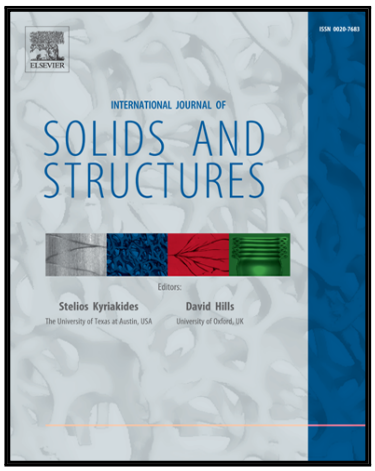

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A non-coaxial critical-state model for sand accounting for fabric anisotropy and fabric evolution

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Abstract: Soil fabric and its evolving nature underpin the non-coaxial, anisotropic mechanical behaviour of sand, which has not been adequately recognized by past studies on constitutive modelling. A novel three-dimensional constitutive model is proposed to describe the non-coaxial behaviour of sand within the framework of anisotropic critical state theory. The model features a plastic potential explicitly expressed in terms of a fabric tensor reflecting the anisotropy of soil structure and an evolution law for it. Under monotonic loading, the fabric evolution law characterizes a general trend of the fabric change to gradually become co-directional with the loading direction before the soil reaches the critical state. When a sand is subjected to rotation of principal stress directions, the fabric evolves with the plastic strain increment which is further dependent on the current stress state, the current fabric and the direction of stress increment. During its evolution, the fabric rotates towards the loading direction and reaches a final degree of anisotropy proportional to a normalized stress ratio. With the incorporation of fabric and fabric evolution, the non-coaxial sand behaviour can be easily captured, and the model response converges to be coaxial at the critical state when the stress and fabric are co-directional. The model has been used to simulate the mechanical behaviour of sand subjected to either monotonic loading or continuous rotation of principal stress directions. The model predictions agree well with test data.