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Numerical and experimental investigation of damping in a dam-break problem with fluid-structure interaction

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Smoothed Particle Hydrodynamics (SPH)

As a Lagrangian, particle approach, SPH is used to calculate field variables by transforming partial differential equations into ordinary differential equations with the help of kernel functions.

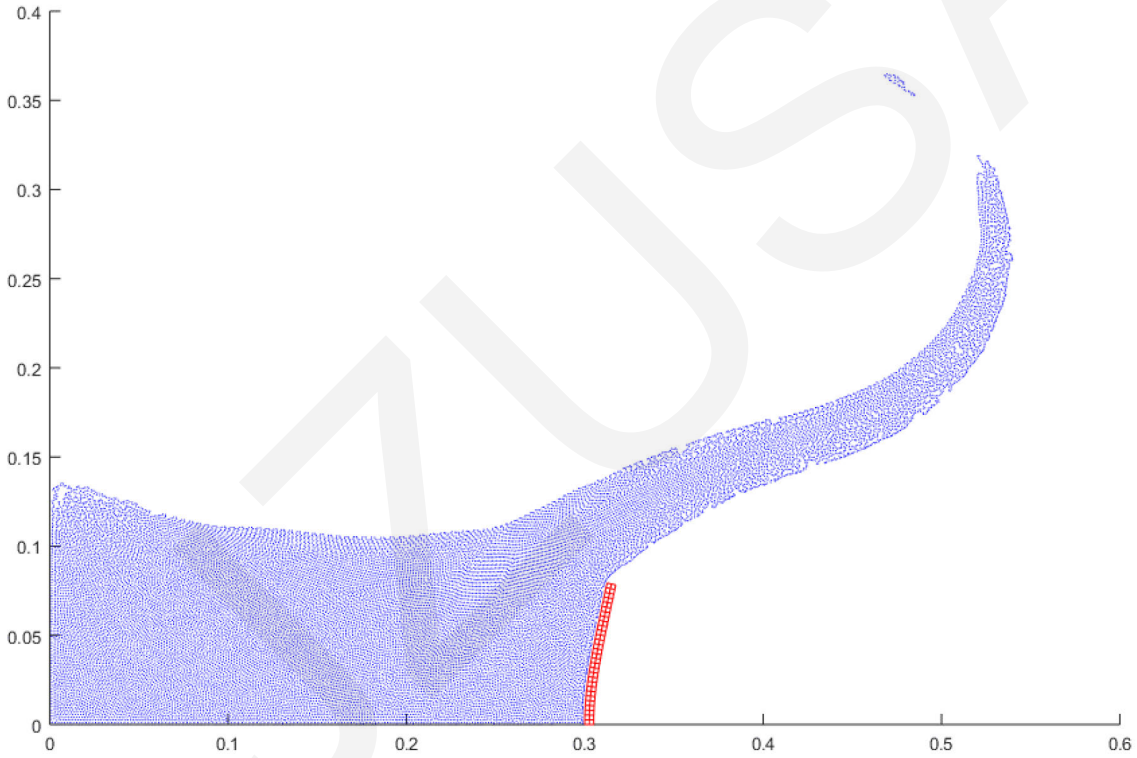


Fig. 1. Simulation of a dam-break problem by SPH

Contact Mechanics

Contact mechanics is based on taking intersecting domains apart from each other by applying the contact forces to the intersecting domains.

