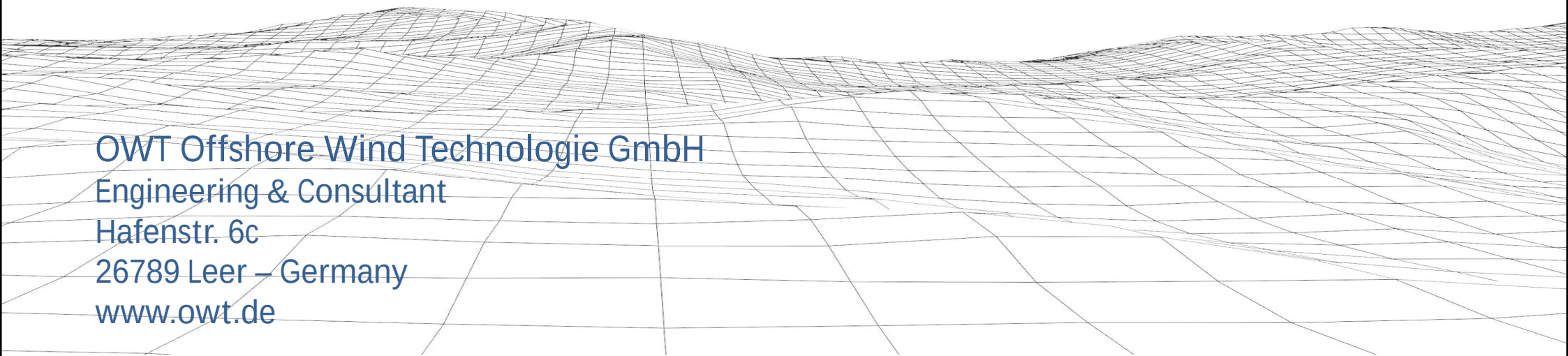
Parameter Study of a door frame for wind energy towers using Ansys and DOE



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Introduction

The aim of this study is to find the best frame geometry that leads to the lowest damage values which caused by fatigue on weld seam of the frame and on the free edge of the frame.

For this purpose a parametric study is carried out using the design of experiment methods with three parameters and thereof a response surface is created.

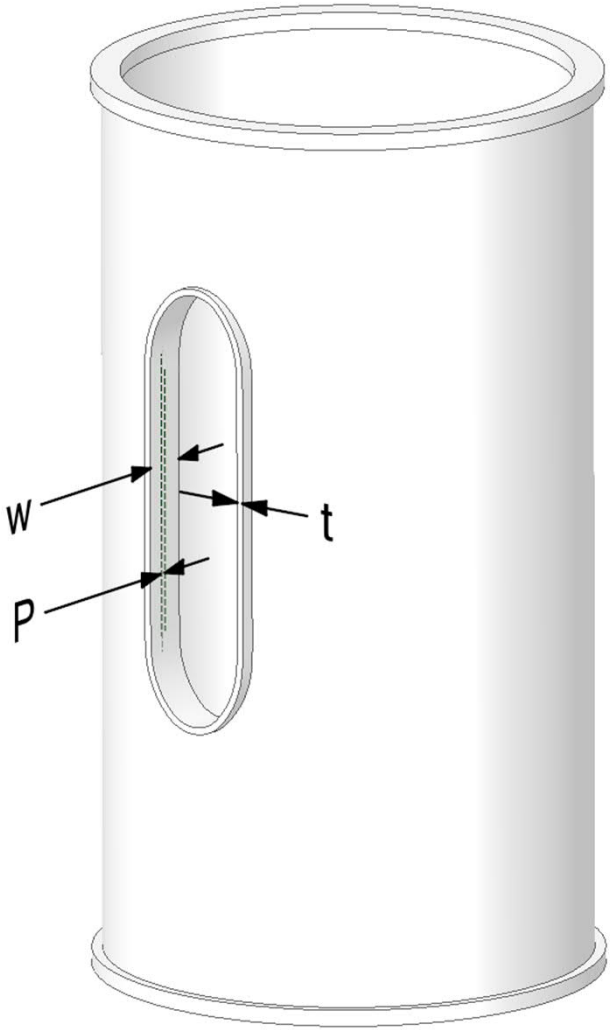
Parameters

Frame Parameters are :

