STEADY STATE -- SUMMER INTERNSHIP TECHNICAL CASE STUDY

Prompt

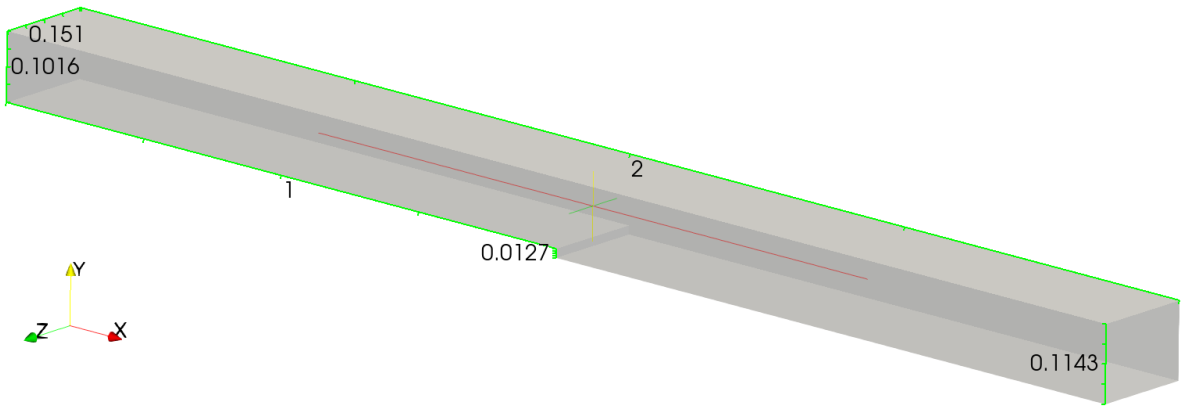
A simulation will be performed using OpenFOAM on a backward facing step problem and compared to an experimental result.

A complete description of the experimental setup and results can be found here, and the important details are summarized below.

The experiments were conducted on the tunnel floor of a low-speed wind tunnel facility.

The test configuration consisted of a 1.0m long, 0.151m wide, and 0.101m high rectangular inlet duct followed by a 0.0127m rearward-facing step in the floor.

The experiment was performed at an inlet velocity of 44.2m/s using air at standard temperature and pressure. The step-side wall boundary layer was tripped at a location 1.0 m upstream of the step and the Reynolds number (based on momentum thickness) was 5000 at a location 4 step-heights upstream of the step.



Geometry of the backward facing step simulation - dimensions are in meters.

The setup files for a sample simulation in OpenFOAM-v2012 are provided in a separate *intern-prompt.zip* file. The sample simulation is constructed to provide a quick result and can be run in under 5 minutes in serial. Use the *runAll.sh* script inside an OpenFOAM-v2012 environment to run the simulation. A line plot is generated as part of the simulation run and is saved in the *postProcessing/line_1/<time_step>/line_U.csv* file. You can use this data to compare to the provided experimental data located in the top directory in the *experimental.dat* file.

Set up a simpleFoam simulation to process and report the following results:

1. Visualize the flow over the backward facing step (i.e. streamlines, slice, etc.).
2. Use python matplotlib (or any other plotting tool that can be automated or scripted) to compare the results of the simulation to the provided *experimental.dat* file inside the setup folder. This data was pulled from Station 8 from the experiment results and the simulation data is extracted in the *postProcessing/line_1/<time_step>/line_U.csv* file.
3. Change one option in the simulation setup to influence the accuracy of the simulation.
4. **EXTRA CREDIT:** Reattachment point after the backward facing step; compare to experimental data.

Key Questions

1. What are some other ways you could improve the accuracy of this simulation?
2. How could you determine or demonstrate the accuracy of your simulation?
3. What is the importance of both verification and validation when evaluating a CFD code?

Instructions

Once the prompt is understood, please send across an estimated date of completion + availability for a 60 minute Zoom call. We will send across the invite shortly after.

Once the case study is complete, share both your OpenFOAM case directory and quick write-up with us 24 hours ahead of the scheduled presentation time (or give a warning if that's not feasible). The first 30 minutes will be dedicated to the presentation of your simulation set-up and write-up, which will then transition into a Q&A session. No presentation materials or deck are needed (just bring yourself!). Any additional questions you may have about the role, assignment, company, etc. can also be covered in the last 30 minutes.

Prompt Modification

If you anticipate a computationally expensive and/or manually intensive effort associated with performing this analysis that exceeds more than a couple hours, please feel free to propose back to us a modification to simplify this constraint.

For any questions, please feel free to reach out to ben@steadystate.com (co-founder & CTO).

Useful References:

ERCOFTAC backward facing step case description:
http://cfd.mace.manchester.ac.uk/ercoftac/doku.php?id=cases:case030

Sample plots:
http://cfd.mace.manchester.ac.uk/ercoftac/doku.php?id=cases:case030-plots