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Introduction

Pavement serviceability is highly sensitive to subgrade moisture. Flooding and high groundwater weaken soils and accelerate deterioration, yet traditional mechanistic-empirical designs cannot capture these transient effects, especially in sandy subgrades under cyclic loads.

Background

- Climate-driven increases in rainfall and groundwater reduce subgrade strength and pavement life. Mechanistic-empirical designs assume stable soil properties and miss transient moisture effects. While large-scale tests exist, few combine cyclic loading with controlled moisture.
- The Pave-Safe™ platform (UNH) addresses this by linking climate, moisture, and soil response to guide safe roadway reopening.



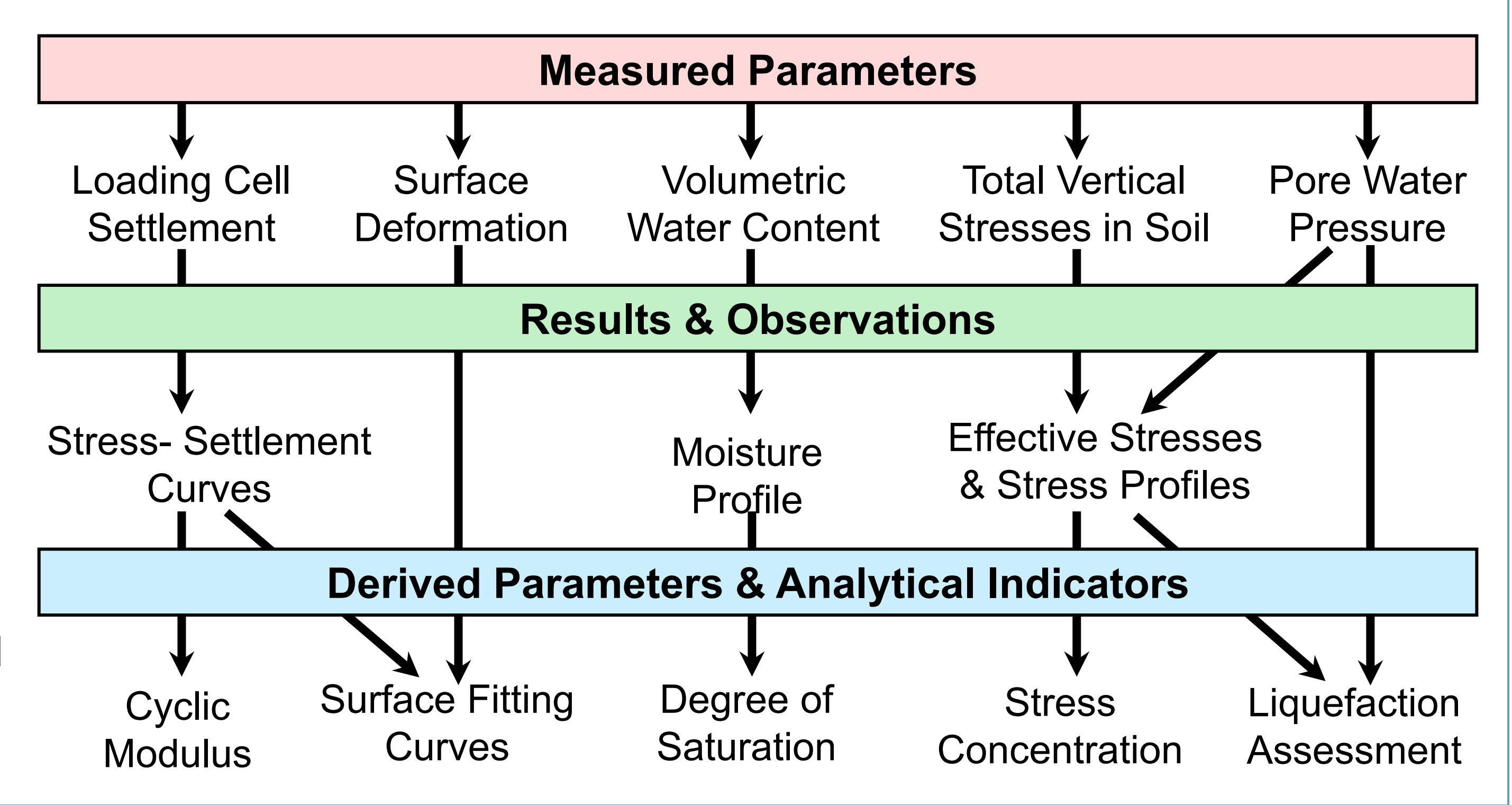
Objective & Methodology



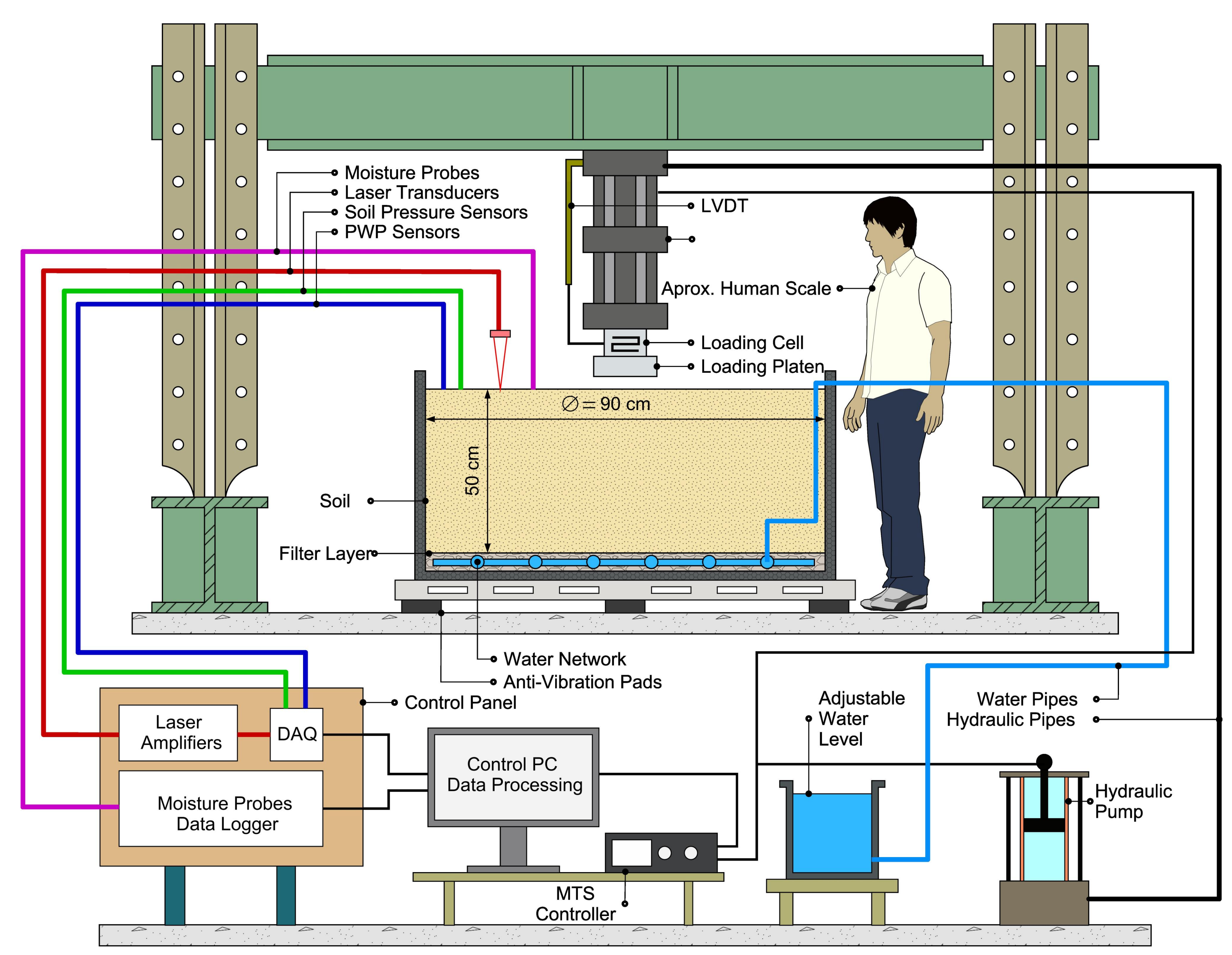
Evaluate the effect of density & moisture on sand subgrade under cyclic loading.
Provide validation data for the Pave-Safe framework.

