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Effects of void redistribution on liquefaction-induced landslides

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Lateral spreading of layered slopes remains one of the most pervasive and costly forms of liquefaction-induced ground failure. While analytical methods to predict soil response up to the triggering of liquefaction in the free field continue to be refined, there is still great uncertainty concerning the response of soil beyond initial liquefaction. This paper, which presents the results of a series of dynamic centrifuge tests on model soil slopes subject to seismic loading, clarifies the mechanisms involved in the propagation of liquefaction through complex strata and the behaviour following liquefaction, in particular its effects on ground surface acceleration and the mode of lateral deformation. Experimental data suggest that the spatial variation of permeability in stratified deposits can affect the rate of pore pressure build-up and subsequent dissipation during and after earthquake excitation. The onset of liquefaction-induced densification can result in the formation of water inter-layers trapped below overlying low-permeability strata, the presence of which can initiate excessive localised shear deformations. The subsequent decrease in effective stress at the bedding interface is not taken into account by conventional sliding block analyses that estimate permanent ground displacements. A void redistribution mechanism for the formation of such inter-layer systems is described by considering the insitu loading paths that occur under post-seismic conditions. The key consequence of this behaviour is that the shear strength of the liquefied soil is not solely dependent on the pre-cyclic material properties and state parameters, but rather reflects the response of the composite system.