PO.ID 018

Fully integrated simulation and design process for offshore wind turbines including support structures

Michael Hänler[1] Thomas Bauer[2] Michael Beyer[1] Uwe Ritschel[2]

[1]Windrad Engineering GmbH, Bad Doberan, Germany [2]Rostock University, Rostock, Germany

www.windrad-engineering.de

The Task

Steel support structures are among the most costly components of wind turbines. Increasing rotor diameters and installation in deeper water pose high demands on support structures. To reduce costs and optimize these structures an integrated simulation and design of complete support structures is a key factor. We present a systematic approach to design support structures optimized to specific site conditions and hence closing the gap to a fully integrated load calculation. We focus on robust and reliable analysis as well as design tools to speed up the design process considerably.

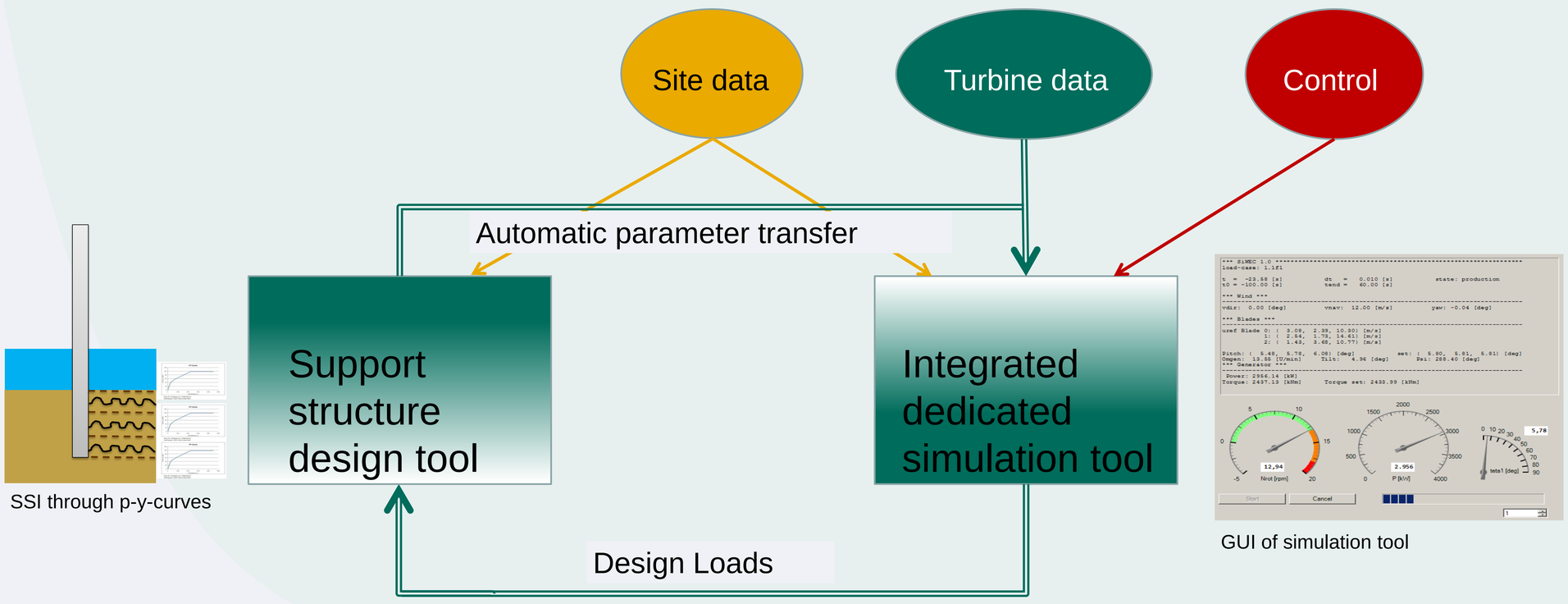
The Objectives

- Using constraint optimization for cost optimized support structure layout
- Fully integrated simulation and design offers saving potential for the support structure
- Fast and reliable design tools enable a site specific design

The Means

Constrained optimization algorithm

- Wall thicknesses are optimized with respect to axial, shear and total buckling as well as utilization of welded seams based on initial set of ultimate and fatigue loads
- Eigenfrequencies are calculated by Eulerian beam theory taking into account the stiffness of the piled foundation with site specific p-y-curves, if required frequencies are not met stiffness will be increased with minimum amount of steel using influence matrices
  - New design is automatically fed into fast load simulation program capable of doing fully integrated load calculations to deliver new set of ultimate and fatigue loads, this step offers the possibility to integrate the optimization of other turbine components in the same design loop



The Benefit

Using fast and robust analysis and design tools a considerable speed up in the iteration process for an optimized support structure design can be achieved. Due to the fully integrated design process a mass reduction of 5% to 10% compared to a sequential approach can be reached. Depending on the variation of soil conditions and water depth there is an additional saving potential by adapting the support structure to site conditions.