Controlling Vortex-Induced Vibrations in Tandem Cylindrical Systems using Tripwires

Sheida Talebi[1] & Alis Ekmekci[1]
1 Institute for Aerospace Studies, University of Toronto, Toronto, Ontario, CANADA

The present research investigates the effects of tripping on the vibration characteristics of tandem cylinders in subcritical flows. In engineering structures, elements are often positioned in tandem, with downstream components located in the wake of another structure. Although extensive research has been conducted on the vibration characteristics of smooth tandem cylinders, the impact of tripping on their vibration response remains unknown.

Previous research by Vaziri & Ekmekci (2022) within our group showed that up to a 98% amplitude reduction and a 102% amplitude increase in vortex-induced vibrations (VIVs) can be achieved by placing a single straight tripwire at specific locations on a single cylinder. These findings have significant implications. For example, enhancing structural vibrations can augment energy extraction in VIV-based energy harvesters from hydrokinetic sources. In contrast, such significant mitigation in vibrations unveils a control concept involving only a single straight tripwire to suppress unwanted structural vibrations.

There are several questions to be explored: What does a tripwire addition to the upstream, downstream, or both tandem structures with flexible mounting do to their vibration response in relation to the fluid forcing and the flow structure around the bodies? Does the tripwire alter the flow interactions between the tandem structures? How do the tripwire application location and the distance between the structures influence the flow structure, forcing and vibration response of the elastically mounted cylinder? If the goal is energy extraction, could a tandem arrangement with a particular spacing between the structures and a specific tripwire placement enhance the energy transfer? Alternatively, if vibration reduction is the objective, could a certain tripped tandem configuration achieve the best result? Motivated by these questions, we will investigate the impact of tripping on tandem cylinders in subcritical flow. Concurrent measurements of cylinder motion via a laser distance sensor and the instantaneous global velocity field using particle image velocimetry will be carried out. Also, a force analysis will be performed based on the displacement data. During these investigations, the upstream cylinder will initially be kept stationary while the downstream cylinder is elastically mounted with low mass-damping, and secondly, the upstream cylinder will undergo forced oscillations at the oscillation amplitude and frequency of the flexibly-mounted smooth or tripped single cylinder case, while the downstream cylinder is free to oscillate. Cases of both cylinders untripped, only the upstream cylinder tripped, only the downstream cylinder tripped, and both cylinders tripped will be tested systematically for varying cylinder spacings and different tripwire locations.

References:

Vaziri, E. & Ekmekci, A. 2022 Effects of a single spanwise tripwire on a free-ended circular cylinder undergoing vortex-induced vibration in the lower synchronization range. *J. Fluid Mech.* **950**, A7.

Email address for correspondence: *alis.ekmekci@utoronto.ca*