TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): __FHWA____

INSTRUCTIONS:
Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *TPF-5(279)*	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) 2016 ☑Quarter 2 (April 1 – June 30) 2016 ☐Quarter 3 (July 1 – September 30) 2016 ☐Quarter 4 (October 1 – December 31) 2016

Project Title: *High Performance Computational Fluid Dynamics (CFD) Modeling Services for Highway Hydraulics*		
Name of Project Manager(s): *Kornel Kerenyi*	**Phone Number:** *(202) 493-3142*	**E-Mail** *kornel.kerenyi@fhwa.dot.gov*
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**

Project schedule status:

☑ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date

Project Description:

The Federal Highway Administration established an Inter-Agency Agreement (IAA) with the Department of Energy's (DOE) Argonne National Laboratory (ANL) Transportation Analysis Research Computing Center (TRACC) to get access and support for High Performance Computational Fluid Dynamics (CFD) modeling for highway hydraulics research conducted at the Turner-Fairbank Highway Research Center (TFHRC) Hydraulics Laboratory. TRACC was established in October 2006 to serve as a high-performance computing center for use by U.S. Department of Transportation (USDOT) research teams, including those from Argonne and their university partners. The objective of this cooperative project is to:

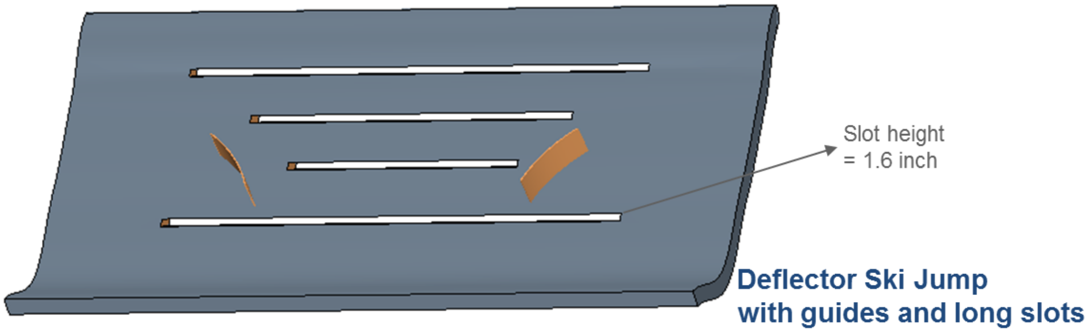
- Provide research and analysis for a variety of highway hydraulics projects managed or coordinated by State DOTs
- Provide and maintain a high performance Computational Fluid Dynamics (CFD) computing environment for application to highway hydraulics infrastructure and related projects
- Support and seek to broaden the use of CFD among State Department of Transportation employees.

The work includes:

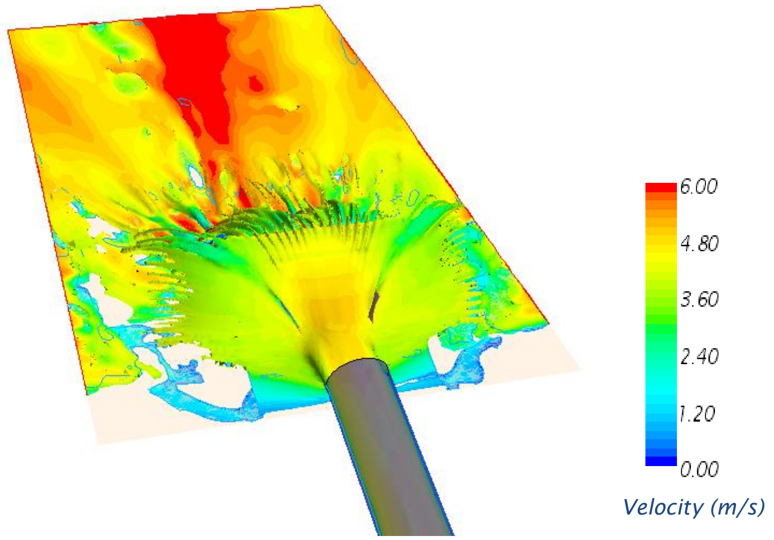
- Computational Mechanics Research on a Variety of Projects: The TRACC scientific staff in the computational mechanics focus area will perform research, analysis, and parametric computations as required for projects managed or coordinated by State DOTs.
- Computational Mechanics Research Support: The TRACC support team consisting of highly qualified engineers in the CFD focus areas will provide guidance to users of CFD software on an as needed or periodic basis determined by the State DOTs.
- Computing Support: The TRACC team will use the TRACC clusters for work done on projects; The TRACC system administrator will maintain the clusters and work closely with the Argonne system administrator's community; The TRACC system administrator will also install the latest versions of the STAR-CCM+ CFD software and other software that may be required for accomplishing projects.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

