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# Navigation Systems Research Program Computational Lock Model - Numerical Laboratory

**Problem**

Whether it is 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. The problem is that often these ideas fall outside the CoE's lock design guidance (EM 1110-2-1604). Perhaps some of these ideas, while economically feasible, may not provide the service required for safe navigation through the lock. Currently, the design concept must be carefully evaluated in a rather large-scale physical model. These large-scale models provide the required information, but they 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.

**Research Approach**

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.

**Labs/others involved**

This work compliments other flow solver development such as the high fidelity vessel effects, Coastal and Hydraulics Laboratory (Dr. Chris Kees) and the coupling of ADH with the Cold Regions Research and Engineering Laboratory's Discrete Element Model (Dr. Mark Hopkins).

**Final Products**

A numerical model capable of simulating the large and small scale flow features of navigation locks will be developed. Hydraulic coefficients for components such as ports and valves will be determined from detailed 3D flow modeling. 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. A technical report providing guidance for modeling navigation lock filling and emptying systems will be published.

**Point of Contact**

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