# Solid-fluid transition modeling of flow liquefaction considering instability state of soil

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## Abstract

Soil flow liquefaction is one of the most dangerous threats to civil engineering structures. It can lead to catastrophes such as the excessive settlement and tilting of buildings, lateral flow of ground, land instability and dam failure. Flow liquefaction involves a phase transition from solid to fluid. A constitutive model that can simulate both the solid and fluid behavior in a unified way was proposed. The model adopts a phase transition criterion to detect the onset of flow liquefaction, and associates an elastoplastic relation and a fluid relation in a single framework, making it possible to describe the contrasting behaviors of soil in different phases before/after flow liquefaction. The scheme of the model can be applied by choosing any appropriate elastoplastic and fluidal relations. In this study, two specific models, namely Cyclic Mobility model for solid phase and a Bingham model for fluid, were selected as an application example. The simulated results of undrained triaxial tests demonstrated that the proposed model is capable of describing the fundamental behaviors of soil both in solid and fluid phases, with a smooth transition from the soil-like behavior to the fluid-like behavior during the phase transition process. The proposed constitutive model can be incorporated into a numerical method, such as the smooth particle hydrodynamics method (SPH), to simulate and predict the flow failure of a real ground in engineering.

Keywords: **Soil liquefaction; Flow liquefaction; Constitutive model; Phase transition.**