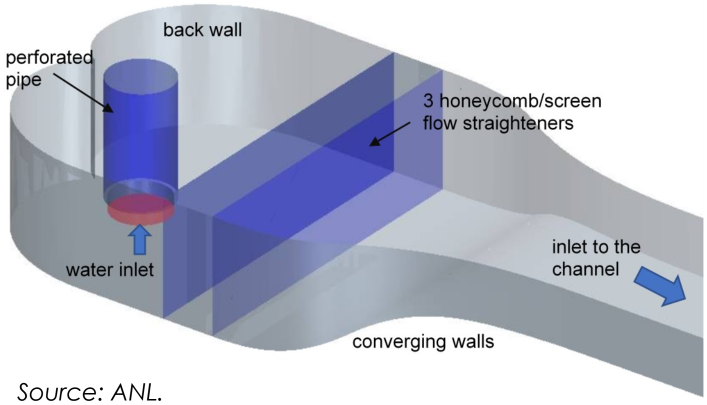
Three-Dimensional Computational Analysis of Construction Design Alternatives for a Flow Accelerator

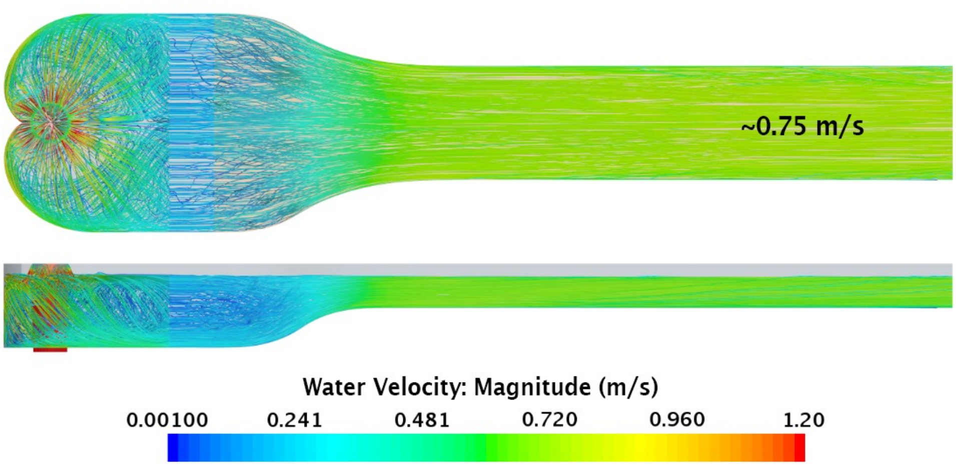
The Turner-Fairbank Highway Research Center's (TFHRC's) J. Sterling Jones Hydraulics Research Laboratory (Hydraulics Laboratory) provides technical assistance to other Government agencies to solve complex hydraulic problems using high-performance computing clusters. The TFHRC's Hydraulics Laboratory conducts research in partnership with Argonne National Laboratory's (ANL's) Transportation Research and Analysis Computing Center (TRACC). Recently, three-dimensional computational fluid dynamics (CFD) analysis was used to aid design of the flume entry and flow accelerator sections that feed water flow into a 10-ft-wide channel for the Engineer Research and Development Center (ERDC) Coastal and Hydraulics Laboratory. The design was based on the plans of the existing fiberglass flume inlet at TFHRC's Hydraulics Laboratory. The TFHRC flume inlet feeds water to a 6-ft-wide flume channel, so a scale-up factor of 10/6 in the width of the inlet section of the TFHRC flume would meet the width requirement of the ERDC flume channel.

CFD is used to study scale-up options for the TFHRC flume head section that yields a good, well-functioning design for the planned ERDC flume head section, and achieves a flow leaving the head section that is as uniform as possible over a cross section in the upstream section of the flume. In the CFD study, alternatives for the inlet and flow distribution pipe were investigated. The hole diameter and spacing in the flow distribution pipe were analyzed for effects on the flow distribution. Alternative designs to distribute flow from the inlet pipe were checked to see what configuration yielded the most uniform flow downstream. The converging contour and length of the converging section were modeled and tested for adequate performance in the scaled-up head section. Variations in the placement, size, and position of the honeycomb flow straighteners and screens were modeled and optimized. The effect of the length and diameter of tubes in the honeycomb on flow straightening and water surface height in the flume were investigated. Results of these investigations were used to obtain a scaled-up head section design for the ERDC flume design.



Source: ANL.

Schematic drawing of the flow accelerator at TFHRC Hydraulics Laboratory.



Source: ANL.

Top view and side view of streamlines of water velocity in an example scaled-up flume model.

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