EverStressFE1.0 Software for 3D Finite-Element Analysis of Flexible Pavement Structures

Submitted to

The Washington State Department of Transportation

June 2009

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Introduction

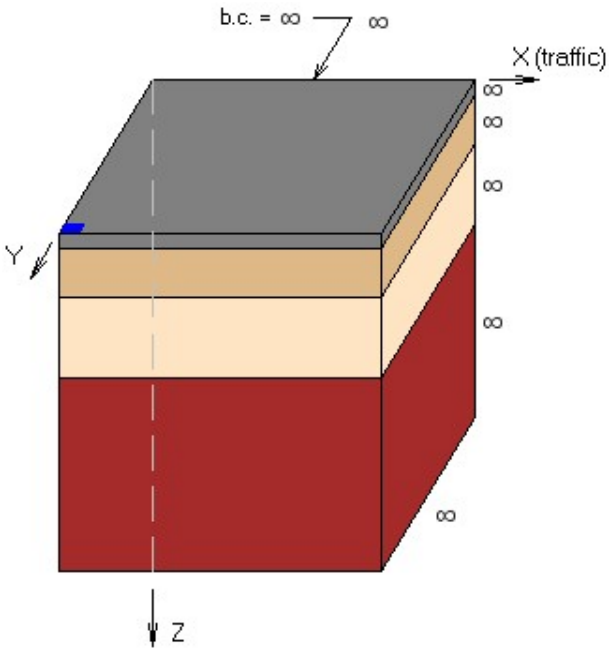
EverStressFE version 1.0 (available for download at www.civil.umaine.edu/everstressfe) is a user-friendly three-dimensional (3D) finite-element based software package for the analysis of asphalt pavement systems subjected to various wheel/axle load combinations. EverStressFE is useful for both flexible pavement researchers and designers who must perform complex mechanics-based analyses of flexible asphalt pavement systems.

Traditional analysis software packages such as EverStress, BISAR, or KENLAYER are based on available analytical solutions, and therefore may not realistically account for complex loads, mixed boundary conditions, inter-layer slip and debonding, and 3D response. General-purpose finite element packages can overcome these limitations, but they can be difficult to learn and use effectively, model generation can be time-consuming, simulation times can be long in the case of 3D analysis, and extracting results of interest can be difficult.

EverStressFE addresses the shortcomings of both of the previously described approaches. An efficient 3D finite element solver is coupled with a highly graphical and user-friendly interface that incorporates automated mesh generation and numerous visualization tools designed to extract results of specifically of interest to the pavement analyst. This document summarizes some of the key features of EverStressFE. More detailed information can be found in the hyperlinked HTML help files that are integrated with the software package.

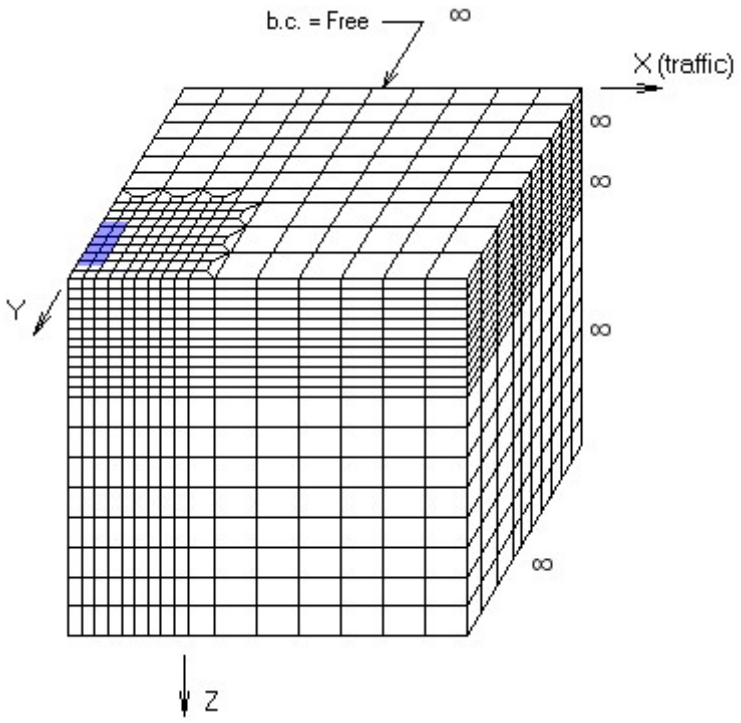
Software Features

Some of the major features of EverStressFE are summarized below.



