



- 1 *Preparing the blade for testing series.*
- 2 *Transport of a rotor blade to the test site at Bremerhaven*

ROTORBLADE TESTING

Fraunhofer IWES

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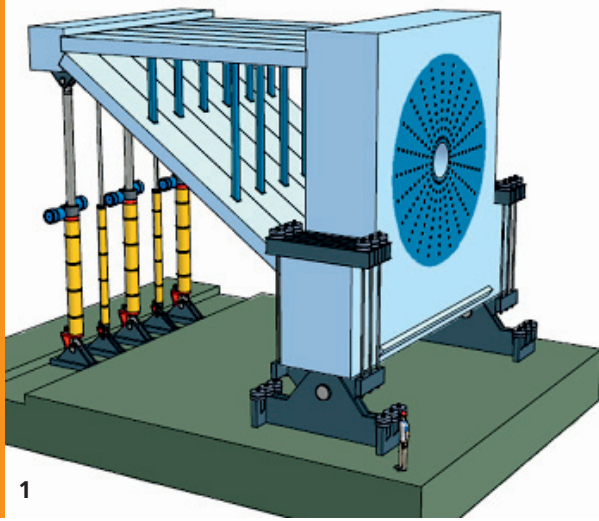
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Fraunhofer IWES operates a purpose built laboratory for testing wind turbine rotor blades under static and fatigue structural loading. Full-scale structural testing of turbine blades is required for certification of a new blade design and is important for investigating the accuracy of numerical design models and possible defects or weak areas in a blade design. In addition to performing certification tests of turbine blades, Fraunhofer IWES also conducts research and experiments that further develops the science of blade testing and seeks to continually improve the testing and measurement techniques and methods. The current laboratory can test blades up to 70 meters in length. The root of the blade is mounted in a fixed orientation and loading is applied to the blade using hydraulic cylinders. Static loading is performed in a vertical downward direction, while fatigue loading can be performed vertically or horizontally. During static loading, the force applied to the blade from each hydraulic

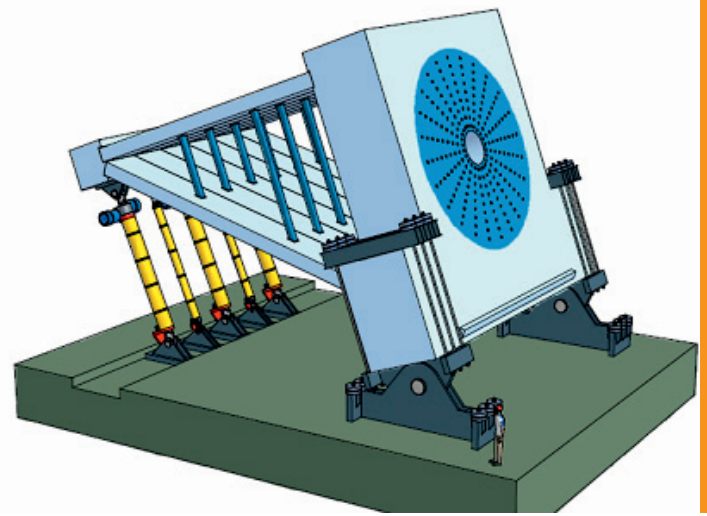
cylinder is controlled using a loadcell placed between the blade and the loading cable. This setup means that Fraunhofer IWES can carefully control the loads and corresponding bending moment distribution in the blade during the entire test.

Testing rotor blades up to 90 meters

In 2011, a new blade test hall offers the capacity of statically testing blades up to 90 meters in length. In order to accommodate the large tip deflections, the blade will be mounted to a tilt-block that rotates during the test. For a fatigue test, accelerated testing methodology is used to transform the predicted fatigue 108 to 109 cycles of variable amplitude loading on a turbine blade over its lifetime to a damage equivalent 1 to 5 million constant amplitude cycles that can be applied in the lab. Fatigue tests are performed by oscillating the blade at the first Eigenfrequency in flap- or edge-direction using a single hydraulic



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cylinder attached near the midpoint of the blade span. The acceleration of the blade self-mass as it swings back and forth creates a distributed applied force in the blade. The cylinder must only add enough energy to the system to overcome the air and structural damping in order to maintain constant amplitude. The bending moment distribution along the blade can be adjusted by adding mass to the blade and by slightly varying the forcing frequency.

