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Finite element modelling of debris flow propagation

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We present a finite element model for the simulation of catastrophic landslides of debris flow type. The model is based on a two-dimensional formulation of the propagation phase problem, studied with an eulerian approach. The analytical problem is defined by the mass and momentum conservation laws. The spatial and temporal evolution of the propagation is studied analysing the variation of the debris flow thickness and the velocity vector components in the x- and y-direction. The equations are written adopting the "shallow water" hypotesis (depth-integrated equations), considering the mobilized material as an incompressible and isothermal fluid. The system of partial differential equations is discretized using the Finite Element Method and solved with non-linear algorithms. The temporal discretization of the governing equations is based on a second order Taylor series expansion. The spatial discretization is obtained by means of the Galerkin method, using three-nodes plane triangular elements and defining linear shape-functions for the interpolation of the solution at the mesh nodes. To efficiently solve the computational phase, the Jacobi iteration scheme is introduced to determine the unknown increments in the variables at each time step. We show the code validation in 1D and 2D, with benchmark problems. Particular attention is paid to evaluate the mobilized volume, velocity and runout distance of debris flows.