Title: DETECTION, QUANTIFICATION AND LOCALIZATION OF DELAMINATION FAILURES IN FRP-BASED TOWERS OF FLOATING OFFSHORE WIND TURBINES

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Currently, the continuous visual inspection of FOWTs is impractical due to non-possibility to access to the platform by workboat in certain sea state conditions as well as the high costs derived from the transportation of maintenance technicians to offshore platforms located far away from the coast, especially if helicopters are involved.

With the aim to avoid undesirable downtimes and reduce maintenance costs, structural health monitoring is an area of special interest for the inspection and maintenance of floating offshore wind turbines (FOWTs).

For such purpose, a vibration-based structural health monitoring (SHM) method has been developed for the inspection of the condition of fibre-based towers of FOWTs with structural damage produced by external forces both operational and extremal cyclic loads. This SHM method has been evaluated by small-scale testing of wind turbine towers considering multiple damage case scenarios in fibre-based towers. The core of this work is to investigate the feasibility of the use of modal parameters (vibration energy, damping, mode shapes and natural frequencies) as key performance indicators for the detection, quantification, and localization of delamination defects in 1:50 scale towers of a FOWT, being in this case, the Enerocean's innovative W2Power platform (12 MW).

In short, this strategy is based on the comparison of the key performance indicators of intact and damage composite towers with different damage states, which are determined using a reliable and cost-effective non-destructive test. The great advantage of this system is that the offshore turbines can be continuously online monitored without the need to carry out preventive inspections of the platform structural elements by specialized technicians with the subsequent associated high cost.

The experiments showed that the shift of the key performance parameters is intrinsically related to the damage state of the towers and therefore, it is a clear indicator to evaluate the structural integrity of the towers with the advantages of being a simple and cost-effectiveapproach.

The findings of this research project possess relevant implications for the assessment of damage breakages in FRP-based marine structural components such as columns, bracers, chords, blades, towers or any other structural element of interest. This research is included in the framework of the FIBREGY Project (H2020). FIBREGY envisages a feasibility assessment of the design and construction of a new generation of marine renewable energy platforms using lightweight FRP materials in certain structural elements. The FIBREGY consortium is composed of relevant stakeholders of the offshore renewable energy sector and funded partially by the H2020 program of the European Commission with an overall budget of 8 million Euro (GA952966).

In the last year of FIBREGY, it will be performed a further open sea test using a 1:6 prototype of the W2Power platform in the Canary Islands in order to demonstrate the feasibility of the main addressed technologies in FIBREGY in sea trials under metocean conditions. The proposed SHM methodology will be validated in a real environment thanks to this testing campaign and the potential results will be also shared with the scientific community

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STRUCTURAL HEALTH MONITORING OF FRP-BASED TOWER OF FLOATING OFFSHORE WIND TURBINE

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RESUMEN

The FIBREGY project aims to develop a structural health monitoring (SHM) system to diagnose the structural integrity of the 1:6 scale towers installed in the W2 Power floating offshore wind turbine prototype deployed at PLOCAN (Canary Islands). The SHM system is based on a network of fibre optic sensors, strain gauges, accelerometers, and inclinometers. In this context, the feasibility of a series of key performance indicators (KPIs) for the damage assessment of the FRP towers is considered. As the first phase of this task, 1:50 scale FRP towers with different types and sizes of delamination failures are tested. The delamination defects were introduced artificially using an impact machine. The main idea behind this is to evaluate if the KPIs are affected by the delamination defects. The KPIs are obtained using a non-destructive test based on operational modal analysis. The results revealed that the KPIs are affected by the damage conditions of the tower and therefore, their variations are a good indicator for the detection and quantification of the delamination defects in the tower. The findings of this Horizon 2020 research can be potentially used for the identification of delamination defects in FRP-based towers of floating offshore wind turbines and other FRP-based marine structural components such as columns, bracers, blades, or towers. This research has been carried out in the framework of the FIBREGY Project (GA952966), which is composed of relevant stakeholders of the offshore renewable energy sector and funded partially by the Horizon 2020 program of the European Commission with an overall budget of 8 million Euro.

PALABRAS CLAVE: Structural Health Monitoring, Key Performance Indicators, Composite Structures, Delamination, Modal Parameters..