STABILITY PREDICTION OF MULTIPLE FREELY-OSCILLATING BODIES

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Vortex induced vibrations are of great interest to many fields of engineering. One of their latest practical application worth mentioning is the design of submerged moving or deformable structures that are able to convert energy from marine currents and waves.

The VIVACE project [2] proposes, for instance, the extraction of energy from marine currents at low speeds using arrays of spring mounted cylinders. Taking advantage of the fluid-structure instabilities experienced by the array of spring mounted cylinders, one may efficiently harvest mechanical energy from the motion of multiple freely oscillating bodies.

The analysis of Vortex Induce Vibrations (VIV) of a single body has received considerable attention, e.g., the case of a single oscillating cylinder [1]. However, the identification of the physical mechanisms behind the fluid-structure instabilities of multiple interacting bodies remains vastly unexplored. For this purpose, we propose a Linearised Arbitrary Lagrangian Eulerian (L-ALE) method to explore the dynamics of multiple freely-oscillating cylinders. The L-ALE method rationalises the Eulerian motion of the flow with the Lagrangian displacement of the fluid-solid interface. It is practically done by introducing an extension displacement field $\hat{\boldsymbol{\xi}}_e$, which propagates into the fluid the solid deformation ([3]). The motion y_n of each cylinder in the transversal direction is governed by the following equation

$$\ddot{y}_n + \frac{4\pi\gamma_n}{U_n^*}\dot{y}_n + \left(\frac{2\pi}{U_n^*}\right)^2 y_n = \frac{2C_{y_n}(t)}{\pi m_n^*} \text{ for } n = 1, \ldots, N \tag{1}$$

where U_n^* is the reduced velocity, $C_{y_n}(t)$ is the vertical force coefficient and m_n^* the mass ratio between the cylinder and fluid densities. The cylinders having only one degree of freedom, the displacement field is a function of the cylinders' displacement and can be therefore decoupled from the fluids equations.

Our code will be compared both to a single cylinder and a tandem ([4]), see figure 1.

The number, their distance, their mass, and damping ratio, as well as their shape are some of the parameters that influence the stability of the system. We will investigate configurations that produce the greatest amplitudes of motion, and a stability map of the system will be presented.

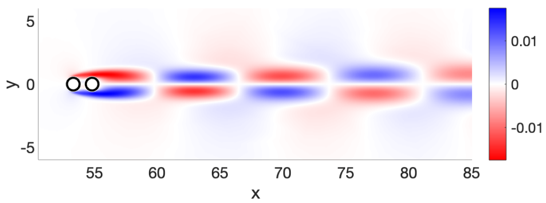

FIGURE 1. *Transversal velocity of the leading eigenmode for the two cylinders configuration ($N = 2$) ($m^* = 2.54$ and $U^* = 15$) at $Re = 100$.*

References

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