VERIFICATION OF 1-D MODEL TO SIMULATE PARTIAL DAM BREAK FLOW

XIE ZUO-TAO[1], ZHANG XIAO-FENG[2], YUAN JING[1], YANG FANG-LI[3]

[1] PHD. Candidate, State Key Laboratory of Water Resources and Hydropower Engineering Science, Wuhan University, Wuhan 430072, China
(Tel: +86-13808669077, Fax: +86-27-68772310, e-mail: xzt1979@163.com)
[2] Professor, State Key Laboratory of Water Resources and Hydropower Engineering Science, Wuhan University, Wuhan 430072, China
(Tel: +86-2762483465, Fax: +86-27-68772310, e-mail: xzt1979@163.com)
[3] Bachelor, State Key Laboratory of Water Resources and Hydropower Engineering Science, Wuhan University, Wuhan 430072, China
(Tel: +86-2762483465, Fax: +86-27-68772310, e-mail: yangfl81@163.com)

Usually dams are in security, but for some casual factors, the accidents of dam break happened at times, which had made great loss of lives and possessions. So in order to provide measures for avoiding disasters and reduce the loss induced by dam break, forecast of the risky disaster through the simulation of dam break flow is needed in the project period of dam.

Because the simulation of dam break flow is of great importance and quite difficult, many researchers had studied on it . For the distance of reach influenced by dam break is long, 1-D mathematical model is usually applied to simulate the dam break flow. Because of discontinuity of flow at the cross section of dam site for partial dam break flow, discharge therein could not be computed directly from the 1-D unsteady flow equations.

The traditional approach for discharge at the dam site of partial dam break is to use empirical formula computes the peak discharge firstly and then approximately estimate the discharge process therein. This method is very simple but can't acquire good accuracy. So another method is presented that weir formula of wide crest flow is adopted in 1-D model , as discharge at the dam site can be computed by the formula according to the upstream and downstream water level therein . As weir flow formula is originally obtained under steady flow condition, verification is needed before applying to such strong unsteady flow. Unlike 1-D model, horizontal 2-D model can compute the discharge at the dam site of partial dam break under certain conditions automatically. In order to verify whether the weir flow formula can be applied in 1-D model to simulate dam break flow or not, this paper uses 2-D model to verify it.

In the process of the verification 1-D model and horizontal 2-D model are needed. Unlike 1-D model, horizontal 2-D model can compute the discharge at the dam site of partial dam break under certain conditions automatically, which makes the verification possible.

The verification is conducted in a rectangular channel with a channel length of 20 km, a width of 1000 m, and a horizontal bottom. The dam is placed in the middle of channel. When 2-D model is used to simulate the dam break flow, the computational domain is discretized into 400×20 uniform mesh, and the size of mesh is 50×50m ; for 1-D model flow domain is discretized into 401 grids with a uniform grid spacing $\Delta x = 50\,\mathrm{m}$. The initial water depth in the reservoir is H_0 and the downstream water depth is 0 (dry bed).

In the process of verification, three different breach widths (b=300m, b=500m and b=700m) and four different water depths in the reservoir are considered; Manning roughness coefficient n=0.03; the outlet is controlled by the stage-discharge relationship obtained by Chezy formula.

The results show that discharge process of 1-D and 2-D model agree quite well, and differences of peak discharges are within the range of ±5%. The peak discharges of 1-D model and 2-D model are also compared with the empirical formula (Formula of the American watercourse experiment-station: $Q_m = \frac{8}{27}\sqrt{g}(B/b)^{0.25} bH^{3/2}$) . It can be seen from Table-1 that computed peak discharge is also very close to the empirical formula result at dam site for partial dam break flow. So conclusion can be drawn that coupling of weir formula with 1-D unsteady flow equation is applicable for the simulation of the partial dam break flow.

This paper has used 2-D model to verify whether the weir flow formula can be applied in 1-D model to simulate dam break flow or not. The computed results show that discharge process of 1-D and 2-D model agree quite well, and differences of peak discharges are within the range of ±5%. Moreover, computed peak discharge is also very close to the empirical formula result at dam site for partial dam break flow. So coupling of weir formula with 1-D unsteady flow equation is applicable for the simulation of the partial dam break flow, this conclusion can supply foundation for the research of dam break flow.

Keywords: Partial dam break; Dam break flow; Weir formula; 1-D flow model; 2-D flow model

1) breach width b=300 m

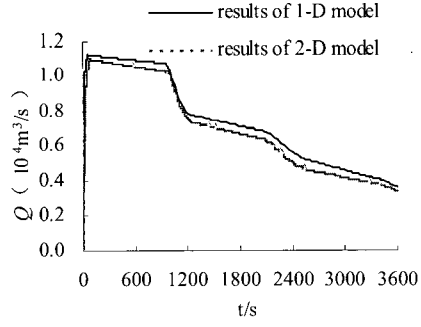

Fig.1 Results while H_0=10m

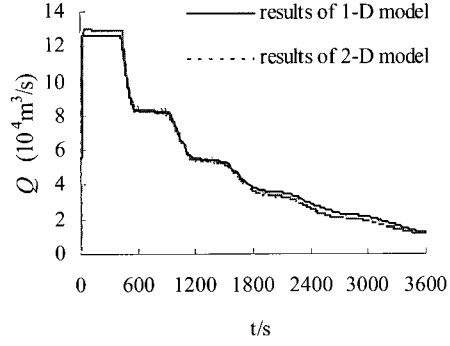

Fig.2 Results while H_0=50m