
Low Cycle Fatigue of Ultra High Performance Concrete

JP Ulfkjær, Aarhus University



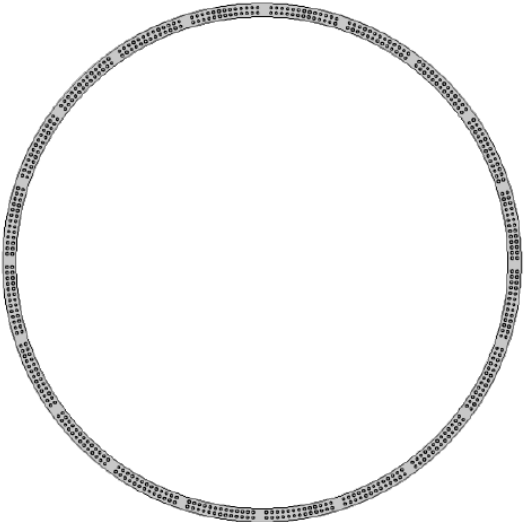
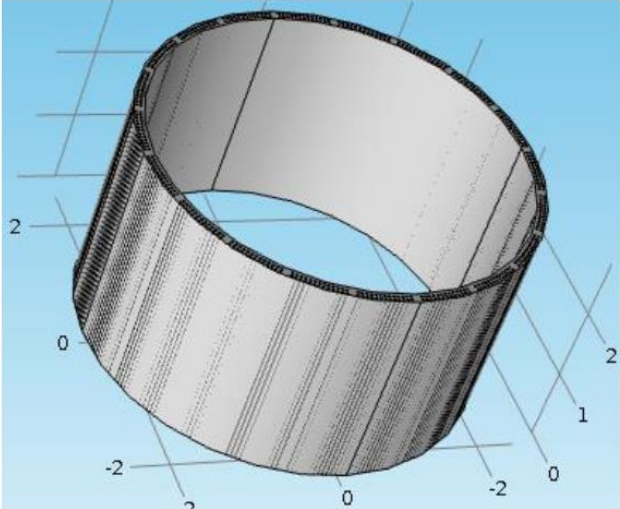
Conelto wind turbine tower