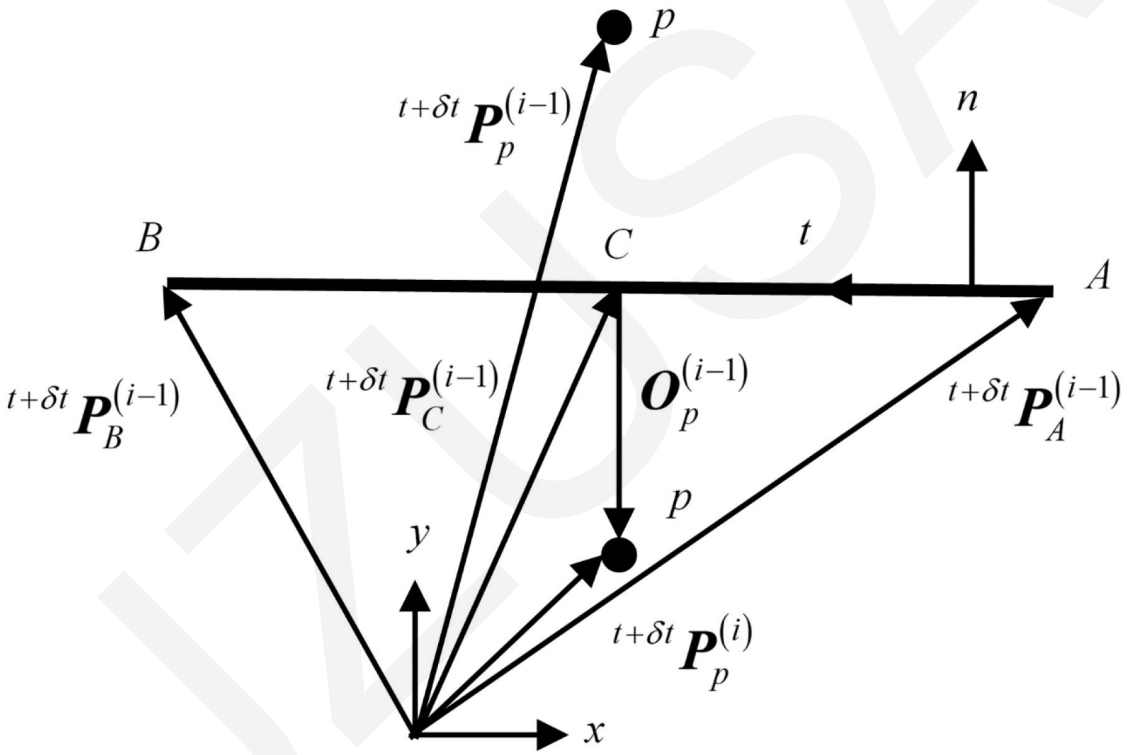


Fig. 2. Geometry of a structural system composed of a particle and contact surface

Dam-break experiment

A series of experiments was carried out to investigate the structural damping effect. The setup was similar to the one used by Koshizuka et al. (1995). The main improvement of this experimental setup was that the pressures at the downstream wall were recorded. Experiments were carried out using rubber plates with different material and geometric properties.

