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Simulation of Complex-Shaped Particle Breakage with a Bonded Particle Model Using the Discrete Element Method

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Abstract : In Discrete Element Method (DEM) simulations, the breakage behavior of particles can be simulated based on different principles. In the case of large, complex-shaped particles that show various breakage patterns depending on the scenario leading to the failure and often only break locally instead of fracturing completely, some of these principles do not lead to realistic results. The reason for this is that in said cases, the methods in question, such as the Particle Replacement Method (PRM) or Voronoi Fracture, replace the initial particle (that is intended to break) into several sub-particles when certain breakage criteria are reached, such as exceeding the fracture energy. That is why those methods are commonly used for the simulation of materials that fracture completely instead of breaking locally. That being the case, when simulating local failure, it is advisable to pre-build the initial particle from sub-particles that are bonded together. The dimensions of these sub-particles consequently define the minimum size of the fracture results. This structure of bonded sub-particles enables the initial particle to break at the location of the highest local loads – due to the failure of the bonds in those areas – with several sub-particle clusters being the result of the fracture, which can again also break locally. In this project, different methods for the generation and calibration of complex-shaped particle conglomerates using bonded particle modeling (BPM) to enable the ability to depict more realistic fracture behavior were evaluated based on the example of filter cake. The method that proved suitable for this purpose and which furthermore allows efficient and realistic simulation of breakage behavior of complex-shaped particles applicable to industrial-sized simulations is presented in this paper.

Keywords : bonded particle model, DEM, filter cake, particle breakage
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