The Tower



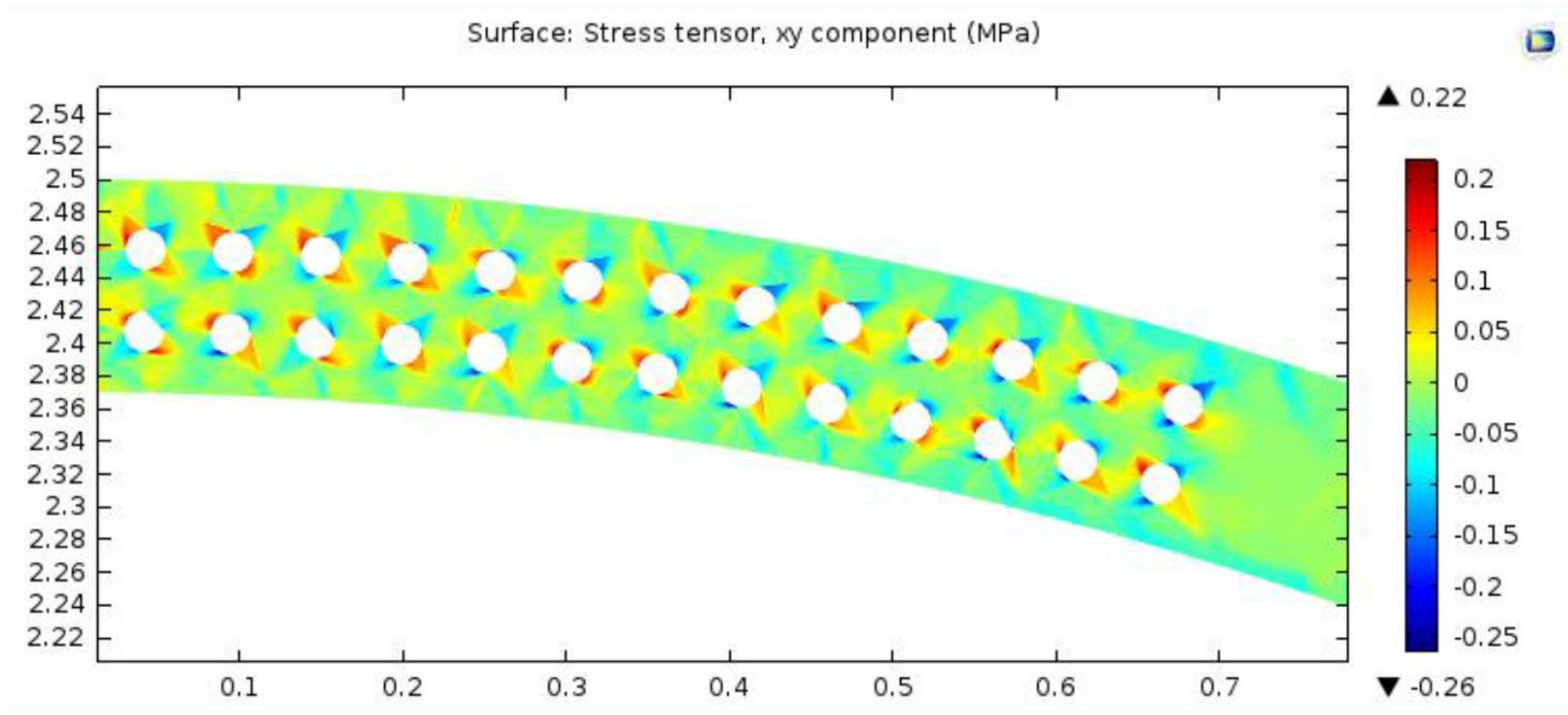
Conelto wind turbine tower

The Rings

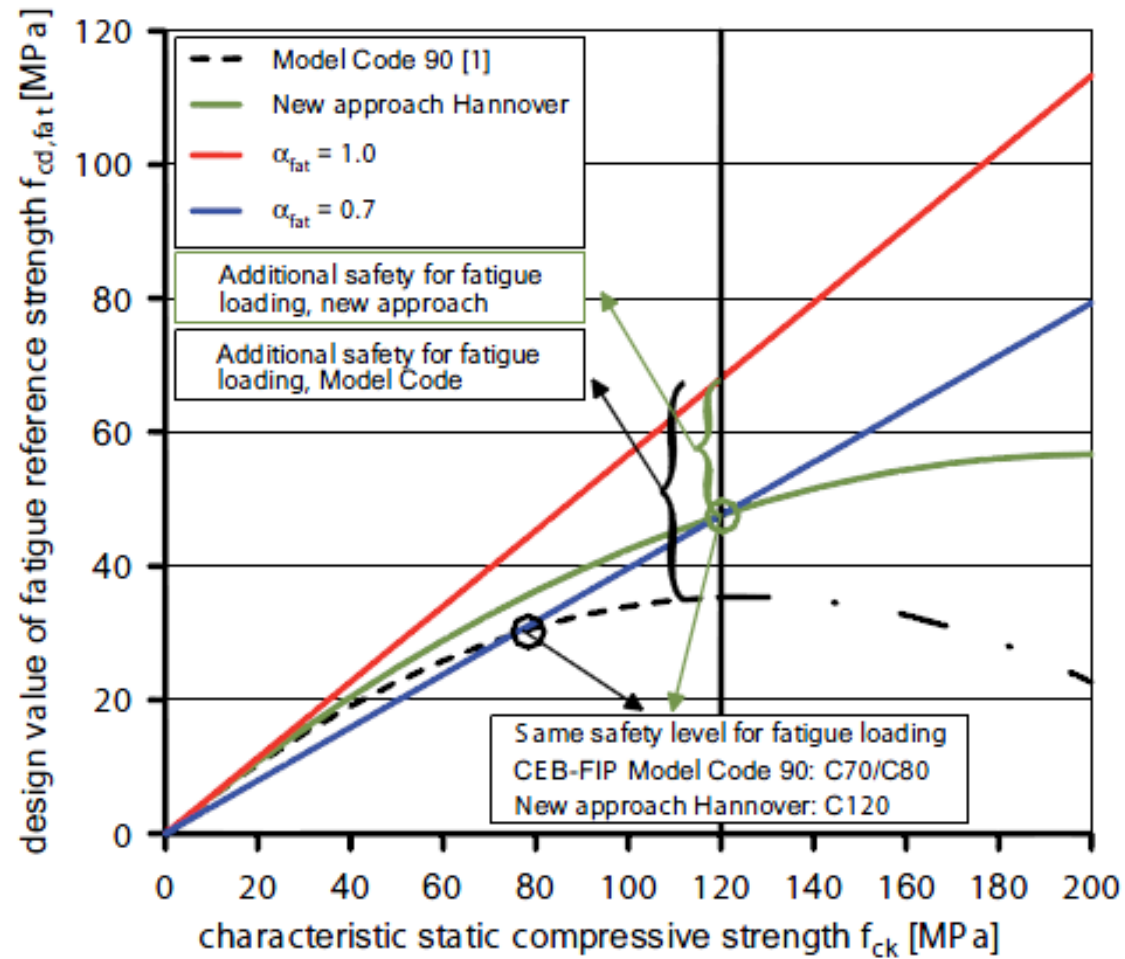


Conelto wind turbine tower

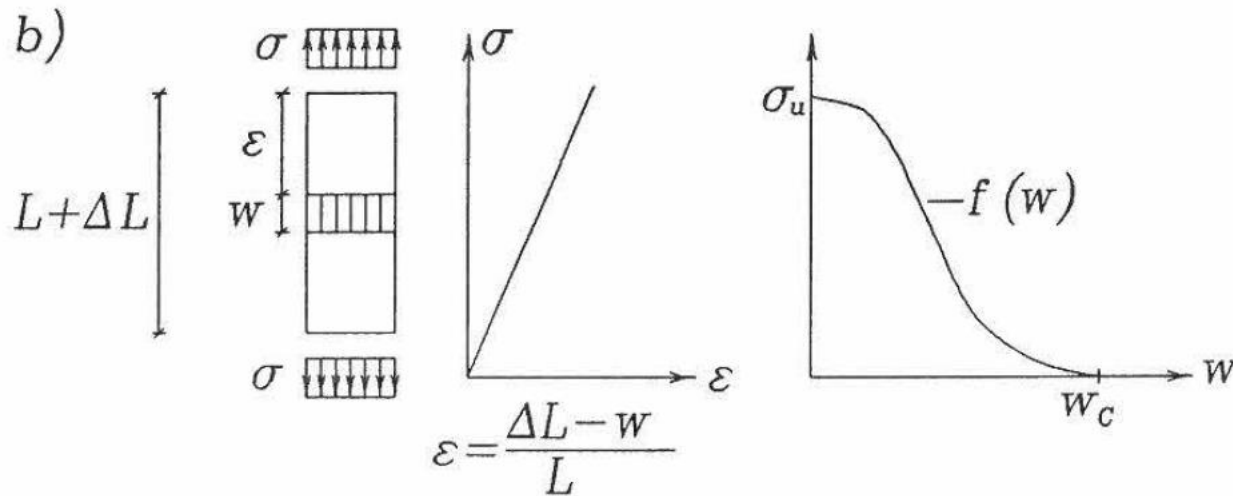
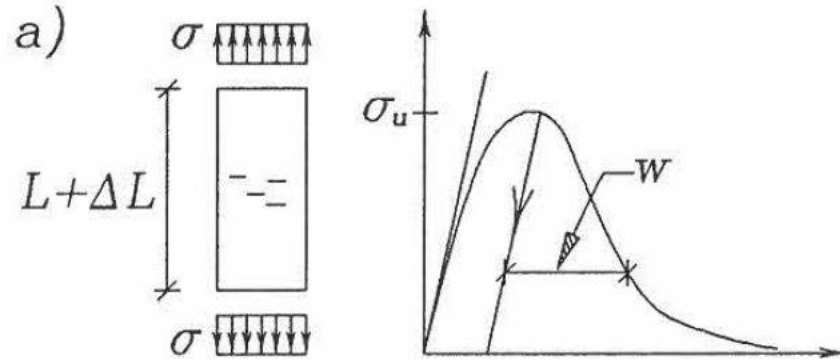
The Rings



