Structural Engineering Seminar Series

CEE 595 S

Structure-property relations and elastoplastic modeling for the deformation of granular matter

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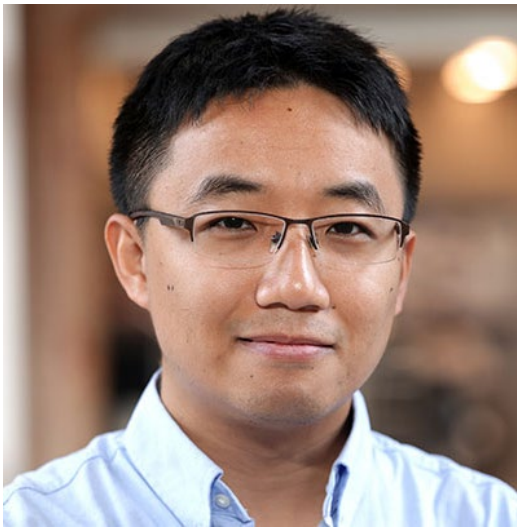
Abstract:

The deformation of granular matter is governed by the complex interplay between elastic deformation, plastic particle rearrangements, and their underlying packing structure. Due to the disorder in particle packing, pinpointing the role of structure in deformation behaviors, such as shear banding, is challenging. In this presentation, we will discuss a recently developed structro-elastoplastic (StEP) framework for modeling the deformation of an experimental granular system, which is a two-dimensional raft composed of interfacial granular particles with controllable particle attractions. We use machine learning methods to develop a structural descriptor, softness, which predicts the propensity of a particle to rearrange. Microscopic interplay between softness, elasticity, and particle rearrangements was extracted from the experimental data and used to inform the StEP model, which in turn captures the strain localization and shear band formation. We will also discuss how the disordered structure evolves when granular rafts are subjected to cyclic loading and vibration, along with potential methods to extend the StEP framework to large-scale and three-dimensional granular systems.

Bio:

Hongyi Xiao is an Assistant Professor in the Department of Mechanical Engineering at the University of Michigan, Ann Arbor. He earned his PhD in Mechanical Engineering from Northwestern University in 2018, after obtaining his bachelor's degree in Energy and Power Engineering at Tsinghua University in 2014. Prior to joining Michigan, Dr. Xiao held postdoctoral appointments at the University of Pennsylvania and at Friedrich-Alexander-Universität Erlangen-Nürnberg in Germany. Dr. Xiao's research focuses on the structure-property relationships in granular materials such as powders, grains, and sand. By integrating experiments, particle- based simulations, and theoretical modeling, he investigates how particle-level properties and packing structures influence the collective behavior and macroscopic characteristics of granular materials. He aims to not only advance the fundamental understanding of granular physics but also address practical challenges in bulk solids processing, additive manufacturing, and robotics when operating in soft terrains.



Monday, November 17, 2025 4:00 – 5:00 p.m.

1310 Yeh Student Center