Vortex-induced waves along cables

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VOXERT-INDUCED VIBRATIONS

Vortex shedding has a characteristic frequency defined by the Strouhal number. As it approaches a structure frequency a lock-in occurs and this resonance leads to larger vibration amplitudes.

FLUID MODEL

\[ \frac{\partial^2 \psi}{\partial t^2} - \nabla \cdot (\nabla \psi + \nabla \varphi) = f \]

The numerical simulation of the entire flow field using the Navier-Stokes equations is not effective because of strong computational requirements. Conversely, a phenomenological wake oscillator model (van der Pol) is proven really useful...

- \( q \) = near wake variable – fluid lift
- spanwise interactions [2]
- coupled by the structure acceleration [3]

THEORY

wave features established by

dispersion relations intersection [5]

REFERENCES


DEEPWATER OIL FIELDS

Vortex-Induced Vibrations (VIV) are a major cause of fatigue damage for all structures connecting the well heads at the sea bottom to the floating facilities

- slender structure \( L/D > 10^3 \)
- catenary geometry
- non-linear wave reflection

focusing on travelling waves

STRUCTURE MODEL

The classical mono-dimensional cable model is effective in describing the main features of the structure dynamics. However, results of the theory extends to more general cases like beams with internal flow ...

- \( y \) = transverse displacement
- coupled by the fluid lift

EXPERIMENTS

free-hanging cable in water towing tank [6]

evidence of a travelling wave propagating downstream

COMPARISON

* experimental data

\[ \text{Stray line} \quad [\text{Williamson (1996)}] \]

\[ \frac{T}{T_{\text{Steady}}} = \frac{f}{f_{\text{Steady}}} \]

* experimental data

\[ \text{model prediction} \quad [\text{Dvorec (1986)}] \]

\[ \frac{T}{T_{\text{Steady}}} = \frac{f}{f_{\text{Steady}}} \]