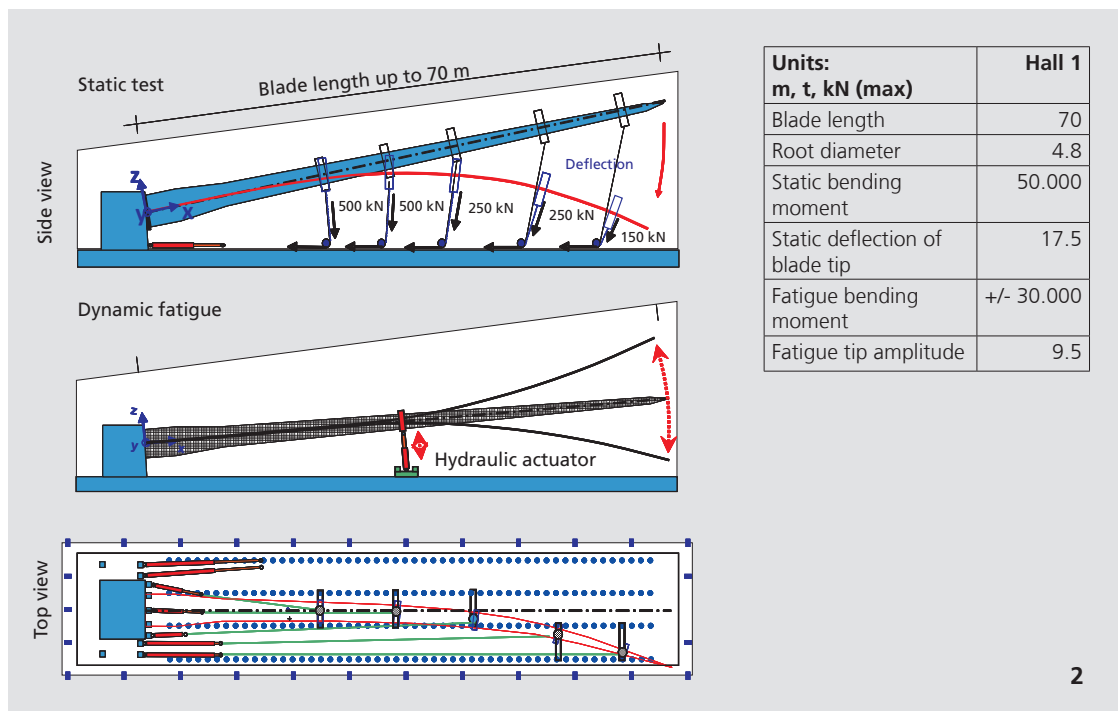
Time and cost reduced testing

By testing dynamically in Eigenfrequency, the amount of energy required to run the test is drastically reduced compared to a quasi-static fatigue test. Fraunhofer IWES is currently working on developing methods for biaxial Eigenfrequency fatigue of turbine blades that will enable both the edge and flap direction fatigue tests to be

performed simultaneously, thereby achieving a more realistic loading of the blade and reducing the testing time and costs. A state of the art HBM MGC+ measurement system is used to record the response of all test transducers simultaneously during the test. Up to 250 strain gauges can be connected to the system in addition to load-cells, draw wire displacement sensors, loadframe rotation sensors, accelerometers, and temperature and humidity sensors. Custom measurements, for example measurement of the adapter plate and pitch bearing deflections, can also be integrated into a test. Measurement frequencies over 400 Hz. are possible and strain data recorded during impulse excitation is used to determine the blade Eigenfrequencies by FFT. Other specific tests include integrated measurement of root bolt axial force and bending during pitch bearing installation and under applied load.

Services

- Blade test (static test and dynamic fatigue test, biaxial examination, ultimate test)
- Production (coupon and beam specimen, demonstration rotor blades, preparation of samples from components and structures)
- Component tests (development of testing concepts, testing under static and dynamic conditions, behaviour under extreme environmental conditions)
- Applied materials development (determination of material suitability, experimental studies on material behavior, determination of materials' aging properties, application and advanced development of hypotheses on the strenght of materials)
- Material testing (testing under static loads and cyclic loads, testing fibre composite materials, development of models for materials and simulation of material)



- 1 The tilt block function allows adjustment of the blade root angle during the test
- 2 Static and fatigue test methodologies at the 70 m test facility