- Position of the frame (misalignment from the shell thickness midline): P [mm]
- Frame thickness: t [mm]
- Frame width: w [mm]

To created The Parameter will be calculated in They study will be in range:

- -220 < p <90
- 30 < t < 75
- 320 < w < 500



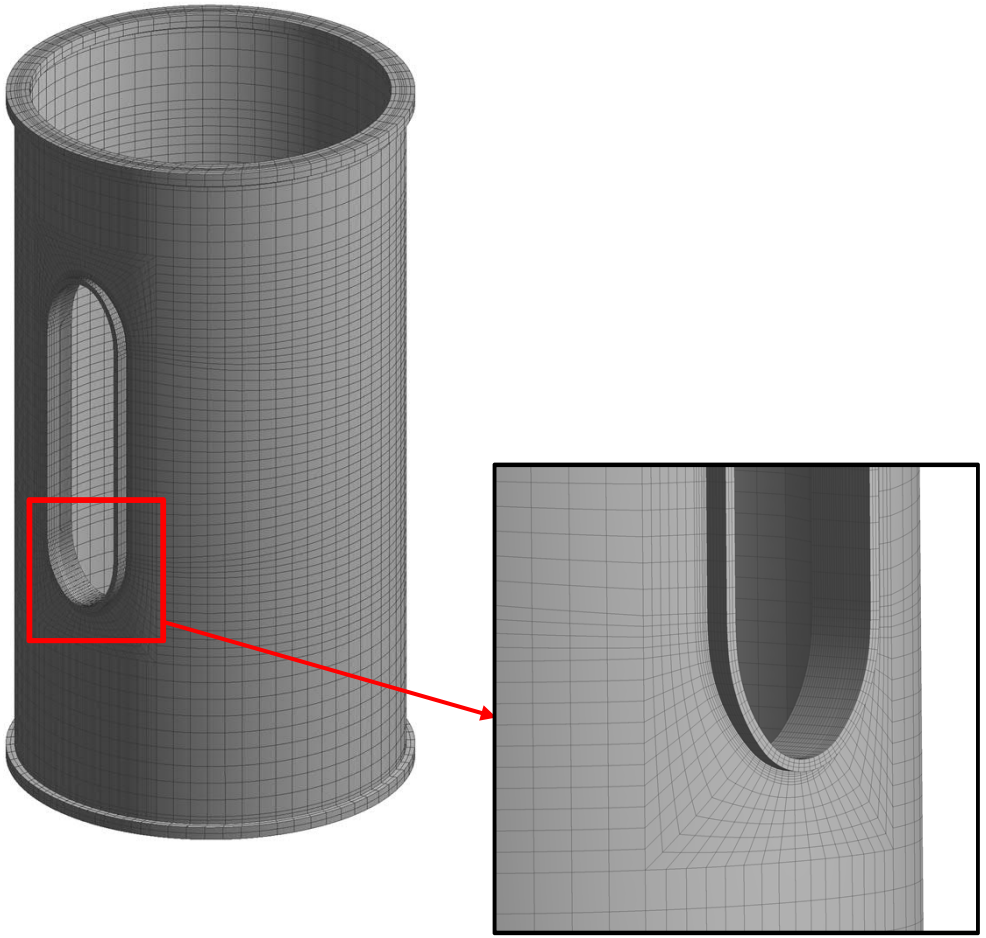
Mesh

The calculation is linear executed with structural steel as material

Young modulus E = 210,000 MPa

Passion ratio ν =0.3

A hexa-mesh type SOLID186 is used with fining around and on the frame



Boundary conditions

An arbitrary moment was applied as load on the upper surface of the shell. This load represent the damage equivalent fatigue loading on the tower.

