Chenchen Huang, M.S.[1]; Cheng Zhu, Ph.D., P.E.[1]; Yusuf Mehta, Ph.D., P.E.[1]; and Daniel Offenbacker, Ph.D.[2]

[1] Center for Research and Advanced Transportation Engineering Systems (CREATES), Rowan University; [2] Applied Research Associates (ARA) Inc.

Background

❑ Issues with HVS field test:
- ➢ Expensive
- ➢ Time-consuming
- ➢ Limited to test pavement structures and properties

❑ Numerical method is a good way to predict the mechanical responses of pavement under traffic loading conditions.

Figure 1 : Rowan University's Heavy Vehicle Simulator (HVS)

Goal & Methodology

❑ Using Finite Element Method (FEM) modeling to evaluate the deformation performance of conventional flexible pavements in HVS test.

- ➢ Build elastic model to determine appropriate mesh size and model dimension.
- ➢ Take Prony series parameters fitting to determine the viscoelastic model parameters in ABAQUS
- ➢ Take HWD (Heavy Weight Deflectometer) test to validate the FEM model.
- ➢ Take FEM numerical simulation of HVS test.

Elastic Model

- ➢ Applying SWL-50 and B-777 loadings on the elastic model (all layers are assigned with elastic model) to determine appropriate mesh size and model dimension through comparing with predications obtained from BAKFAA and KENPAVE software tools.
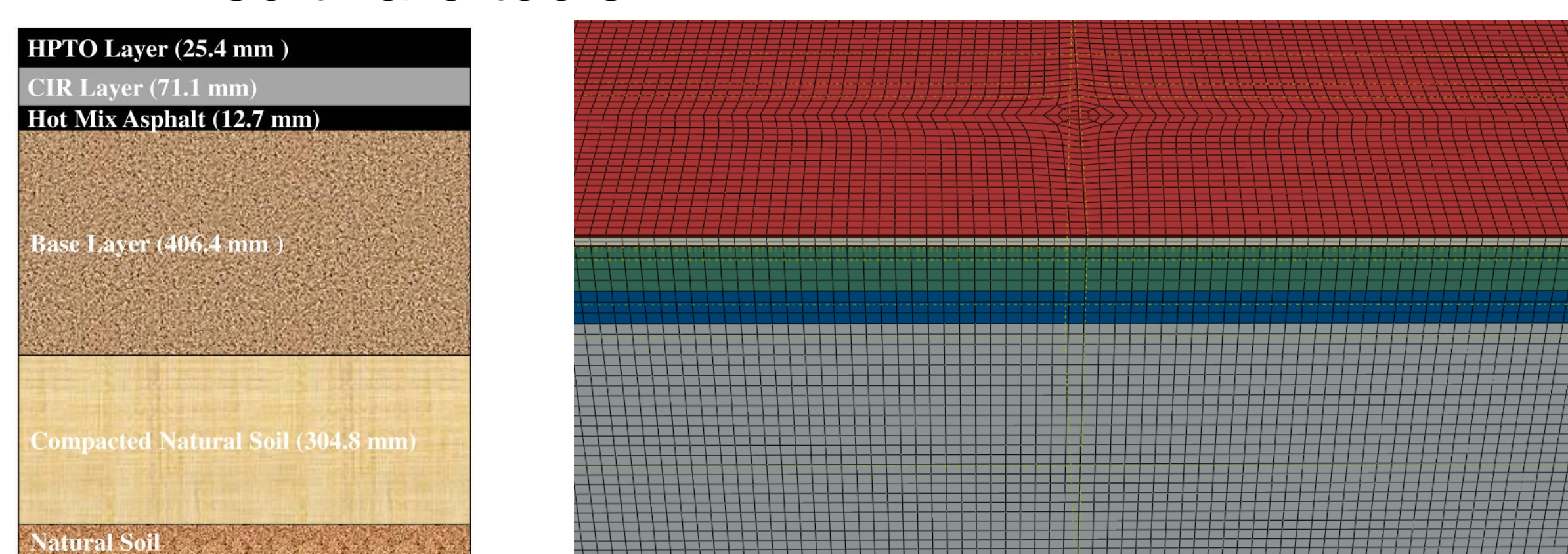
Figure 2: Field and numerical pavement structure

