STATIK DYNAMIK

RUB

COMPUTATIONAL FRACTURE AND FRAGMENTATION MODELING USING PERIDYNAMICS: APPLICATION TO MECHANIZED EXCAVATION IN HARD ROCK

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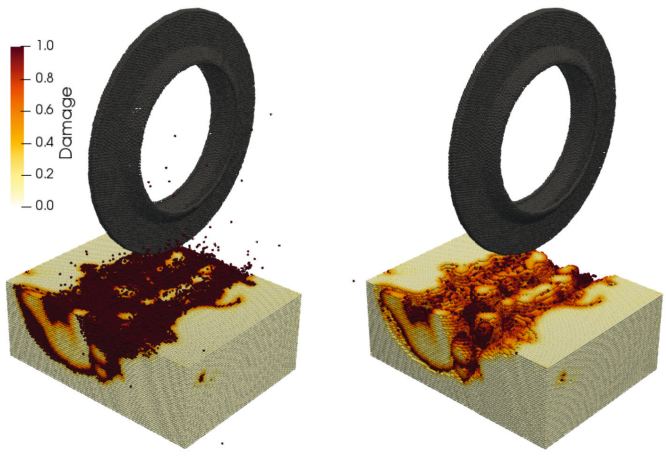
Simulating mechanized excavation using cutting discs of a TBM pose challenges due to the complex fragmentation and crushing of the rock. To address these challenges, a recently developed nonlocal continuum theory suitable for modeling fragmentation processes was analyzed, extended, and applied to simulate rock excavation.

Extensive analysis of the peridynamic theory provided a physical interpretation of the peridynamic horizon size and its influence on wave dispersion properties. The dynamic fracture analyses revealed insights into the impact of the horizon size on the crack propagation velocity and provided evidence of the influence of specimen size and geometry on the dynamic fracture process. Analysis of failure under compressive loads uncovered limitations in existing peridynamic models. To address this, the model was extended to include pore-collapse for simulating crushing in porous materials and a pressure-dependent fracture energy for modeling compressive failure in low-porosity heterogeneous materials. These extensions were validated using indentation tests on sandstone specimens and the biaxial failure strength envelope of concrete.

Following these investigations and extensions, the model was applied to simulate rock excavation and validated using the Linear cutting test and predictions from an empirical model. With the confidence gained from these validated extensions, the model was successfully applied to simulate several excavation scenarios, including mixed-ground conditions, excavation using blunted cutting discs, as well as discs with varying levels of localized damage. The developed model provided a virtual laboratory, where synthetic data can be generated and further analyzed to characterize and optimize the excavation process.



Simulation of the Linear Cutting test (left), material points with a damage value greater than 0.95 are filtered out for the visualization of the chip formation (right).

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