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Lagrangian-Lagrangian simulation of solid-liquid flows by the DEM-SPH method

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In this study, we present the DEM-SPM method, a Lagrangian-Lagrangian coupled algorithm, for simulating solid-liquid flows involving free surfaces. The DEM solid phase and the SPH liquid phase are connected using the local averaging technique, where the governing equations are modeled taking account of the local mean voidage. Conservative forms of momentum balance are derived via a variational approach. Furthermore, provided by a corrected kernel approximation, SPH boundaries can be modeled without extra wall particles, and the boundary representation is unified for both DEM and SPH phases. Level-set functions are deployed to facilitate this boundary model. To examine the validity of the DEM-SPH method, we perform 3D simulations of a dynamic flow in a solid-liquid dam break and a quasi-steady flow in a rotating cylindrical tank. In both tests, the simulation results are in good agreement with those obtained in validation experiments.

Keywords: solid-liquid flow, fluid-particle interaction, discrete element method, smoothed particle hydrodynamics, wall boundary condition