PO.ID
040b

Accelerated Validation of Offshore Turbines

Prof. Dr.-Ing. Andreas Reuter / Prof. Dr.-Ing. Jan Wenske

Fraunhofer IWES, Appelstr. 9a, 30167 Hannover

Fraunhofer IWES

Introduction

Reliability and availability of all technical systems in offshore wind turbines are essential for keeping the promise of a lower cost of energy while introducing a new generation of 6+MW turbines. In spite of the diversity of existing rotor, drive train, control system and support structure concepts, challenges regarding reliability and validation of properties remain the same. On the other hand operators of large offshore wind farms are expecting a mature product from day one. This conflict can be addressed by improved validation processes during the development of new products. In this context Fraunhofer IWES offers a variety of test facilities and validation methods to reduce the risks of new technical developments.

Why Validation in Test Labs

Depending on the component of a turbine, the validation efforts historically have been focusing on two main areas: the material qualification and the turbine prototype testing. This has left a major gap in the area of component and system validation. Also prototype turbine testing lacks the possibility to control the applied load level – wind conditions on a turbine site just cannot be controlled or condensed to allow predictions on the fatigue behaviour. Therefore in the last years a variety of large test labs have been developed, starting from full blade up to complete nacelle testing. In parallel methods for meaningful extreme and fatigue tests have been developed or are still under development. The advantages are obvious: full control of loads to be applied, accelerated fatigue testing is (sometimes) possible and easier access to the component under test.

Available Infrastructure at Fraunhofer IWES

Blade Test Facility

70m / 90m Rotor Blade Test Facility: hydraulic actuators for static and dynamic blade tests
Max. static bending moment: 115.000 kNm // Maximum blade tip deflection: 30 m
(block can be tilted 20º during static tests for a much higher effective maximum blade deflection)
Max. dynamic bending moment: ± 30.000 kNm // Maximum blade tip deflection: ± 9,5 m

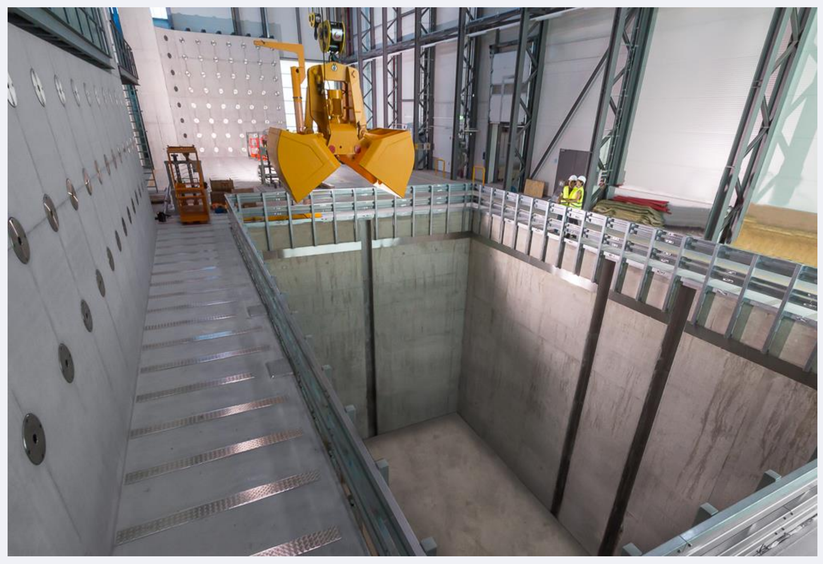
Laboratory for material and subcomponent tests: static and dynamic material characterization, rain erosion test stand, 6x12 m clamping plate with strong walls for blade subcomponent testing

The testing stands are augmented with manufacturing facilities for fiber reinforced composite parts, including a Demo-center for automated manufacture of rotor blades, available Q4/2015

Dynamic Nacelle-Testing Laboratory - DyNaLab - Test stand for complete nacelles of wind turbines with medium voltage grid emulation and load application system (virtual rotor)

LAS (Load Application System): 6-dof Stewart-Platform with zero-g unit
Dynamic load application: 20.000 kNm bending moments, ± 2.000 kN thrust and shear forces
Prime mover: 10 MW Twin Direct Drive (15 MW overload capability up to 6min.)
Nominal torque: 8.600 kNm, Overload torque: 13.000 kNm,
Artificial grid: 44 MVA installed converter power - S''_k emulation 20-300 MVA (impedance control),
0 to 46 kV line to line voltage level with independent single phase control – HiL test environment

Rotor shaft test stand for main shafts of 2-5MW wind turbines:
Accelerated fatigue testing of various main shaft geometries in under realistic boundary conditions
Hydraulic actuators for shear forces up to 4.000 kNm and bending moments up to 12.000 kNm



Test Center for Support Structures (in cooperation with ForWind)

The Support Structure Test Center (TTH) in Hanover offers a unique infrastructure for testing all types of support structures (towers and foundations) on a scale of 1:10 and larger.

The foundation test pit and the span can be used to investigate fatigue and extreme load behavior under multi-axial loading including the effects of interactions between soil and support structures.

Outlook – next steps

With all this infrastructure available the main challenge remains to develop reliable test methods to allow a fast and cost-efficient statement about the viability and reliability of a design. The growing size of specimens creates additional pressure on the research community to create tests with a higher statistical evidence – the results from just one blade tested is not enough to cover possible variances. Therefore Fraunhofer IWES is developing procedures on the basis of sub-component testing to supplement available procedures. Here, IWES partakes in several standard committees and works in direct cooperation with certification bodies and customers.