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Thermo-mechanical modelling for velocity prediction in catastrophic landslides

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Thermal pressurisation has been proposed in literature as the key phenomenon to interpret the mechanics of the final collapse of large slope failures. A new thermo-mechanical model is proposed by improving on an existing one, applicable to large landslides and rockslides consisting of a coherent mass sliding on a thin clayey layer. The considered time window is that of catastrophic acceleration, which starts at incipient failure and ends a few seconds later, when the acquired displacement and velocity are such that the landslide is broken up into pieces. The model takes into account frictional heating, pore pressure build-up and thermoplastic collapse of the soil skeleton, leading to the vanishing of shear resistance and unconstrained acceleration. First, an existing thermo-elasto-plastic constitutive model for clays is discussed, and modified by re-formulating it in a general stress space and taking into account thermal softening. The soil constitutive model is then employed into an existing 1-D landslide model (Vardoulakis 2002), resulting in a set of three equations describing the time evolution of temperature, excess pore pressures within the shearband and slide velocity. The resulting model equations are shown to be well-posed, and then are discretised and integrated numerically to back-analyse the final stage of the case history of Vajont that occurred in Italy in 1963. Finally, a generalisation of this model and its potential applicability to the velocity back-prediction of other well-documented case histories are discussed.

Reference:

Vardoulakis, I., 2002. Dynamic thermo-poro-mechanical analysis of catastrophic land-

slides. Geotechnique, 52(3): 157-171.