

Vortex-Induced Vibrations of Slender Structures in Shear Flow: A Review

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Long slender structures in the ocean, such as tethers, cables and risers, are subject to vortex-induced vibrations when placed in cross-flow. Significant progress has been made in our capability to predict VIV of such structures, yet several outstanding problems remain. The purpose of the talk is to outline both progress and remaining problems as needed for application.

We first outline conceptual developments and basic understanding of VIV. We start with simple structures in uniform flows: The variability of the added mass and lift coefficient with reduced velocity, the definition of a correlation length along a uniform structure, and the notions of "wake capture" and "lock-in" response are discussed. The effect of in-line as well as transverse oscillations, and the presence of multi-frequency response and the apparent collapse of the correlation length, are phenomena that appear even in simple structures and flows, in the presence of slight non-uniformities. The effect of Reynolds number, cylinder inclination, the role of roughness and protrusions, as well as the presence of turbulence, are only partly understood and relative few data exist, while a pressing need exists for such understanding for applications.

Subsequently, we outline extensions, developments, and outstanding problems related to ocean cables and risers, which constitute complex structures within complex flows. Basic concepts still apply, yet new issues arise: Multi-frequency response is a generic property in such situations, while turbulence in the flow causes variations in the response, particularly coupled with roughness and protrusions.

Reynolds number effects in all VIV situations remains an outstanding problem of particular importance. The considerable cost of testing at high speed results in few existing high-Re VIV data in the open literature. As full-scale data become available, particularly from the Offshore Industry, it is found that Reynolds number has significant effect, beyond the well-known transition when the boundary layer on the body becomes turbulent. The few data available in the open literature provide intriguing new properties that necessitate new understanding of high-Re flows.