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Application of the Discrete Element Method for analysis of fundamental particle interactions during rupturing seismic sources

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The Discrete Element Modelling (DEM) is a computer simulation approach capable to simulate brittle materials fragmentation. The unique feature of this approach is that it explicitly considers individual particles in a material and their mutual interactions. The DEM presents an alternative to typical continuum mechanics based approaches which assume the material to be a continuous medium and thus no movements, rotations, or inter-particle interactions are taken into account. In consequence, no microscopic information on fragmentation processes are available and thus also macroscopic description of breaking is quite limited. On the other hand, within the DEM approach, the medium is represented in a corpuscular-like way and the dynamics of the medium under external forces is described by an inter-particle interaction evolution. This allows to “look into” the material at a microscopic level and to attach fundamental particle interactions with a complex, macro-scale response of the medium observed in nature.

In the DEM approach loads and deformations can be applied to virtual sample of the material and simulated dynamics can be directly compared to physical laboratory tests or field observations. What differs this approach from standard laboratory observations is a richness of available information on a process. It is incredibly difficult (and even impossible) to obtain the same data in real physical laboratory tests. However, the price for this is a complexity of DEM simulations requiring huge computational resources. We take advantage of parallel version of open source DEM software – ESyS Particle to simulate breaking processes of brittle materials.

We focused our attention on two popular laboratory experiments – Uniaxial Compression and Brazilian Test. We have got an insight into creation of cracks under the simulated laboratory conditions. Additionally, we were able to monitor a nucleation and temporal evolution of cracks which finally lead to breaking apart a sample in the Brazilian Test and Uniaxial Compression tests. Consequently, we were able to infer some rules which govern the fracturing of different materials with specific Young’s Modulus, Poisson Ratio and Unconfined Compressive Strength.