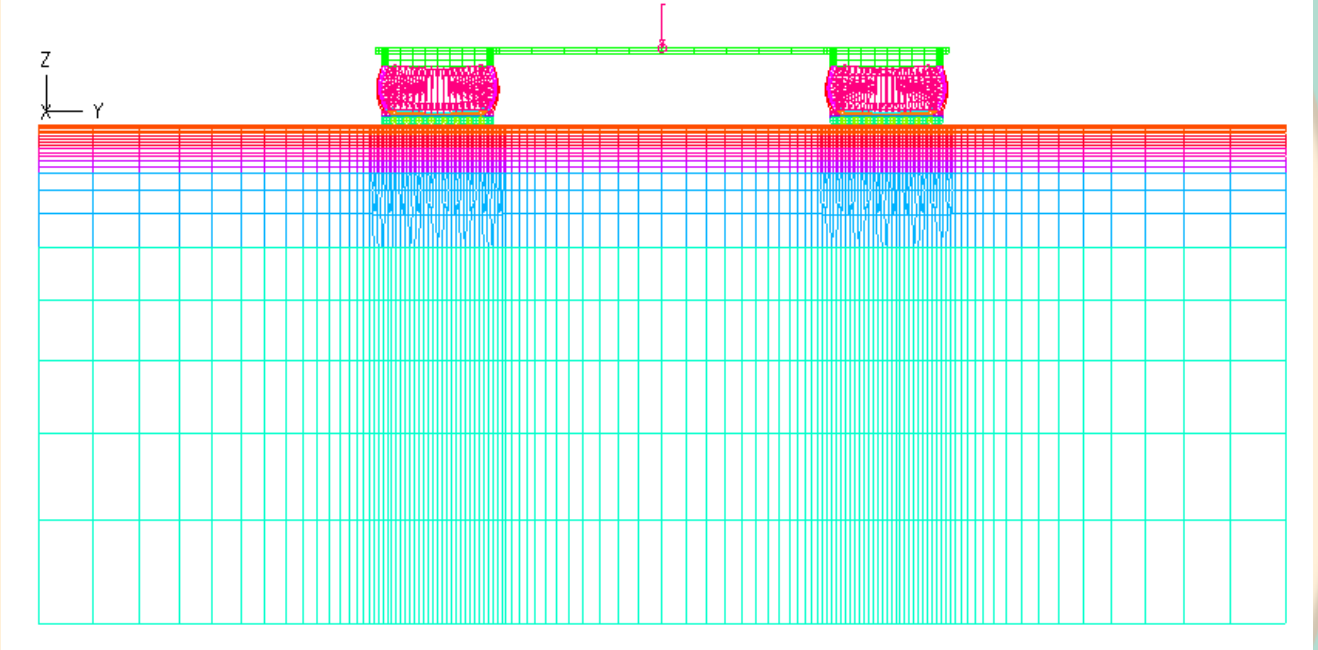
WORLD ROAD ASSOCIATION MONDIALE DE LA ROUTE
Norfolk, Virginia / September 19-22, 2012
7th symposium on pavement surface characteristics
SURF 2012

Effects of Tire Axle Load and Inflation Pressure on Near-Surface Pavement Response



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Quality Engineering Solutions, Inc

QES

Outline

- Background
- Develop 2-D Axle-Tire-Pavement Contact Model
- Investigate Tire Axle Load and Inflation Pressure on Near-Surface Pavement Response
- Conclusions & Recommendation

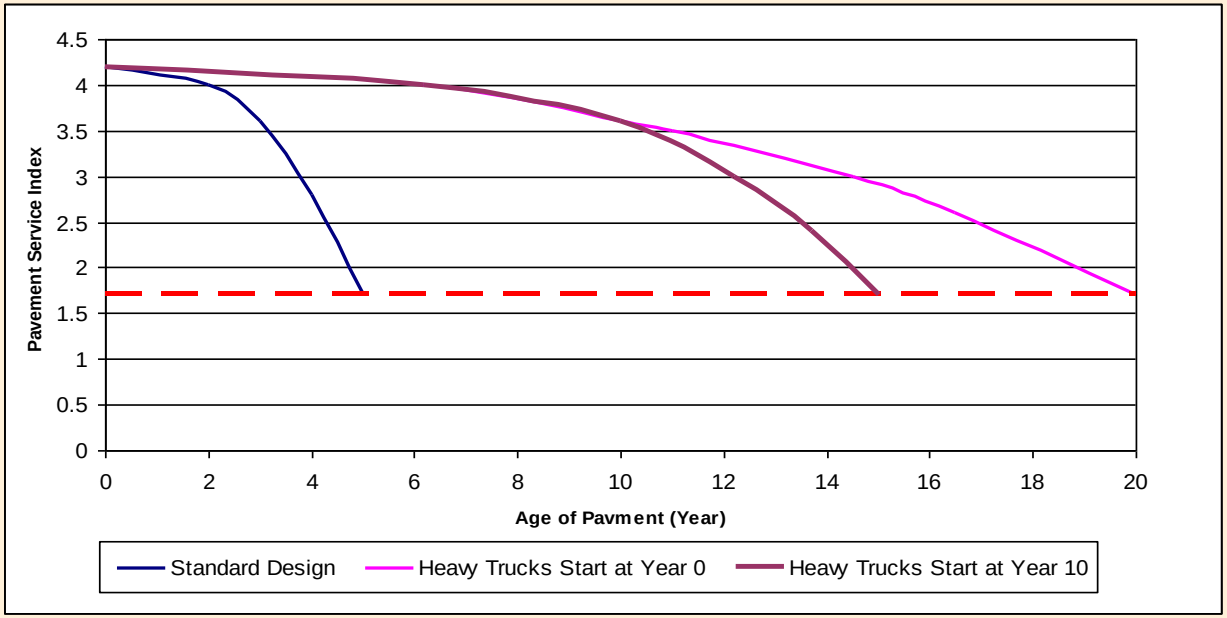
Background

- **Damaging Effects of Overloaded/Heavy Loaded Vehicles to Pavements**

Background (Cont.)

