A constitutive model for gas hydrate-bearing soils with considering hydrate occurrence habits

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To exploit the resource of methane hydrate, it is crucial to understand the mechanical behavior of hydrate-bearing sediments. Here an elastoplastic constitutive model is developed for describing the mechanical behavior of gas hydrate-bearing soils (GHBS). To address the effect of the hydrate occurrence habits, the concept of the effective degree of saturation of the gas hydrate is introduced, and the effective stress stresses are redefined for describing the mechanical response of the GHBS. Within this context, a yield or loading function is developed with considering the bonding effect of gas hydrate, so that the yield function can expand or shrink as gas hydrate forms or dissociates. To describe more realistically the mechanical behavior of the GHBS, a non-associative flow rule is proposed by assuming the dilatancy to be a function of bonding stresses, suction stress and stress ratio. The proposed model are applied to analyze the mechanical responses of the GHBS with different hydrate occurrence habits under different environmental loadings. It is demonstrated that the proposed model can capture well the main features of the mechanical behavior of GHBS, including the hydrate-induced enhancements of stiffness, strength and dilatancy, the unsaturation-related characteristics and the hydrate occurrence habits dependency, showing that the proposed model is capable of describing the mechanical behavior of GHBS due to hydrate dissociation or under other environmental loadings.