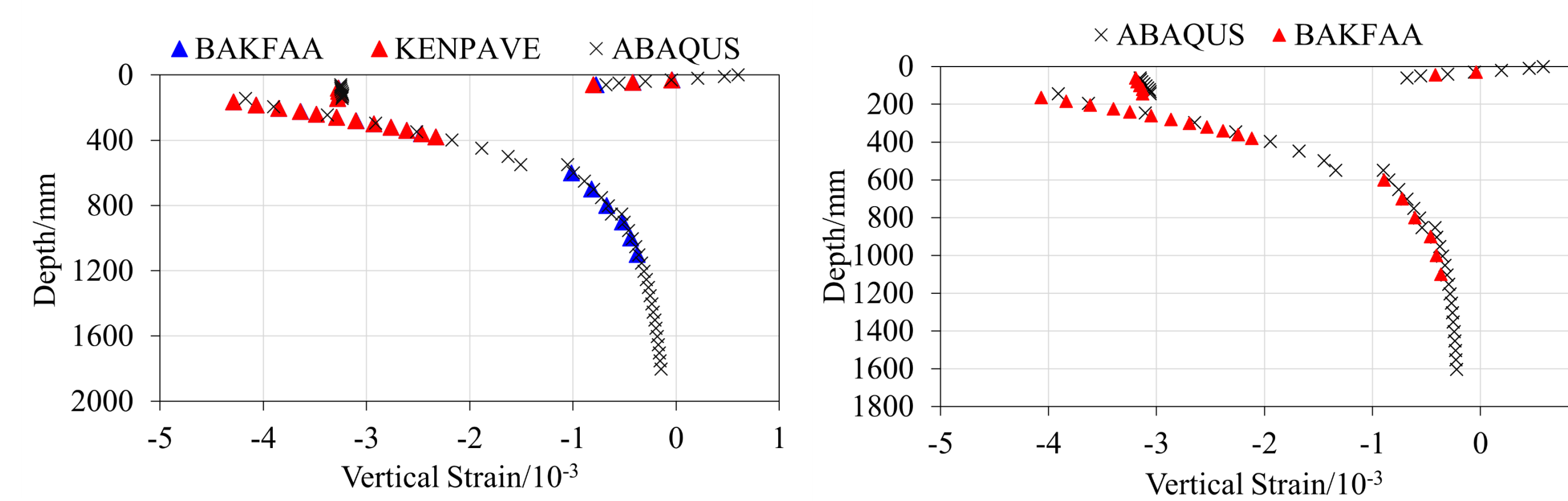➢ Compared the results of elastic model with predications got from BAKFAA and KENPAVE.

Figure 3: Comparison between ABAQUS, BAKFAA, and KENPAVE results of elastic model

Table 1: Elastic parameters of each pavement layer

	CIR	HPTO&HMA	Base layer	Subgrade layer	Soil
Young's Modulus (kPa)	8617	14505	151	199	197
Possion's Ratio	0.33	0.35	0.35	0.45	0.4

Prony Series Fitting

❑ Based on Dynamic Complex Modulus (DCM) testing data, the parameters of viscoelastic model for CIR and HPTO layers were determined.
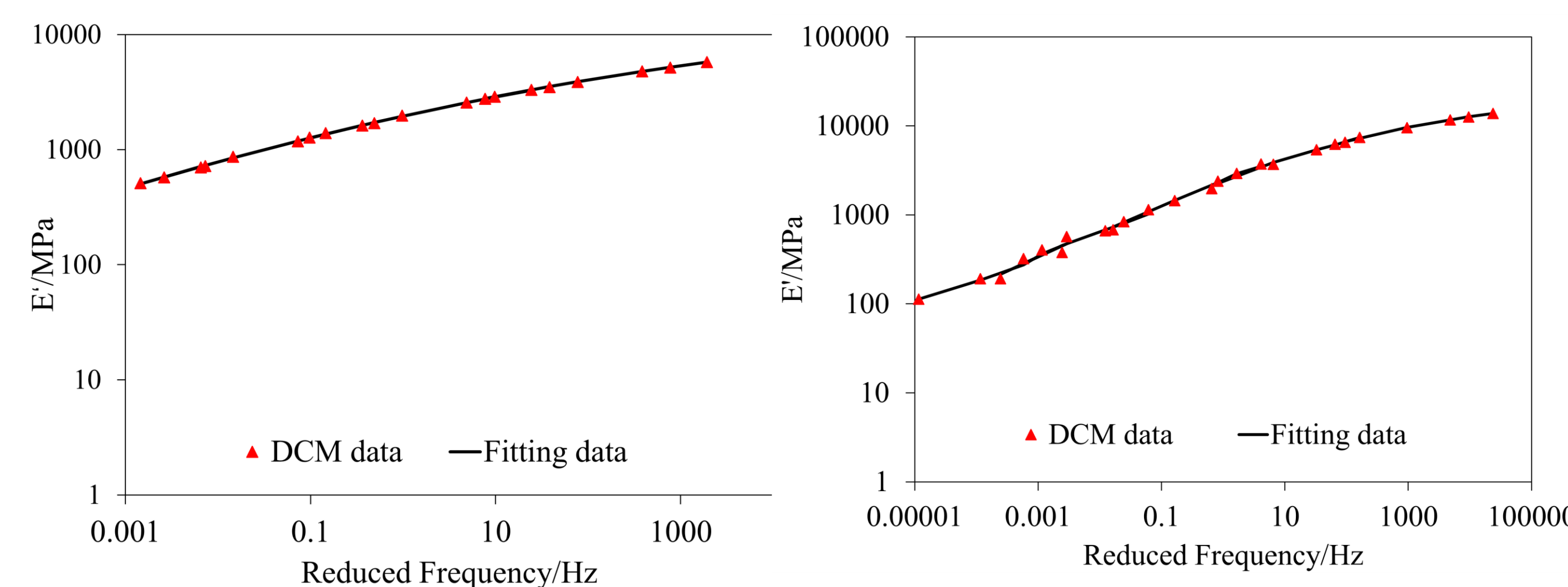
Figure 4: Comparison between DCM data and Prony series fitting data of CIR (Cold in-place Recycled) layer

