Postdoctoral researcher vacancy, Dept. of Civil Engineering, University of Michigan, Ann Arbor Jan-Dec 2026, Advisor: Jeremy Bricker jeremydb@umich.edu
Topic: CFD simulation of flow through the St. Mary's River (Lake Superior) sluice gate complex

Background: Water that flows from Lake Superior to the lower Great Lakes is controlled by operation of the Soo shipping locks, a set of hydropower plants, and a sluice structure with 16 vertical lift gates. Operation of these lift gates controls the water level of Lake Superior, and determines the flow regime for the rapids directly downstream; these rapids are a unique and sensitive aquatic habitat for native lake fish. Though discharge coefficients for flows resulting from simple gate operations (fully open or closed) have been developed, discharge coefficients for the sluice gate complex have not been determined for complex gate operations such as partial openings or spatially staggered operations of the gates. Therefore, we need a postdoc to apply CFD to determine the water levels across the gate structure for specified discharge conditions, considering a range of full, partial, and staggered gate opening conditions.

Methods: The postdoc will apply OpenFOAM to construct a CFD (RANS and/or LES) simulation of a small-scale model of a section of the gate complex, for validation of the CFD setup against laboratory experiments. Laboratory experimental data for flow through this small scale model is being acquired by another postdoc working in the same laboratory, and the new postdoc will have the opportunity to participate in this physical laboratory modeling as well if they desire to. Measurements will include bulk discharge, water levels, and turbulence quantities at specific locations. After model scale validation, the CFD model will be expanded to encompass the full 16-gate structure, also at model scale. Turbulence and surface tension effects will be quantified via a sensitivity analysis by creating a larger-scale CFD model as well. The postdoc will investigate the largest scale that can be simulated while constrained by the y+ wall condition as well as computational load. If prototype scale is not feasible with wall layer boundaries, other methods (such as a simplified drag law boundary condition) will be investigated for prototype scale simulation. A final validation will take place by comparing the CFD velocity field at prototype scale with ADCP measurements taken downstream of the real structure. The validated CFD model (either at prototype scale, or at an enlarged model scale applying Froude scaling) will then be evaluated for a wide range of flow conditions and gate opening scenarios to determine discharge coefficients and outflow patterns. Results will be presented to the US Army Corps of Engineers as both a comprehensive report and a presentation, and the work should also be submitted as an academic manuscript.