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Research on Support Structures in the German Offshore Wind Farm alpha ventus

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RAVE
RESEARCH AT ALPHA VENTUS

Summary

RAVE – "Research at alpha ventus" coordinates different projects connected to the German offshore test site "alpha ventus". One of these projects is **GIGAWIND *alpha ventus*** dealing with OWEC support structures. In this field of structural design main objectives are reduction of material cost and personal cost.

Objectives

Within the optimisation process for offshore wind energy converters (OWEC) one essential part comprises the support structure. At the German test field "alpha ventus" twelve turbines shall be installed in 30 meter water depth where all loads of wind, turbine and waves have to be carried into load-bearing ground. In particular these aspects become more important since thousands of OWECs are planned in the North and Baltic Sea. Objectives:

RAVE – Research at alpha ventus:

- Optimisation and cost reduction of further offshore wind farms
- Measurement campaign in alpha ventus (600 sensors)
- funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)

GIGAWIND alpha ventus (Part of RAVE):

- Holistic design concept for OWEC support structures
- Designing lighter support structures (reduction of material cost)
- Optimising the design process (reduction of personnel cost)

Especially the holistic view is shown in the following design aspects:

Design Aspects

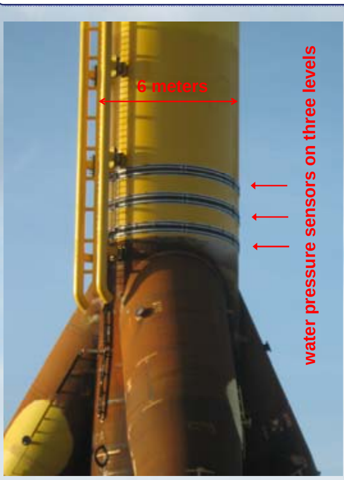

Fig. 1: Multibrid tripod with measurement system (source: DEWI)

Loads – Analysis of multidirectional wave loads for the estimation of optimized sea state coefficients and correlation with wind loads. Water pressure sensors are installed along the circumference of the main column to develop more detailed models with CFD models.

Fatigue – In structural and fatigue design the varying influence of manufacturing aspects is captured by high safety factors. Up to now positive effects of serial production are not considered in the design standards. For this reason different parameters like geometry tolerances and aspects of welding like distortions and residual stresses shall be measured during the manufacturing process.

Corrosion – Corrosion protection for offshore steel structures. Knowledge about actual condition of corrosion protection systems and corrosion processes will lead to more efficient protection systems for the support structure.

Scour – Development of new scour protection systems and local scour monitoring. A combination of lab tests and numerical simulation (CFD) as well as information of the real depth of scour will lead to an efficient concept for scour protection.

Foundation – For the OWEC support structures tripod or jacket foundation structures with open ended driven steel pipe piles are used as foundation elements. Within this research project the effect of cyclic axial and lateral forces is investigated and quantified by means of numerical modeling of the load-carrying behaviour for the used offshore piles.

ForWind
Center for Wind Energy Research

Design Aspects & Holistic Design Concept

Validation – Automated validation of general structural models. Eigenmodes of the structure identified from measurement data serve to modify FE-models deriving conformity to the reality.

Design concept – Dimensioning an OWEC support structure has to meet two requirements, safety and cost-effectiveness. Usually this is an iterative process and requires a very efficient simulation and design package as shown above, see figure 2.

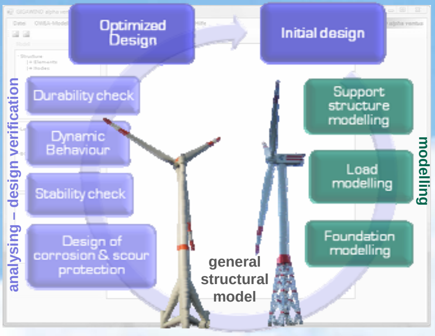

Fig. 2: Design process for OWEC Support Structures

Tools for different design aspects are made available, e. g. load models and validated general structural models. The software package provides interfaces between these tools and thus saves time in the design process. After modelling the general structural system with FEM or MKS the geometric information of the system as well as node coordinates will be transferred automatically to another tool, called *WaveLoads*. Within an internal routine *WaveLoads* calculates node loads from a design wave or specific sea state and gives results back to the structural model.

Monitoring – Reliable load monitoring at global and local parts of the structure. A sensor and cost efficient SHM-system for offshore structures is required because of difficulties in maintenance.

Project Partners GIGAWIND *alpha ventus*

Leibniz Universität Hannover

- Institute for Structural Analysis
  Prof. Dr.-Ing. habil. Raimund Rolfes
  Dipl.-Ing. Gerrit Haake
- Institute for Steel Construction
  Prof. Dr.-Ing. Peter Schaumann
- Franzius-Institute for Hydraulic, Waterways and Coastal Engineering
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- Institute for Building Materials
  Prof. Dr.-Ing. Ludger Lohaus
- Institute of Soil Mechanics, Foundation Engineering and Waterpower Engineering
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- Institute for Wind Energy and Energy System Technology (IWES)
  Dr.-Ing. Holger Huhn

See **www.gigawind.de** for more details.

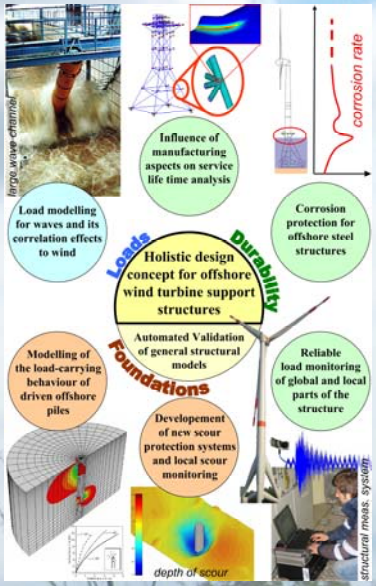

Fig. 3: Work packages in GIGAWIND *alpha ventus*

Leibniz Universität Hannover

Fraunhofer Institut Windenergie und Energiesystemtechnik IWES

Co-operation partners in GIGAWIND *alpha ventus*:

AREVA MULTIBRID REpower Systems