- Pavement damage follows approximately a 4th-power rule, which means that if the load is doubled, the damage will be 16 (2^4).
- If the load is increased by 20%, the damage is doubled!

Background (Cont.)



(Source: Wilde, 2012)

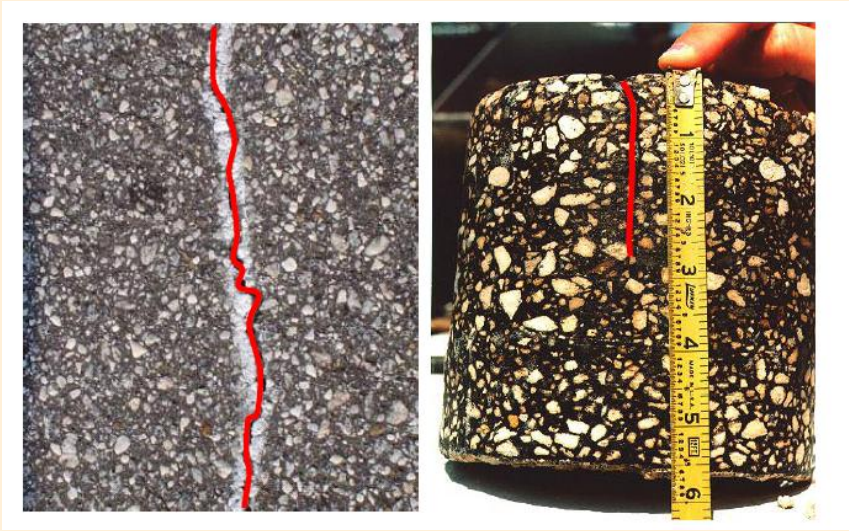
Heavy/Over Load results in fewer allowable repetitions before failure

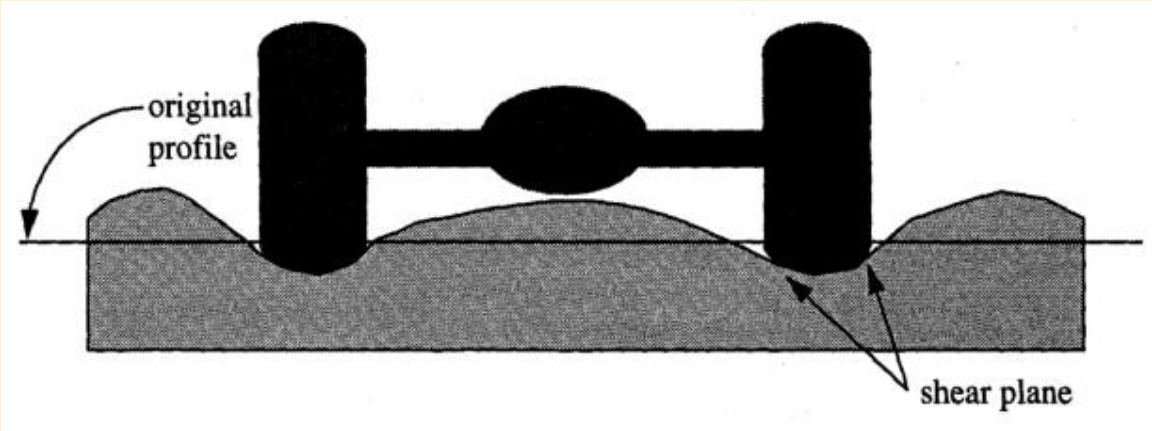
Background (Cont.)

- **Damaging Effects of Under/Over Inflated Tires to Pavements**

Background (Cont.)

