Fraunhofer IWES

Data and facts

Structural analyses on components and large-scale models

At the Test Center for Support Structures (TTH) in Hannover, the Fraunhofer IWES collaborates with the operator Leibniz University Hannover to offer tests and parallel analyses for support structures of onshore and offshore systems and wind turbine components on a large scale (1:9 to 1:3). Long-term loading by waves, wind, and turbine operation is simulated on an accelerated timescale so that meaningful results are available after only three to four months. It is thus possible to quantify system reserves and exploit optimization potentials. Moreover, environmentally compatible construction technologies can be systematically assessed.

Our competences at a glance

- Planning, execution, and evaluation of structural tests
- Analytical and numerical analyses of the support characteristics of structures
- Comparison of standards for reference structures
- Parallel analyses such as the determination of SN diagrams or tests under climatic conditions
- Cyclic load tests on support and foundation structures/components on a scale of up to 1:3
- Determination of the dynamic behavior/fatigue behavior on an »accelerated timescale«

Fatigue behavior of major components

A clamping field is available for the uniaxial and multiaxial loading of major components and support structures to investigate the fatigue behavior of typical onshore and offshore structures and new developments. Test setups can be loaded specifically by means of a 1 x 1 meter grid of anchor points, and 8-meter-high portal frames are available for the application of additional loads.

Fatigue strength analyses

We launched the Application Center IOn the clamping field, damage to steel K-joint or double K-joint nodes and tubes of jacket structures can be detected under a coating several millimeters thick, for example, and damage parameters determined for use under extremely corrosive environmental conditions at sea. To this end, the steel nodes are subjected to several 100,000 load cycles until a hairline crack appears. This is done by clamping the main tube at both ends and applying a cyclic load to a connecting tube with the aid of a hydraulic cylinder.

Analytical and numerical preliminary analyses showed that a hairline crack is to be expected at the welded joint between connecting tube and main tube. Strain gauges are used to determine when total failure occurs and can have a detrimental effect on the stability of the turbine in the field. Further non-destructive test methods are also used – for example: ultrasonic testing.

Climatic chamber

The effect of environmental factors on manufacturing and repair methods for offshore structures can also be investigated at the Test Center for Support Structures in Hanover: In the walk-in climatic chamber, climatic environmental influences can be set precisely and reproducibly. This test infrastructure allows accelerated timescale experiments to be performed to investigate corrosion processes or the durability of coating systems.

Resonance test machine

In addition to the clamping field, further laboratory equipment and testing machines are also available for parallel analyses: A resonance test machine makes it possible to realize a large number of load cycles – especially for fatigue strength analyses on fasteners such as bolts or welded joints, and also on concrete samples and 3-point bend test samples – in a short period of time. It has a load capacity of up to 1 MN and frequencies of between 60 and 80 Hz, so that 10^7 to 10^8 load cycles are possible in short periods of time. The testing equipment is designed to consume much less energy than a servo-hydraulic universal testing machine.

Foundation test pit

A 14 x 9 x 10 m (L x W x D) test pit with a filling volume of approx. 1,260 m^3 soil (sand or other soils, also layered) and the associated loading and safety devices is available for experimental model tests on foundation elements. It is equipped with state-of-the-art measuring and control technology and was designed to apply cyclic loads with test forces of up to 2 MN.

In 2014, the geotechnical test pit was filled for the first time with a soil model similar to typical Northsea non-cohesive sands. Using a variety of methods, the model sand can be installed with different packing densities (medium to very dense) and water saturation levels of up to 98 %. The soil can be instrumented with pore water transducers and various soil pressure gauges and is qualified by taking cylindrical samples and CPT measurements during and after installation.

Foundation structure models such as monopiles, suction buckets, pile groups etc. can be inserted by various means - hydraulic pile driving, vibratory driving, jacking, also "wished-in-place" – and then mechanically loaded statically, cyclically, and dynamically. Taken together with the results of parallel numerical simulations, the data from experimental tests help to optimize the design of the foundation structures. These can thus be dimensioned so as to use less material and simplify the logistics.

Technical data clamping field

- Concrete base slab: 18.5 m x 9.5 m (L x W)
- Abutment wall: 9.5 m x 10 m x 8 m (L x W x H)
- Anchor point grid: 1 x 1 m
- Anchor points: 1 MN tensile and compressive loads, 420 kN transferable shearing force
- 14 hydraulic cylinders with individual capacity of up to 2 MN

Further information

Fraunhofer IWES secures investments in technological developments through validation, shortens innovation cycles, accelerates certification procedures, and increases planning accuracy by means of innovative measurement methods in the wind energy and hydrogen technology sectors. At present, there are more than 300 scientists and employees as well as around 150 students employed at the nine sites: Bochum, Bremen, Bremerhaven, Emden/Leer, Görlitz, Hamburg, Hanover, Leuna and Oldenburg.

Collaboration partners

Leibniz Universität Hannover

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