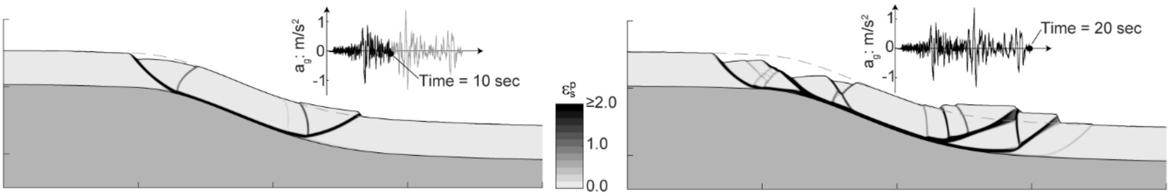
The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

Material point method for large deformation seismic response analysis



Marc Kohler*[1], Andreas Stoecklin[1] and Alexander M. Puzrin[1]

[1] Institute for Geotechnical Engineering, ETH Zurich, Stefano-Franscini-Platz 5, 8093 Zürich, Switzerland, marc.kohler@igt.baug.ethz.ch

Key Words: *Numerical Modelling, Material Point Method, Earthquakes, Landslides*

Landslides triggered by earthquakes are one of the major seismic hazards and can cause large damages and fatalities. The material point method (MPM) [1] has become increasingly popular to model such large mass movements [2]. A limitation of existing MPM implementations is the lack of appropriate boundary conditions to perform seismic response analysis of slopes. Therefore, an extension to the basic MPM framework is presented for simulating the seismic triggering and subsequent collapse of slopes within a single analysis step. The concepts of a compliant base and free-field columns are transferred to the MPM framework and enable the application of input ground motions while accounting for the absorption of outgoing waves.

The presented methodology [3] is applied to an example slope to illustrate the proposed procedure and to benchmark it against the results obtained using a coupled Eulerian Lagrangian (CEL) finite element analysis. The triggering is performed in a Lagrangian and the following runout in Eulerian step due to the large deformations. However, the input motion cannot be applied during the runout analysis which might lead to an underestimation of the predicted displacements. This disadvantage can be overcome by the presented "all-in-one" MPM approach. The comparison shows that for short duration ground motions both methodologies lead to almost identical results, whereas for longer earthquake events the failure mechanism propagates further down- and uphill into stable parts of the slope, resulting in a considerably larger landslide.

REFERENCES

[1] Sulsky, D., Chen, Z. & Schreyer, H. L. (1994). A particle method for history-dependent materials. *Computer Methods in Applied Mechanics and Engineering*, *118*(1–2), 179–196. doi: 10.1016/0045-7825(94)90112-0.

[2] Soga, K., Alonso, E., Yerro, A., Kumar, K. & Bandara, S. (2016). Trends in large-deformation analysis of landslide mass movements with particular emphasis on the material point method. *Géotechnique*, *66*(3), 248–273. doi: 10.1680/jgeot.15.LM.005.

[3] Kohler, M., Stoecklin, A and Puzrin, A. M.. (2021) 'A MPM framework for large deformation seismic response analysis'. Canadian Science Publishing. doi: 10.1139/CGJ-2021-0252.