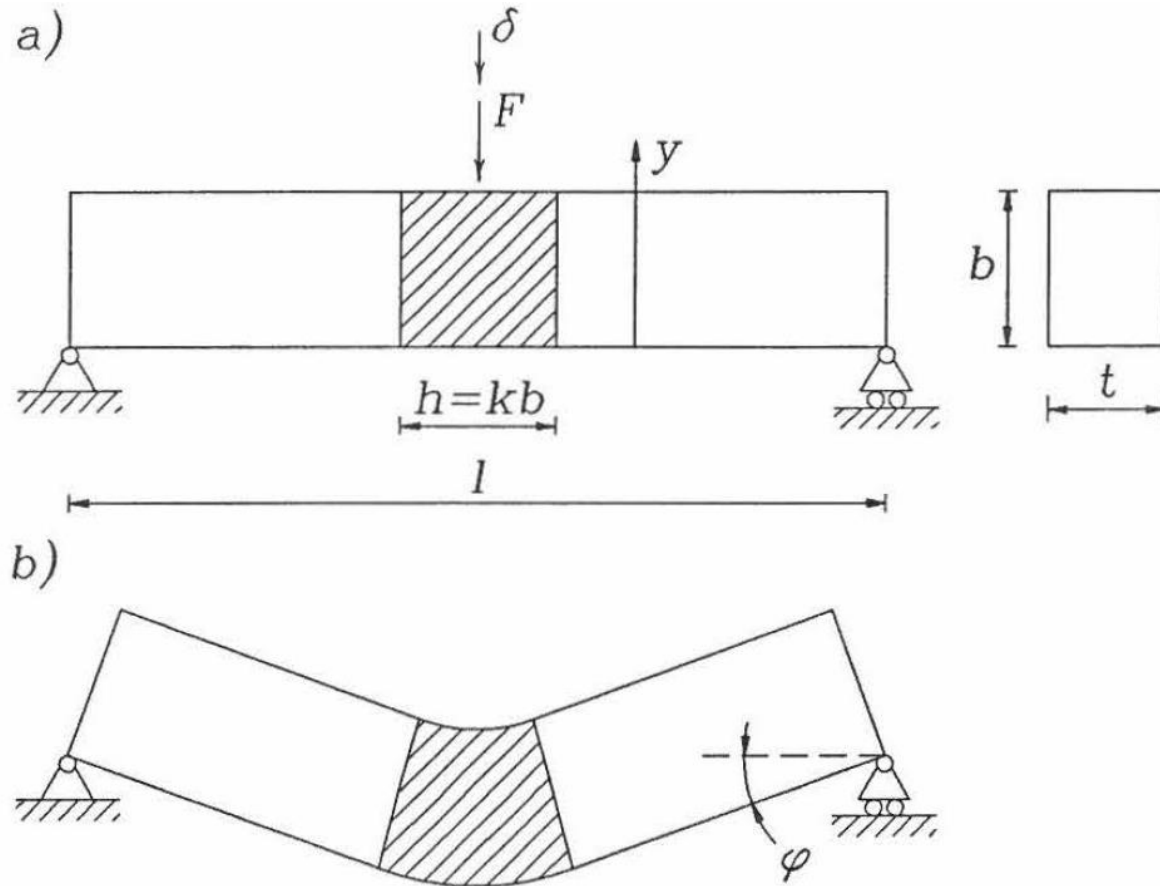
Fatigue



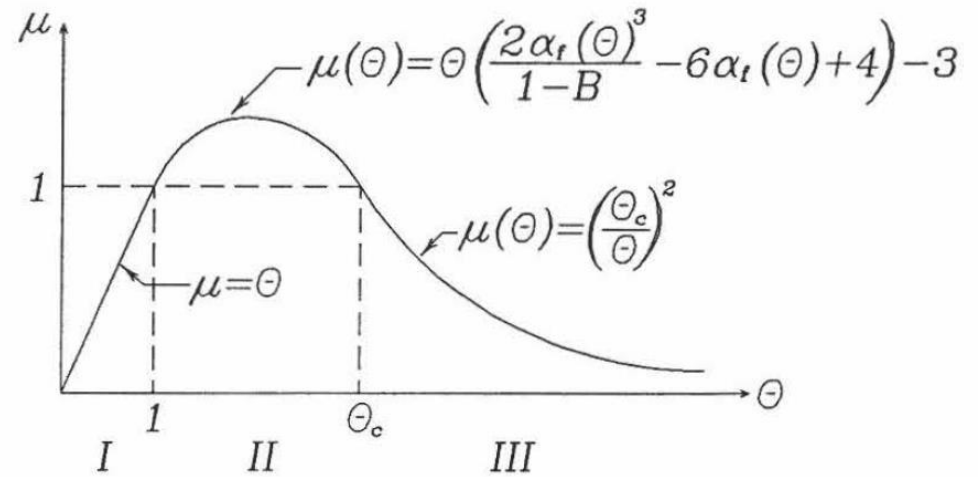
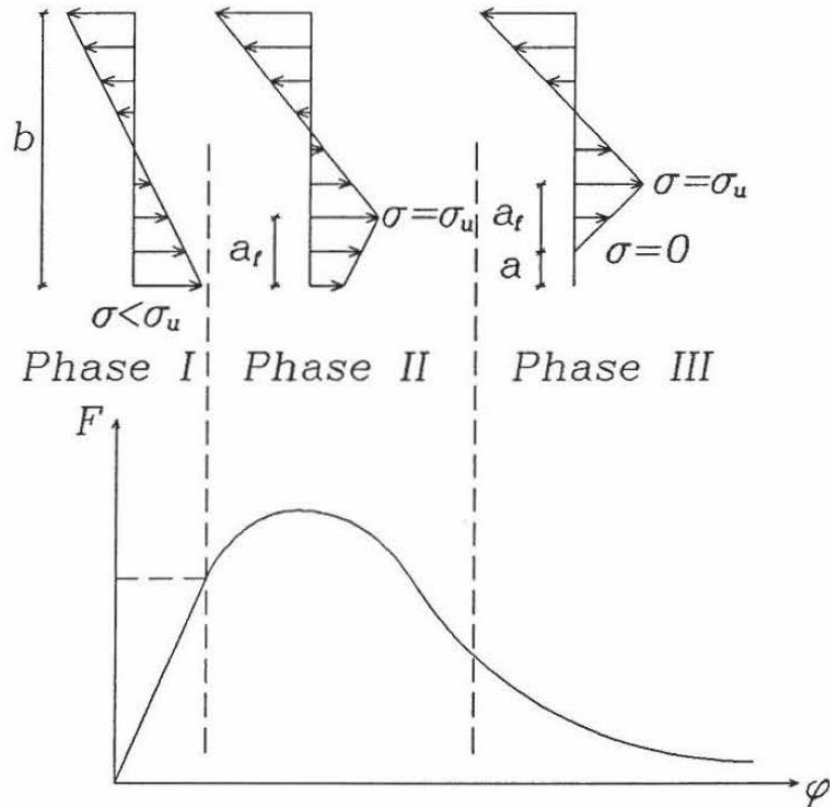
Concrete in tension



