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A coupled DEM-CFD method for impulse wave modelling

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Rockslides can be characterized by a rapid evolution, up to a possible transition into a rock avalanche, which can be associated with an almost instantaneous collapse and spreading. Different examples are available in the literature, but the Vajont rockslide is quite unique for its morphological and geological characteristics, as well as for the type of evolution and the availability of long term monitoring data.
This study advocates the use of a DEM-CFD framework for the modelling of the generation of hydrodynamic waves due to the impact of a rapid moving rockslide or rock-debris avalanche.
3D DEM analyses in plane strain by a coupled DEM-CFD code were performed to simulate the rockslide from its onset to the impact with still water and the subsequent wave generation (Zhao et al., 2014).
The physical response predicted is in broad agreement with the available observations. The numerical results are compared to those published in the literature and especially to Crosta et al. (2014).
According to our results, the maximum computed run up amounts to ca. 120 m and 170 m for the eastern and western lobe cross sections, respectively. These values are reasonably similar to those recorded during the event (i.e. ca. 130 m and 190 m respectively).
In these simulations, the slope mass is considered permeable, such that the toe region of the slope can move submerged in the reservoir and the impulse water wave can also flow back into the slope mass. However, the upscaling of the grains size in the DEM model leads to an unrealistically high hydraulic conductivity of the model, such that only a small amount of water is splashed onto the northern bank of the Vajont valley. The use of high fluid viscosity and coarse grain model has shown the possibility to model more realistically both the slope and wave motions. However, more detailed slope and fluid properties, and the need for computational efficiency should be considered in future research work.
This aspect has also been investigated by Crosta et al. (2014) via 2D and 3D FEM ALE modelling without considering the water seepage in the slope mass has been used. Their results can be a good way to estimate the slope and wave motion for fast sliding conditions. The 3D modelling can also clarify the lateral motion of water and estimate the potential risk of water overtopping the dam crest. The DEM and FEM ALE modelling can be used together to analyse fast moving rockslides (i.e. flowslides, rockslides, rock and debris avalanches) both in dry conditions and for their interaction with water basins.

References

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