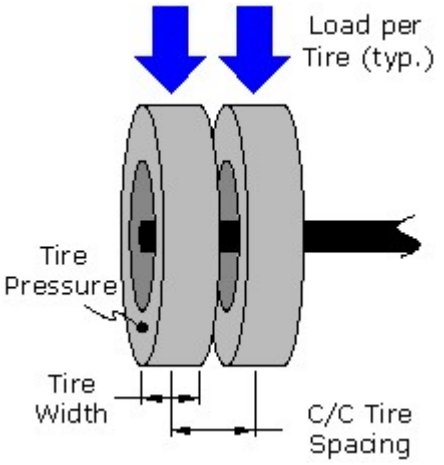
- **Intuitive and user-friendly graphical user interface**. EverStressFE is designed to be user-friendly and intuitive. Graphics are provided that are continuously updated as the user changes parameters. The user can zoom in and out on many of the graphics. EverStressFE includes automatic mesh adjustments, which can be overridden by the user, to reduce the chances of selecting a poor mesh.
- **Ability to model systems with 1-4 layers**. The pavement materials are assumed linearly elastic, and EverStressFE allows the specification of up to four distinct layers including the subgrade.
- **¼-symmetric meshes with quadratic elements**. To minimize computational time, ¼-symmetric models are employed. The user can specify a mesh with a locally refined region as shown below or a simple grid mesh. In either case, 20-noded solid, quadratic elements are

used to model the soil materials as they provide a good balance between computational time and accuracy.



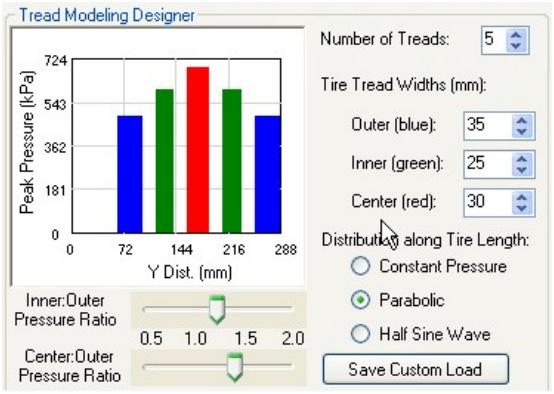
- **The ability to model various boundary conditions**. The user can model a finite domain with fixed-displacement boundary conditions or simulate an infinite domain using infinite elements. With the infinite domain option, the user can choose whether to use free or infinite boundary conditions for the asphalt layer along the boundary that would correspond to the edge of a roadway. These various options for boundary conditions give the user flexibility to best idealize the scenario of interest.

- **The ability to capture inter-layer slip and debonding.** The user has the ability to model various degrees of bond at layer interfaces including completely bonded, partially bonded, and completely debonded. Partial bonding is handled through the use of interface elements that allow varying degrees of inter-layer shear transfer.



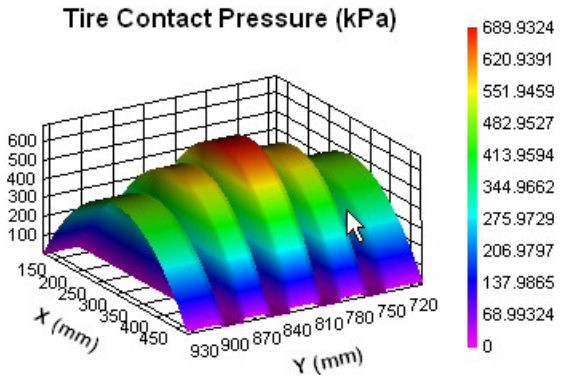
- **Modeling of multiple-wheel systems**. The user can quickly specify up to four wheels (i.e. tandem axles with dual tires). Standard tire contact areas are defined as circular or rectangular. Diagrams are provided to aid the user in specifying parameters.