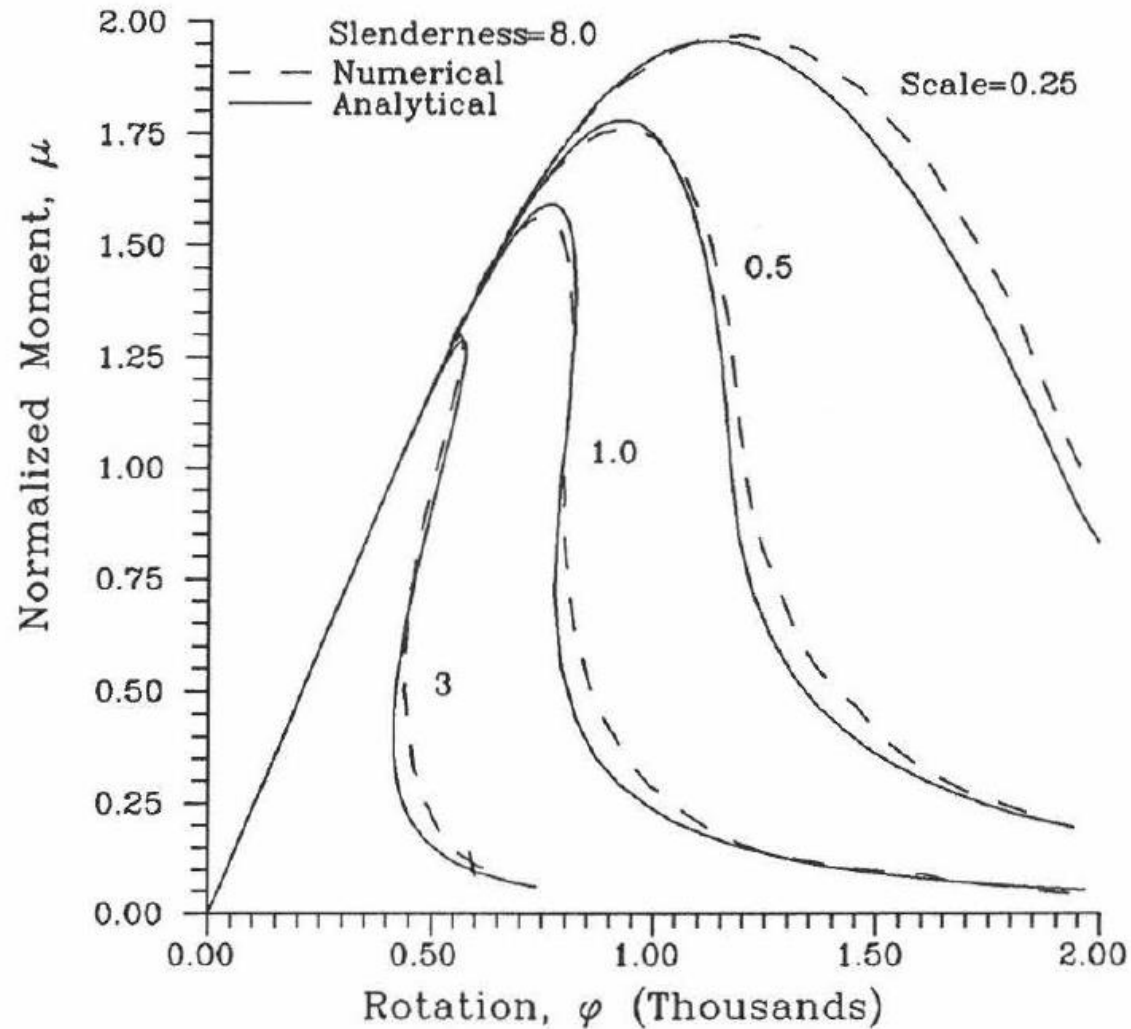
Size Effects in Model



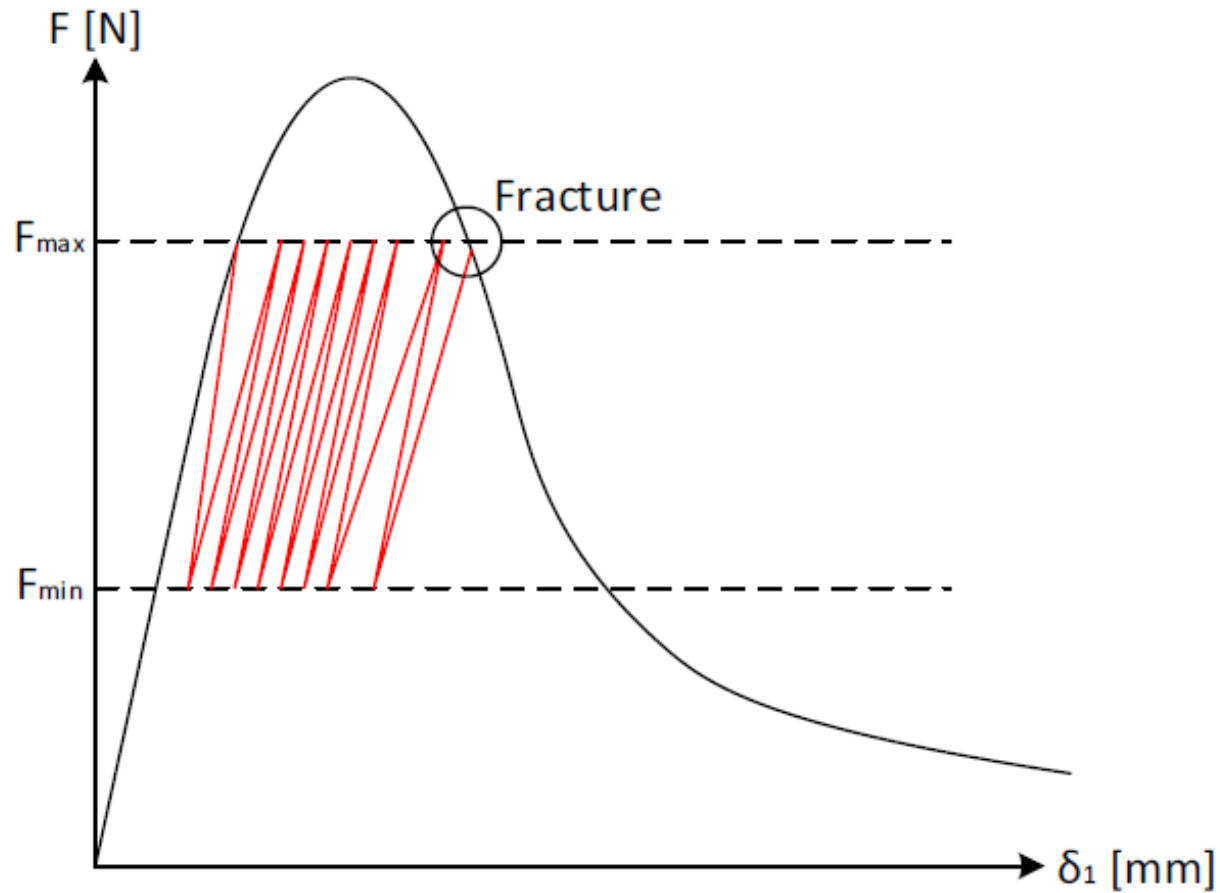
Beam model



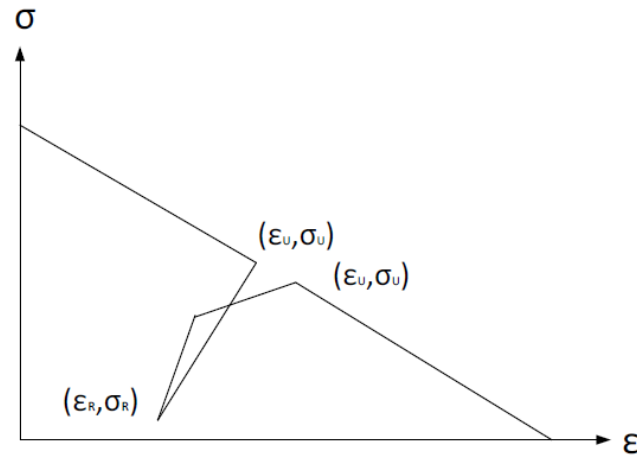
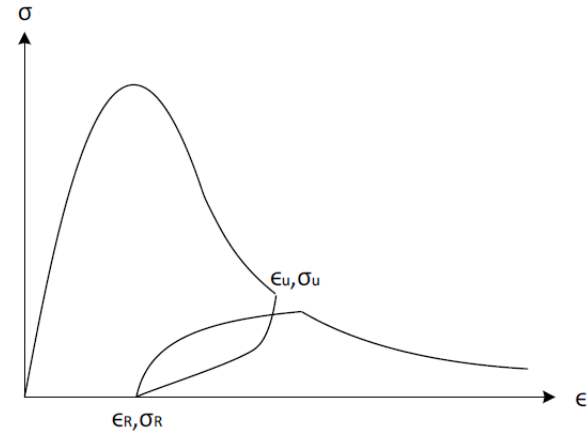
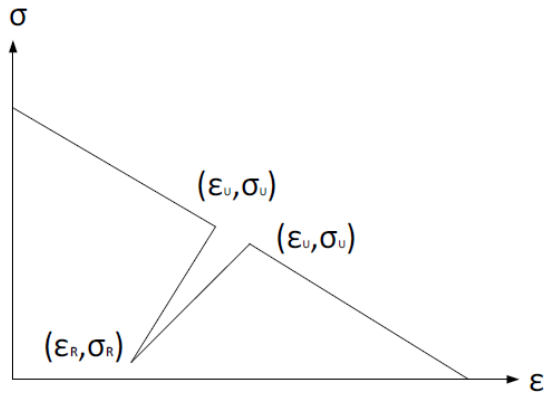
Size Effects in Model