- **Top-down Cracking and Instability Rutting**





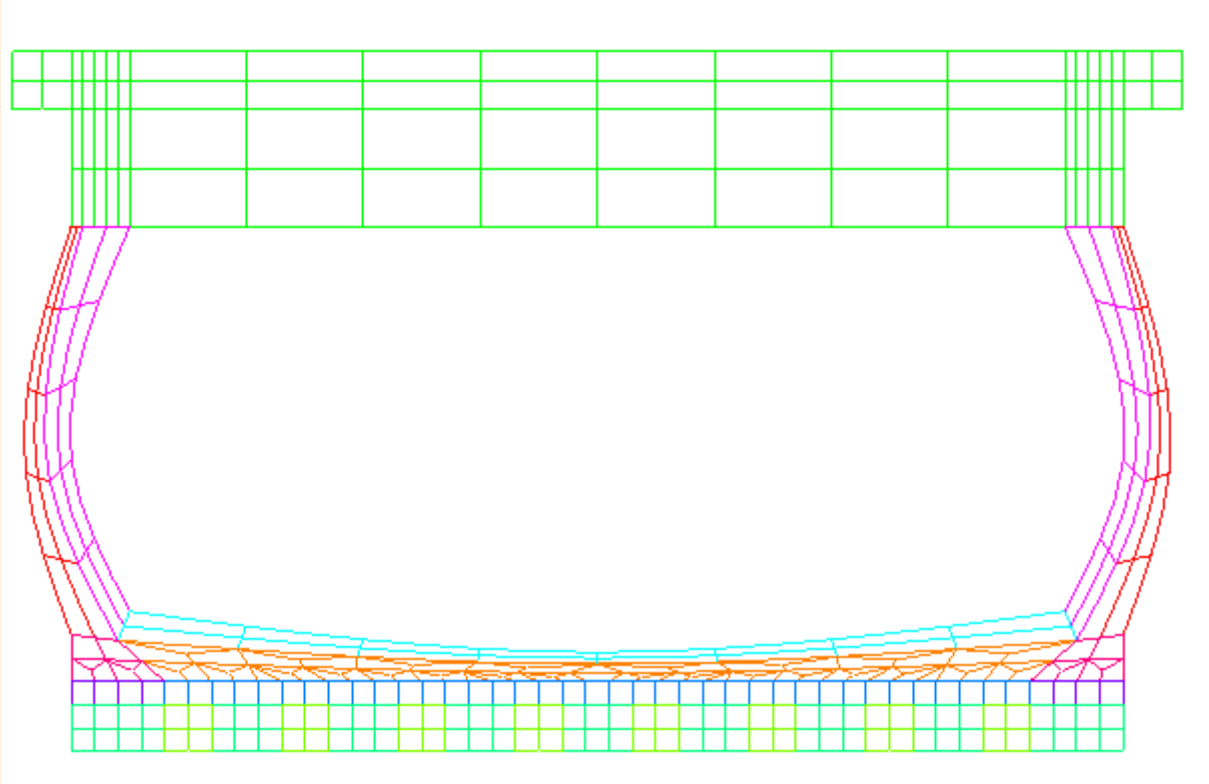
Develop 2-D Axle-Tire-pavement Model

- **Tire to Be Modeled**

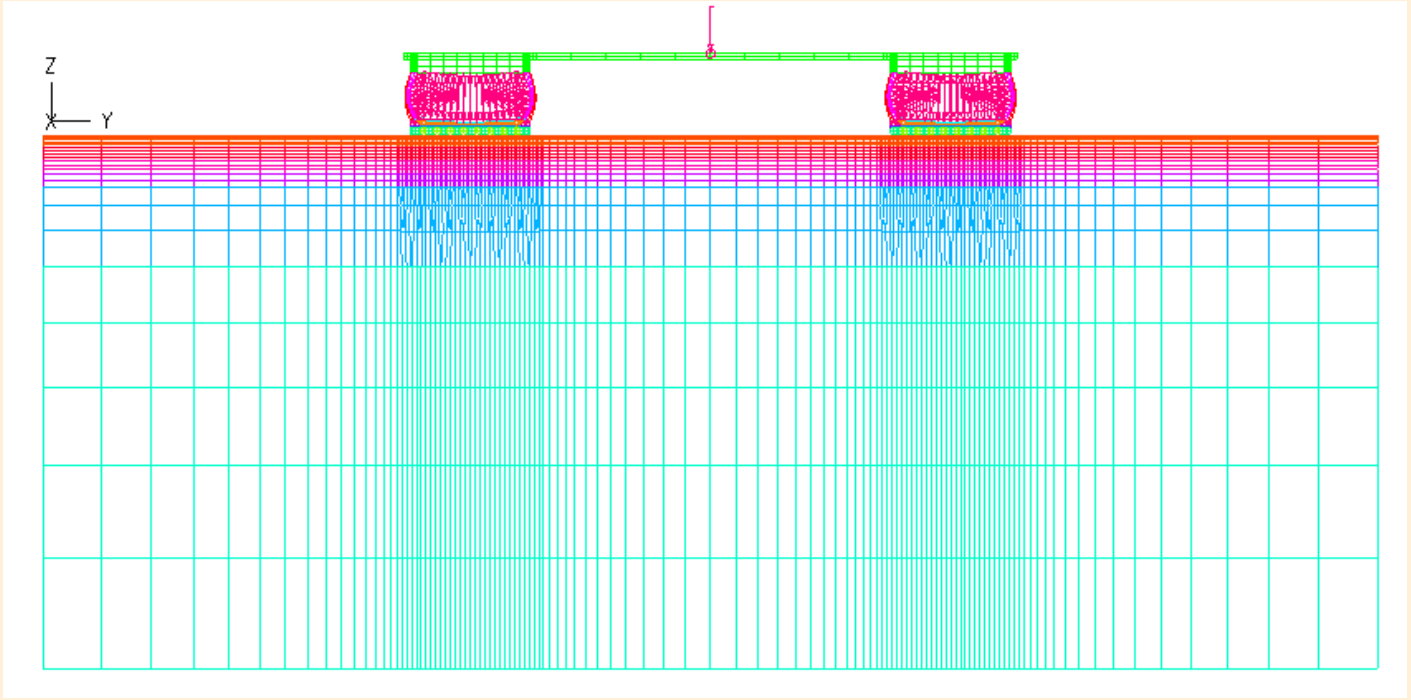
Michelin X One® XDA-HT™ Plus 445/50R22.5

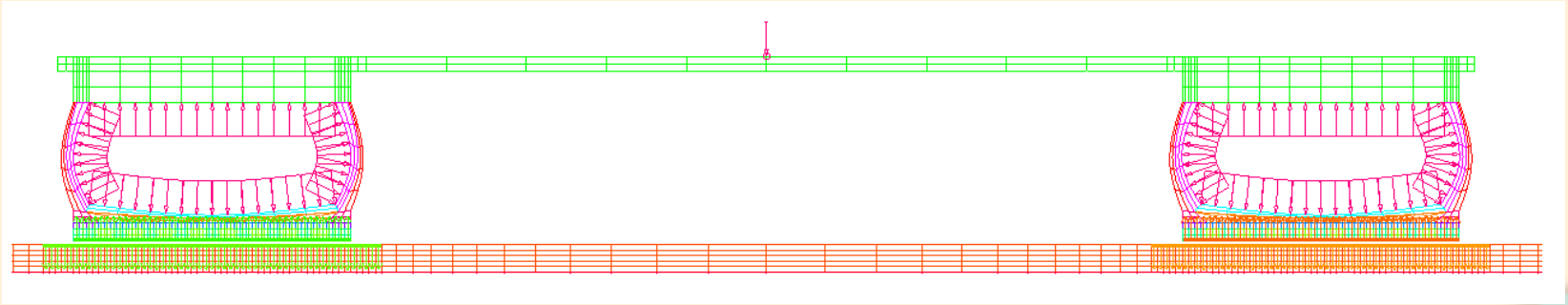
Develop 2-D Axle-Tire-Pavement Model (Cont.)

