# Impact of freestream turbulence on the recirculation region downstream of a backward-facing step

S. Yadala*, G.K. Jankee*, L. Li*, N.A. Worth* and R.J. Hearst*

Backward-facing-step (BFS) flows occur when there is a sudden expansion in the geometry. Such configurations give rise to separated flows that eventually reattach, a common occurrence in nature and manufactured systems. The reattachment length $X_r$ (and recirculation zone) is crucial because it sets the initial conditions for the recovery process downstream and affects properties such as heat and mass transfer, skin friction and drag. While $X_r$ is known to be influenced by the step height ($h$) and the incoming boundary layer parameters[1], its relation with the freestream's turbulent properties is not fully understood yet, motivating the current study. To this end, experiments were conducted in a water channel facility equipped with an active grid[2]. Three BFSs with different step heights were each subjected to three freestream turbulence conditions. Velocity fields were measured using planar PIV and the reattachment length for each test case was determined by finding the point closest to the bottom surface with zero mean velocity. Preliminary findings indicate that $Re_h$ (figure 1(a)) is most influential, causing an increase in the reattachment length. Increasing turbulence intensity (TI) or integral length scale ($L_{u,\infty}$) results in shorter reattachment lengths (figures 1(b) and (c)), but the magnitude of the change is smaller than that induced by varying the step height. Using these measurements, a universal scaling that can predict the reattachment length will be derived. Furthermore, the physical principles that result in the observed trends and the impact of turbulence on the post-reattachment recovery process will be investigated.

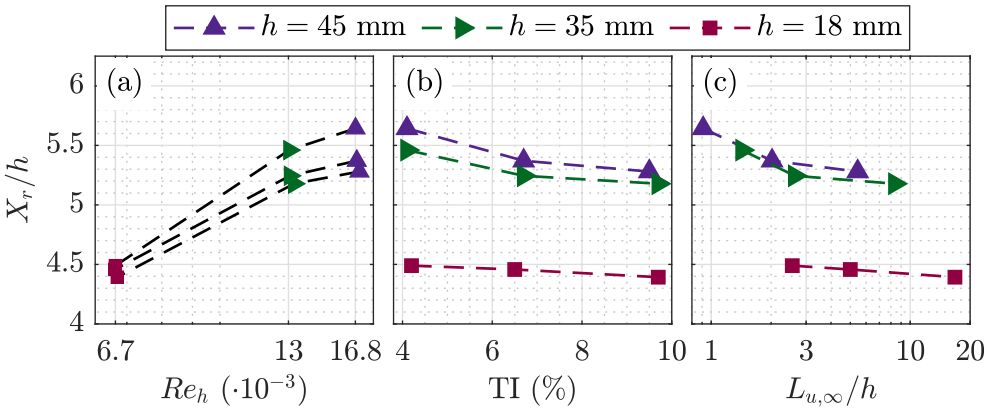


Figure 1: Variation of reattachment length $X_r$ with (a) $Re_h$, (b) turbulence intensity and (c) integral length scale.

*Department of Energy and Process Engineering, Norwegian University of Science and Technology, Trondheim N-7491, Norway

[1]Adams & Johnston, *Experiments in Fluids* **6**, 493–499 (1988).

[2]Jooss *et al.*, *Journal of Fluid Mechanics* **911** (2021).