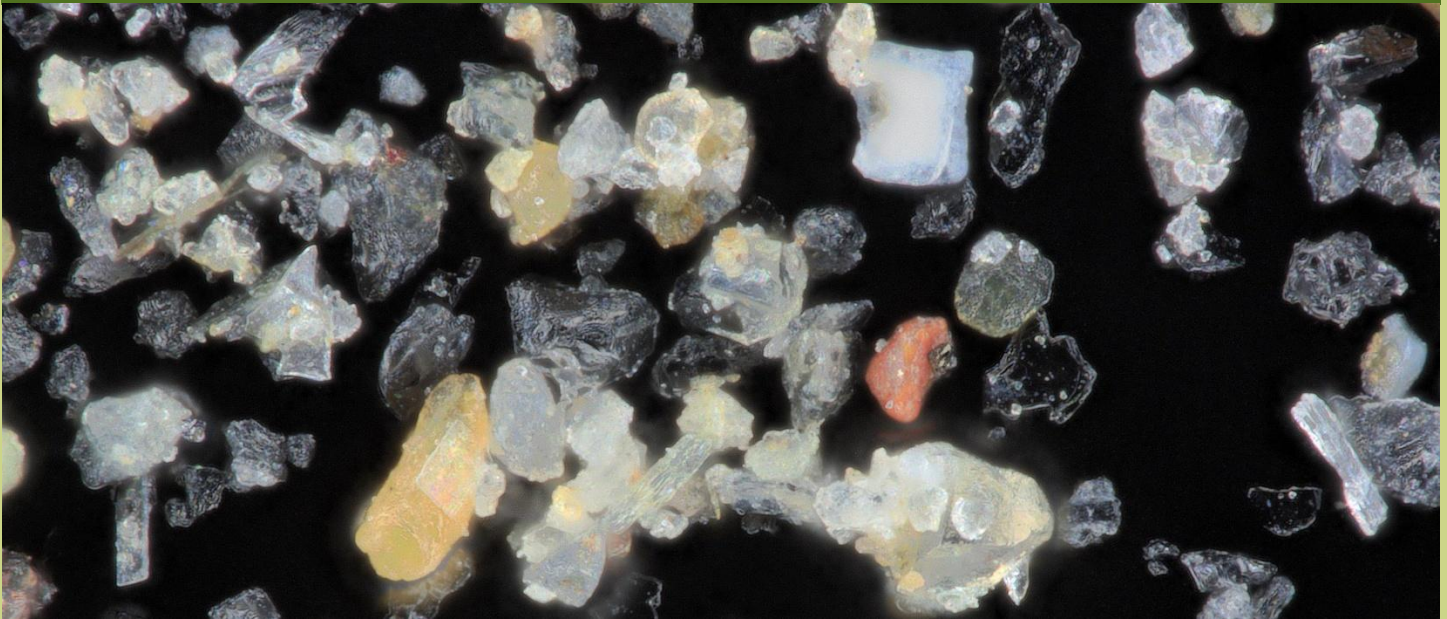


Characterizing the effect of plasticity index on monotonic and cyclic shear behavior of natural low-plastic silt mixtures



PhD Defense

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Date: Dec 1st 2025

Time: 1 PM – 3 PM

Location: FAB 48 Classroom or Join Zoom Meeting: <https://pdx.zoom.us/j/88326882947>

Abstract:

Liquefaction is a phenomenon that can be caused by earthquake shaking, where soil builds up porewater pressure, followed by significant strength loss. Liquefaction failure has been documented in fine-grained soils, especially low-plasticity silt. Similar soils are prevalent in the Pacific Northwest, particularly in Portland, Oregon. This type of soil is considered non-standard because most research in the literature has been conducted on sand or clay, leaving a knowledge gap in the fundamental understanding and evaluation of silt soils. Recent research on silts has used intact specimens that capture natural soil fabric and aging effects, but where there is limited control on plasticity index (PI), or has used reconstituted methods with manufactured silt, where soil composition and index properties can be controlled, but may not replicate the natural soil behavior. This research bridges between research on intact specimens and manufactured soil mixtures by using natural soil and the reconstituted method. Natural soil collected from the Columbia River floodplain was separated into the non-plastic portion and the plastic portion. The portions were then mixed together at set proportions using the slurry method deposition to reach PI of 0, 3, 7, 15, 57. Slurries were tested in 1-D compression, monotonic, and cyclic direct simple shear tests to evaluate the effect of PI on parameters of compression and swelling index, parameters of SHANSEP relationship, cyclic resistance, and post-cyclic behavior. The results showed that normally consolidated non-plastic silt (PI=0) in monotonic tests has contractive behavior like clay material, in contrast with manufactured silts that tend to be dilative. By increasing PI, the S values in the SHANSEP relationship increase linearly from 0.22 (PI=0) to 0.3 (PI=57), and the m values decreases from 0.86 (PI=0) to 0.67 (PI=57). The cyclic results also showed the cyclic resistance ratio for $N=30$ increases from 0.09 (PI=0) to 0.21 (PI=57). The pore water generation at failure criteria is also more than 0.9 for PI from 0 to 7, then decreases to 0.87 and 0.80 for PI of 15 and 57, respectively. Finally, both post-cyclic shear strength ratio and post-cyclic volumetric strain showed an increase at failure criteria from 0.15 (PI=0) to 0.8 (PI=57) and 2.6% (PI=0) to 3.4% (PI=34), respectively. These data can improve the knowledge of geotechnical engineers about the behavior of low plastic silts and could be used for analyzing infrastructure liquefaction hazard along with Columbia River bank.