- **Modeling of Tire**



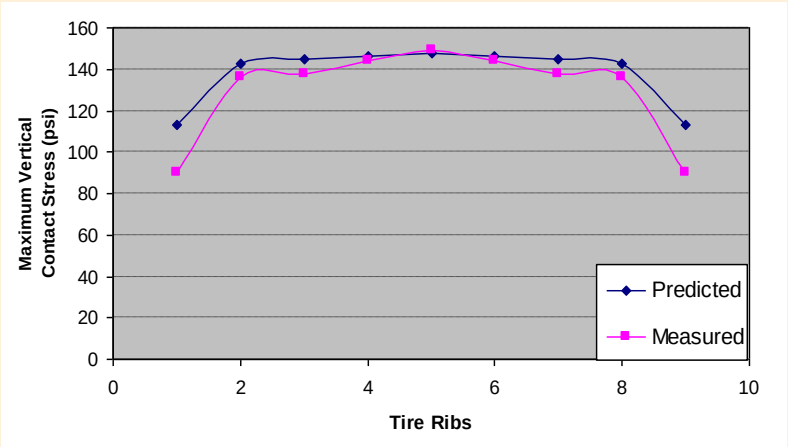
Develop 2-D Axle-Tire-Pavement Model (Cont.)

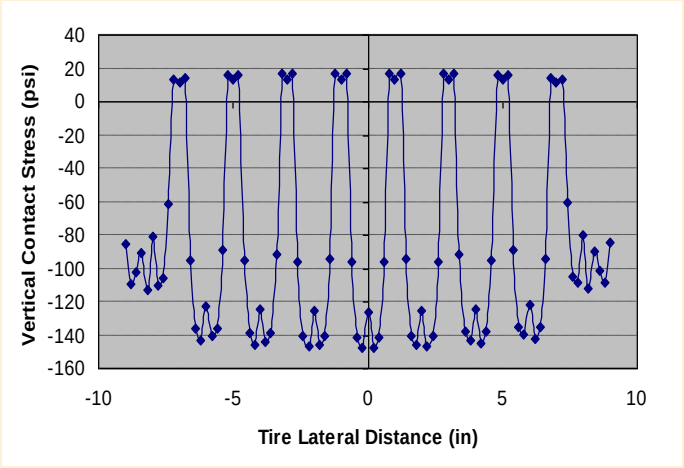


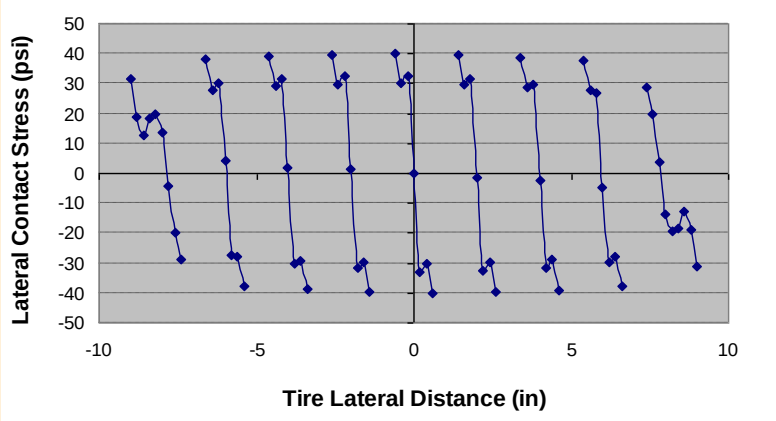


Develop 2-D Axle-Tire-Pavement Model (Cont.)