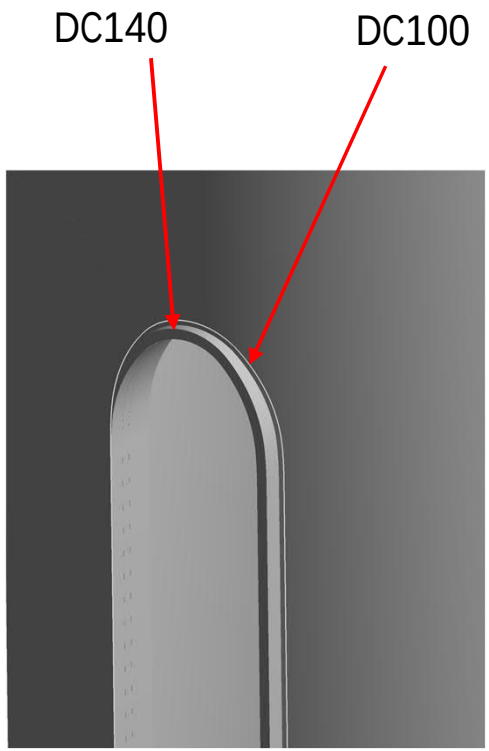
The lower flange is rigidly fixed with the ground. Thus, a remote point for the lower surface of the flange act as the fixation with fundament.

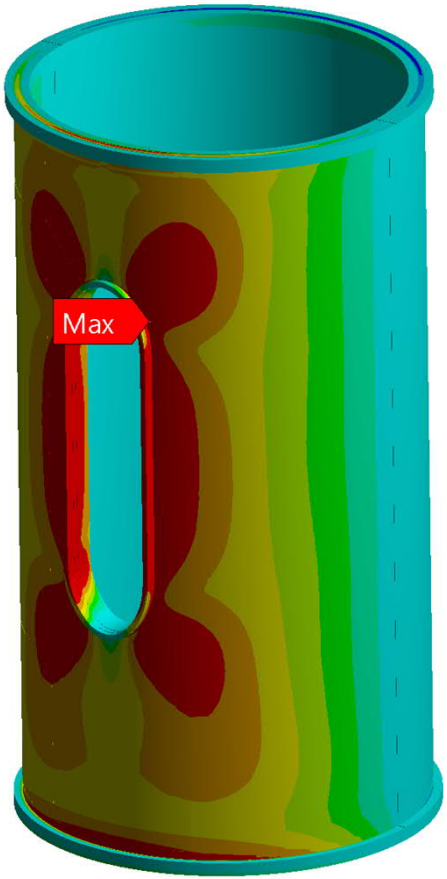
Results

As in figure shown the stress is increased around the frame on weld seam.

The damage occurs first on welded seam and on the frame free edge, so the stresses on these contour were evaluated.

As the stresses are evaluated according to IIW, a stress path with distance of 0.4* thickness of shell is evaluated to approximate the real stress values on weld seam.



