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Stability of accretionary wedges with heterogeneous basal pressure and frictional properties

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Frictional (coefficient μ) and pressure (ratio λ) properties in the bulk and the décollement are usually combined in an equivalent friction coefficient, $\mu' = \mu(1-\lambda)/(1-\lambda_{bulk})$ to question the stability of accretionary wedges according to the classical critical taper theory. Although this theory deals with homogeneous wedges, the equivalent friction coefficient is widely used even for complex pressure and frictional properties distributions. The interest of this work is to understand the role of heterogeneous properties on the wedge stability and thus to question the merits of this equivalent coefficient.
To this end, a general procedure is proposed to extend the critical taper theory to heterogeneous wedges of arbitrary topography. We present a stability study on a wedge whose décollement is partitioned into an internal and an external section, with different λ's and μ's. The method relies on the kinematic approach of limit analysis [1] extended for fluid-saturated rocks [2]. The stability conditions relies on the search for the position of the collapse mechanism composed of two faults, the ramp and the back-thrust, rooting at the same point on the décollement. The root is at the front or towards the back of the wedge for sub- and super-critical conditions, respectively. It is shown that stability depends in a complex manner on the λ's and μ's but also on the relative extent of the two sections [2]. For example, the equivalent friction coefficient approach, based on the external section, is misleading if that region extends less than over 80 % of the décollement. The equivalent friction coefficient should be divided by more then a factor of two for two sections of the same length.

[1] Cubas N., Leroy Y. M. and Maillot B., 2008. Prediction of thrusting sequences in accretionary wedges, Journal of Geophysical Research, doi10.1029/2008JB005717.

[2] Pons A. and Y. M. Leroy, 2012. Stability of accretionary wedges based on the maximum strength theorem for fluid-saturated porous media, Journal of the Mechanics and Physics of Solids, doi10.1016/j.jmps.2011.12.011.