SIMULATING DAM-BREAK FLOW THROUGH IDEALIZED CITY LAYOUTS WITH GPU-BASED SPH METHOD

Jiansong Wu, Tsinghua University, 86-10-62792894, jiansongwu08@gmail.com

1. Jiansong Wu, Tsinghua University and Johns Hopkins University
2. Rozita Jalali Farahani, Johns Hopkins University
3. Robert A. Dalrymple, Johns Hopkins University
4. Hui Zhang, Tsinghua University

The numerical modeling of dam break floods in valley or river thalweg has been underway for a long time, and has achieved plenty of good results. Most of these models are based on solving the Saint-Venant equations or shallow water equations that derived through the depth-averaged integration under the underlying assumptions of hydrostatic pressure distribution. However, for the sudden dam break or levee breach floods in the urbanized areas, these models will not still perform well, especially for the fast transient flows, because the layout of buildings and streets in urban districts can induce complex flow features, such as hydraulic jumps, wave vortices and flow discontinuities. These local three dimensional features make none of the underlying assumptions of the depth-averaged models hold.

To perfectly simulate urbanized dam break flow and make high resolution modeling of local features of dam break flow, this paper uses the Smoothed Particle Hydrodynamics (SPH) methodology employing graphical processing unit (GPU) parallel computing technique to examine the violent dam break flow in urban districts. Fast transient dam break flows in two different city layouts according to the real experiments conducted by Soares-Frazão and Zech (2008) are examined: (1) a square city layout of 5×5 buildings aligned with the approach flow direction, and (2) a square city layout of 5×5 buildings not aligned with the approach flow direction. The present results qualitatively show the typical and good regimes of the urbanized dam break flow just like in the real experiments, and quantitatively agreed with Soares-Frazão et al.'s experimental data. In addition, the present GPU-based SPH model achieved much better results of water-surface profiles and surface velocity than the numerical model based on shallow water equations that used by Soares-Frazão et al. to compare with their experimental data.