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FE-Investigations on Shear Localizations in Granular Bodies within Hypoplasticity

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Localizations of deformation in the form of narrow zones of intense shearing can develop in granular bodies during processes of granular flow or shift of objects with sharp edges against granular materials. An understanding of the mechanism of the formation of shear zones is important since they act as a precursor to ultimate failure. Classical FE-analyses of shear zones are not able to describe properly both the thickness of localization zones and distances between them since they suffer from a spurious mesh sensitivity (its size and alignment). To overcome this drawback, classical constitutive models require an extension in the form of a characteristic length to regularize the rate boundary value problem and to take into account microscopic inhomogeneities triggering shear localization. In the paper, a spontaneous shear localization in granular bodies is investigated with a finite element method based on a hypoplastic constitutive model. To simulate properly the formation of shear zones, a hypoplastic model was extended by polar, non-local and gradient terms to take into account a characteristic length. The extended hypoplastic models were directly compared on the basis of a FE-analysis of a compression test and earth pressure problem of a retaining wall with sand in conditions of plane strain. The numerical results were also compared to corresponding laboratory tests.

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