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Comparison of Particle Flow Code and Smoothed Particle Hydrodynamics Modelling of Landslide Run outs

A. Preh (1), R. Poisel (1), and O. Hungr (2)

(1) Vienna University of Technology, Institute of Geotechnics, Wien, Austria (alexander.preh@tuwien.ac.at, +43 1 58801 20399), (2) University of British Columbia, Department of Earth and Ocean Science, 6339 Stores Rd., Vancouver, B.C., V6T 1Z4, Canada

In most continuum mechanics methods modelling the run out of landslides the moving mass is divided into a number of elements, the velocities of which can be established by numerical integration of Newton´s second law (Lagrangian solution). The methods are based on fluid mechanics modelling the movements of an equivalent fluid. In 2004, McDougall and Hungr presented a three-dimensional numerical model for rapid landslides, e.g. debris flows and rock avalanches, called DAN3D.The method is based on the previous work of Hungr (1995) and is using an integrated two-dimensional Lagrangian solution and meshless Smooth Particle Hydrodynamics (SPH) principle to maintain continuity. DAN3D has an open rheological kernel, allowing the use of frictional (with constant porepressure ratio) and Voellmy rheologies and gives the possibility to change material rheology along the path.

Discontinuum (granular) mechanics methods model the run out mass as an assembly of particles moving down a surface. Each particle is followed exactly as it moves and interacts with the surface and with its neighbours. Every particle is checked on contacts with every other particle in every time step using a special cell-logic for contact detection in order to reduce the computational effort. The Discrete Element code PFC3D was adapted in order to make possible discontinuum mechanics models of run outs.

Punta Thurwieser Rock Avalanche and Frank Slide were modelled by DAN as well as by PFC3D. The simulations showed correspondingly that the parameters necessary to get results coinciding with observations in nature are completely different. The maximum velocity distributions due to DAN3D reveal that areas of different maximum flow velocity are next to each other in Punta Thurwieser run out whereas the distribution of maximum flow velocity shows almost constant maximum flow velocity over the width of the run out regarding Frank Slide. Some 30 percent of total kinetic energy is rotational kinetic energy in Thurwieser, whereas the contribution of rotational kinetic energy in Frank Slide is zero. Thus Frank run out is a real “slide” of a coherent mass, whilst Punta Thurwieser run out is a rock mass fall with much internal movement. The parameters for a run out simulation therefore have to be chosen in such a way that the simulation gives a rock mass fall in one particular case and a slide of a coherent mass in another corresponding to the real conditions.

Punta Thurwieser rock avalanche as well as Frank slide fit well with the data of other mass movements, showing that smaller volumes reach steeper “Fahrböschungen” and vice versa. However, it cannot be assumed that the volume is the only influencing parameter for the run out kinematics. Frank Slide and Randa Rock Fall had both approximately the same volume but very different "Fahrböschungen". The detachment mechanism (sliding, toppling, etc.), the morphology of the detachment surface (more or less undulated in case of a sliding failure mechanism etc.) have significant influence on the degree of loosening of the moving mass and on the trigger mechanism of the run out. The morphology of the pathway of the run out and the presence of saturated soils available for entrainment into the moving mass may also have a great influence on run out kinematics.

Therefore, the prediction of the run out kinematics and the fixing of the parameters is a demanding task in each case.