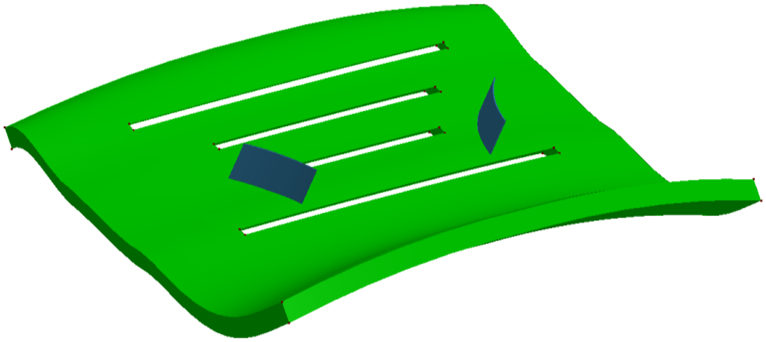
- Optimization on the Energy Dissipater at Pipe Outlets
    - The drainage pipes in many national parks have a very steep slope due to their mountainous topography. The induced high-velocity flows can lead to a tremendous erosion force on the soil at the pipe outlet. Energy dissipaters are commonly installed at the pipe outlet to reduce the velocity and the erosion force as well as eliminate potential scour issues. CFD modeling is used to further optimize the shape of energy dissipaters based on previous results.



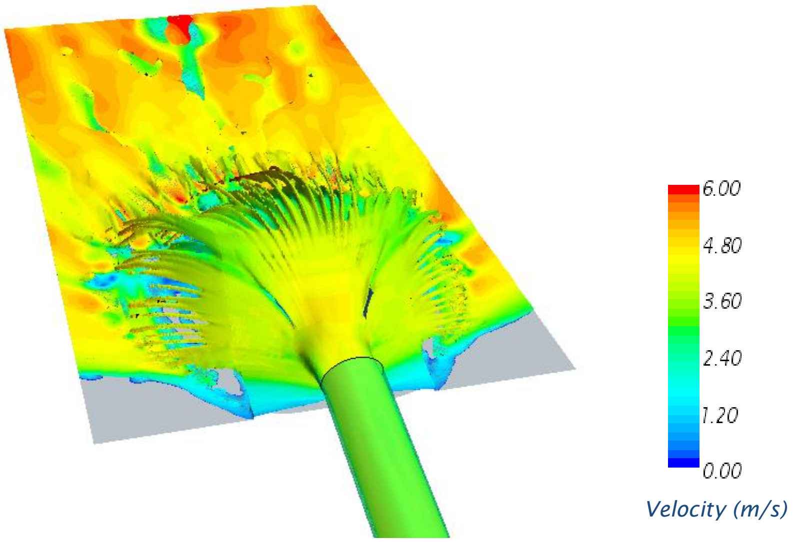
Geometry of the energy dissipater of Deflector Ski Jump with guides and long slots



Velocity distribution of option 6: Deflector Ski Jump with guides and long slots

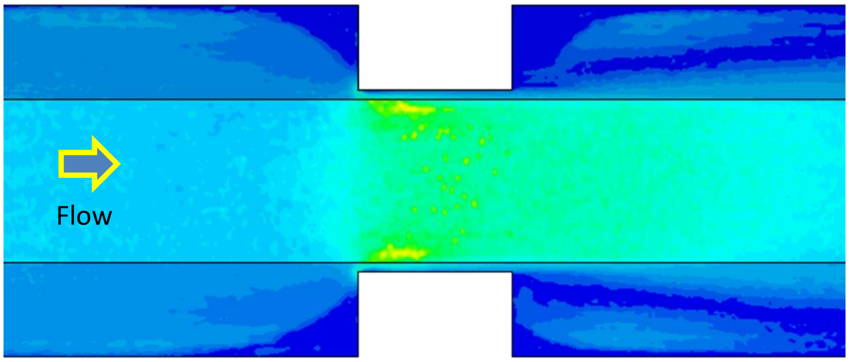


Geometry of the energy dissipater of Deflector Ski Jump (concex bed) with guides and long slots

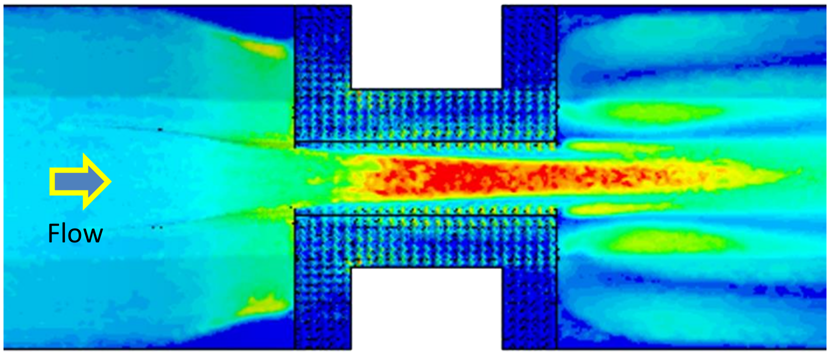


Velocity distribution of option 7: Deflector Ski Jump (concex bed) with guides and long slots

