

# Simulation of sedimentary structures under water flow

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## [Introduction]

It is cleared that the bed form structures are variable with fluid velocity and particle diameter by various experiments. The dynamic mechanism of sedimentation which deforms the bed form has much unknown factors. To reveal these, it is required to simulate the grain motion in fluid flow by considering the dynamic influence on each grain particle. Then we have developed the new simulation technique which treats the fluid flow and the particle motion simultaneously by coupling the Lattice Boltzmann Method and the Discrete Element Method.

## [Methodology]

Lattice Boltzmann method (LBM) is a numerical method for fluid flow, whose feature is an approximation of fluid as an assembly of virtual particles, not continuum. It is suitable for this research because this method can easily calculate fluid flow even in the changing boundary shape. Fluid velocity, density, and pressure are calculated around the solid particles (sand grains) under the non slip boundary condition in LBM. The effects to the fluid from the particles can be simulated because the fluid velocity is fit to the particle velocity in this condition. The force on the particles is divided into two types; 1) solid - fluid interaction force, and 2) solid - solid interaction force. The former force is estimated using the fluid density and the relative velocity between the fluid and solid particles. The latter generates in the collision with other particles. It is treated by springs and dashpots, which is called discrete element method (DEM). Using these forces, the particles move by Newton's law.

## [Particle sedimentation experiment]

We checked the validation with this methodology by the particle sedimentation experiment in a hydrostatic condition. The experiments conducted with the various particle radius, number of particles, and distance from the wall of water tank. The stiffness of DEM springs and dashpots and the effect of the LBM lattice size are considered using experimental results, and then the adequate simulation condition is determined.

## [Sedimentary structure]

We simulated the deformation of ripple in the bed form. The simulation domain is a square shape, and the periodic boundary to the long side direction is set for the infinite river bed. The various radius disks are randomly arranged as sand grains. The gravity is distributed to horizontal and vertical direction for inclined river bed. Some kinds of sedimentary structure are performed with the various initial arrangement, grain radius, and fluid velocity.

We will evaluate quantification and model the mechanism of ripple deformation for the future study.

## [Acknowledgment]

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