Sara Abedi, Ph.D.
Post-doctoral Research Associate
Dept. of Civil and Environmental Engineering
Massachusetts Institute of Technology

Geomaterials: From Nanoscale To Macroscale

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2355 GG Brown (North Campus), University of Michigan

Abstract. Geomaterials, such as rocks, soils, and concrete, play important roles in energy and sustainability related problems, including enhanced oil and gas recovery, geological carbon sequestration, geothermal energy, and eco-friendly construction materials. The understanding and prediction of the multiscale mechanical behaviors of natural and composite porous materials require multidisciplinary research across material science, geomechanical engineering, and geochemical engineering. I employ advanced experimental methods at multiple scales combined with physic-based theoretical approaches to develop novel frameworks for understanding and predicting the behavior of Geomaterials. I will present a combined experimental and theoretical microporomechanic approach for assessing the microtexture and material invariant properties at nanometer length scales of organic rich shales. I will introduce a novel method coupling grid nanoindentation, energy dispersive spectroscopy and raman spectroscopy used for the chemo-mechanical identification of material phase of interest. I will then describe a micromechanics-based modeling approach to decode the mesotexture and intrinsic material phase properties. By combining experimental characterization with this micromechanical model, I will show the intricate interplay of maturity and particle properties at the nanometer length scales. The results of this research provide information on the fundamental building block of organic rich shales, which in turn is used to construct and validate multiscale predictive models. A second multiscale material behavior in the context of granular material failure and flow will also be presented. I will describe the experimental procedure combined with Digital Image correlation technique to study strain localization in sand specimens from the meso-scale perspective. The results allow us to understand the meso-scale kinematic behavior inside shear bands through the course of large deformation and also the physical mechanism underlying shear band formation in a supposedly uniform soil specimen.

Dr. Abedi is a Water-Geo-Energy Systems Faculty Candidate