Flow Structure Dynamics in Arrays of Undulated Cylinders

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Fluid flow over simple cylinders has been well characterized through experimentation and simulation. However, complex seal-whisker inspired undulated-cylinder topographies have been limited to biological studies, single cylinder simulations, or single cylinder visualization experiments. The present study experimentally investigates the wake, and wake-interactions, between one to nine undulated elliptic cylinders with varying spacial orientations, including axial shifting to study the effects of the geometry along the length of the whiskers. The undulated cylinders were 3D printed using a high-resolution fused deposition modelling (FDM) printer, surface texture was smoothed and coated, and scaled up to a mean chord length (C) of 3.36 cm, a mean thickness of 1.75 cm, and a length (L) of 60 cm. The specimens were mounted onto a modular grid with 1C incremental spacing and placed into a 5 m long wind tunnel with 1.2 m width and 0.8 m height. Stereo particle image velocimetry (SPIV) was used to visualize the spanwise plane directly behind the cylinder arrays at increments of five chord lengths, C, with a corresponding Reynolds number ranging between 13,000-23,000. Ensemble averages were generated using 2,000 images per each of the three downstream planes to visualize wake behaviour far downstream. A momentum balance is pursued and insights in the recovery of the wake are provided through the analysis. The results of the analysis may be applied to a variety of column structure designs requiring reduced wake growth, reduced vibrations, as well as behavioural biological research.

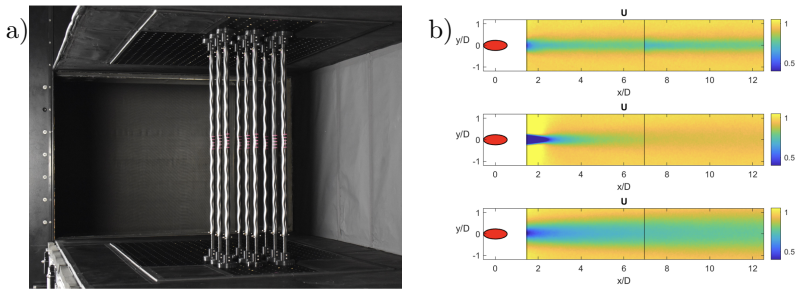

Figure 1: (a) Setup of undulated cylinder array. (b) Velocity distribution in the downstream direction.

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