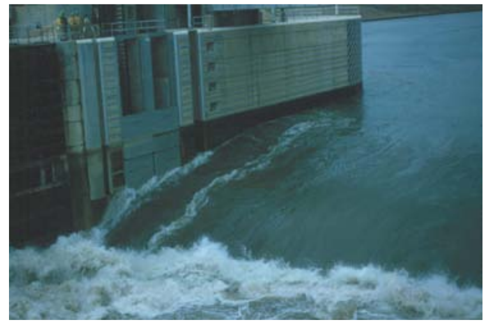
US Army Corps of Engineers®
Engineer Research and Development Center

Hydrodynamic Design of Inland Structures

Description

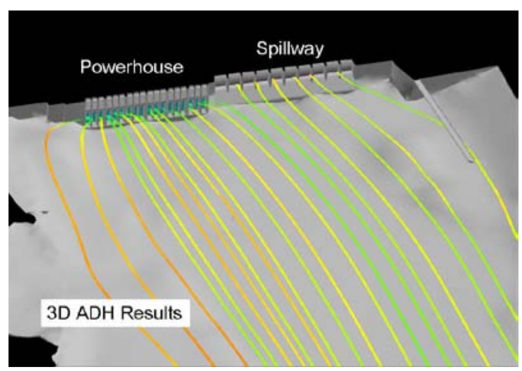


This work unit is a spin-off of a previous effort that coupled CRREL's DEM model with CHL's Adaptive Hydraulics (ADH) flow solver. That coupling work continues, but this work focuses on extending the ADH code to compute forces on user-identified boundaries. This work will develop methods with which to evaluate the hydraulic design of inland structures such as locks, spillways, high-velocity channels, etc. Evaluation tools will be developed within the 2D Shallow-water, 3D Shallow-water, and 3D Navier-Stokes modules of the Adaptive Hydraulics (ADH) numerical flow model. The result will be a modeling system that can estimate forces on the structures as well as the hydraulic influence of various components of hydraulic structures.

Issue

Designers often face difficult challenges at hydraulic structures. Many problems involve fluid/structure interactions – deployment of bulkheads under flowing water, vessel response to flow conditions, and the momentum of floating objects (e.g. tows, debris, ice) prior to impacting a structure. The winter of 2004-2005 saw relatively high flows on the Ohio River. The resulting swift currents were difficult for towboat pilots to handle. As a result, several barge trains struck spillways of Ohio River locks and dams. Emergency devices to deflect runaway barges away from the spillways could prevent barges from striking spillways. Also needed are emergency devices to stop flows in the event of mechanical failure at a hydraulic structure.

Users



Hydraulic engineers responsible for design of hydraulic efficiency, accident avoidance, and environmental stewardship at Corps projects.

Products

Previous efforts resulted in the integration of a 2D flow model and the DEM, producing a river ice/debris model. Demonstration applications were made for ice accumulation at the Soo Lock approach and woody debris passage at the Harland Diversion project. Also, demonstration of the ability to compute vessel/fluid interaction was made in a prototype design of a boom that would deflect a runaway barge from striking a spillway, applied at the Greenup Lock and Dam on the Ohio River. Vessel movement and the loads generated in the boom were computed. These simulations and the novel modeling system have been submitted for peer review in a paper to be published in ASCE's *Journal of Hydraulic Engineering*.

The primary technical transfer will be in terms of papers, technical notes, and data sets that can be honed into design guidance. Ultimately, multiple workshops are planned for Corps staff interested in using these models to address problems such as improved methods for preventing debris and ice from entering lock chambers. Discrete Element Model examples can be found at: http://www.crrel.usace.army.mil/sid/hopkins_files/Riverice/river_ice.htm

Benefits

The use of numerical modeling in place of physical modeling for predicting hydrodynamic forces on hydraulic structures will decrease hydraulic evaluation costs. Computer models capable of computing hydrodynamic loads on bridge piers, lock guard walls, culvert valves, tainter gates, flood walls, and moored ships will advance the Corps' ability to provide cost-effective structural, mechanical, and geotechnical designs.

Corps Program

Navigation Systems Research Program, Mr. Charles E. "Eddie" Wiggins, Program Manager.

Point of Contact

Richard L. Stockstill, ATTN: CEERD-HN-N, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, Richard.L.Stockstill@usace.army.mil

Mark A. Hopkins, USACE Cold Regions Research and Engineering Laboratory, 72 Lyme Road, Hanover, NH, Mark.A.Hopkins@usace.army.mil

Partners

U.S. Army Engineer Research & Development Center, Coastal & Hydraulics Laboratory and Cold Regions Research Engineering Laboratory.