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Modelling soil liquefaction during strong earthquakes

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The cyclic shearing of saturated granular soil under undrained conditions is known to cause the gradual reduction of the effective stress and finally the liquefaction of the soil if the effective stress is reduced to zero. The evolution of an initial inhomogeneity in the effective stress during cyclic shearing reveals a kind of positive feedback: a decrease in the effective stress reduces the shear stiffness, which in turn leads to an increase in the shear amplitude and to the faster reduction of the effective stress. As a result, a small inhomogeneity increases and eventually evolves into a shear band [1]. The effective stress during a dynamic shear excitation of a soil layer may develop in such a way that the liquefaction is localized in thin separate zones. This scenario is illustrated by the numerical modelling of the dynamic soil liquefaction with the use of two different constitutive models: a hypoplastic model and a nonlinear cyclic shear model [2–4]. The formation of a liquefaction zone leads to an isolation effect: the liquefaction zone isolates the upper part of the soil layer from the shear excitation. The subsequent motion of the above situated soil rapidly decays in spite of the continuing motion of the base.

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