Data and facts

Reliable Testing of Rotor Blades for the safe Operation of Wind Turbines

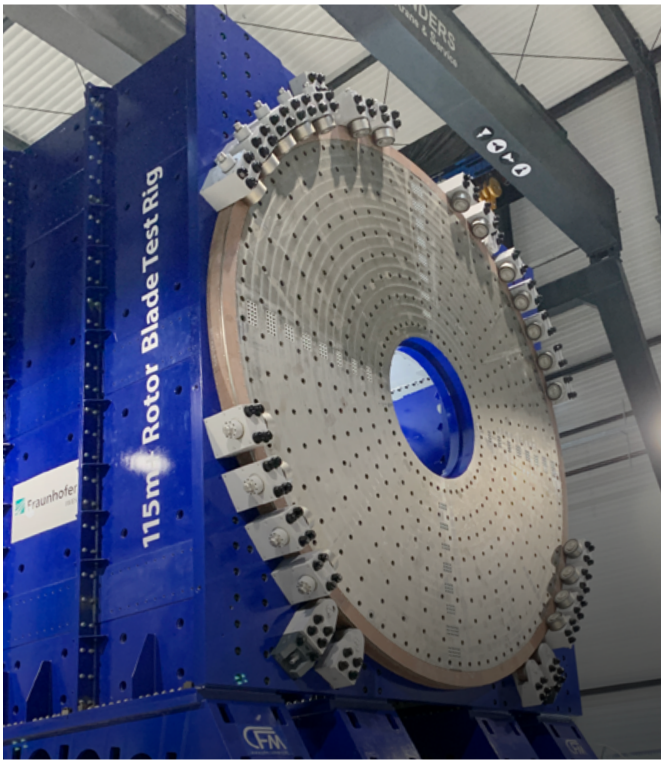
Full-scale rotor blade testing

Mechanical testing remains an essential part of ensuring the reliable operation of rotor blades throughout the lifetime of 20+ years.

Since 2009, Fraunhofer IWES has performed more than 40 test campaigns for the certification of rotor blades. In addition to three full-scale test rigs, IWES operates an accredited material laboratory and offers the opportunity to perform segment and component tests of rotor blades.

Our competences at a glance

- DIN EN ISO/IEC 17025-accredited laboratory for IEC 61400-23
- Recognized IECRE testing laboratory
- Ground-based excitation
- Variable test setup using combinations of hydraulic actuators, winches, and weights
- Model validation beyond certification: modal analysis, model update, torsional stiffness test
- Additional data acquisition (optional):
  - Digital image correlation (DIC)
  - Thermography
  - Acoustic emission
  - Optical deformation measurements
- Test set-up simulation and optimization



Max. root bending moment	70 m rig	90 m rig	115 m+ rig
Static	50 MNm	115 MNm	160 MNm
Fatigue vertical	± 30 MNm	± 30 MNm	± 70 MNm
Fatigue horizontal	± 8 MNm	± 30 MNm	± 70 MNm

Our test rigs are conveniently located on the German coast with open sea access for transport.

Test method development

Development and design of non-standard tests (e.g., biaxial or tests for unconventional blade designs) are essential parts of Fraunhofer IWES' research activities.

Virtual test rig
With the continuing blade growth, the importance of test set up optimization is ever increasing. Fraunhofer IWES has developed ALBATROS – a validated numerical tool chain for test set-up optimization. This virtual test rig is continuously being improved and allows both the optimization of standard tests and the development of new test approaches.

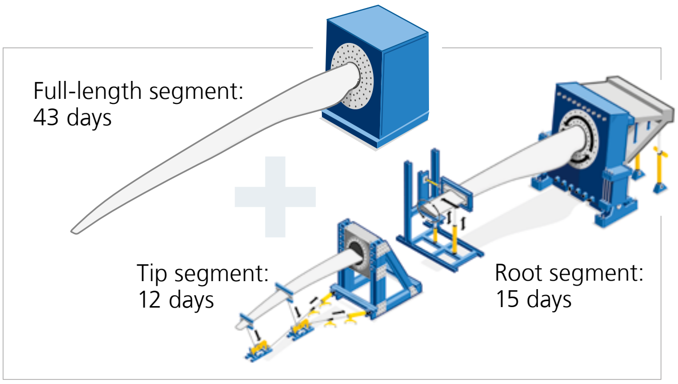
Biaxial test
Traditionally, flap and edge fatigue tests are performed separately. Combining both in a single test offers the potential to shorten the testing time and make the test more representative of field conditions. However, as blades are excited in (or close to) the natural frequency, the differences in frequencies between edge and flap direction lead to a chaotic displacement pattern of the blade tip.

In order to achieve 1:1 excitation, Fraunhofer IWES uses artificial springs and decoupled masses to tune system frequencies. Biaxial testing with elliptical (1:1) excitation has been successfully demonstrated and is available upon request within IEC 64100-23 certification tests.

Biaxial test fatigue setup with spring element and decoupled masses

Segmented testing (i.e., splitting the blade into two tests) can be utilized in order to shorten the testing time. Using the virtual test rig environment, IWES has developed the sequential test method, which is based on a two-step approach.

First, the fatigue test is performed for a limited number of cycles on a full-scale blade. Subsequently, the blade is cut, and two additional fatigue tests are performed on the root and tip segments of the blade. This significantly shortens the testing time and reduces overloads. A case study for a 110m reference offshore blade has revealed that the testing time can be shortened by 65% and damage accumulation above targets can be reduced by 75%.



Sequential testing approach: full length blade test followed by two segment tests on the same specimen

Further information

Fraunhofer IWES develops innovative methods to accelerate the expansion of the wind energy and hydrogen economy, minimize risks and increase cost efficiency. Innovations in technological developments are validated and innovation cycles are shortened. Planning and development of offshore wind farms are accelerated and made more precise. At present, there are more than 300 scientists and employees as well as more than 100 students employed at the nine sites: Bochum, Bremen, Bremerhaven, Görlitz, Hamburg, Hannover, Leer, Leuna, and Oldenburg.

Supported by:

Federal Ministry for Economic Affairs and Climate Action

Federal Ministry of Education and Research

on the basis of a decision by the German Bundestag

Bremen Bremerhaven

European Union
Investing in Bremen's Future
European Regional Development Fund

FUNDED BY ERDF

Origin of funding:
Hall construction: Federal Ministry of Education and Research, State of Bremen, and European Regional Development Fund ca. €5 million | Test bench setup: Federal Ministry for Economic Affairs and Climate Action ca. €18 million

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