Viscoplastic dam-breaks

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We analyse through numerical simulations, experiments, and scaling laws the dam-break problem for viscoplastic materials. Numerically, both two and three-dimensional (2D and 3D) scenarios are taken into account thanks to a proposed adaptive stabilized finite element framework able to compute efficiently free surface flows of highly viscoplastic materials. We choose to focus on the Bingham model. Momentum and mass equations are solved by using the Variational MultiScale method coupled with a regularization technique and anisotropic mesh adaptation. A convective self-reinitialization Level-Set method is used to describe the interface evolution. The obtained 2D multiphase results on viscoplastic column collapses show good agreement with literature. Additionally, new 3D simulations for both cylindrical and prismatic columns are explored through energy budget and bluenew scaling laws based on which the collapse process is divided into three regimes: (1) viscous; (2) visco-plastic (mixed); and (3) plastic. These regimes are stressed for a wide range of initial column aspect ratio (1-20) and Bingham number (0.003-0.3). Lastly, the simulations are compared to experiments either taken from existing literature or performed using tailings, mineral suspensions, Carbopol, Mayonnaise, and Ketchup for cylindrical and conical columns.