Figure 5: Comparison between DCM data and Prony series fitting data of HPTO (high-performance thin-overlay) layer

HVS Test

❑ As shown in Figure 6, the HPTO, CIR and HMA layers are assigned with viscoelastic model; base, subgrade and soil layers are assigned with elastic model in HVS test.
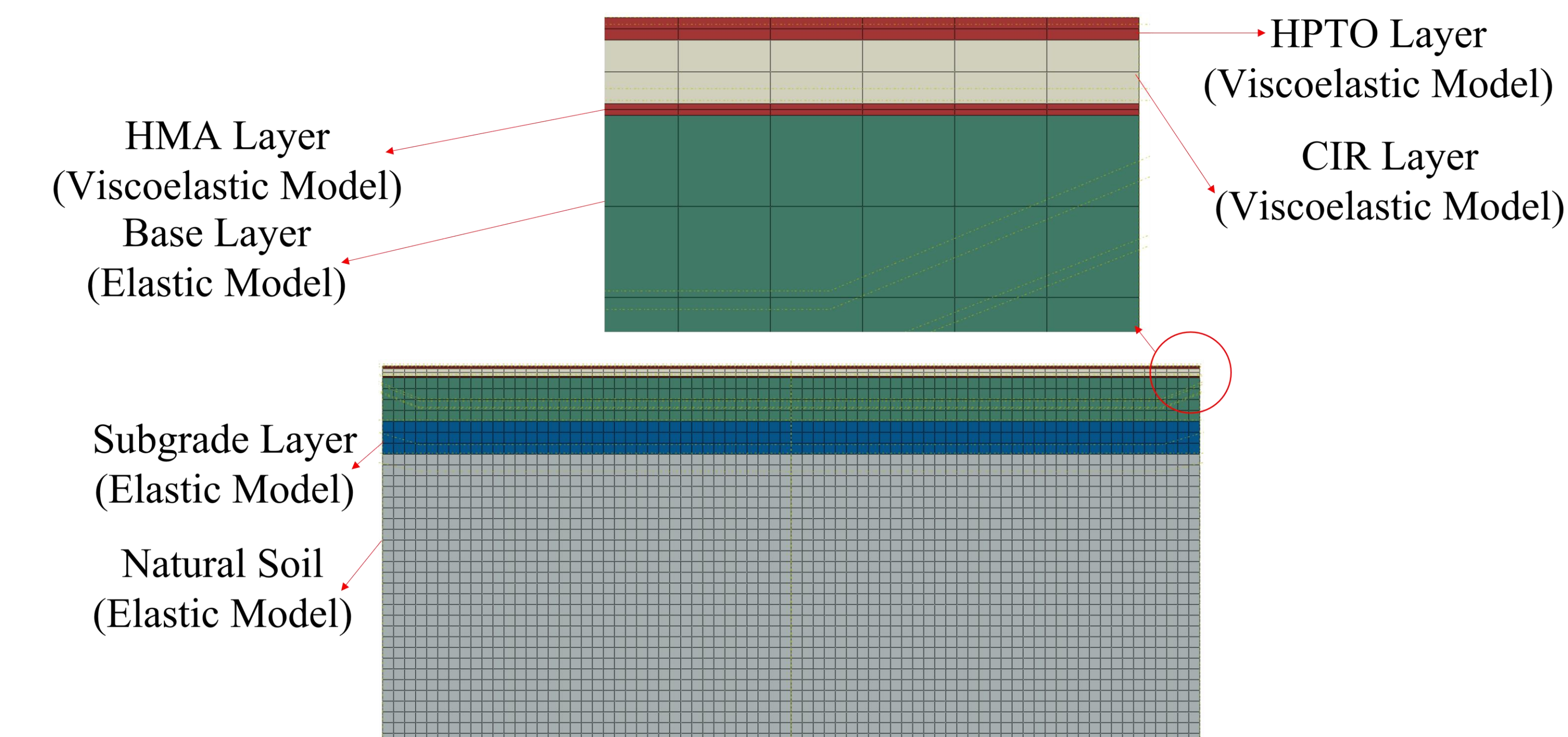
HPTO Layer (Viscoelastic Model)
CIR Layer (Viscoelastic Model)
HMA Layer (Viscoelastic Model)
Base Layer (Elastic Model)
Subgrade Layer (Elastic Model)
Natural Soil (Elastic Model)

