Distinguishing between the different types of post-peak strength loss

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# ABSTRACT

The propensity for loose soils and tailings to undergo a post-peak loss of strength (i.e. strain softening) is a fundamental aspect of tailings storage facility (TSF) failures involving slope instability. The loss of strength that can occur in geomaterials – often dramatic, and with little warning, can lead to flow slides and thus significant damage to the surrounding area. Indeed, for this reason much current analysis of tailings and foundation soil mechanical behaviour is focussed on determining brittleness, i.e. the magnitude of post-peak strength loss.

Factors contributing to the post-peak loss of strength of geomaterials include shear-induced excess pore water pressure (EPWP) in contractive soils during undrained shearing, or frictional softening where platy clay particles align to form a “slickenslide” with lower effective frictional strength. While both mechanisms have seen considerable discussion, experimental evidence, and implementation in the analysis of slope failures, there remains much ambiguity as to which mechanism is potentially relevant in a given situation. Further, there appears to be no consensus as to if these two mechanisms interact in some cases, and if so when and how, with this having considerable importance in some slope models where the potential for a soil to “stay” weakened could influence the potential future stability of a structure.

The current paper carries out a review of historical laboratory testing and other experimental evidence to examine the interaction of frictional softening and shear induced EPWP in post-peak strength loss of geomaterials. The relevance of this distinction on two recent TSF failures and their post-failure investigation process is outlined. Experimental techniques to assess which mechanism is relevant and in what proportion are discussed. Finally, the potential relevance of the distinction between these mechanisms on the interpretation of large strain in situ tests and the mechanical basis for post-peak strength selection processes are discussed.