

Report on Durability and Fatigue Challenges in Wind Wave and Tidal Energy Event

This one-day event in Bristol brought together developers, professionals, and academics, from the rapidly developing world of renewable energy systems. The event was focused on the technical durability assessment of renewable structures and particularly highlights the design and development of offshore systems. The speakers were drawn from established companies in this sector as well as from emerging technologies together with experienced professionals in advanced monitoring and theoretical assessment of renewable structures.

The morning commenced with key notes from Steve Gilkes from Garrad Hassan on the current state of the wind energy sector which in particular emphasized the fast growth of the sector; in both rated power and size with new machines exceeding 115m rotor diameter and 5MW rated output. The morning continued with Geoff Dutton from ERU RAL describing the application of thermoelastic stress measurement techniques and acoustic emission monitoring during a wind turbine blade fatigue test. The most highly



loaded regions of the blade were identified and a novel adaptation of the thermoelastic technique was made to allow the identification of all known areas of developing fatigue damage in the blade.



The morning session continued with David Smurthwaite from Transmission Dynamics on future in-service load measurements for wind turbines that combined torque and gearbox vibration loading using a remote data transfer via GPRS network to improve the reliability of diagnostics procedures. This was followed by Roger Haines from Garrad Hassan who depicted the state of the art fatigue design and analysis of wind turbines hub assemblies. The complexity of the in-service loading was demonstrated and it was shown that simply combining loads in an automated fashion using unit stresses may not be valid because of significant non-linearities in the applied stress time histories introduced by the structure. The morning session culminated with a presentation from Daniel NG from Hexcel on the experimental techniques developed to examine blades composite material fatigue. Several different jigs were evaluated, many of which encountered many problems associated with compression – compression fatigue. This sparked a lively discussion after the presentation.

The afternoon session was mainly dedicated to the development of offshore renewables. The first presentation from Daniel Shuter, Corus group, described a collaborative project aiming to look into a 30% reduction in costs necessary for offshore wind to be economical. The project includes cheaper/faster fabrication of towers

and foundations; extended structural lives through improved designs and fabrication methods and Light-weighting of turbines and supporting structures.

The next two presentations described innovative emerging technologies in offshore systems. Charles Taylor from Ocean Power Delivery gave an overview of the development of Pelamis Wave Energy Converter (WEC) where the prototype structure provided a platform to demonstrate a system designed to resonate and absorb energy. The design is based upon accepted oil and gas standards where developed Pelamis simulation software (PEL) was used for the fatigue analysis. This was followed by Peter Fraenkel from Marine Current Turbines describing a 3-year demonstrator in current technology; this led to the present prototype where production of the first machine is nearing completion and will be the world's largest installed and working marine current turbine.

Next, two papers demonstrated the complexities involved in evaluating the wind and wave load interaction in the fatigue design. Tim Camp from Garrad Hassan detailed the latest design using numerical tools developed for space-frame support structures for offshore wind turbines and illustrated the importance of integrating wind and wave loads in a single numerical model in order to calculate accurately structural fatigue loads. This was followed by Andrew Henderson, Offshore Wind Energy, who focused on the wave loads from data generated by the Blyth offshore windfarm where wave loads can be estimated from the measured surface profile and compared with the strain measurements. It was shown that care must be taken in choosing how the wave loads interact with the support structure and the relative contribution of the waves to the overall fatigue damage.

The afternoon was concluded by two more general but not less noteworthy aspects of design for durability in renewable systems. Claudio Bittencourt, DNV, described how certification guidelines using 'DNV OSS-312 Certification of Tidal and Wave Energy Converters aspects for offshore systems' consider aspects such as asset integrity, uncertainties on loading and influence of control system, maintenance regime, installation and decommissioning against cost/investments and revenue provided from power generation. Traditional certification processes that appear to focus on safety issues fall short of the needs of the renewable energy sector. The last presentation by John Draper, Safe Technology, described a new method to estimate fatigue lives at weld toes that seems to remove most existing uncertainties and is simpler to use than current methods.

This event was unusual for its merits and comprehensiveness in an emerging field. It appeared to have reached its objectives and, with much enthusiasm emanating from all who participated, we hope that it will consolidate in the future as a regular gathering of professional engineers and academics to exchange opinions and discuss recent progress and challenges in this sector. The co-sponsorship from the IMECHE, IOM³ and the BWEA is kindly acknowledged.

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