ME-474 Numerical Flow Simulation

Exercise: convergence study

Fall 2021

The aim of this exercise is to compute the length of the recirculation region in the 2D, laminar, incompressible flow past a backward-facing step, and to assess the accuracy of the results.

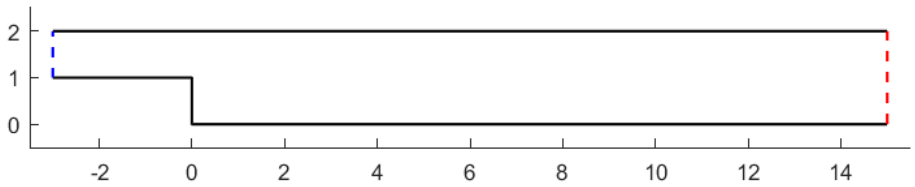

Figure 1: Geometry of the backward-facing step.

The geometry is shown above. The flow is from left to right. The channel height is $h = 1$ m before the step, and 2 m after the step. The length of the upstream channel is 3 m, that of the downstream channel is 15 m. A fully developed parabolic profile of maximum velocity U is to be imposed at the inlet. Use the geometry file provided on Moodle or create it yourself, and set up the simulation for a Reynolds number $Re = Uh/\nu = 200$.

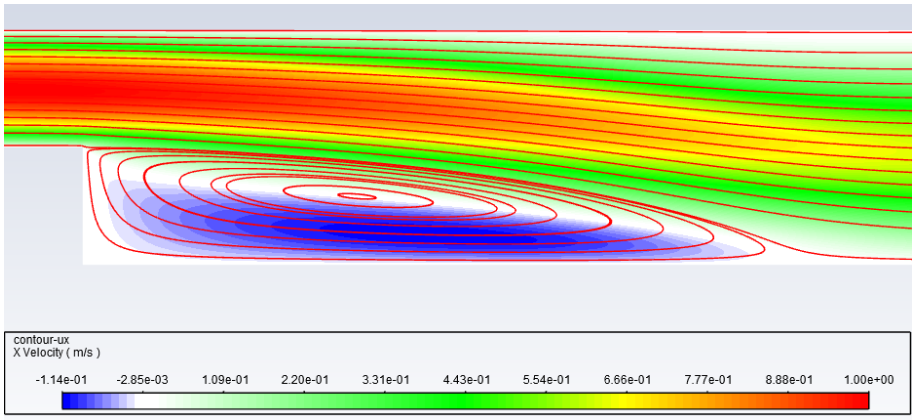

Figure 2: Streamlines (red solid lines) and contours of streamwise velocity near the recirculation region.

Compute the recirculation length L, i.e. the distance between the lower corner $(x = 0, y = 0)$ and the stagnation point on the lower wall. Repeat on different meshes. Evaluate the relative variation of L from one mesh to the next, and comment. Use Richardson's extrapolation to estimate the exact value of L.

Do your results compare well with those in the figure below? Even for larger values of the Reynolds number? If not, what do you suggest to improve them?

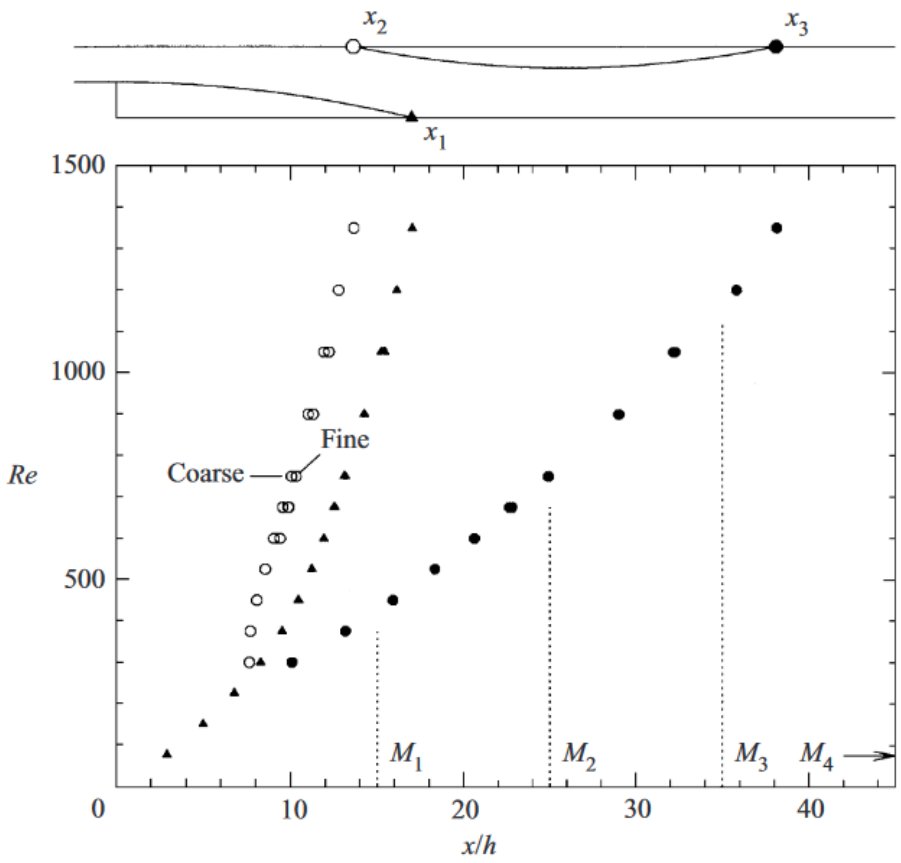

Figure 3: Location of the stagnation points in the backward-facing step flow (from Barkley, D., Gomes, M., & Henderson, R. (2002). Journal of Fluid Mechanics, 473, 167-190).