US Army Corps of Engineers®
Engineer Research and Development Center

Computational Lock Model – Numerical Laboratory

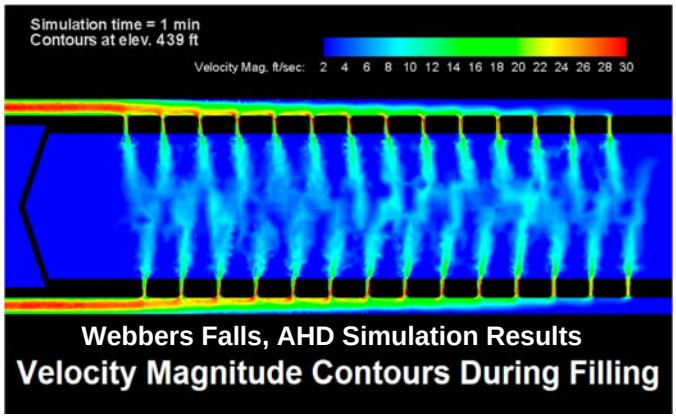
Description

The three-dimensional Navier-Stokes component of the ADH code has been validated with field data to reproduce large-scale flow features. This study will test ADH's ability to model near-field flow. Numerical results will be compared with existing physical model data. In particular, these tests will evaluate boundary conditions, relative to mesh resolution, for turbulence models when applied to confined (conduit) flow and free-surface flows. Testing will then be directed to quantify the accuracy of simulating lock culvert flow (pressures, velocity profile, etc) and lock chamber flow conditions (jet expansion, movement of free surface, etc.). The code will then be extended to address the inadequacies determined in the testing. Finally, the capability of modeling a vessel moored in the chamber during locking operations will be developed.

Webbers Falls Lock, Arkansas

Issue

Whether new lock construction, rehabilitation of an existing lock, or operational changes to meet modified project objectives, innovative ideas regarding the filling and emptying of locks are being proposed. Often these ideas fall outside the Corps' lock design guidance (EM 1110-2-1604). Some of these ideas, while economically feasible, may not provide the service required for safe navigation through the lock. Currently, a design concept must be evaluated carefully in a large-scale physical model. Such models provide the required information but are expensive in terms of both time and money. Since the flow is unsteady, data acquisition on physical models is challenging and generally limited to point values or gross measurements (e.g. hawser forces). An economical tool for detailed evaluation of locks and lock components is needed. This need can be filled with a numerical flow model capable of simulating flows in navigation locks.



Webbers Falls, AHD Simulation Results
Velocity Magnitude Contours During Filling

Users

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

Products

A computational flow model will be developed which is capable of predicting lock system performance including: operation time; cavitation potential; and forces on valves, gates, and other components. This model will be applicable to pressurized and free-surface flows. A modeling system that accounts for a barge/ship in the lock chamber and that can

calculate hawser forces during locking operations will be constructed. Updates for EM 1110-2-1604 and EM 1110-2-1610 regarding loss coefficients for lock components and hydraulic design of lock culvert valves will be drafted.

Benefits Rehabilitation designs to extend a project's life or remedial methods to address accidents at hydraulic structures can be evaluated. This tool will supplement and replace some large-scale physical lock models currently required resulting in time and cost savings.

Corps Program Navigation Systems Research Program, Mr. James E. Clausner, Program Manager.

Point of Contact Dr. Richard L. Stockstill, ATTN: CEERD-HN-NL, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, (Richard.L.Stockstill@erdc.usace.army.mil)

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