Large eddy simulation of fluid/structure interaction of two in-line cylinders in a turbulent flow

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This work reports the numerical results obtained by the CEA with the in-house CFD software TrioCFD within the framework of an OECD/NEA benchmark focusing on the fluid/structure interaction issue. The experimental facility consists of two in-line cantilever cylinders placed in a thin channel and subjected to vibrations under the effect of a turbulent flow[1]. Three kinds of calculations using the wall-resolved large eddy simulation approach are considered: first, a simulation with fixed cylinders; second, a one-way coupling with imposed displacement of the cylinders; and third, a more realistic two-way coupling. The first case is used to conduct a sensitivity analysis of the mesh size using two tetrahedral meshes called respectively coarse (16 million elements) and fine (85 million elements). Unlike the coarse mesh, the average and RMS velocity profiles computed with the fine mesh downstream of the cylinders are found to be in good agreement with the experiment, as shown in Fig. 1(a). In the one-way coupling, a small harmonic displacement corresponding to a vibration mode of a clamped-free Euler-Bernoulli beam is imposed on the cylinders. An arbitrary Lagrangian-Eulerian method is employed to solve the fluid/structure interaction involving moving boundaries. In the two-way coupling strategy, a reduced Euler-Bernoulli beam model is coupled to the fluid software by using a partitioned time marching algorithm. At the time of the present abstract, the results of the simulations with the two-way coupling method are still pending. However the average and RMS velocities, as well as the spectra of velocity, pressure, and cylinder acceleration spectra at given points will be further compared to that recorded experimentally.

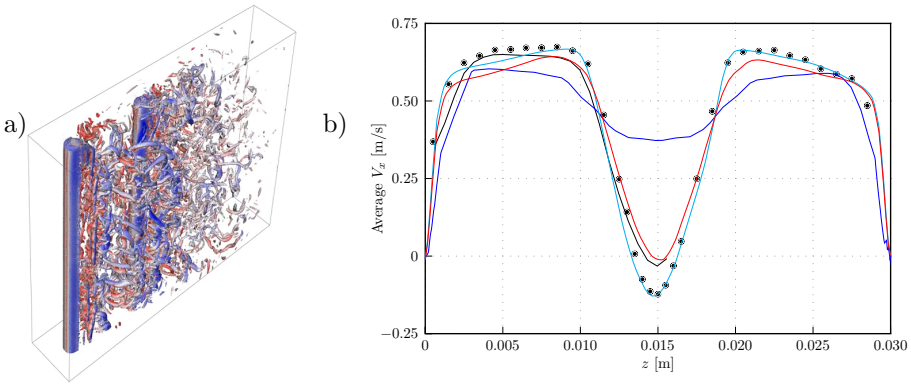

Figure 1: (a) Iso-surfaces of the Q-criterion colored with the velocity magnitude. (b) Streamwise velocity profile behind the first cylinder with: ◉◉◉ experiment (LDV) —— experiment (PIV), —— fixed cylinders (coarse mesh), —— fixed cylinders (fine mesh), —— imposed displacement (fine mesh).

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