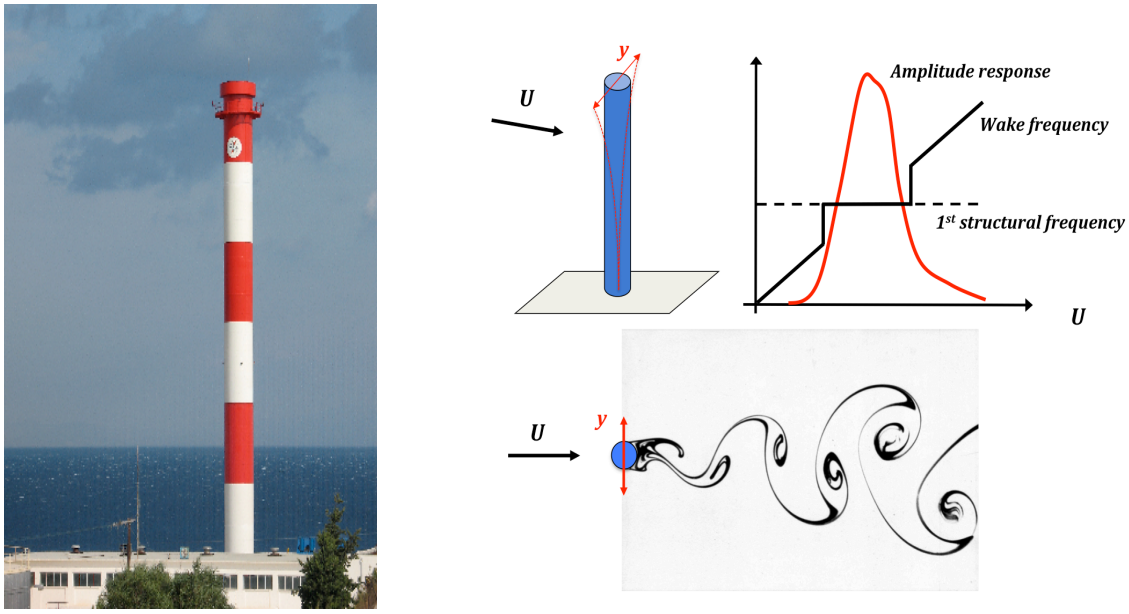
PhD opportunity:

Vortex-induced vibrations on industrial chimneys



(Left) Beirens's industrial chimney, (right) schematic view of vortex-induced vibrations (the Karman vortex wake photograph is taken from Van Dyke, M., An album of fluid motion, 1982).

Tall industrial chimneys can be prone to vibrations under wind effects and must be designed and/or treated accordingly. For an isolated chimney, one generally considers two kinds of vibrations: in-line vibrations due to atmospheric turbulence and cross-wind vibrations due to the chimney's vortex signature. For the former, the source of excitation (e.g. the incoming wind turbulent fluctuations) can be considered as independent of the chimney's dynamic response. This problem can then be addressed using well-accepted methods that only require a good mechanical definition of the chimney and reliable data for the turbulent wind. The latter is more complex. It is the consequence of a nonlinear coupling between the Karman vortex wake and the chimney's motion. Significant vibrations can then be observed in a limited range of wind velocities and in case of light structures with low structural damping, aerodynamic or mechanical devices have to be designed for the alleviation of the cross-wind vibrations.

Numerous vortex-induced vibration models can be found in the scientific literature and various design methods are proposed in the Eurocode or other international standards. However, their application for industrial chimneys is still not satisfactory. Contradictory results can be found and many open questions remain. Very few studies have been carried out at supercritical Reynolds numbers (e.g., chimney with large diameter). Wind turbulence effects on the VIV response remain unclear, as well as the effect of non-perfect circular cross-section and additional chimney supplies. Moreover, VIV prediction methods proposed by international standards have often proved to be unworkable in practice for the design of alleviation devices, such as tuned mass dampers.

The goal of this PhD project is thus threefold. It aims at improving our understanding of the cross-wind vibrations of industrial chimneys, validating more accurate predictive models than those proposed in the Eurocode or other standards and checking the wind tunnel test methods usually retained to determine the VIV for slender structures of circular cross-section at supercritical Reynolds number. To this end, specific wind tunnel tests and full-scale chimney measurements will be carried out during this research project.

This PhD will combine theory and experiment. It will start with a review of the analytical VIV models that can be used for chimneys. The PhD candidate will also be involved in the elaboration and management of wind tunnel and full-scale measurement tests. He/she will be in charge of the data processing and subsequent development and validation of VIV models.

This three-year position could start October 1st, 2018. It is fully-funded by the CSTB (Centre Scientifique et Technique du Bâtiment) and Beirens (Poujoulat group) which is a French company and a leader in the design, manufacture, installation and maintenance of self-standing industrial chimneys. The PhD candidate will be mainly located at LadHyX and will benefit from the collegial supervision of LadHyX/CSTB/Beirens and CERIC Laboratory (Poujoulat Group). He/she will also be expected to spend some time in Nantes (CSTB), Châteauroux (Beirens) and Denmark (VLStaal-Poujoulat Group) during this PhD project.

Potential candidates should have a solid background in fluid mechanics, structural dynamics and a great interest in experimental, data analysis and modelling. Knowledge in fluid-structure interactions would also be appreciated. For the application, please contact the people listed below including a CV, a motivation letter and the name of two academic referees.

Location: LadHyX (Ecole Polytechnique)

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