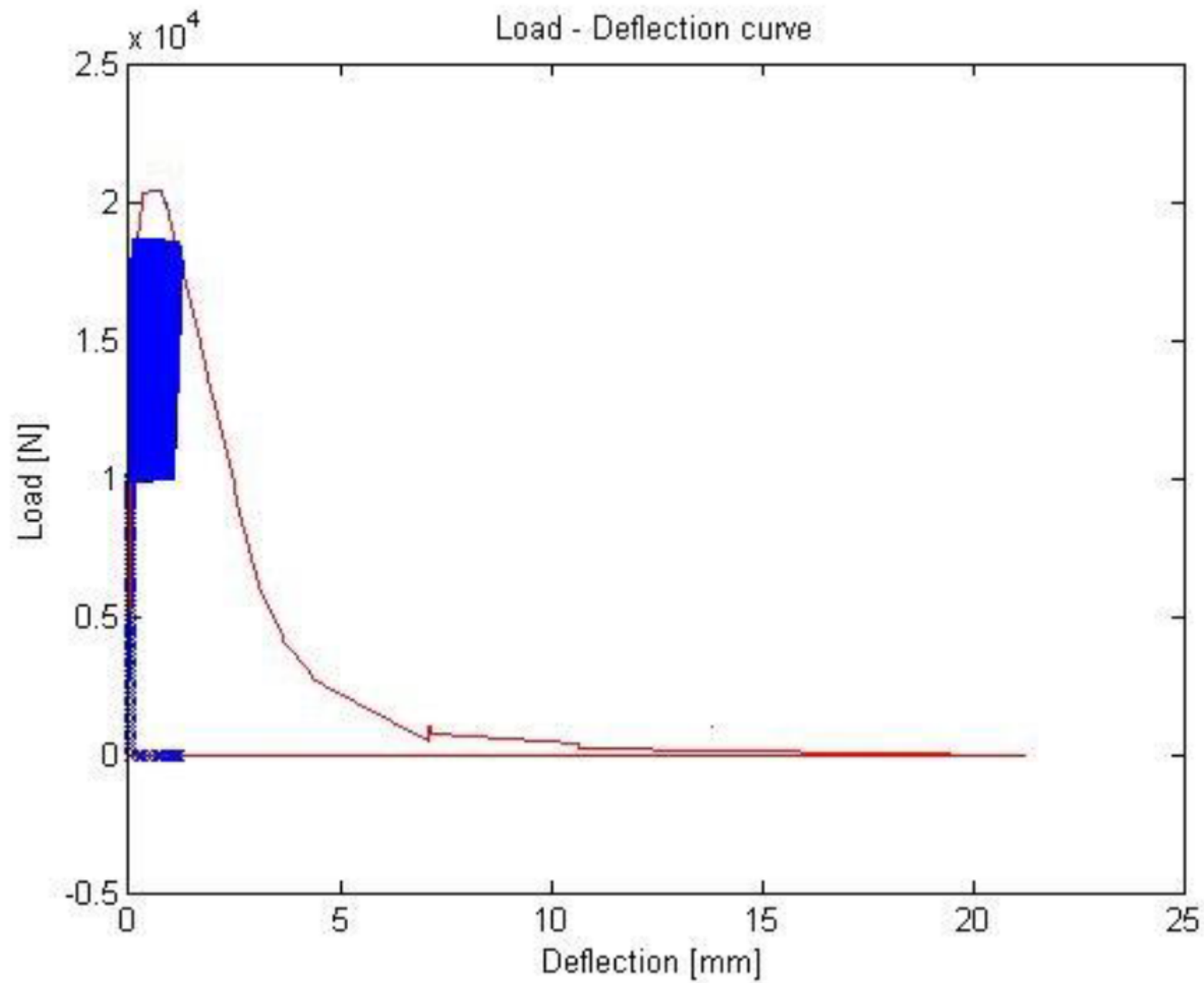
Fatigue in Model



Fatigue in Model



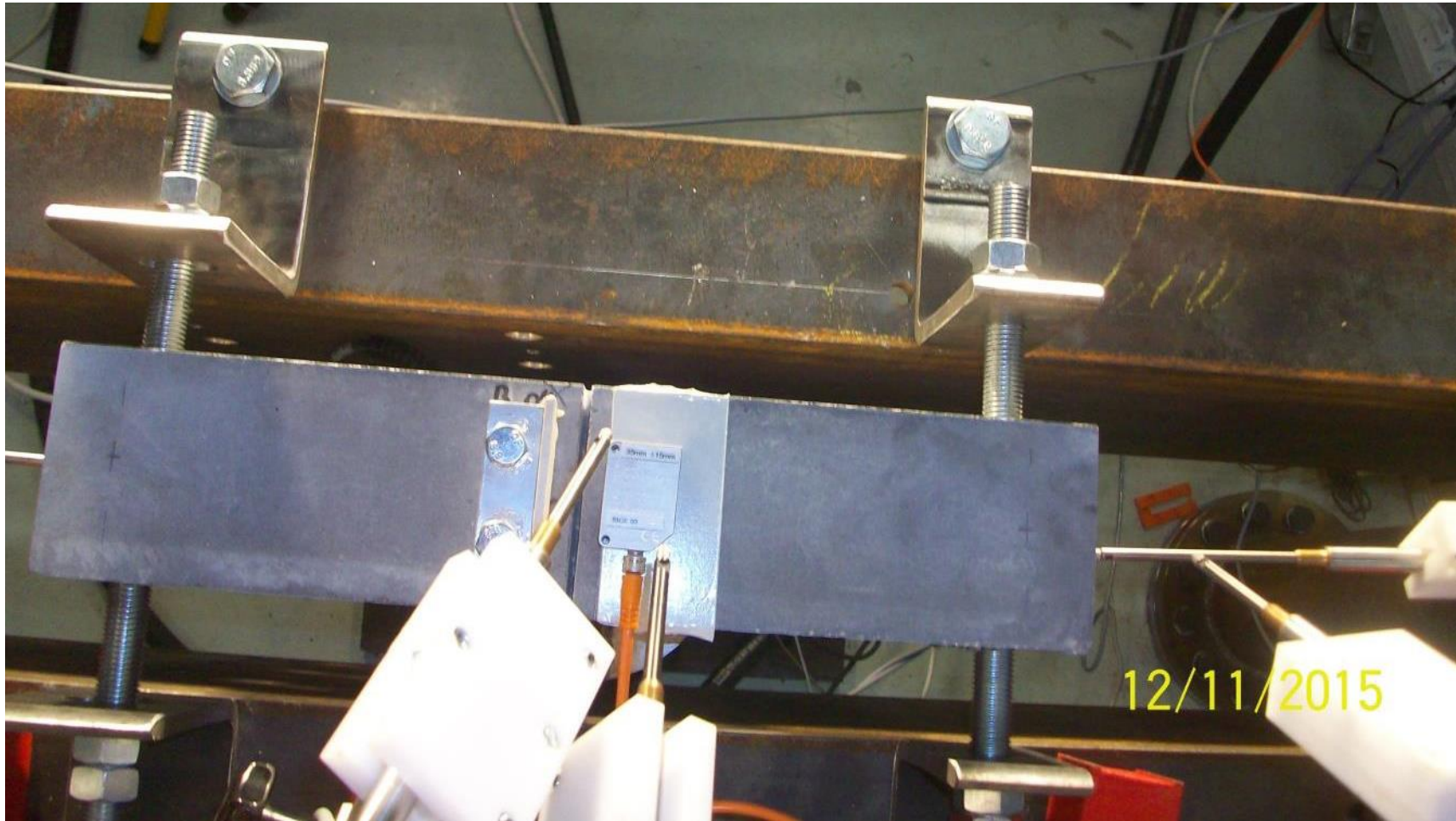
Load - Deflection curve



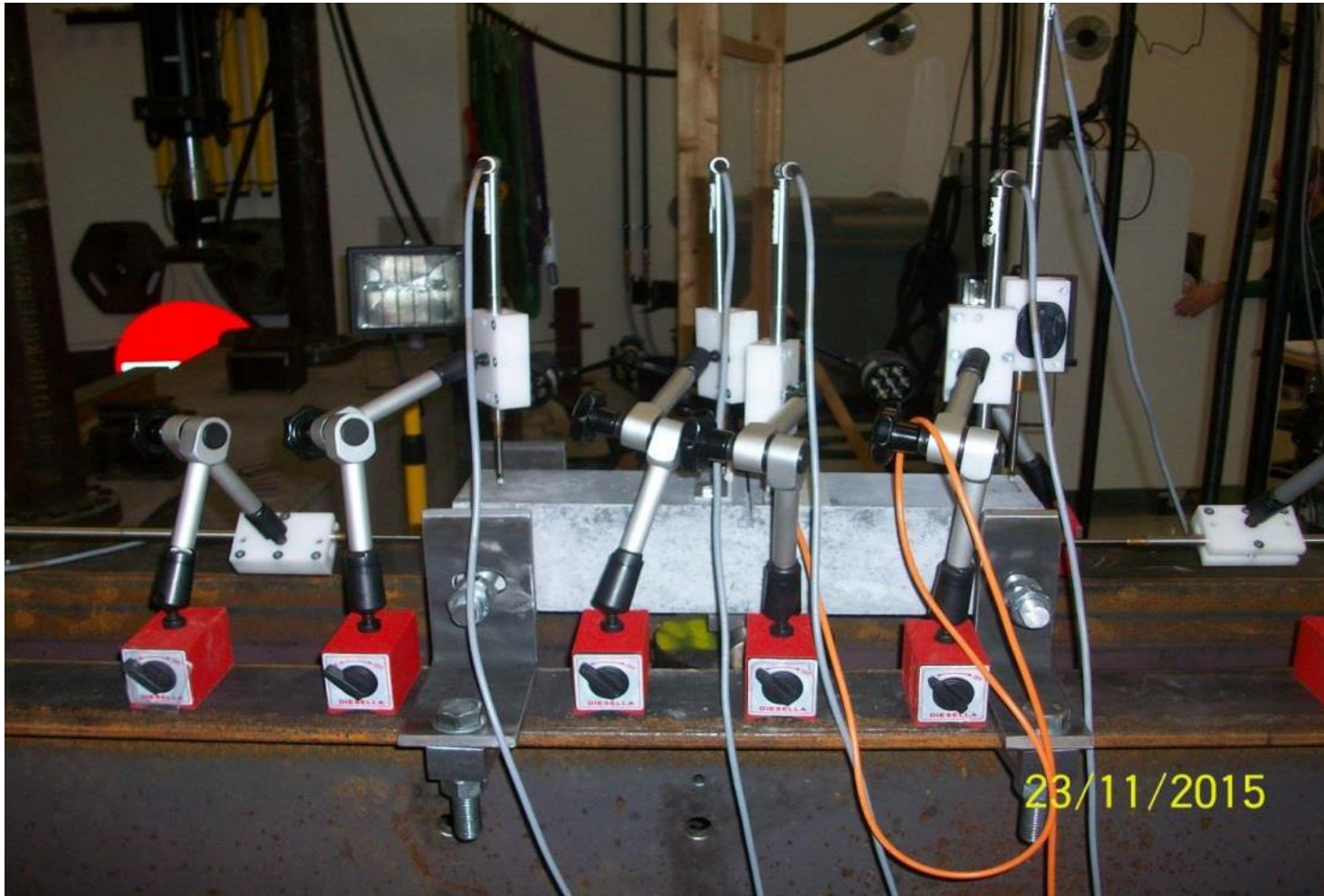
Testing



Testing



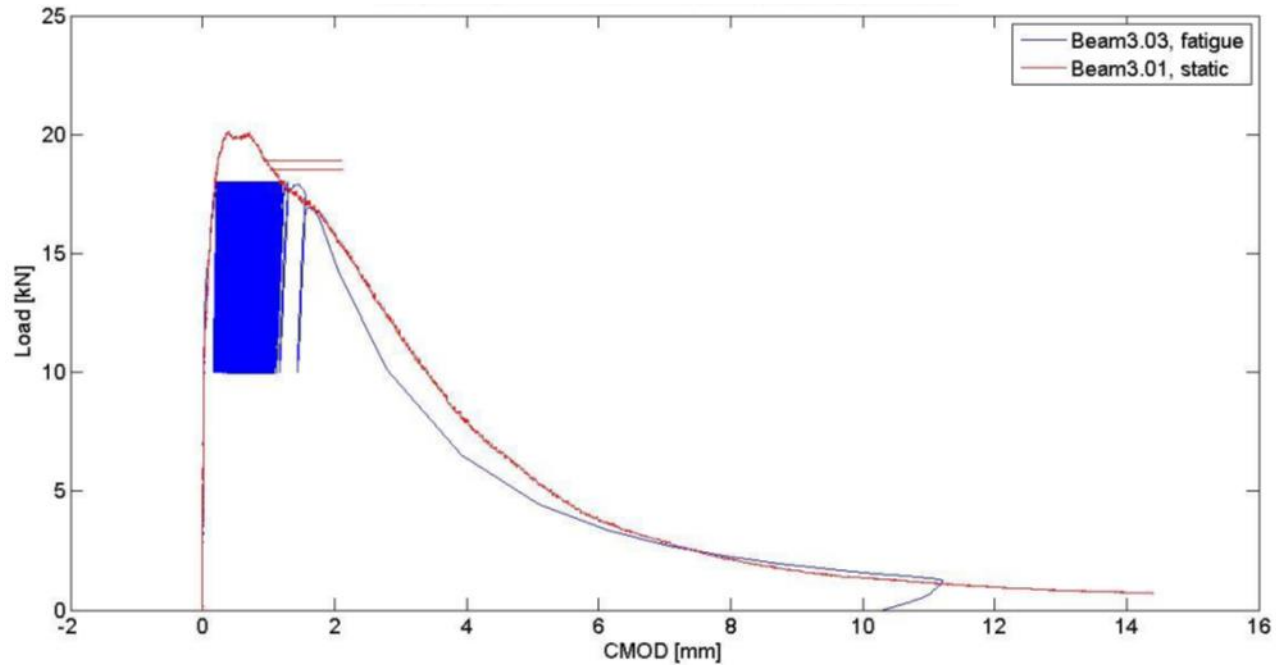
Testing



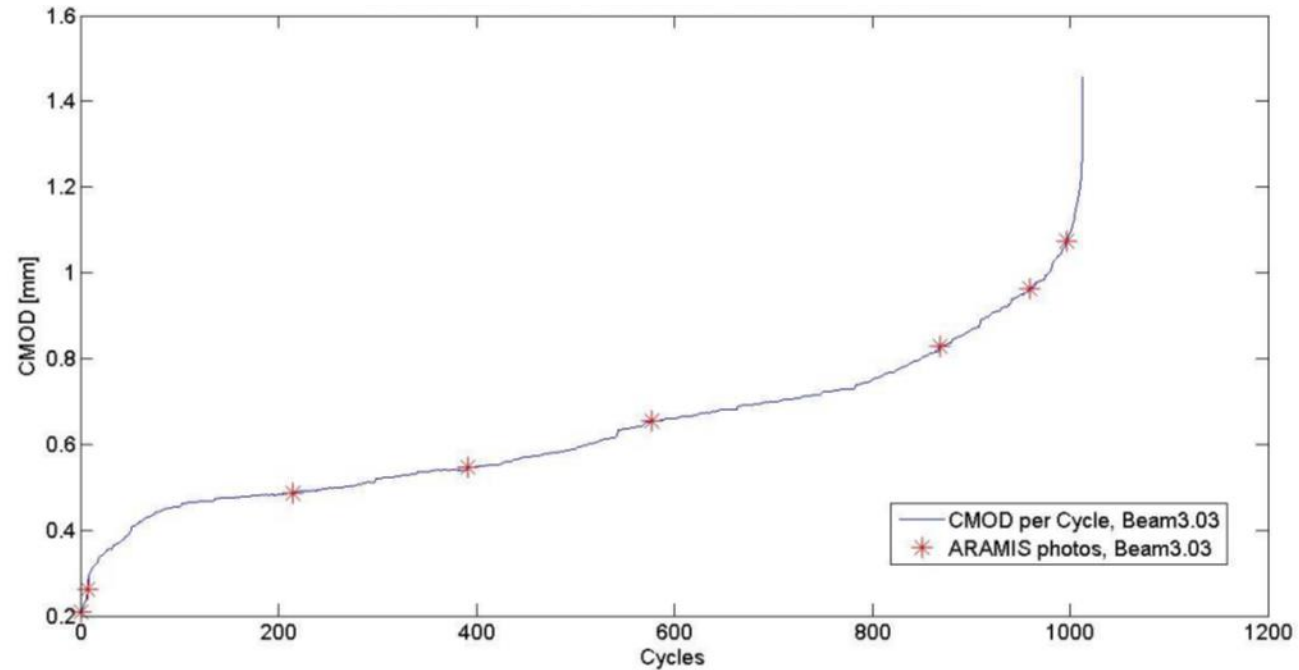
Testing



