Simulations to re-run and why

Is it possible that the only cases that I need to re-run are the case of tilt angle equals $\pi/4$ rad and $3\pi/8$ rad This is possible because the case of 0 rad is already alright and can be easily explained. So too is the case of tilt angle $\pi/2$ rad which is basically the simulated version of a setup whose experimental data exists. However, it might be a good idea to re-run all $3\pi/8$ rad cases especially the high velocity cases (0.9 m/s to 1.3 m/s). This is because only in the later stages of simulation did I found that the simulation results are different when I ran the same case on OpenFOAM 17.06. Usually I run the simulations using OpenFOAM 2.3.x, but one day, as I re-run the 1.0 m/s case on OpenFOAM 17.06 on my laboratory Lenovo, the simulation produces a large vibration previously absent when ran on OpenFOAM 2.3.x. Then, I found that the case when 0.9 m/s also yields a large and coherent vibration pattern.

Is this just an artifact of continuing from another simulation, but with different boundary conditions? Well, I have attempted to induce stable and coherent vibrations from other freestream velocities as well, even at other tilt angles (for example when $3\pi/8$ rad), but failed. This suggests that when a stable and coherent vibration appears, it is purely due to the inherent solution of the governing equations by the solver. However, since it is dependent on the solver, using a different solver yields different results. The case when 0.9 m/s for example, has been replicated on the server computer Tornado—even after decomposing the case into 16 parts, and running on a Courant number of about 5, I still manage to obtain similar results to the case ran on 4 cores using OpenFOAM 17.06 on the laboratory Lenovo machine.

The data for tilt angle $\pi/8$ rad is alright, since we can easily explain the trend found in the data too. Perhaps I only need to re-run the cases where the freestream velocity is equal to 0.9 m/s and 1.0 m/s, since the root-mean-square amplitude of the total lift force is somehow bigger for the case of $\pi/8$ rad at 0.9 m/s and 1.0 m/s, compared to 0 rad.

But the cases of $\pi/4$ rad and $3\pi/8$ rad are hard to explain since the vibration amplitude is similar for both cases past the KVIV lower branch, although the contribution to the total lift that is in-phase with the cylinder displacement is far smaller for the case of $\pi/4$ rad.

For the most part, the asymmetry that was present in the cylinder displacement signal when $\pi/4$ rad is gone with the revised mesh. The revised mesh changes the distribution of cells in the plate domain of the simulation by deploying a higher concentration of cells nearby the circular cylinder neutral position.

How to proceed: simulation scheduling

No re-runs are needed for the 0 rad case. I need to re-run the $\pi/8$ rad case, with focus on freestream velocities 0.9 m/s to 1.3 m/s, using either OpenFOAM 4.1 or OpenFOAM 17.06.

I need to re-run all $\pi/4$ rad cases since the asymmetrical displacement signal seems to be an artifact of meshing (for plates with tilt angle larger than $\pi/4$ rad, it seems that the mesh needs to have a concentrated band of mesh near the cylinder neutral position, in the plate domain). Preferably, the $\pi/4$ rad case should be run on OpenFOAM 2.3.x to elicit a low amplitude response, and possibly a low total lift amplitude too. This is so that when I re-run the $3\pi/8$ rad case, we can obtain a trend where the amplitude response at $3\pi/8$ rad is larger than $\pi/4$ rad. If this can take place, it will be easier to explain the trend as follows. The vibration when $3\pi/8$ rad is larger than $\pi/4$ rad because the plate tilt is closer to $\pi/2$ rad, hence is driven by a much stronger streamwise vortex.

Needless to say, no re-runs are necessary for the case of $\pi/2$ rad since the results are already established and compares well to experimental studies by other researchers. Furthermore, I have elicited results for $\pi/2$ rad that is most similar to results available in the literature using the new mesh with a circular inflation layer around the cylinder, even at a y^+ mean of 5. However, it merits mentioning that this new $\pi/2$ rad simulation with a circular inflation layer around the cylinder and detached cylinder-plate domain produces a flow visualisation that is more pixelated compared to its predecessors. Is this an artifact of meshing, or is it the result of overclocking the Courant number to a maximum of close to 5 throughout the simulation, remains a question that merits further investigation, if time permits.

Why the 0 rad simulation is easy to explain

Why does the 0 rad simulation results easy to explain, in addition to being a long-awaited result to amplifying the vibration amplitude greater than what was observed when $\pi/2$ rad? What differentiates the simulation setup for 0 rad from other tilt angles, in the sense that all other tilt angles except for $\pi/2$ rad produces only low vibrations as the reduced velocity U^* is increased past the lower branch of the Karman vortex-induced vibration KVIV.