

#### Conceptual optimal design of jackets

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# **Conceptual optimal design of jackets**

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Figure 1: A jacket in its natural environment.

## Motivation

Conceptual design describes the jacket in rough terms [1], such as height, width, number of legs. This study and investigates the influence of leg distance on optimized jacket mass.

Structural optimization can explore a large design

space (400 jackets) in a short time (2 hours), and

thus lead to better conceptual jacket designs.

### The influence of leg distance on jacket mass

400 conceptual jacket designs with small changes in the top and bottom leg distances are created and optimized in JADOP. Figure 2 and 3 shows two of them. Figure 4 shows the trends for mass and frequency.



## **Model & Software**

In the research project ABYSS, a finite Timoshenko beam element software, JADOP, is developed for structural optimization of jackets. Main features of JADOP are

- Analytic sensitivities
- Parametric jacket topology
- Realistic wind and wave loads
- Fatigue post processing
- Stress concentration factors
- Advanced optimization lacksquare

#### **Optimization problem** Minimize the mass of a jacket, subject to fatigue constraints:

minimize  $f(\mathbf{x})$ 

Objective (mass)

Figure 2: The Innwind reference jacket has a Figure 3: The new conceptual jacket has bottom and top leg distance of 34 and 14 bottom and top leg distance of 28 and 19 meters, marked with a blue circle in Figure 5. meters, marked with a red star in Figure 5.



subject to  $\mathbf{K}(\mathbf{x})\mathbf{u} - \Delta \mathbf{P} = \mathbf{0}$  State equation  $\underline{\sigma} \leq \Delta \sigma(x) \leq \overline{\sigma}$  Fatigue (stress)  $\underline{\lambda} \leq \lambda_1(\mathbf{x}) \leq \overline{\lambda}$ Frequency  $\underline{x} \leq x \leq \overline{x}$ Design variables  $\underline{u} \leq u \leq \overline{u}$ State variables



**Figure 4:** Three contour plots showing how the leg distance influences the optimal design of the support structure. Note how larger leg distance really influences the jacket mass, while frequency is almost unchanged. The black line indicates jackets where the extended legs would meet at the tower top.

#### References

- [1] Marc Seidel. State-of-the-art design processes for offshore wind turbine support structures. Stahlbau, 85(9):583–590, 2016.
- [2] Thomas von Borstel. Design report reference jacket. Technical report, 2013

[3] A Waechter and L T Biegler. On the Implementation of a Primal-Dual Interior Point Filter Line Search Algorithm for Large-Scale Nonlinear Programming. Mathematical Programming, 106(1):25–57, 2006.