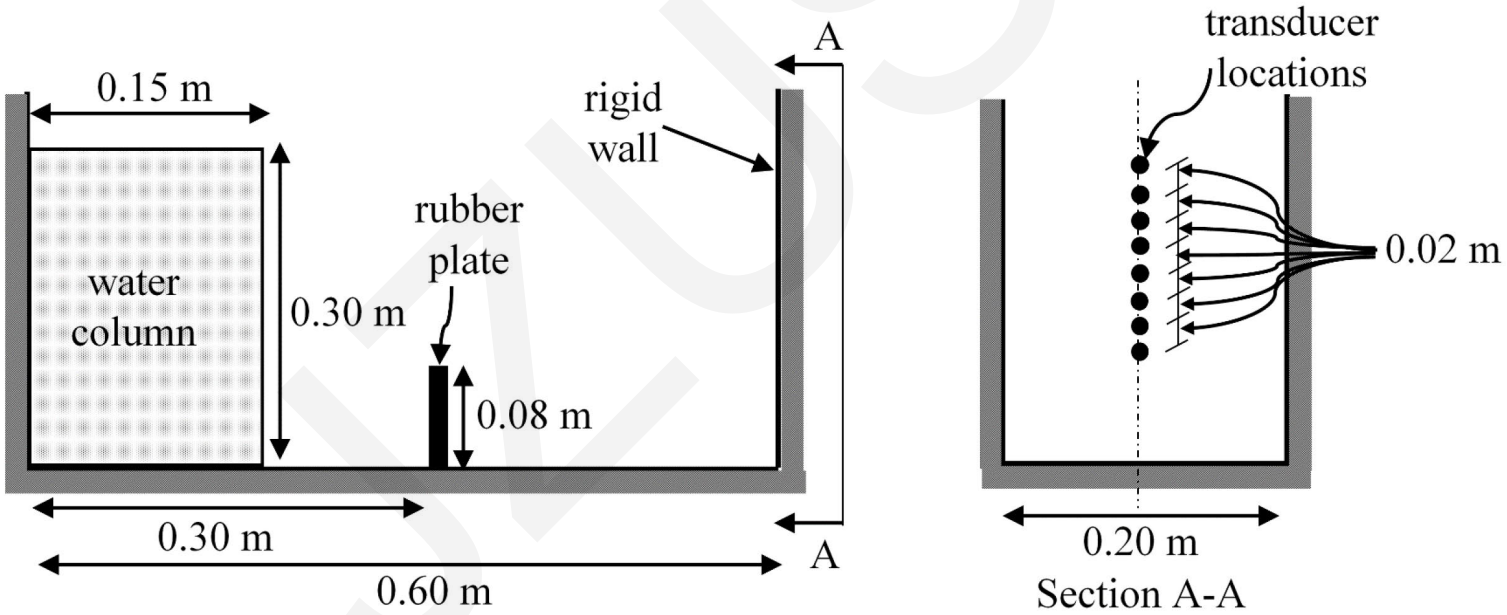


Fig. 3. Geometry of the experiment.

Results

Three different rubber plates were used to investigate the damping effect. Each plate had a different thickness, modulus of elasticity and damping ratio.

Table. 2. Pressure results

Rubber plate thickness (mm)	Location of the transducer reading the peak pressure (mm from the bottom wall)	Peak pressure (kPa)	
		Measured	Calculated
5	32	15.2	14.2
10	28	16.1	15.7
15	32	12.0	11.3

Results

The free-surface profiles and displacements of rubber were recorded by a high-definition camera.

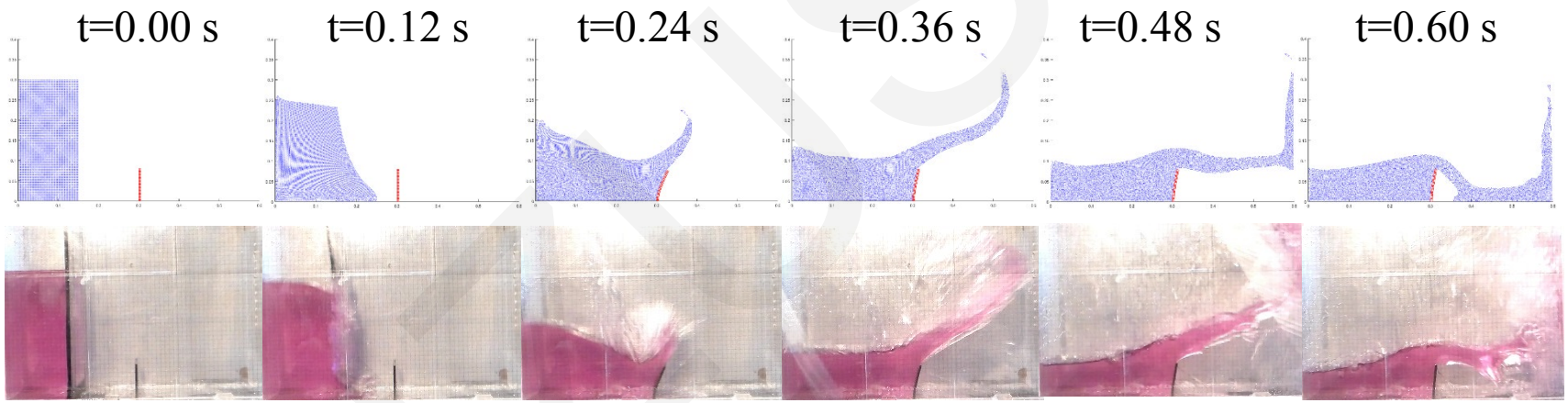


Fig. 4. Free-surface profiles of experiment with 5 mm rubber plate.

