavement response to loading. For demonstration purposes, one asphalt concrete (AC) pavement section was selected from the instrumented pavement sections of a comprehensive research project called the Superpave In-Situ Stress/Strain Investigation (SISSI), sponsored by Pennsylvania Department of Transportation.

In mechanistic-empirical pavement design, the material properties of the different layers must be specified so that the response of the pavement to imposed loads can be determined. Two analytical approaches are employed in the FEA to describe the behavior of asphalt concrete (AC) materials: the Direct Approach, the use of the elastic modulus corresponding to field temperature and loading time to capture the temperature and time dependency of AC materials; and the Indirect Approach, the use of the interconvertion technique to convert dynamic modulus from laboratory tests on specimens procured from the field to relaxation modulus required for viscoelastic material models, such as Prony series. Both linear and nonlinear behaviors were modeled for granular materials.

The developed Global-Local (GL) finite element modeling approach is capable of simulating the observed pavement responses to multiple axle loads with different load configurations, loading time, and temperatures. In addition, important FEA issues on model geometry, material properties, load and boundary conditions, element type, and mesh refinement are discussed in detail. All these factors affect the overall FEA efficiency.

FEA of pavement structures, if validated, can be extremely useful, because it can be used directly to estimate pavement response parameters without resorting to potentially costly field experiments. If accurate correlations between the theoretically-calculated and the field-measured response parameters can be obtained, then the finite element model can be used to simulate pavement response utilizing measurements from instrumented strain gages. This presentation will share the assumptions and models found to best model the measured pavement responses in a computationally-efficient manner.

Reference

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Keywords: finite element analysis