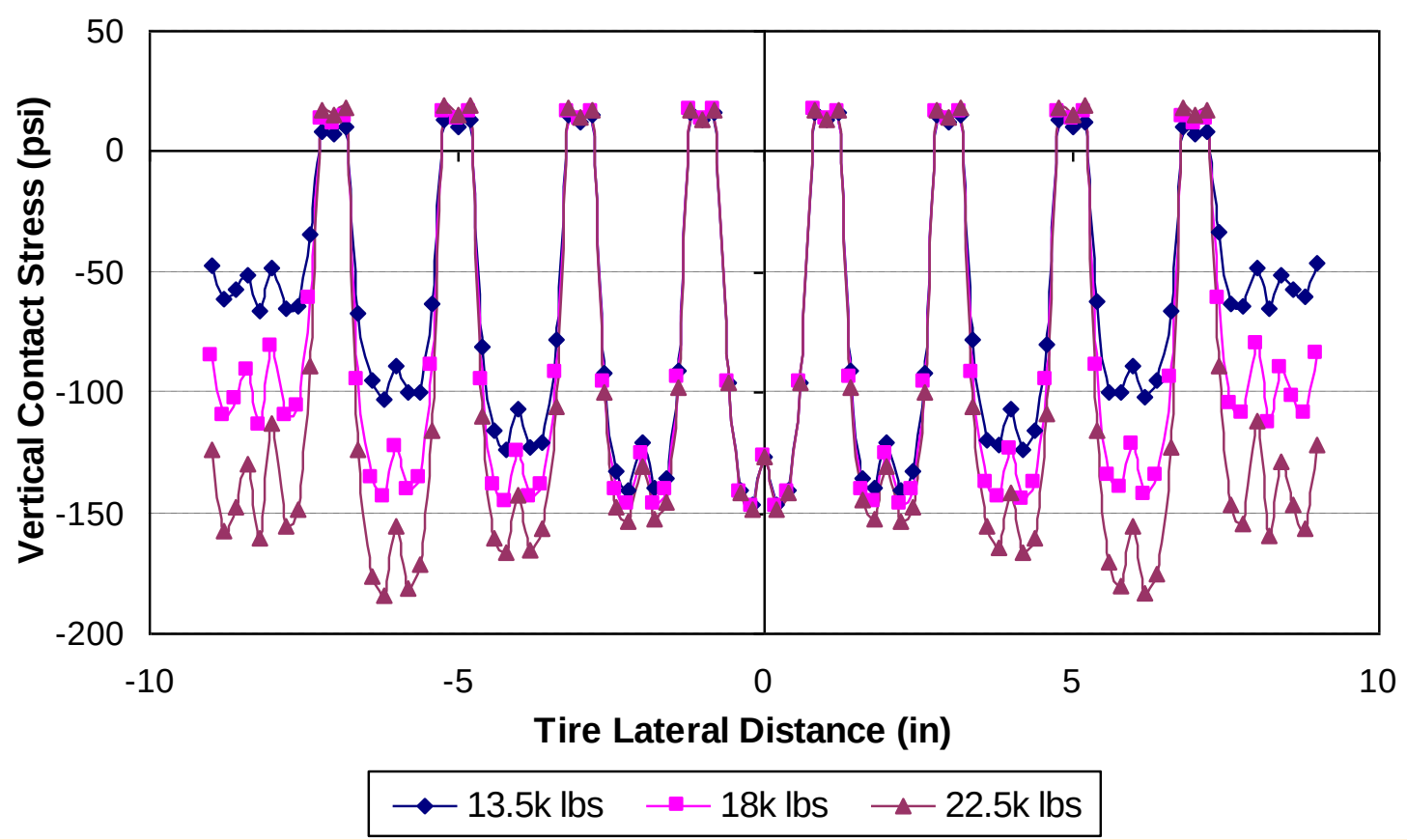
- **Model Verification**



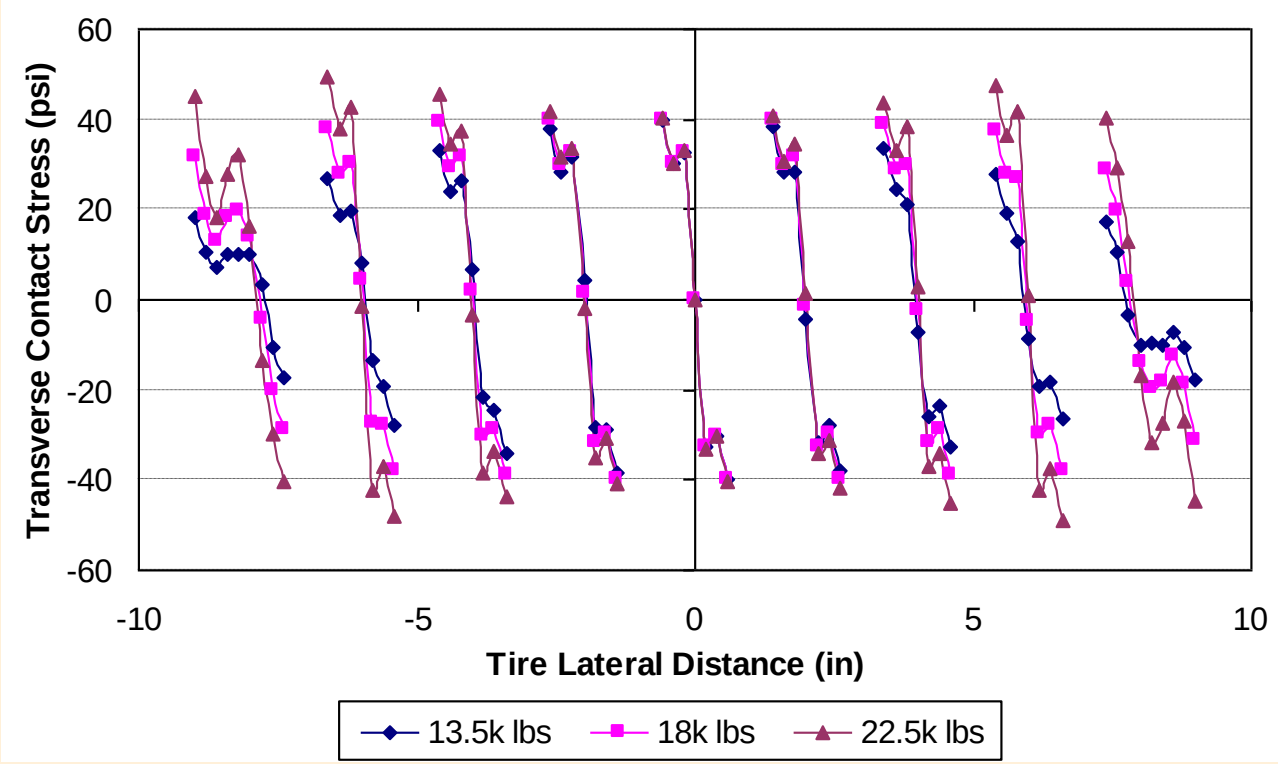




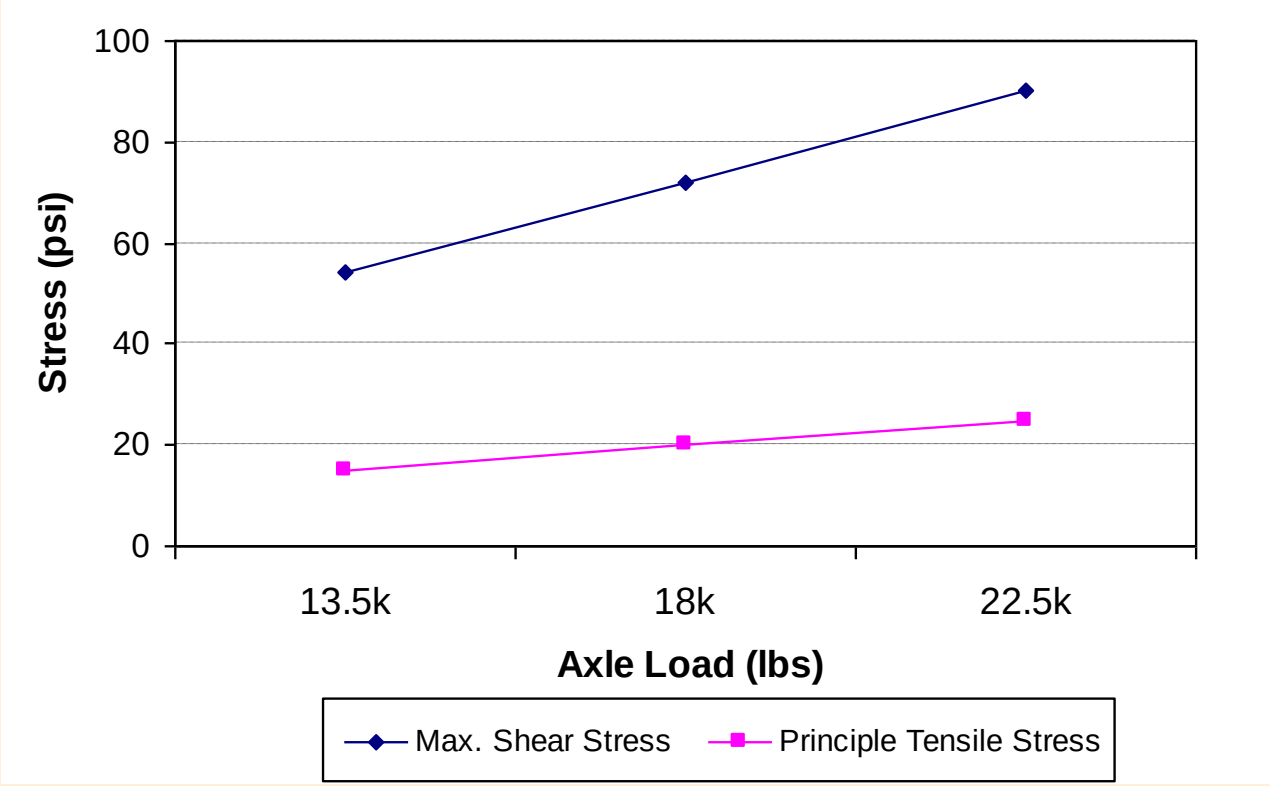
Effects of Axle Load on Near-Surface Pavement Response