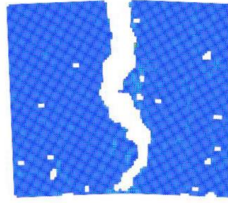
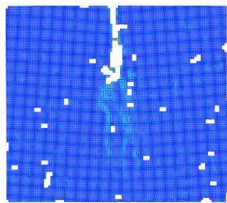
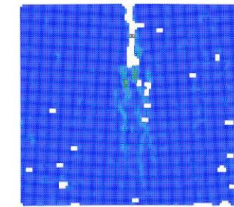
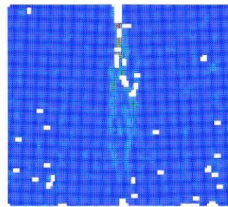
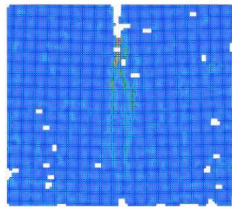
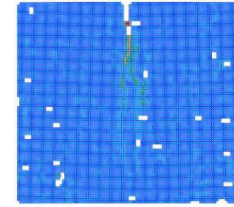
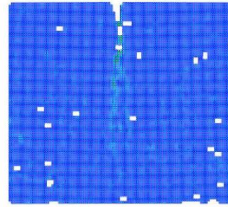
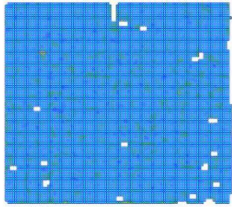
Testing CMOD - Load



