Enhance Soil-Structure Interface Shear Resistance of Foundation Elements Subjected to Monotonic Axial Loading Using Bio-Inspired Designs

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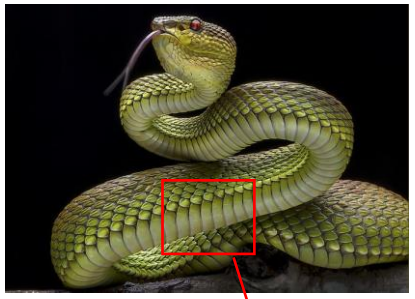
Abstract

Surface characteristics (i.e., surface pattern and roughness) of foundation elements influence soil-structure interface shearing behavior under static and cyclic axial loading. A smooth plate simulating conventional steel piles and three bio-inspired rough plates of different surface were 3D printed and then the soil-plates interface was subjected to monotonic shearing at a constant rate. Based on the preliminary results, The interface shear strength of rough surfaces increased with surface roughness level (i.e., asperity height or h). The interface shear resistance increased with level of roughness. This increase ranged from ~60% to 111% when compared to the soil-smooth interface shear resistance (no surface elements).

Background

Surface characteristics of construction materials representing foundation elements (i.e., surface pattern and roughness) influence soil-foundation interface shearing behavior. To improve soil-foundation interface resistance, several researchers have investigated the role of utilizing engineered or idealized bio-inspired surfaces. For example, surfaces inspired by snake ventral scales were utilized to improve the static interface shear resistance of soil-structure interfaces.



Ventral scales

Problem Statement

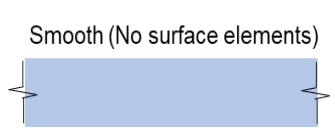
Surface characteristics (i.e., surface pattern and roughness) of foundation elements influence soil-structure interface shearing behavior under static and cyclic axial loading.

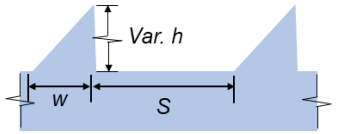
The effects of surface characteristics on clayey soil-foundation interface properties have not been experimentally investigated.

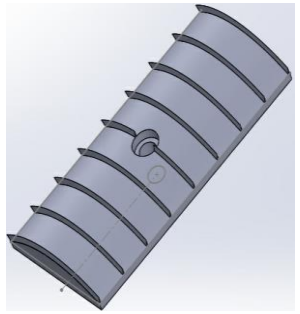
Objectives

Design and propose 3D printed smooth and bio-inspired rough surfaces to improve the static soil-foundation interface shear resistance and perform interface shear tests on these designs.

Experimentally evaluate the increase in interface shear resistance of soil-foundation with level of roughness when subjected to monotonic axial loading.

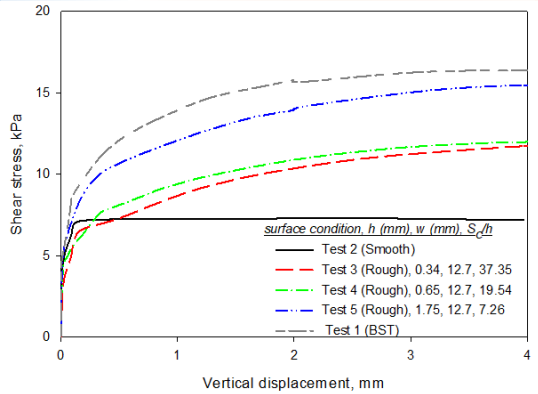


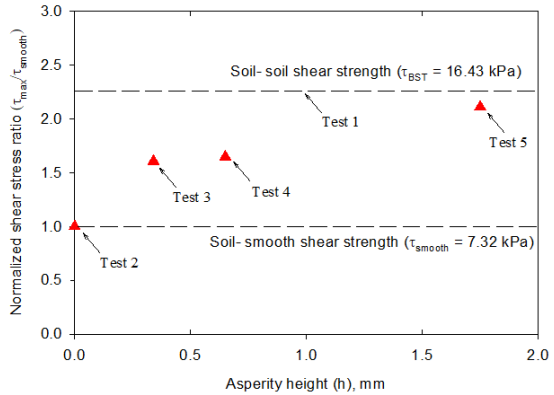




3D smooth and rough printed shear plates

Results





Conclusions

The interface shear resistance increased with asperity height (or roughness level). This increase ranged from ~60% to 111% when compared to the soil-smooth interface shear resistance (no surface elements).

soil-smooth interface showed a volume contraction during interface shearing while a dilative behavior was observed for clay-rough interfaces.