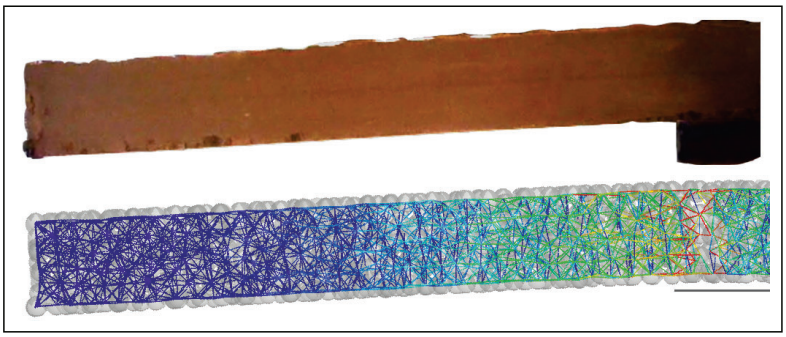
Complex Bonded Structures as Fracturable Particles

Modelling of three-dimensional DEM bonded-particle structures with specific bonding criteria allowing complex breakage into several fragments



Many developments regarding modern DEM concern techniques to enable complex particle behavior, e.g. (as relevant to this project) relating to modelling of particles with complex geometries, deformation, and breakage abilities, for which in general several basic approaches are each conceivable. One promising technique that allows these aspects to be considered in combination is to use complex bonded-particle structures: modelling of particles, each consisting of a multitude of via bondings interconnected sub-particles. Specific bonding criteria further allow each bonding to break individually, depending on the conditions within the structure. This enables the structure to represent a fracturable particle. Further, by specifc (complex) sub-particle arrangement, complex-shaped structures can be set up accordingly. As DEM bondings are virtual beam elements, typically supporting deformation (when reacting to loads), such bonded-particle structures consequently reveal certain deformation capabilities. In cooperation with FLSmidth Tailings Solutions USA, the described technique is applied to an industrial application, specifically for modelling fracturable filter cake as bonded-particles. This bulk material can be characterized as consisting of complex-shaped fragments (comparable to flat cuboids), with above all: complex fracture behaviour. For parameter determination, various tests are performed, e.g. typical ones, as for density or friction, and further regarding the bonded structure, such as the exemplarily shown simple test, where a filter cake structure is moved over an edge until fracture from its own weight (laboratory test and corresponding DEM simulation, illustrating particles with bondings). As shown, the sub-particles are spherical, which enhances the computational efficiency, particularly regarding large-scale application (as intended for this project). Further, the distinctive particle size distribution, packed in a random but tight arrangement, gives the fracturable particle a complex character, as in terms of distributed behavior. Additional to this distribution, with resulting varieties in bondings, further deviations in the bonding breakage criteria can be defined to adjust an even more complex (and especially inhomogeneous) fracture behavior of the bonded-particle structure.

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