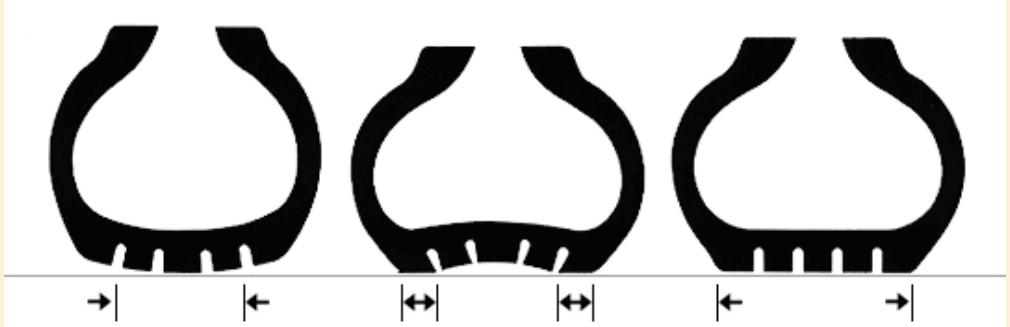
Effects of Axle Load on Near-Surface Pavement Response (Cont.)



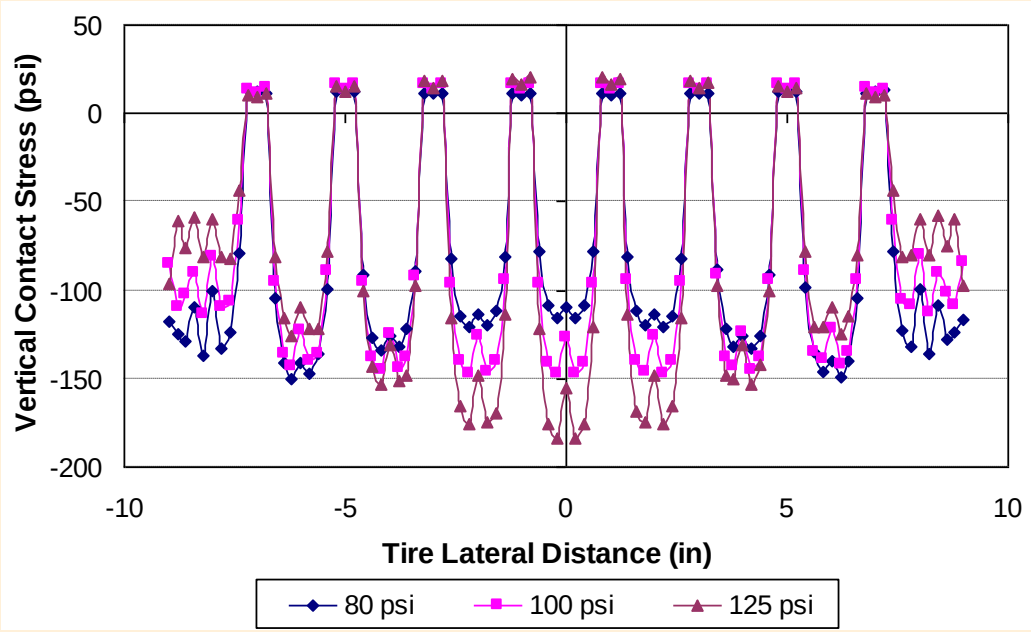
Effects of Axle Load on Near-Surface Pavement Response (Cont.)