- **Modeling of spatially varying tire contact pressures.** Spatially varying tire contact pressures can also be specified with EverStressFE. A built-in tool called the Tread Designer is available to aid the user in creating a realistic, spatially varying tire contact distributions that include the modeling of discrete tire treads. The user can also load a custom contact pressure distribution file and view the pressure distribution using EverStressFE's visualization tools.

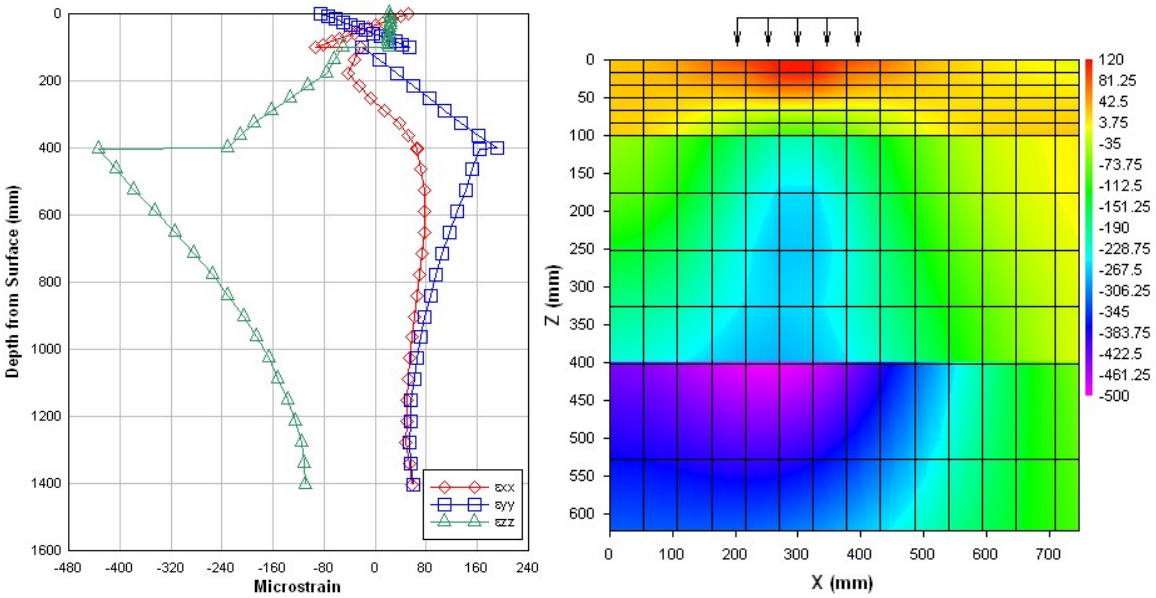


- **Batch analysis capabilities.** EverStressFE includes the ability to define multiple models and sequentially batch multiple runs. The user can simultaneously add multiple projects to the

batch list as well as save and load the lists. This allows multiple simulations or parametric studies to be conducted efficiently.



- **Visualization of results.** Simple user-controlled 2D plots of output parameters (strains and displacements) vs. depth from the pavement surface can be generated. The user can be also generate colormaps representing the quantity of an output parameter through a user-selected plane in the model. The user can specify the extents and limits of the colormap. Strain values can be retrieved from the plot by placing the mouse over the point of interest. The displaced mesh can also be plotted.



- **Output of critical values.** Critical strains that are often used as inputs to pavement distress models (e.g. rutting and fatigue models) are summarized for the user after completion of a simulation.
- **Hyper-linked documentation**. A hyper-linked, searchable help utility is packaged with EverStressFE that also includes a tutorial illustrating program use.