10th International Congress on Civil Engineering, 5-7 May 2015
University of Tabriz, Tabriz, Iran

ISPH numerical modeling of dam-break case with an obstacle

Habibeh Sheybanifard[1], Mohammad Zounemat-Kermani[2],Gholam-Abbas Barani[3], Rasoul Memarzadeh[4]

1,2- Water Engineering Department, Shahid Bahonar University of Kerman
3,4- Civil Engineering Department, Shahid Bahonar University of Kerman

sheybanifard@agr.uk.ac.ir

Abstract

In this paper, impact of a wave generated by a dam break with a rectangular obstacle is modeled with a two-dimensional version of incompressible smoothed particle hydrodynamics method.
The ISPH method is a full Lagrangian method that employs a strict incompressible hydrodynamic formulation to solve the fluid pressure and the numerical solution is obtained by using a two-step semi-implicit scheme. Removing the gate from the water column was done so immediately that could be considered a sudden gate break. For this modeling, experimental case related to the phenomenon of dam break were considered and results of the numerical model were validated by experimental data. The computational results demonstrate that the ISPH flow model could provide a promising simulation tool in coastal hydrodynamic applications.
Keywords: Free-surface flows, Dam break, Numerical modeling, Incompressible smoothed particle hydrodynamics , Obstacle.

1. Introduction

Dam break problem (collapse of water column) and prediction of the obtained waves from water flows have high importance in hydraulic science. In this regard, numerical methods because of higher accuracy as well as lower price than experimental models are considered powerful instruments for simulating this phenomenon.

Smoothed particle hydrodynamics is better in large deformation modelling, various boundaries, and high accuracy on free surface particle dispersion compared to mesh-based methods. Another preference of this method is based on incompressible smoothed hydrodynamics in solving equations of flow (momentum conservation and mass conservation) and calculating advection of particles in Lagrangian coordinates in a direct way without any numerical diffusion. Influence of numerical diffusion is usually in Eulerian methods, which has made a series problem in flow modelling with large deformation on free surfaces.

SPH method is particular not only in compressible fluids but also in incompressible fluids in Incompressible Smoothed Particle Hydrodynamic (ISPH), fluid is definitely considered incompressible and its pressure and particles velocity are solved by projection method [1].

This numerical method has been shown to be robust and applicable to a wide variety of other fields. For example, the method has been successfully used for free surface hydrodynamics problems, such as the study of gravity currents , wave propagation and simulation of the impact of solids.

Smoothed particle hydrodynamics (SPH) developed during the 1970's in astrophysics to study the collision of galaxies and the impact of bolides on planets. Monaghan (1999) used weak compressible smoothed particle hydrodynamics method for simulating solitary wave along the offshore [2]. Shao and Gotoh (2004) studied wave propagation and wave interaction with floating blades while considering turbulence models for large eddy simulation [3]. Shao (2010) considered wave interaction with porous media by incompressible smoothed particle hydrodynamic method [4]. Zhu (2010) used incompressible smoothed particle hydrodynamics method for considering wave interaction with porous media [5]. Safdari et al. (2010) introduced corrected incompressible smoothed particle hydrodynamics method (including correction on solid boundary) and started modelling flow around the solid body [6].

The following investigation used incompressible smoothed particle hydrodynamics method for modelling dam break flow with a rectangular obstacle. In order to verify the measurement results, laboratory report on the dam break with an obstacle were used. Cubic spline function and distance of 0.006m were used for the numerical simulation.