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Optimised model of cable installation configuration

[Version 1]

STEP4WIND

Training network in floating wind energy

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Document History

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1. Overview

This report explores the methodology to model dynamic cable configuration for floating offshore wind turbines (FOWT) using an opensource module MoorDyn coupled with OpenFAST. This report has been published as a journal publication under the title: **Modelling Methodology of dynamic cable configuration for FOWT using MoorDyn** in Ocean Engineering and Marine Energy. This current document provides an overview of the publication's insights and its conclusions. Nevertheless, the publication is yet under review, thus not yet available.

2. Abstract

A simplified Methodology to model dynamic cable configuration using MOORDYN v2 coupled with OPENFAST, an opensource code developed by NREL (National Renewable energy laboratory), USA is presented by recreating the reference steep wave configuration. This approach uses the IEA 15MW Semisubmersible model to extract the platform motions and analyse the effect of platform motions on the dynamic cable configuration by subjecting the platform to 50-year return period environmental loads from the West of Barra Site. Static and dynamic analysis are performed to determine the configuration behaviour in terms of tension and curvature across the arc length. The methodology is further validated based on its response under static and dynamic analysis after recreation of the cable using similar methodology on OrcaFlex. The comparison confirms high levels of similarity in the cable behaviour and load estimations. A comparative study is then performed between the cable response under 12MW INS semi-submersible platform and 15MW IEA semi-submersible platform to understand further the role of platform and mooring line configurations on the dynamic cable. The methodology proposed can be replicated to model different cable configurations and further optimize the configurations. The comparative study results portray the impact of mooring line configurations and platform parameters on the cable response. Future work is suggested based on limitations faced throughout the process.

3. Objectives

The objective of this paper is to validate the modelling methodology used to model a steep wave dynamic cable for FOWT on MoorDyn against commercial package OrcaFlex. The stages of validation are :

- Modelling of dynamic cable (steep wave configuration) on MoorDyn
- Static and dynamic Analysis
- Implementing the same modelling methodology on OrcaFlex
- Validation by comparison of cable response in terms of maximum curvature, tension, hog and sag bend positions.

Followed by the validation of the methodology , Comparison of cable response under different FOWTS (15MW vs 12MW) is performed to understand the role of Mooring line configuration and platform on the cable response subjected to similar environmental loads at the west of barra site.

4. Conclusions

This paper implemented a modelling methodology earlier used to model umbilical for wave energy converters [1] to model steep wave dynamic cable configuration for IEA 15MW Semi-submersible wind turbine. The reference steep wave dynamic cable configuration was replicated using MOORDYN coupled with openfast. The modelling methodology used to model this configuration using MOORDYN was found to be reliable when validated against the cable response on OrcaFlex. Though there seems to be slight slippage with regards to magnitude of occurrence of certain conditions, the location of such conditions across the arc length in both cases was found to be accurate in both static and dynamic analysis. Though cable configuration layouts were observed to be different at certain times, in both cases the configurations adhered to the criteria of distance from sag bend to seabed and hog bend to sea surface.

To understand the role of platform and mooring lines, comparison of the statics and dynamics of the model under same environmental loads and external forces was performed. The resemblance in the statics and dynamics of both the cases clearly defines the extent of impact platform and mooring lines have on the cable response. Though the magnitude of platform motions varied, It was observed from comparison between the reference model and recreated model both in the static and dynamic analysis of different cases, that the order among different configurations (NEAR, FAR,TRANS,CC1 AND CC2) in terms of both tension and curvature had a small but clear difference. The difference in cable response in terms of critical cases CC1 and CC2 were observed to be almost negligible than the NEAR,FAR and TRANS cases. The 12MW INS Semi-submersible platform with 5 line mooring configuration seems to be restricting excessive bending and tension in NEAR and FAR cases respectively whereas the bending and tension in the cable is comparatively larger in case of 15MW IEA Semi-submersible platform with 3-line mooring configuration. Yet both the platforms and mooring line configurations perform similarly in critical cases. Assuming the probability occurrence of the critical cases to be extremely low a more detailed comparison in terms of fatigue life of the cable would be a stronger support to conclude that the 12MW INS Semi-submersible platform with 5-line mooring configuration comparatively provides a larger life span for the cable.

For further ideal comparison a cost analysis could be performed and a trade-off between total cost of 12 MW platform with 5 mooring lines and fatigue life of the cable and 15MW platform with 3 mooring lines and fatigue life of the cable. It is to be noted that though the order remains the same, the position and time of occurrence of certain scenarios might differ. Only a few cases from the reference model were analysed due to higher processing time on MOORDYN. A larger case set would surely strengthen the conclusions made regarding the order and deeper understanding of the role of platform motions on the position and time of occurrence of certain scenarios along the dynamic cable arc length.