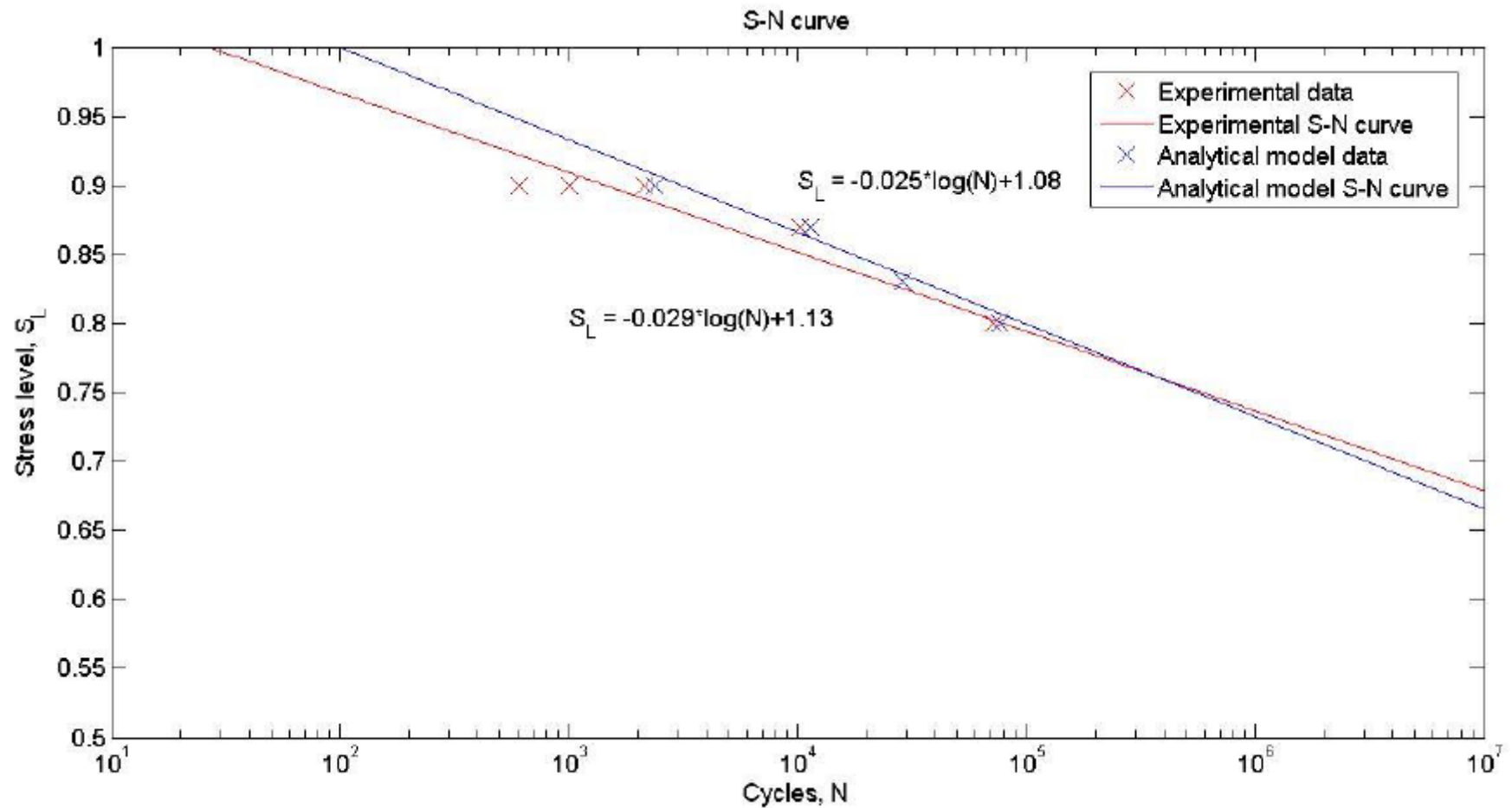
Testing- Cycles - CMOD



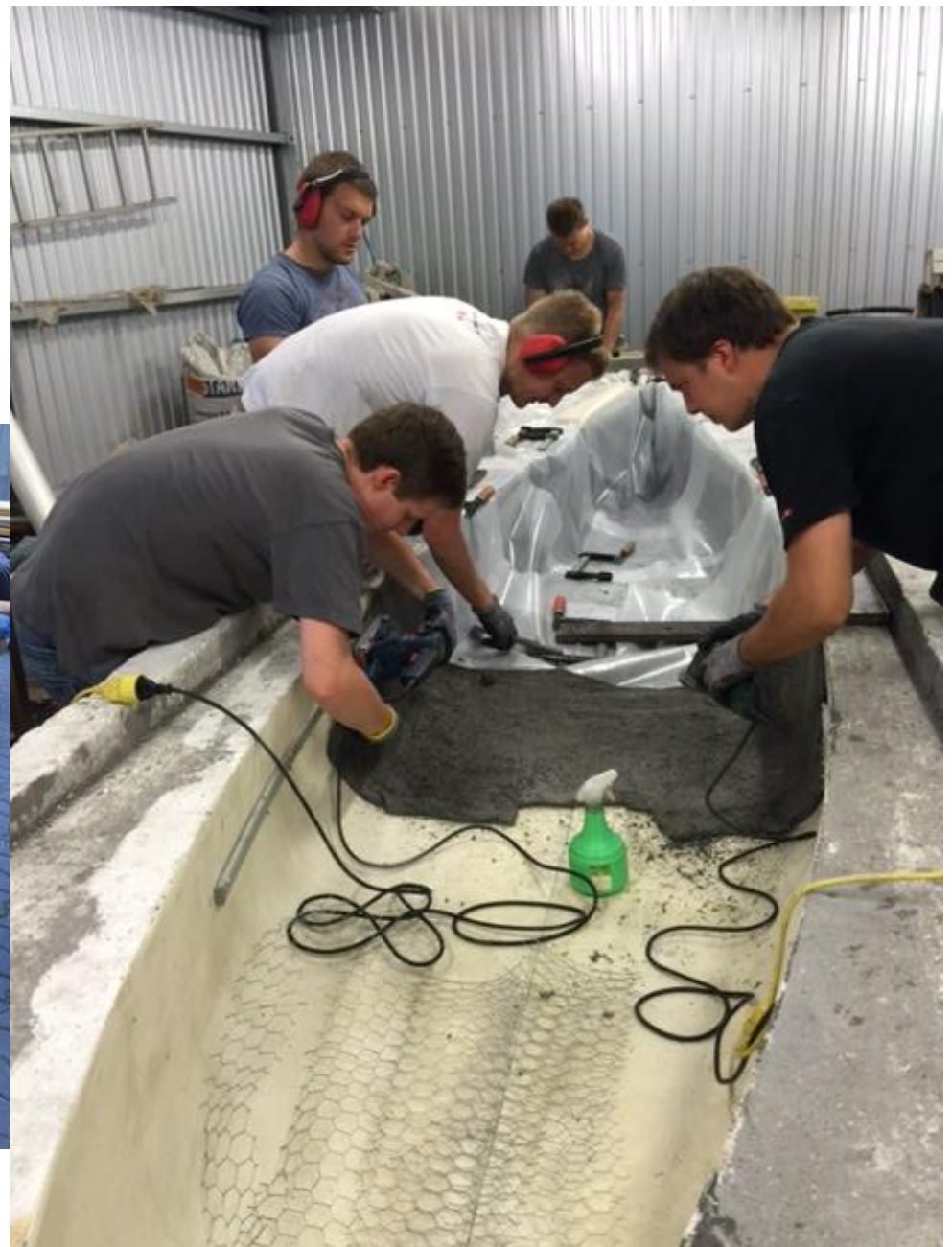
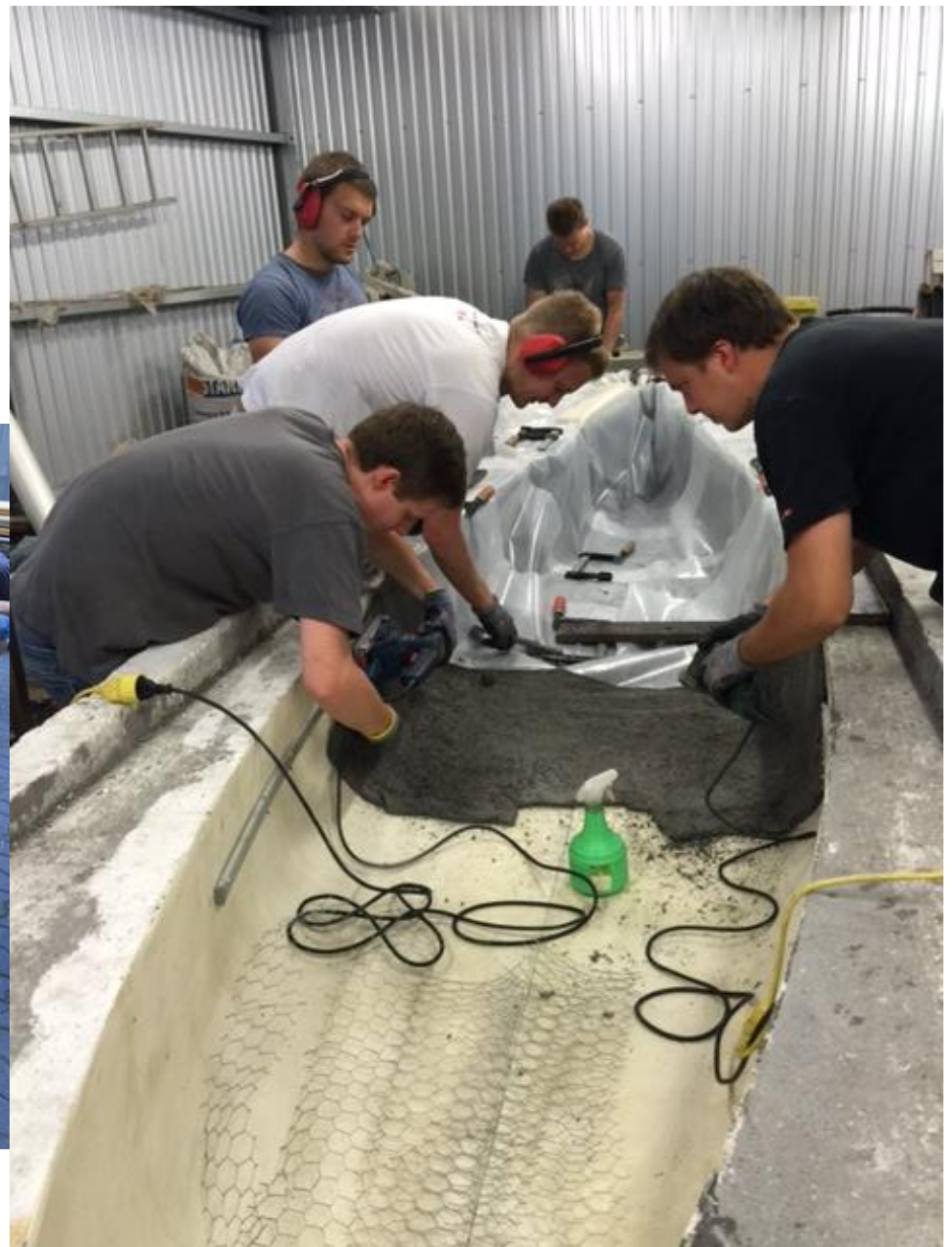
Testing