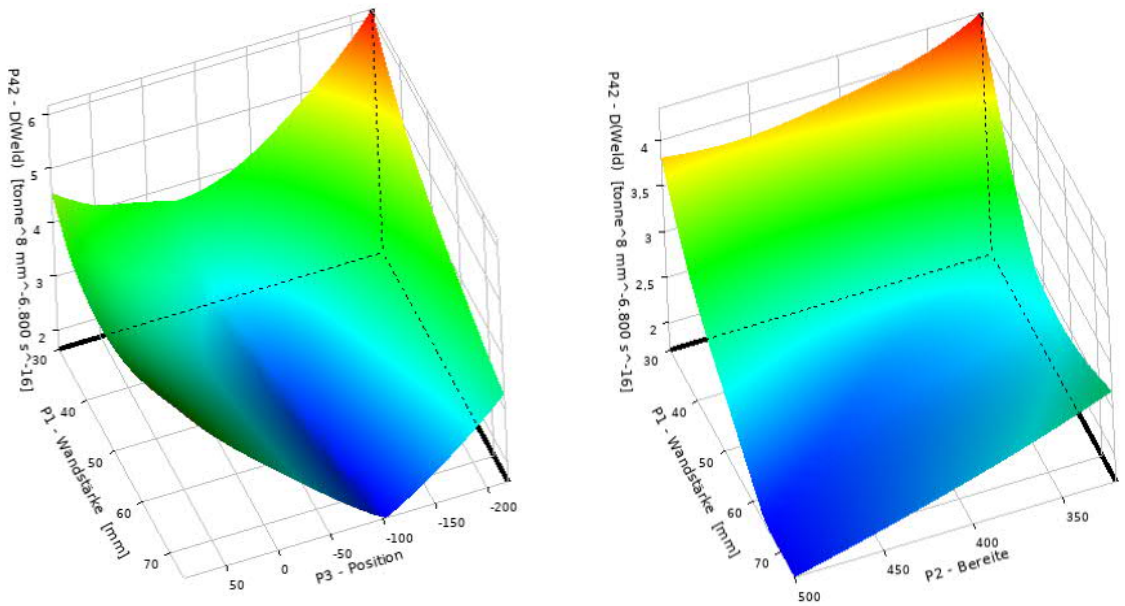


Response surface in weld seam (DC100)

A response surface is created, this shows the changing in damage by changing the parameters

It shows that increasing the thickness and the width of the frame decrease the damage on weld.

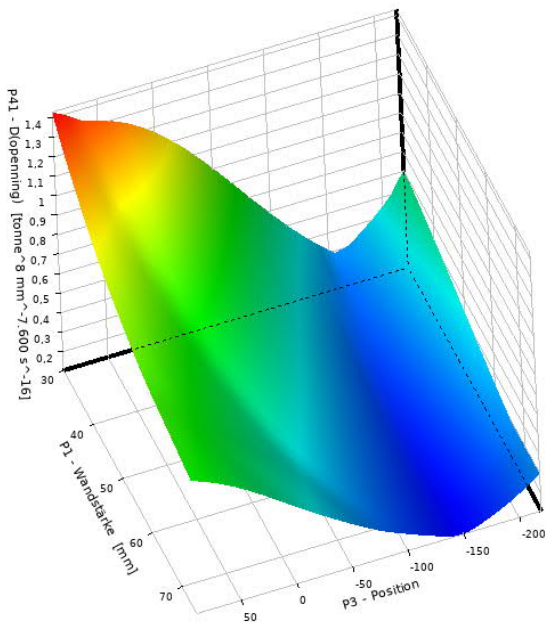
The positing of the frame is optimum when its axe misalign of about 100mm which is the major outcome of the this study.

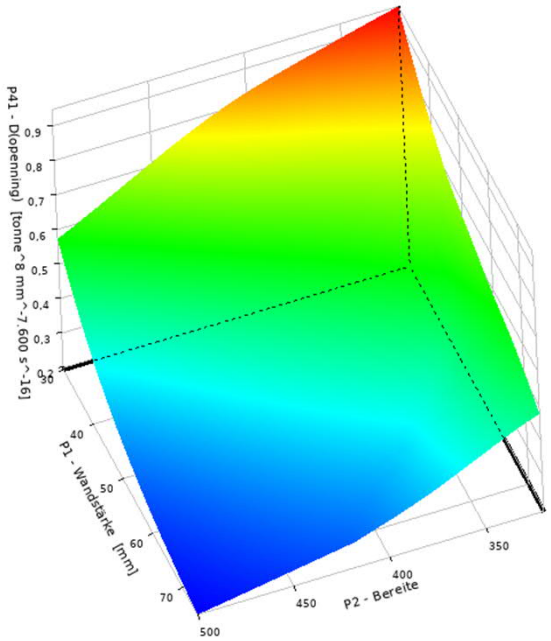


Note: the absolute values of damage are not relevant as the moment is arbitrary in this study

Response surface of free edge (DC140)