Scope

- 27 large-scale models of subgrades
- Material: Ottawa Sand F-75 .
- Moisture Conditions:
 - Dry, OMC, off-OMC, unsaturated, & saturated
- Cyclic loading applied by MTS actuator
- Response captured by 26 sensors



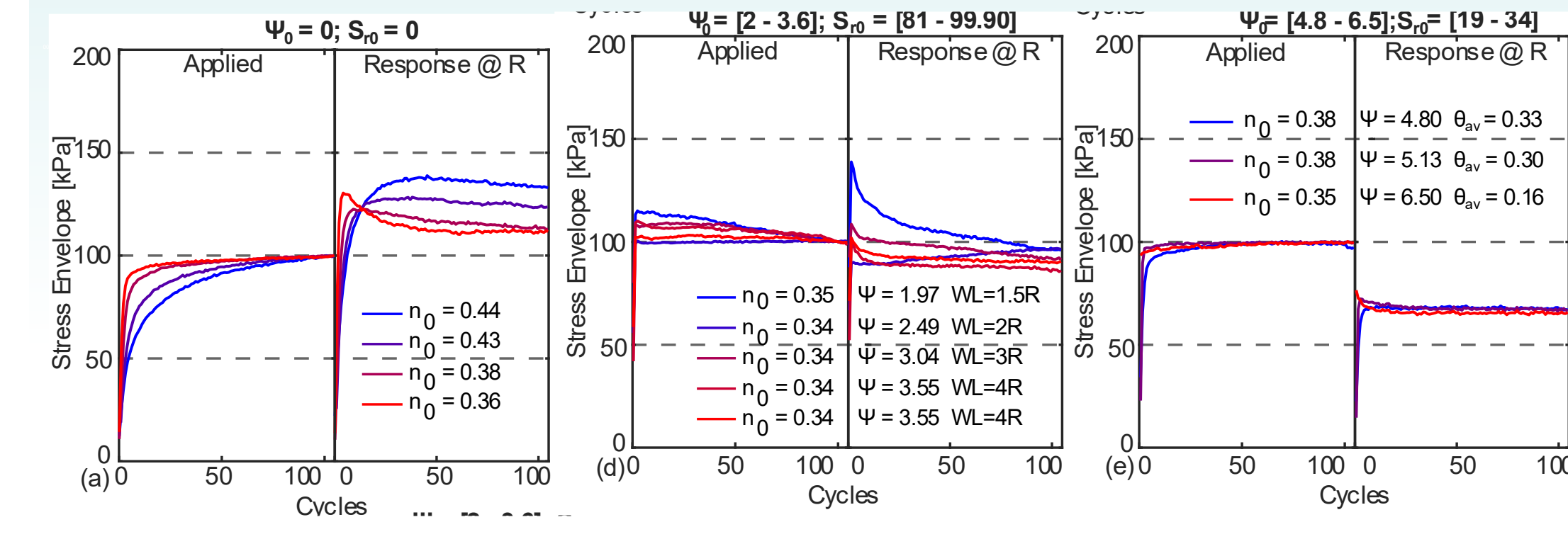
Experimental Setup



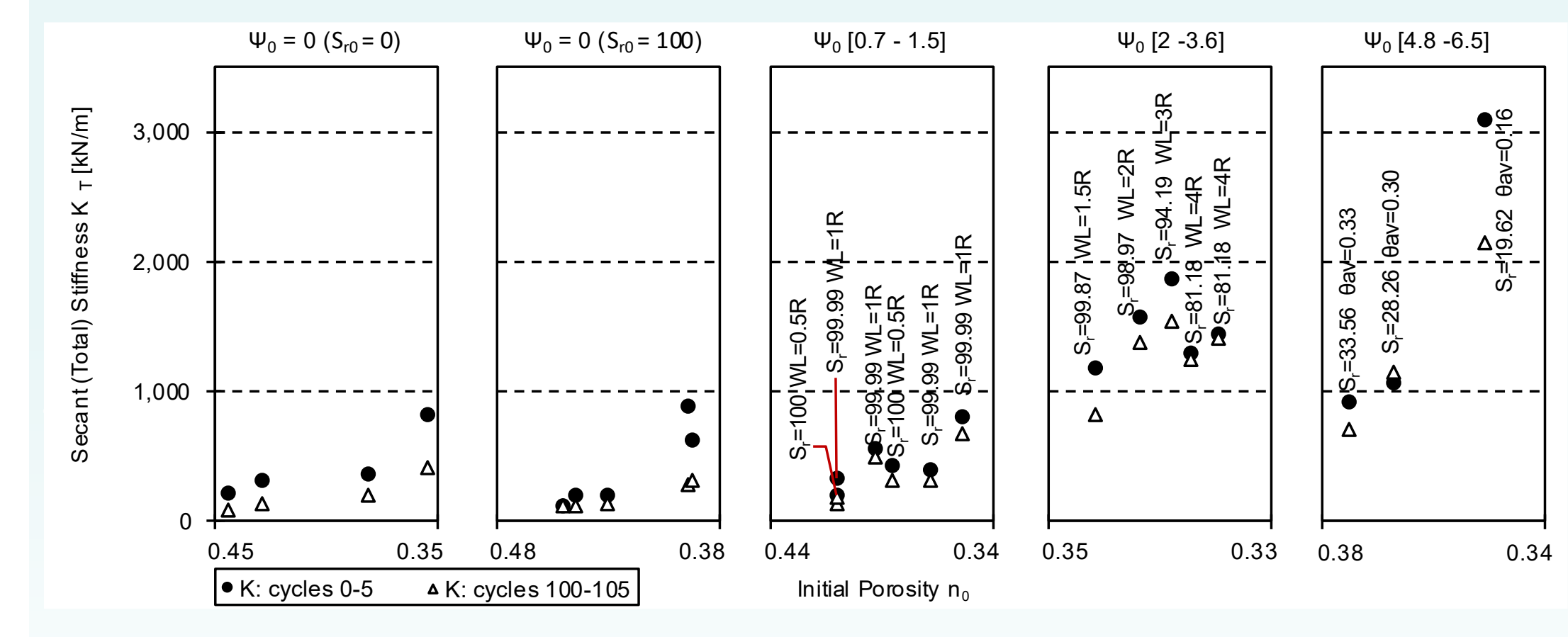
Physical Modeling

Stress Propagation

- Lower Density → Higher Stress Transmission
- Higher Suction → Lower Stress Transmission



