

A hybrid method on modeling of grain crushing

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Abstract

Crushing of granular particles involves inhomogeneous, continuous changes in both grain shapes and sizes. Widely considered a challenge in micromechanical modeling, prevailing existing studies based on discrete element method have largely resorted to oversimplified methods such as clustering or replacing-particle approaches. We propose a hybrid computational approach by pairing peridynamics with a physics engine to simulate crushable granular materials under mechanical loadings. The hybrid approach uses peridynamics to analyze and simulate the breakage of individual particles, and allows the physics engine to handle the rigid-body motion of particles and inter-particle interactions. The hybrid framework enables rigorous modeling of particle breakage and allows reasonable simulation of irregular particle shapes during the continuous breakage process, overcoming major drawbacks/challenges faced by many existing methods. A demonstrative example of 1D compression on crushable sand is shown and compared with experimental data. Good agreements are observed in terms of normal compression line, grain size distribution evolution, fractal dimension, and grain shape changes.

Keywords: Grain crushing, peridynamics, physics engine, particle morphology

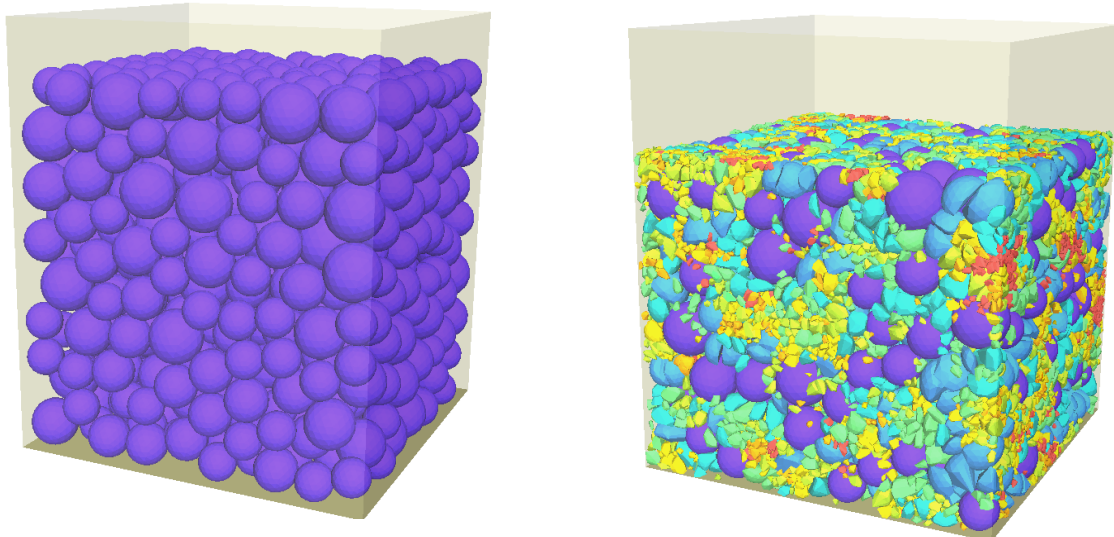


Figure 1. Hybrid peridynamics/physics engine modeling of crushing sand under 1D compression (left: initial packing before compression; right: final state)

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