Continuous monitoring of the structural condition of the tower and supporting structure of floating and static offshore wind turbines

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The TOWERPOWER Europe-wide consortium has purposed to create a Continuous Structural Monitoring (CSM) system that provides real-time structural analysis of the wind turbine tower structure through a novel integration of NDT techniques and advanced electronic communication. This offers potential to drastically reduce the incidence of repairs/replacements and associated downtime.

The outcome of TOWERPOWER project will provide the wind farm owners, operators and the insurers with extremely valuable data to base decisions of extending the life of the wind turbines. In addition, a best practice, and a standard approach for test methods will add great value to the wind sector, as there are no standards available at the moment for the inspection of these structural components.

TOWERPOWER results will advance and integrate inspection techniques to produce a system that is able to monitor the whole wind turbine structure (Holistic). The inspection will provide analysis of structural defects and will be capable of anticipating (Predictive) the time before a component can be replaced allowing for better planning and scheduling of maintenance activities cutting down O&M costs (Economical). Real-time wireless connectivity will allow the TOWERPOWER system to be utilised to monitor OWT conditions onshore, taking into account the unpredictable nature of offshore conditions (Safe). TOWERPOWER is a system that will BE capable of:

- monitoring the whole OWT tower structure
- predicting the lifespan of the structural components
- reducing operations and maintenance costs
- monitoring from an off-site (onshore) location

Fatigue prone details (welded steel) at the jacket or tripod support structures and degradation of the grouted joint between the pile and transition piece in offshore installations are being addressed. Probabilistic models for assessment of the fatigue reliability are being developed. Combined techniques for monitoring grout damage and slippage on wind turbine tower structures and grout support joints have been selected and these include Acoustic emission (AE) and Guided waves (GW). The effectiveness of AE and GW as a structural monitoring tool for the tower of an offshore wind turbine has been assessed. These techniques can detect defects in the metallic structure, debonding of the metallic structure and the grout and finally defects in the grout.

It has been proved experimentally and numerically that the guide wave technique allows good energy transmission despite the high dissipation of the grout (Figure 1). Moreover, simulations showed that these techniques can detect not only defects in the steel (transition piece and tower) but also debonding between the grout and the steel which is one of the main reasons of the degradation of towers.

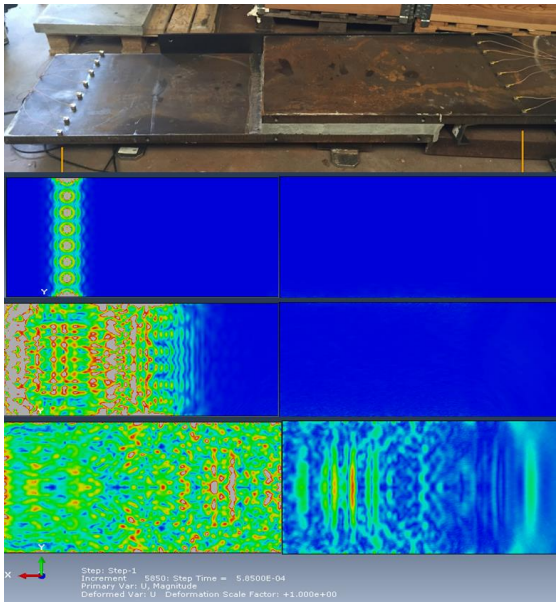

Figure 1 Guided Waves propagation through grout: experimental and numerical results

The combination of different NDT techniques and the data analysis will allow the correlation of all this information, while a reliability-based approach to calibrate Fatigue Design Factors (FDF) for offshore wind turbine support structures and the integration of structural condition information will optimise the damage-mitigation activities. Additionally, high-level software is needed to process the received signals using neural network technology in order to automatically detect potential flaws/faults. TOWERPOWER will facilitate and establish standards for inspection of offshore structural components.