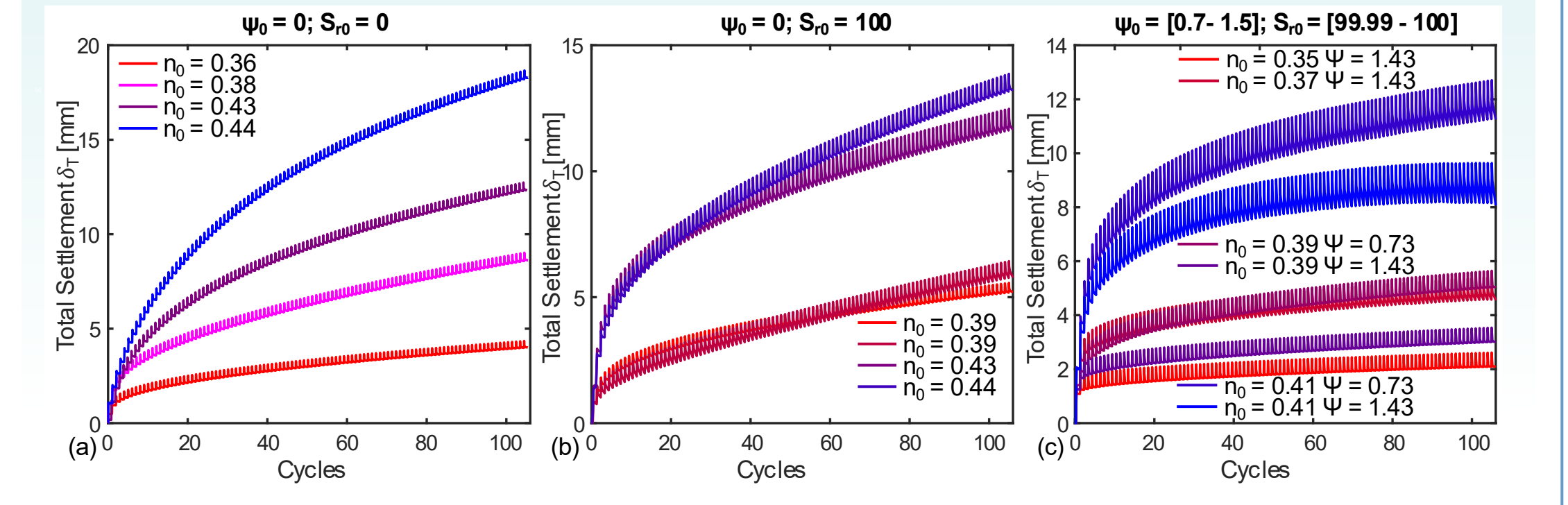
Stiffness



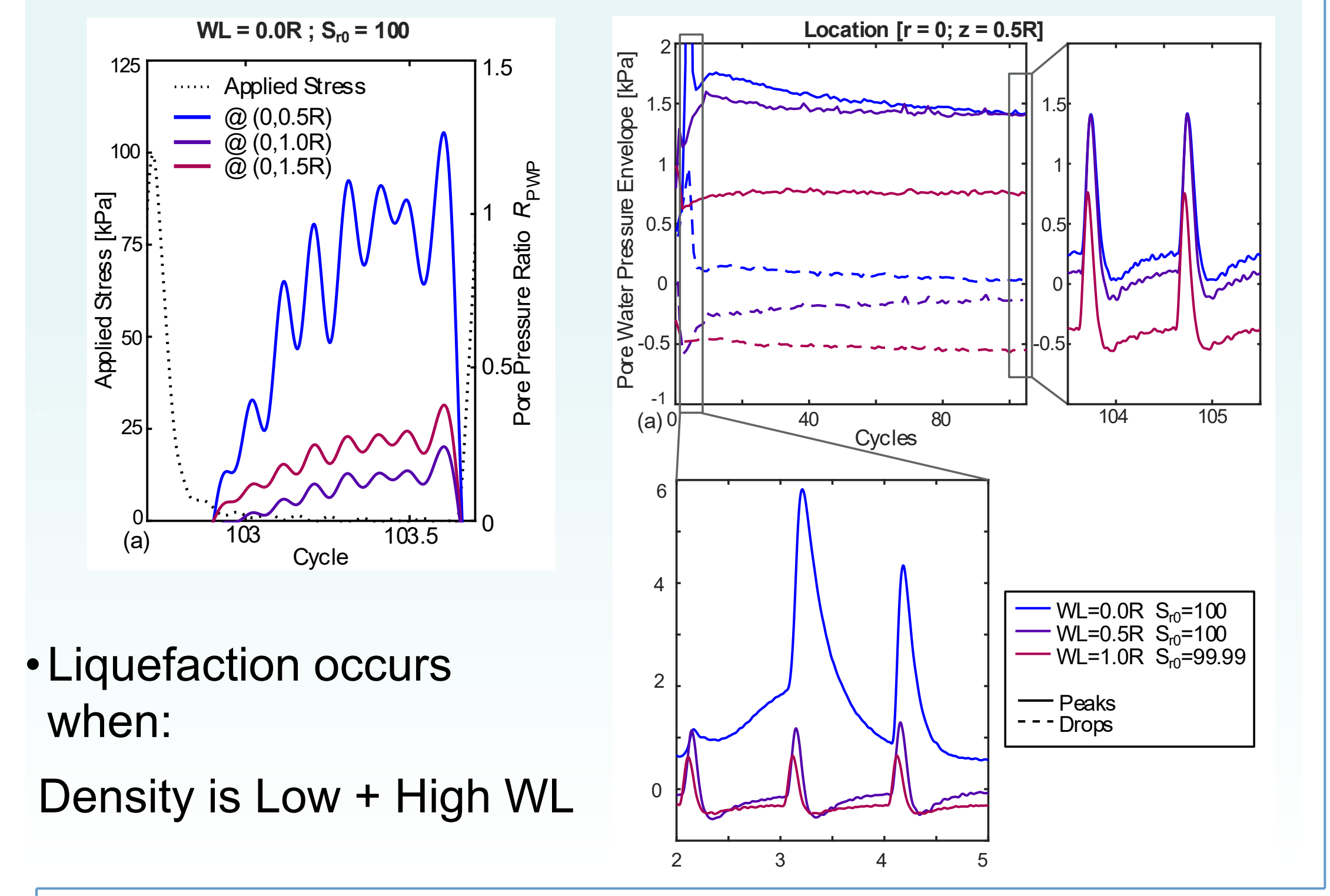
- Total Stiffness increases with suction levels
- Density plays role in enhancing the stiffness
- Resilient stiffness (Cyclic) has similar trend as Total

Settlement & Deformation

- Higher Density → Lower Permeant and Cyclic Deformation
- Higher Suction → Increased Tendency to Shakedown



Liquefaction



- Liquefaction occurs when:
 Density is Low + High WL

Why This Work Matters for Sustainability

- Smarter traffic management during vulnerable pavement conditions
- Longer pavement life & less failure
- Lower maintenance & replacement costs
- Reduced raw material use & environmental burden

Next?

PLAXIS
 FE & Constitutive Modeling:
 Validation