Results

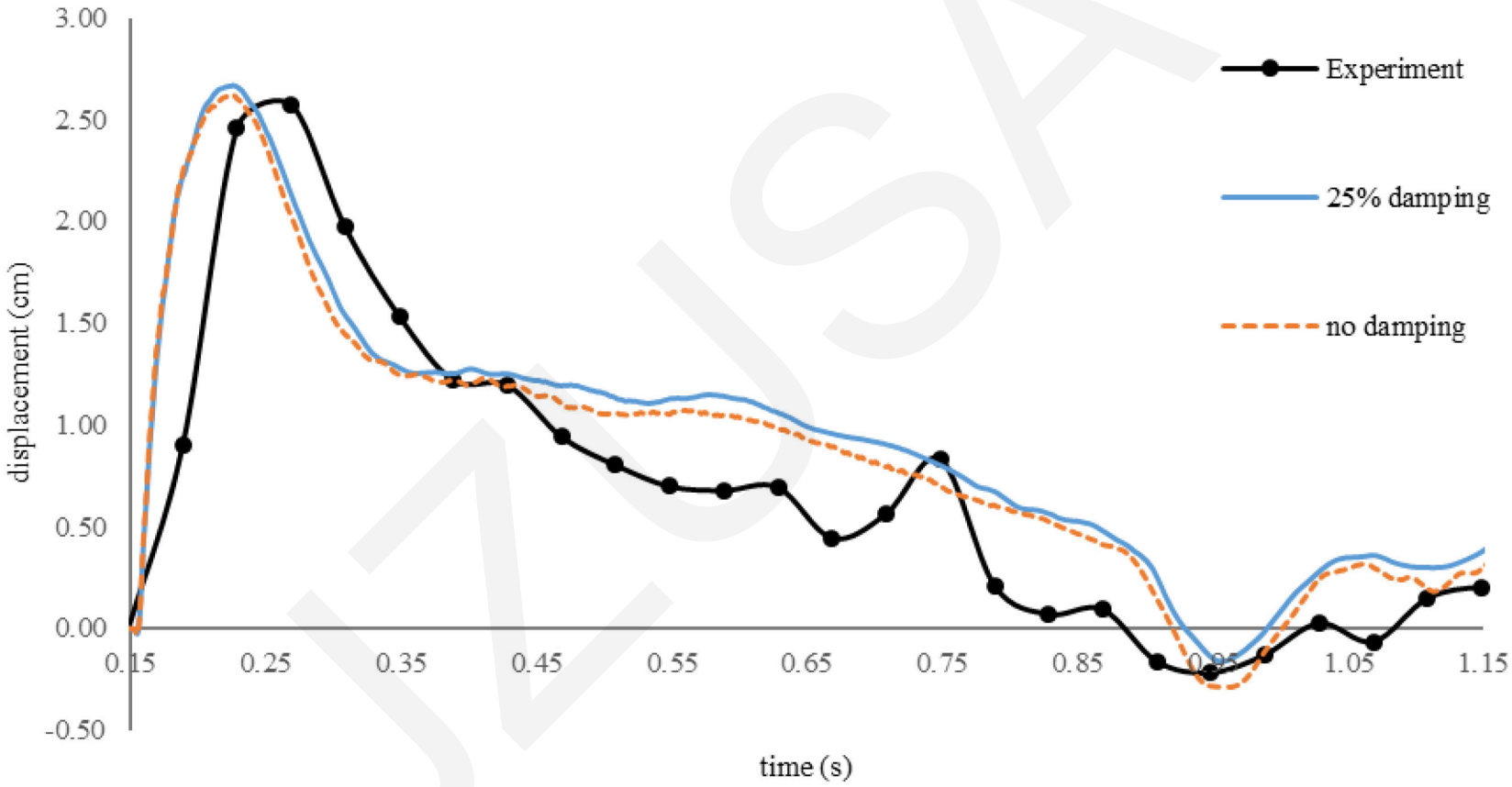


Fig. 5. Tip displacement of the 5-mm rubber plate

Conclusions

- A series of experiments has been carried out to investigate the effects of damping in FSI problems.
- An SPH-FEM based numerical model was developed in which contact mechanics is used for FSI coupling.
- The free-surface profiles, displacements of rubber plates and pressures on the wall of the container were successfully simulated with the SPH-FEM based FSI model.
- The obtained results show that damping is not essential to be used in inertia-driven problems containing continuous interaction.

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