ABSTRACT

Benthic legged locomotion presents distinct challenges, particularly with media that exceed the Atterberg Liquid Limit where soil structural stability is compromised. This presents obstacles when predicting locomotion such as uncertain foot penetration depths and propulsion estimations while walking. Existing contact models predominantly focus on terrestrial dynamics that exhibit plastic behaviors and often use simplified geometries for robotic feet which limits the extent of optimization and specialization during the design process. To address these limitations, this study develops and validates a foot-ground interaction model for complex geometries within submerged sand and loamy-sand terrains. Unlike previous methods, this model eliminates the need for extensive real time terrain and foot knowledge or characterization while walking; instead, it only relies on interpolated foot geometry and the results of a static Cone Penetrometer Test (CPT). The result is a model that predicts foot sinkage depth, the resultant shear force, and slip magnitude. This method should enable enhanced robustness of robot path-planning algorithms across sandy fluidized media in benthic environments.