**Introduction**

- Slippage and/or debonding are often found in HMA overlays around the world due to a poor interface bond strength.
- The current AASHTO overlay design, which is based on an assessment of thickness deficiency, does not address this slippage issue.
- 3-D non-uniform contact stresses may induce significantly different pavement responses as compared to uniform contact stresses.
- The longitudinal gradient enhances slippage potential, especially under critical conditions such as when a vehicle is driving downhill on a mountain highway with a sudden braking.

**Objectives**

Evaluate the combined effect of measured tire-pavement contact stresses and longitudinal grades on the interface shear stress response. The objective involved pursuit of the following tasks:

1) Obtain tire-pavement contact stresses.
2) Develop a 3-D Finite Element Model for the overlay.
3) Evaluate the interface shear stress response of the overlay under the combined 3-D tire-pavement contact stresses and longitudinal grades.

**Viscoelastic Material Model**

\[
\begin{align*}
\sigma_{x}(t) &= 2G\varepsilon_{x}(t) + 3\int_{0}^{t}E(t)\varepsilon_{x}(t) \, dt + \int_{0}^{t}E(t)\varepsilon_{x}(t) \, dt \\
\sigma_{y}(t) &= 2G\varepsilon_{y}(t) + 3\int_{0}^{t}E(t)\varepsilon_{y}(t) \, dt + \int_{0}^{t}E(t)\varepsilon_{y}(t) \, dt
\end{align*}
\]

**Measurement of 3-D Contact Stress**

11-22.5 Tire

**Pavement Model**

**Loading Conditions**

- a. Shear Tire Contact Pressures
- b. Vertical Uniform Contact Pressures
- c. Vertical Tire Contact Pressures
- d. Vertical + Shear Tire Contact Pressures

**Results**

- **Effect of Loading Conditions on the Interface Shear Stress**
- **Effect of Temperature, Overlay Thickness, Longitudinal Grade and Viscoelasticity on the Interface Shear Stress**

**Summary**

- The distribution of the interface shear stress \( \tau_{yz} \) along the tire central line in the y direction shows that the maximum \( \tau_{yz} \) occurs at the two outside edges of each tire, when only vertical pressure is assigned to each tire. If a y direction horizontal shear pressure is added, the interface \( \tau_{yz} \) in the y part will increase while the interface \( \tau_{yz} \) in the y+ part will decrease due to neutralization.
- The peak stress \( \tau_{yz} \) along the x axis due to measured tire contact pressure is significantly higher than that due to a uniform contact pressure.
- There are four critical locations for interface shear stress under braking scenarios: front edge, side edges, and center of the tire. The most critical location for the interface shear stress is located at the front edge of the tire.
- Increasing the pavement temperature and the longitudinal grade results in increasing shear stress \( \tau_{yz} \).
- Viscoelastic analysis indicates that the absolute interface shear stress \( \tau_{yz} \) increases as the loading continues.