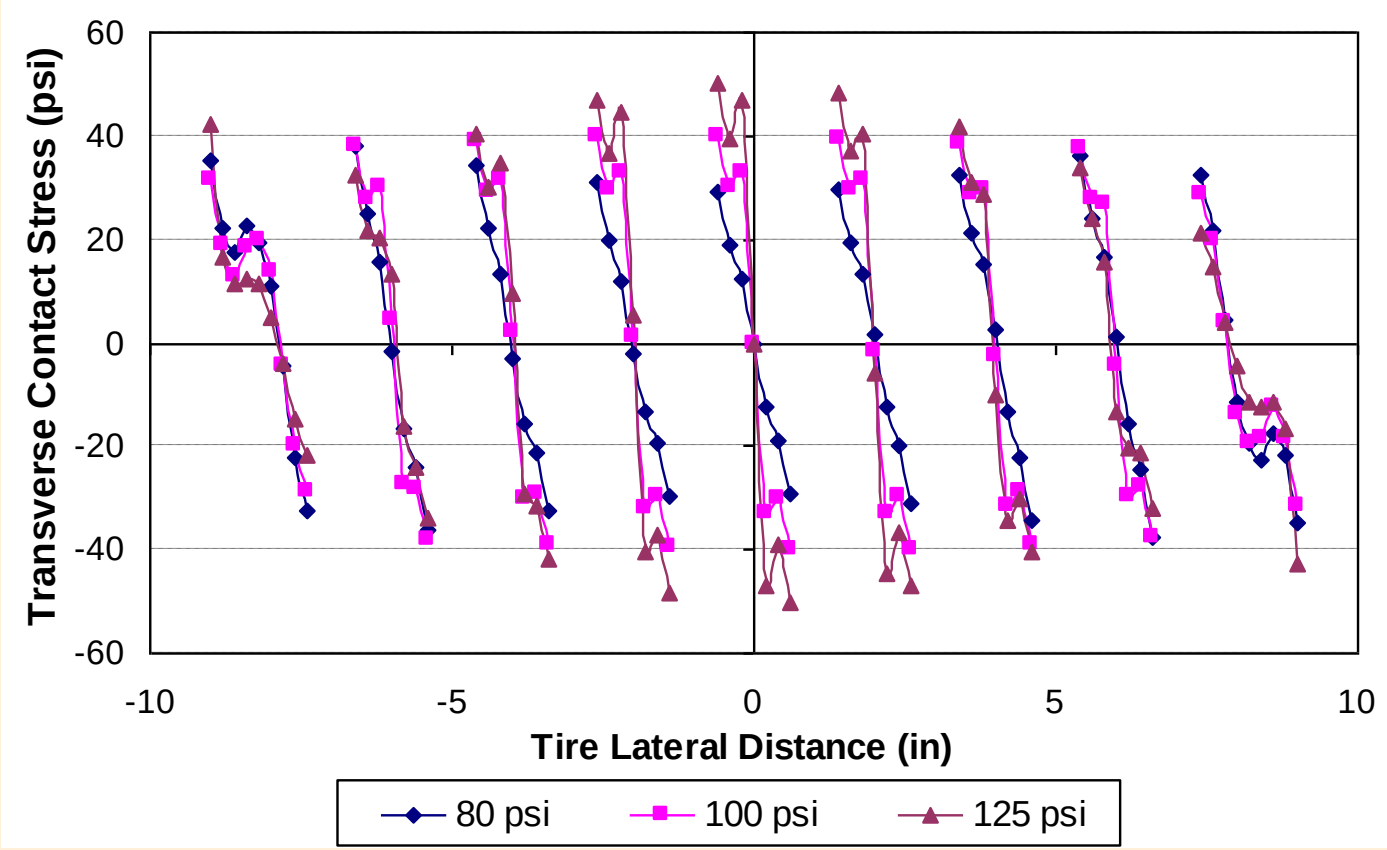
Effects of Tire Inflation Pressure on Near-Surface Pavement Response



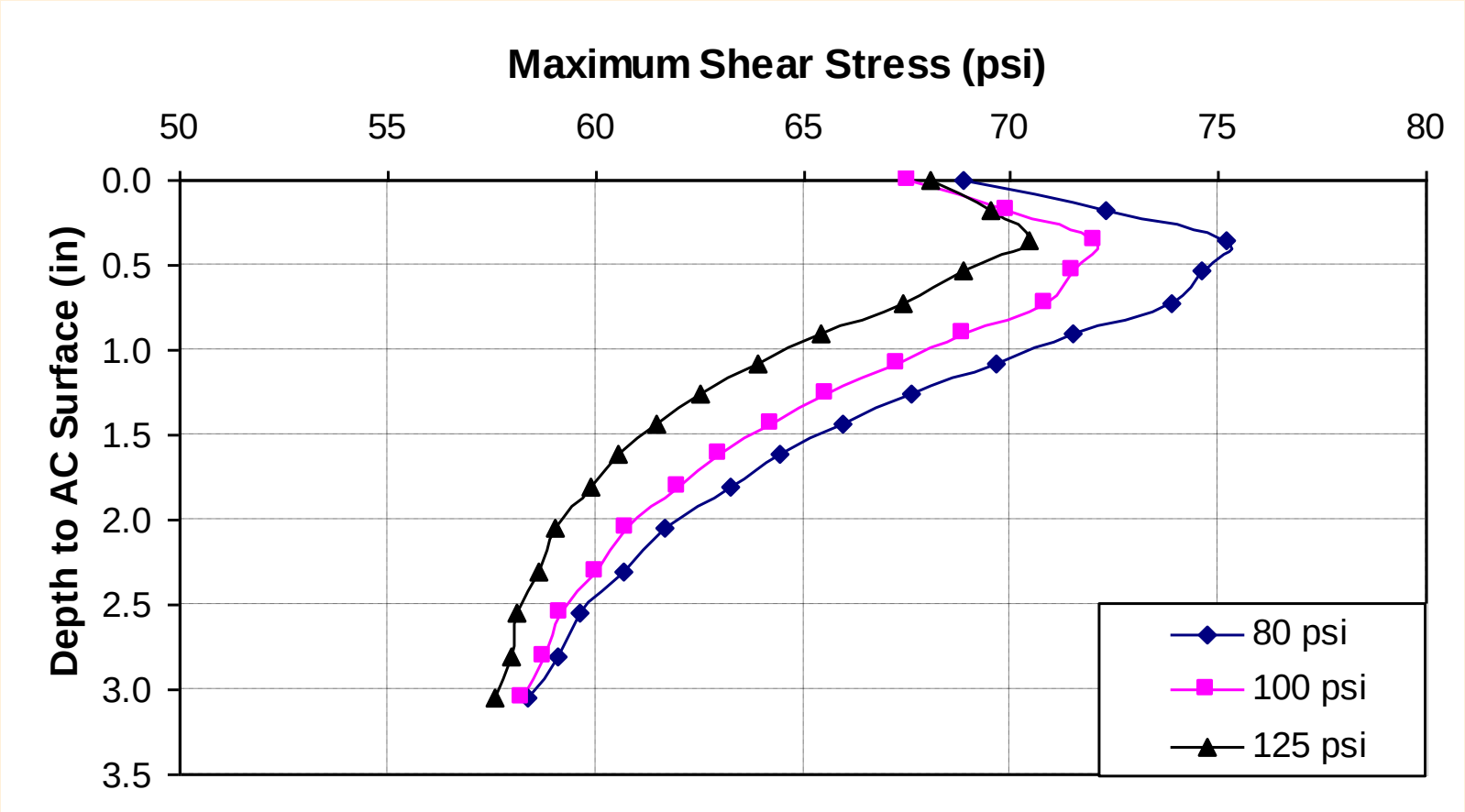
Over Inflation Under Inflation Correct Inflation