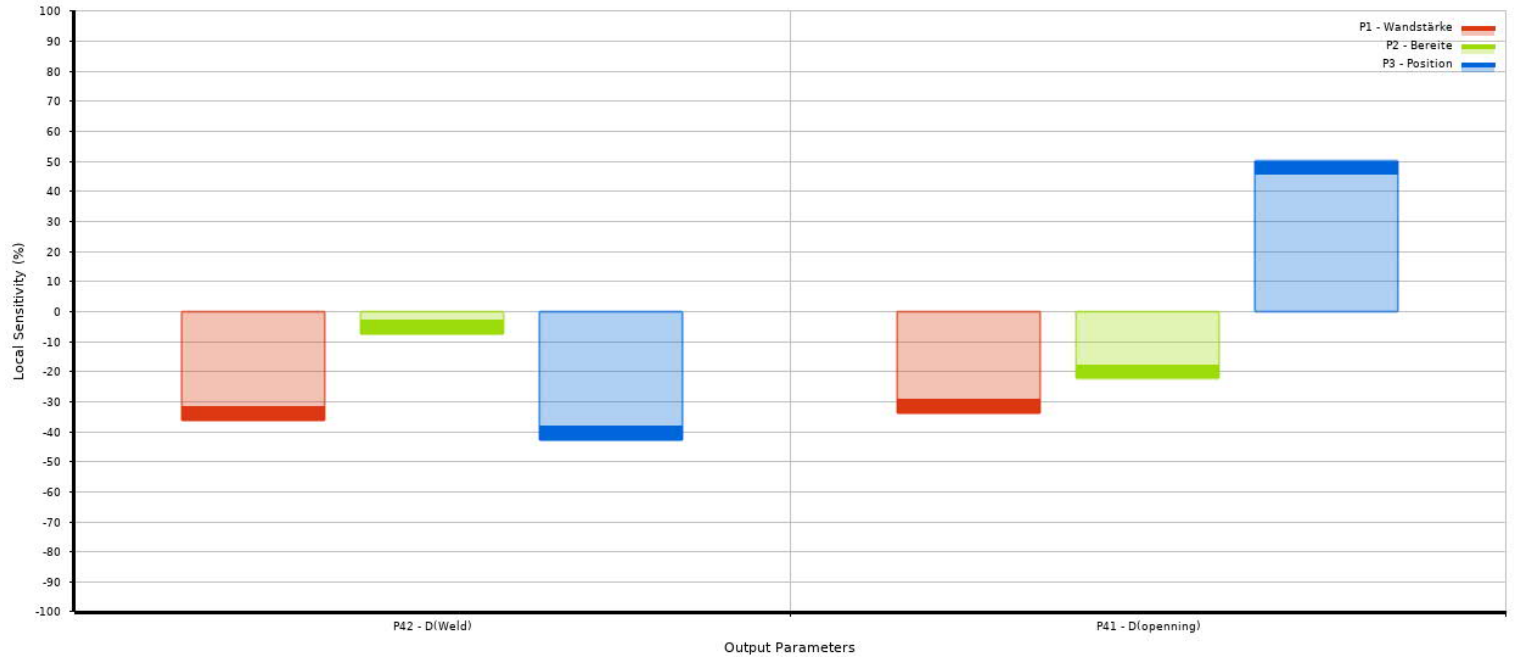
Similar effect can be seen at the parameter on the free edge of the frame:





Sensitivity

According to the sensitivity diagram, the determining of the position has the most impact to the damage, while an increasing width of the frame has less effect.



Summary

For deferent Fatigue classes and several edges or points to check, the design of experiment (DOE) methods and the response surface are powerful methods to determine the optimum parameters values to determine the highest allowable capacity of the structure, namely it gives an answer of the question: which geometry provides the highest resistance to fatigue loading.

Potential

In a more sophisticated study the fatigue capacity in terms of a damage equivalent moment is determined for each point of design. This is an advantage compared to the interpretation of SCF with different SN-curves and correction factors.

As a result, a specific geometry leads to an exact determined fatigue capacity, which then can be used in preliminary designs as granted. Combined with a large parameter set including diameter, it is possible to have all typically requested geometries at hand for preliminary design but also for design documentation.

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