Assessing the characteristic limitations and capabilities of four advanced plasticity and hypoplasticity models in simulating the cyclic response of sands

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ABSTRACT

Numerous constitutive models have been developed for the cyclic loading simulation of granular soils. While the models have succeeded in capturing certain aspects of the stress-strain response for a number of idealized loading paths, several limitations are revealed in capturing other paths or more complex aspects of response. Examples of these are stress overshooting, one-way ratcheting in cyclic strain accumulation, liquefaction strength curves, stress attractor in strain-controlled shearing, hypoelasticity, cyclic oedometer stiffness, and effect of drained pre-loading. These limitations are rather crucial for the end-users, and therefore, providing discussion and analysis of them would be of great value for both applications and future developments. Relying on cyclic loading experimental test data on Toyoura and Karlsruhe fine sands, in the present study direct comparison is presented between relevant experimental results and the corresponding simulations using four advanced constitutive models: two bounding surface elastoplasticity [1,2] and two hypoplasticity models [3,4] – with the models in each category following a hierarchical order of complexity. The presented results elaborate on the specific limitations and capabilities of these rather advanced models in simulating several essential aspects of cyclic loading of sands. Some recommendations will be presented for consideration in enhancing the constitutive models for cyclic loading of granular soils.

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