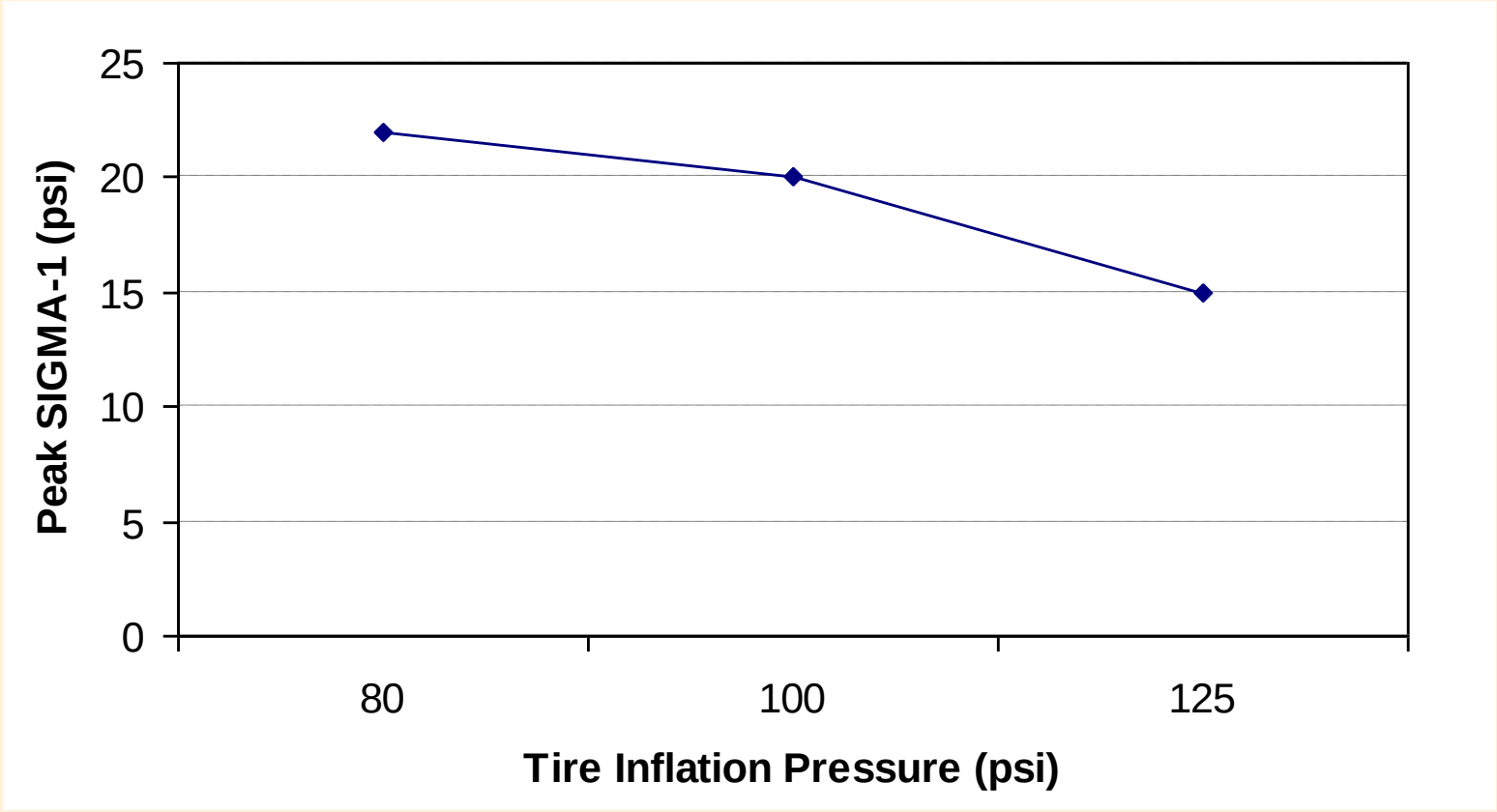
Effects of Tire Inflation Pressure on Near-Surface Pavement Response (Cont.)



Effects of Tire Inflation Pressure on Near-Surface Pavement Response (Cont.)



Effects of Tire Inflation Pressure on Near-Surface Pavement Response (Cont.)



Conclusions

- **The developed 2-D axle-tire-pavement finite element contact model can successfully capture patterns of both vertical contact stress and horizontal shear contact stress distributions.**
- **The maximum contact stress moved from the tire center towards the tire edges when the tire was heavily loaded or under inflated.**

Conclusions (Cont.)

- **Both peak SIGMA-1 and maximum shear stress increase with the axle load. The peak SIGMA-1 and maximum shear stress slightly increase with the decrease of the inflation pressure, which indicates that under inflation might increase the propensity of top-down cracking and instability rutting.**

Future Research Recommendation

- **Need to develop 3-D tire-pavement interaction model to further investigate the effects of tire axle load and inflation pressure on the near-surface pavement response.**

Reference

- Greg A. Hayes and Keith Williamson. Minnesota's Truck Weight Education Program. Presentation for Minnesota Assn. of Townships.
- Wilde W. James. Effect of Heavy Loads on Pavements. Presentation for Houston County Board of Commissioners Meeting, March, 2012.

Thank You