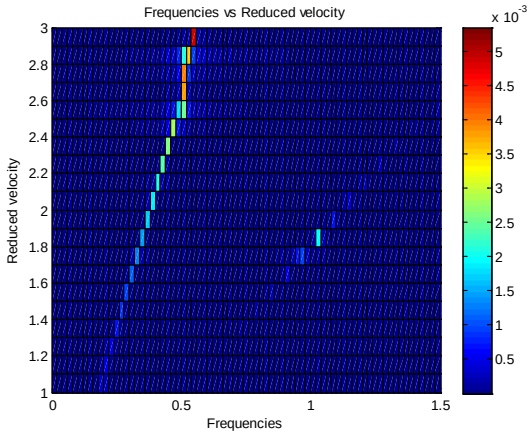
Offshore & Dredging Engineering

Technische Universiteit Delft

Modelling vortex-induced vibrations with a single wake oscillator coupled to both cross-flow and in-line motions

Vortex-induced vibration or as well-known as VIV is a phenomenon that has caught the attention of engineers along history. VIV is related to many engineering fields. In the offshore industry, it is of importance for risers that extract oil from the subsoil, and tethered anchors for floating units.

The main aim of the thesis is to model the VIV phenomenon through a new version of the wake oscillator model by Qu,2019. This modified model includes a new in-line coupling term that is introduced in the wake equation of motion. Apart from having a new in-line coupling term in the wake equation of motion, the model also includes a coupling term that relates the lift force with the fluctuating force in the in-line direction.



In order to analyze the performance of the modified wake oscillator model, it was required to understand the advantages and drawbacks of some models that were implemented before.

During the investigation, four main steps were followed:

1. The performance of the equation of The Van der Pol oscillator to model the VIV phenomenon was explored.

2. Analysis and identification of advantages and drawbacks on the wake oscillator model by Ogink and Metrikine,2010, the one without in-line coupling, were conducted. This wake oscillator model was used to model a rigid cylinder elastically supported in free oscillation experiments.

3. The modified wake oscillator model (Qu,2019) was used to model a rigid cylinder in free oscillation experiments and in forced in-line vibration experiments.

4. Performing a sensitivity analysis in the new model.

After analyzing the behavior of the new model, it was concluded that adding a coupling term in the wake equation of motion was helpful to improve the phenomenological modelling of coupled cross-flow and in-line vortex-induced vibrations of an elastically supported cylinder in fluid flow during free oscillation experiments. However, for the case of forced in-line vibration experiments, discrepancies between the model results and experimental measurements were observed. More in-depth study on the simulation of forced vibration experiments is recommended to further improve the wake oscillator model.

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