Numerical and Experimental Study on Full-scale Test of Typical Offshore Dynamic Power Cable

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ABSTRACT

This paper presents numerical simulation of key physical properties of typical offshore dynamic power cable. Axial, torsional and bending stiffness are included, and validated by performing full-scale tests. Comparison of the results indicates the inherent relation between the complex computer model and actual product. The test results reveal the validity of the assumptions implemented in the numerical model and also indicates the origin of the difference between the simulated and measured results. The results from the paper shed light on how to choose proper physical properties in the global response analysis of offshore dynamic power cables in floating production system. The findings in the paper are critical for the design, installation, operation and maintenance of the offshore dynamic power cables. They also provide a guidance on how the next generation numerical simulation tools should be developed.

KEY WORDS: dynamic; offshore; power cable; full-scale test; finite element modelling;

INTRODUCTION

Dynamic power cables are a key component for traditional offshore oil and gas industry for transmission of power from onshore plant to offshore facility or from floating units to subsea equipment. With the ever-growing demands for renewable energy, the development of offshore wind farm has become more and more attractive for countries with great offshore wind potentials, and accordingly the needs for purpose-fit power cables, especially dynamic power cables. In 2018, 11 manufacturers installed 735 units of offshore wind turbines globally with a total capacity of 3,693 MW (REVE, 2019). The design of the dynamic power cables for an offshore wind farm is more challenging compared to the traditional offshore oil and gas industry because environment condition for the latter is limited to one specific location where floating units are deployed. While there are usually hundreds of wind turbines spreading in a large area for the former case, where environment condition for each individual turbine may differ a lot. The design of the dynamic power cables should be able to ensure integrity for numerous combinations of environmental conditions within the whole wind farm area.

The properties of the dynamic power cables can be estimated either by numerical simulations or laboratory tests. Special purpose software UFLEX developed by SINTEF Ocean is such an advanced non-linear finite element software program for structural analysis of cables and umbilical with complex cross sections (SINTEF Ocean, 2018). The software has been widely used by the industries for structural and fatigue analysis of umbilical and power cables (Parsinejad, 2014).

Apart from numerical simulation, full-scale tests of the dynamic power cables are often unavoidable when the design is novel or has been modified or existing designs will be deployed to a new application without modification. The full-scale tests are often both time-consuming and expensive, nevertheless, there are many advantages by carrying out the full-scale test: verifying the design, benchmarking the numerical analysis results, removing uncertainties in the design, etc.

NUMERICAL SIMULATION

Cross Section of the Dynamic Power Cable

The cross section of the dynamic power cable is shown in Fig. 1. Description of each component in the cross section is shown in Table 1.

![Cross Section of the Dynamic Power Cable](image)

Fig. 1 Schematic illustration of a typical power cable