Figure 6: FEM model structure in HWD and HVS tests
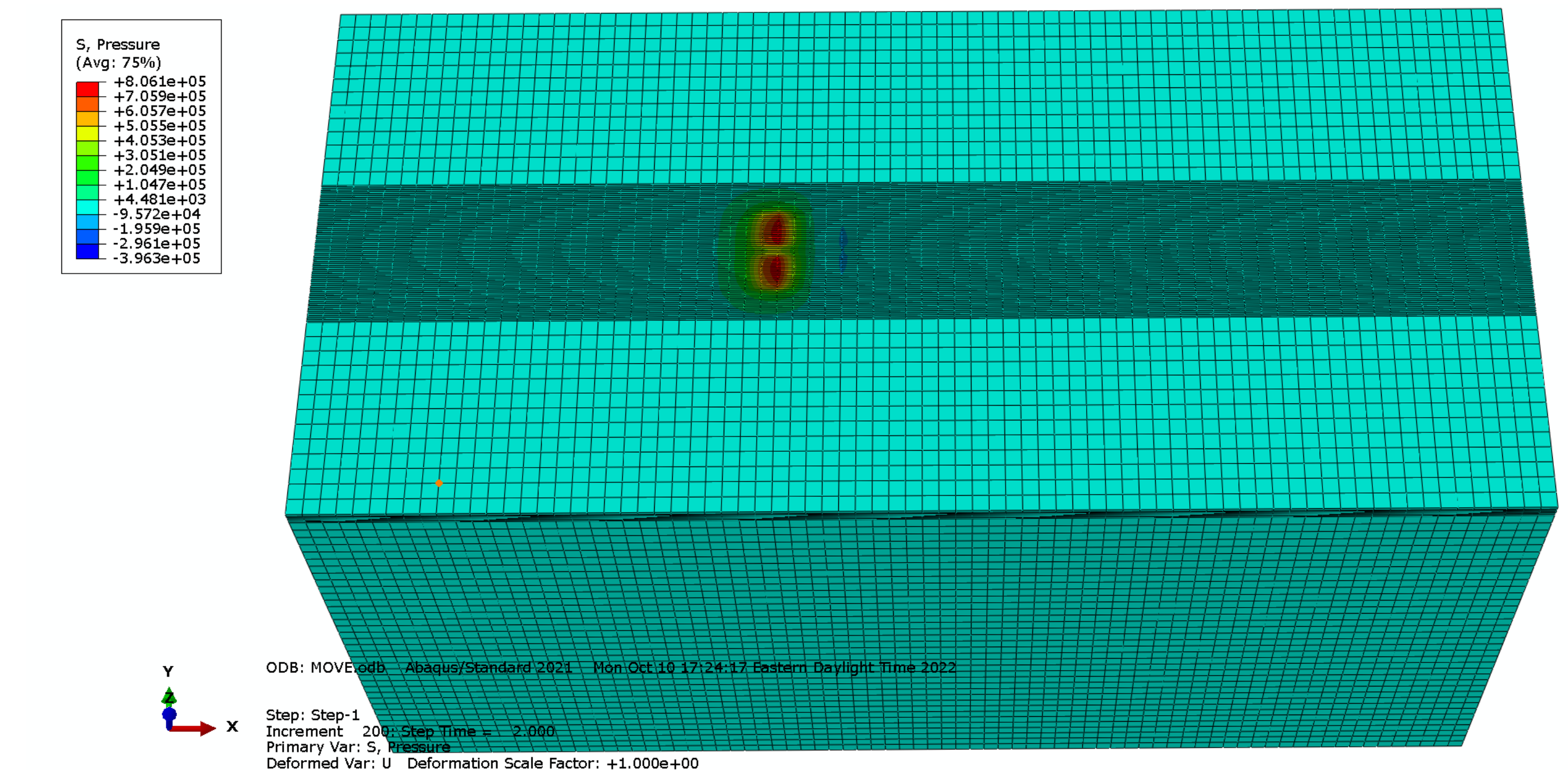
Figure 7: The nonuniform tire stress distribution is considered in HVS test.

