Testing monitoring technologies on dynamic subsea power cables to detect mechanical failures

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ABSTRACT

The objective of this study is to challenge monitoring technologies for the detection of mechanical failures on dynamic cables for offshore wind farms. Tensile and cyclic bending tests were performed to generate mechanical failures. Thermal, strain and acoustic monitoring technologies were included in the test setup. Results analysis permitted to determine the performance of the sensors detection. Acoustic emission sensors and DAS were both able to detect armor wires failures during the tensile test. DTSS showed a potential for following cyclic bending loads using loose-tube fibres. DAS post-processing should be improved to retrieve armor breaking during bending tests.

KEYWORDS

Floating Offshore Wind Farms, Power Cable, Subsea dynamic cable, Mechanical failure, Experimental campaign, Monitoring.

INTRODUCTION

Floating Offshore Wind Farms (FOWF) will be a major contributor in the future of ORE, as 264 GW are planned to be installed by 2050 in the world [1]. Subsea dynamic cables are needed to transport high voltage electrical power between turbines and to the substation (in case of inter-array cables) or to the shore (in case of export cables). High reliability is required for this component and can be enhanced by some return of experience from the O&G sector. The difficulty is that FOWF dynamic cables are subjected to high levels of mechanical, electrical, thermal and chemical stresses, and few floating marine energy demonstrators are currently installed with dynamic cables in service. Appropriate monitoring will be the key to derisking dynamic cables and assess their health.

In this paper, different monitoring technologies are challenged in their ability to detect mechanical failures generated on cable samples at a laboratory level.

CONTEXT

DYNAMO Project

This study is part of the DYNAmic cable MOnitoring (DYNAMO) project started in 2020. DYNAMO is a French collaborative project funded by the National Research Agency, involving eight academic and industrial partners. The global objective of the project is to provide support and methodology for monitoring deployment at the windfarm scale, for detecting failures of dynamic cables. Firstly, a review of the failure modes has been realized, from their initiation and propagation to ultimate cable failure, at materials, components, cable and accessories scale. Secondly, a state of the art of the available sensor technologies suitable for subsea dynamic cable monitoring has been gathered. A major result from these two studies is the association between the physical parameters impacted by a failure mechanism and the associated sensors for the detection of the physical parameter variation. Finally, a sensor deployment strategy has been developed and tested on floating wind farm case studies.

Objectives and perimeter of the study

This paper is focused on the ability of different monitoring techniques to detect mechanical failures. Monitoring technologies to be studied were selected with respect to their capacity to detect variations of physical parameters generated during the mechanical experiments. This experimental campaign is planned to serve three objectives:

- understand the causes and mechanisms potentially leading to the failure of a dynamic cable;
- understand and quantify the physical parameters impacted by the appearance and development of failures;
- challenge the ability of the selected monitoring technologies to detect the mechanisms associated with the failures generated.

To achieve this, three types of tests were conducted: three-points cyclic bending tests at ENSTA Bretagne, tensile and compression tests at Gustave Eiffel University. Only the