Some Experiences with Numerical Modelling of Overflows

Larsen, Torben; Nielsen, L.; Jensen, B.; Christensen, E.D.

Published in:
The Fifth International Symposium on Environmental Hydraulics (ISEH V)

Publication date:
2007

Document Version
Publisher's PDF, also known as Version of record

The Fifth International Symposium on Environmental Hydraulics – 2007

Arranged by

Arizona State University and the University of Arizona under the auspices of the International Association of Hydraulic Engineering and Research (IAHR).

ABSTRACT

SOME EXPERIENCES WITH NUMERICAL MODELLING OF OVERFLOWS

T. Larsen[1], L. Nielsen[2], B. Jensen[3] and E.D. Christensen[3]

[1] Aalborg University, Civil Engineering, Sohngaardsholmsvej 57, 9000 Aalborg, Denmark, e-mail: torben.larsen@civil.aau.dk
[2]NIRAS A/S, Sortemosevej 2, 3450 Allerød; Denmark, e-mail lni@niras.dk
[3] DHI Water & Environment, Agern Alle 5, 2650 Horsholm, Denmark, e-mail: bjj@dhigroup.com and edc@dhigroup.com

Overflows are commonly applied in storm sewer systems to control flow and water surface level. Therefore overflows play a central role in the control of discharges of pollutants from sewer systems to the environment.

The basic hydrodynamic principle of an overflow is the so-called critical flow across the edge of the overflow. To ensure critical flow across the edge, the upstream flow must be subcritical whereas the downstream flow is either supercritical or a free jet. Experimentally overflows are well studied. Based on laboratory experiments and Froude number scaling, numerous accurate and reliable formulas for the estimation of overflows have been derived.

Numerical modelling of overflows is significantly more complicated than standard 1-dimensional river or sewer modelling. The problem is usually managed by incorporating the mentioned empirical formulas in the numerical models. If there are no standard formulas for a specific geometry, physical experiments have to be carried out.

The present study uses laboratory experiments to evaluate the reliability of two types of numerical models of overflows in sewers systems:

1. 1-dimensional model based on the extended Saint-Vernant equation including the term for curvature of the water surface (the so-called Boussinesq approximation)
2. 2- and 3-dimensional so-called Volume of Fluid Models (VOF-models) based on the full Navier-Stokes equations (named NS3 and developed by DHI Water & Environment)

As a general conclusion, the two numerical models show excellent results when compared with measurements. However, considerable errors occur when inappropriate boundary conditions and grid resolutions are chosen. The paper describes the physical and numerical models and summarises the results.

Abstract accepted