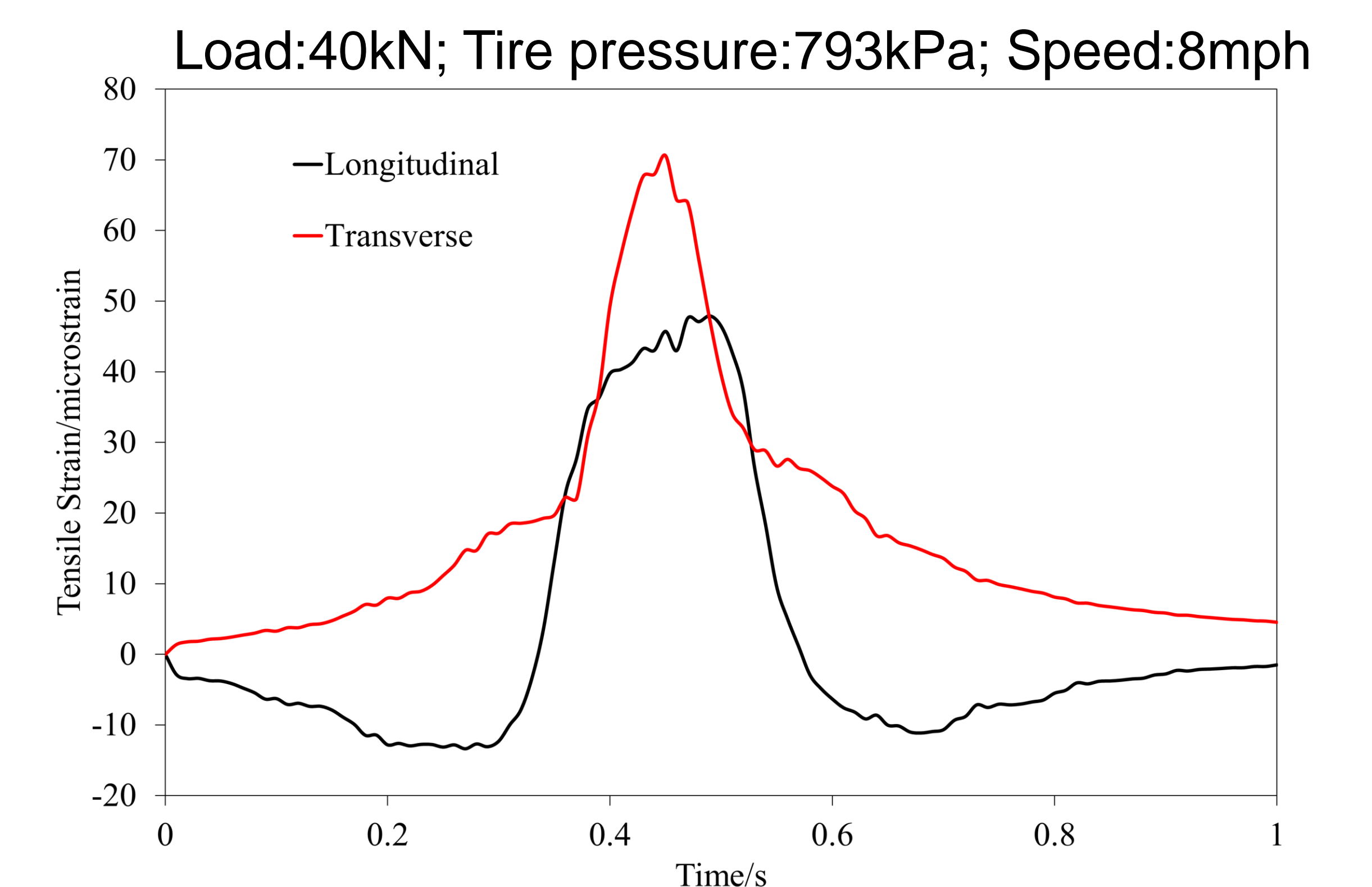Load:40kN; Tire pressure:793kPa; Speed:8mph

Figure 8: Numerical tensile strains from FEM model

Discussion

❑ This study showed the detailed modeling process to evaluate the deformation performance of pavement in HVS test. Next step is to compared this with field results to validate this numerical model.