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3D stability of accretionary wedges by application of the maximum strength theorem

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The objective is to capture the 3D failure modes in accretionary wedges and their analogue experiments in the laboratory from the sole knowledge of the material and interface strengths. The proposed methodology relies on the maximum strength theorem inherited from classical limit analysis. The virtual velocity field is constructed by spatial discretization. The numerical scheme is first applied to a perfectly-triangular 2D wedge. It is shown that the 2D critical slope α_c for stability is captured precisely by the numerical scheme, the ramp and the back thrust corresponding to regions of localized virtual strain. The influence of the back-wall friction on α_c is explored, explained by the Mohr construction and by analogue experiments with sand. The first 3D problem concerns a wedge with a lateral variation in its topographic slope α so that it is sub-critical ($\alpha < \alpha_c$) and super-critical ($\alpha > \alpha_c$) to the right and to the left boundary, respectively. It is shown that the localized deformation of the ramp on the right side, is getting diffuse as one moves to the left side where more décollement is activated. The influence of the two lateral boundaries is felt for wedge widths even greater than the length. The second 3D problem explores the influence of the side wall friction on the results of laboratory experiments. It is found that the deformation is diffuse close to the side wall with a vertical stretching and less dcollement activated. The side wall influences the rest of the wedge over a width 1.5 times the wedge thickness, for realistic friction angles. Comparison with analogue experiments shows the connection between the virtual 3D velocity field and the actual deformation.