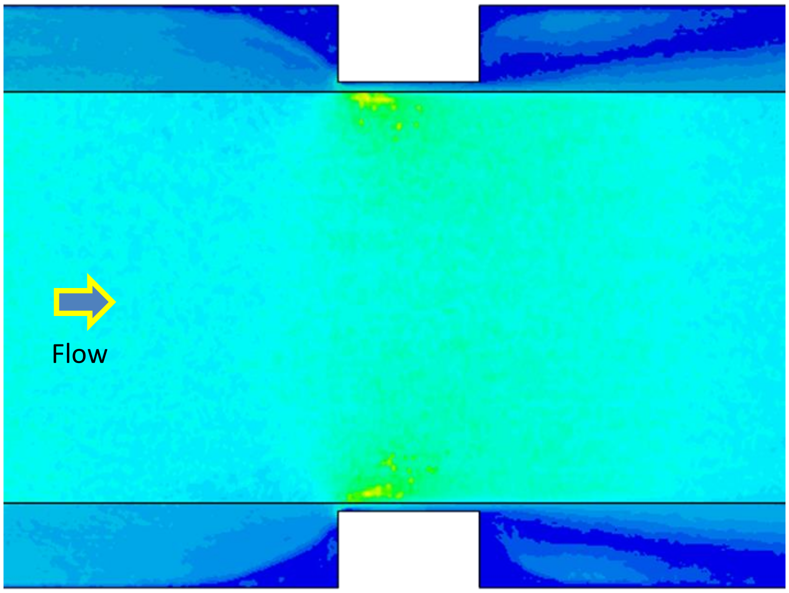
- Hydraulic Performance of Shallow Foundations for Support of Bridge Abutments
    - The database from flume experiments focused on the performance of riprap layouts based on field installations and FHWA HEC-23 design guidelines against clear-water abutment scour combined with Computational Fluid Dynamics (CFD) is used to investigate how flow fields at single span bridge openings, dominated by flow contraction, adjust in response to variations of bed roughness and cross-section geometry due to riprap installations. These adjustments increase bed shear stress magnitudes on the unprotected erodible channel bed leading to underestimated contraction scour depths therefore creating instability, and ultimately causing edge failure of the riprap. The CFD modeling provides an insight into bed shear magnitudes within a nonuniform roughness in the bridge opening, and a comprehensive flow depth-riprap interaction model to define limits for the bridge openings that might be prone to edge failure of the scour protecting riprap.



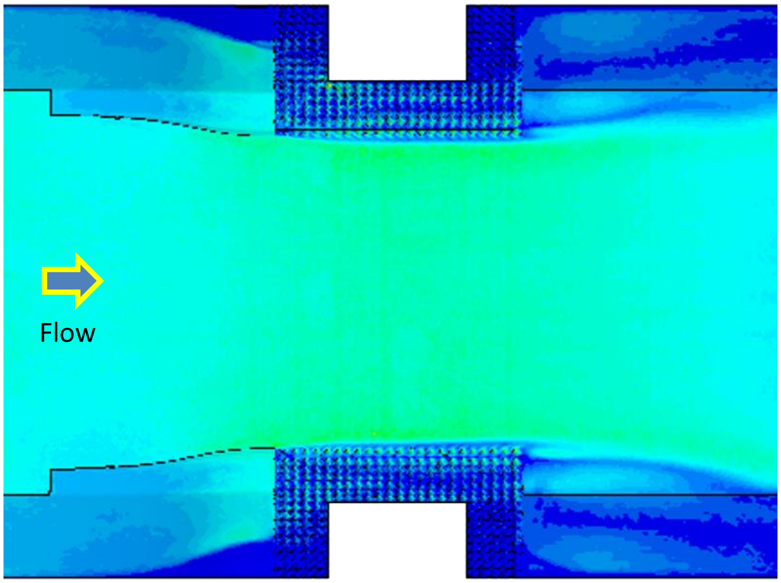
Bed shear stress for the model without riprap, flow depth to opening ratio = 6.2



Bed shear stress for the model with riprap, flow depth to opening ratio = 6.2



Bed shear stress for the model without riprap, flow depth to opening ratio = 16



Bed shear stress for the model without riprap, flow depth to opening ratio = 16

Anticipated work next quarter:

- The hydraulic performances of more cases with different slope lengths will be studied by using CFD simulations.

Significant Results:

- A further optimization on the shape of energy dissipaters for pipe flow outlet was conducted based on CFD simulations.

- Criteria for the bridge openings that might be prone to riprap edge failure were studied.

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

None to report.

Potential Implementation: