Dynamic initiation of decollement in accretionary prisms

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The decollement of the Nankai accretionary prism is a shallow dipping thrust that cuts through an unremarkable and homogeneous sedimentary layer. This observation contradicts the intuition that (1) decollements develop at the favor of weaker sedimentary levels; and that (2) thrusts form at about 30 degrees from horizontal (Andersonian theory of faulting).
There are many examples of accretionary prisms and fold and thrust belts where weak sedimentary levels act as decollement (e.g. evaporites in the Jura and Zagros, shale in the Alberta foothills). Prediction of the taper angle using the critical Coulomb wedge theory also suggests that decollements are often weaker than the rocks composing the bulk of the wedge (e.g. Davis, 1983). On the other hand, it is well documented that rheological weakening can be a consequence of fracturing, rather than its cause, e.g. because fractures act as fluid pathways that can change the local lithology and raise the fluid pressure.
In this contribution, we derive an analytical solution for the stress orientation in a compressed region of homogeneous perfectly plastic material near the surface. We show that for a perfectly plastic rheology the stress orientation is a function of the push direction, the intensity of the push, the surface topography and material properties. All those parameters collapse into a dimensionless number.
Since we consider homogeneous material properties, it is less suited to analyze present day accretionary prism than the critical taper theory. However, it is particularly suited to study the initiation of decollement, before fault-induced weakening takes place. Our analytical solution (1) is general for any surface topography described by a function differentiable in x; (2) predicts generally non-planar decollement; and (3) does not make use of small angle approximation, even for the case of cohesive plasticity.
The analytical solution is tested against a series of static (<<1% shortening) numerical models including visco-elasto-plastic rheology.

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