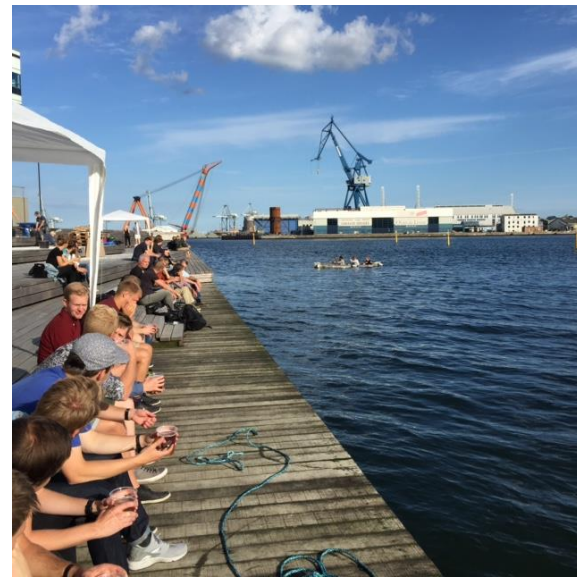
Results



UHPC Canoe



UHPC Canoe



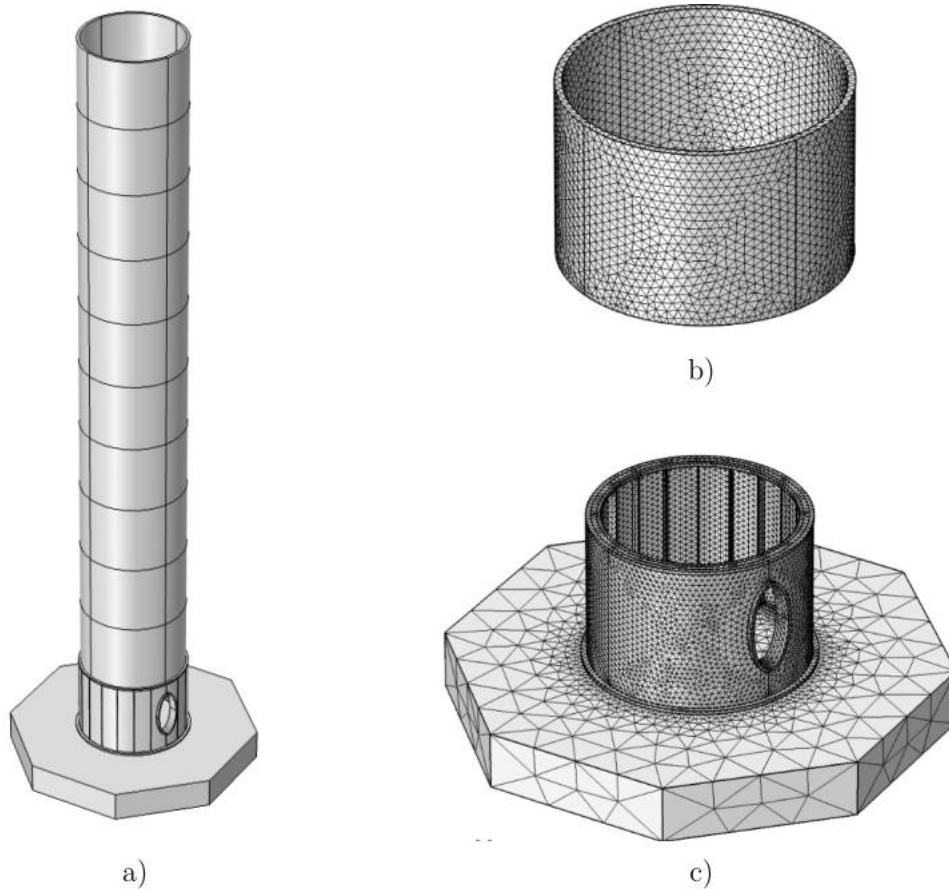
Summary

- Preliminary phase
- New test setup developed that allows for measuring crack growth with Aramis optical measurement.
- Existing model that allows for study of size effects have been developed
- Only few experimental results
- Test setup should be stiffer
- Size effects to be studied



Conelto wind turbine tower using OMA

The Tower - FEM

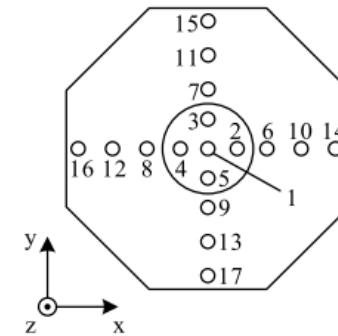
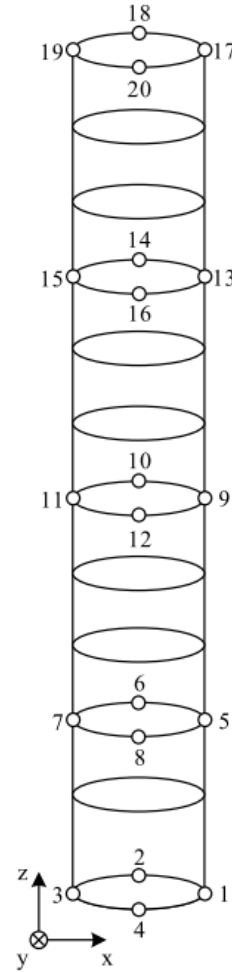
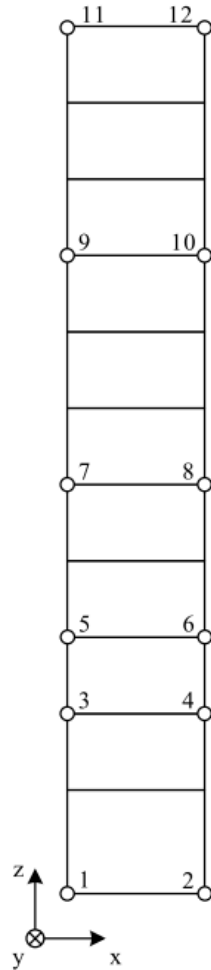


Mode	Natural frequency	
	X	Y
1 st bending	3.705 Hz	3.721 Hz
2 nd bending	20.019 Hz	19.935 Hz
1 st buckling	13.703 Hz	13.704 Hz

Figure 8 a) Full tower geometry, b) Mesh of a concrete ring, c) Mesh of steel base and foundation.

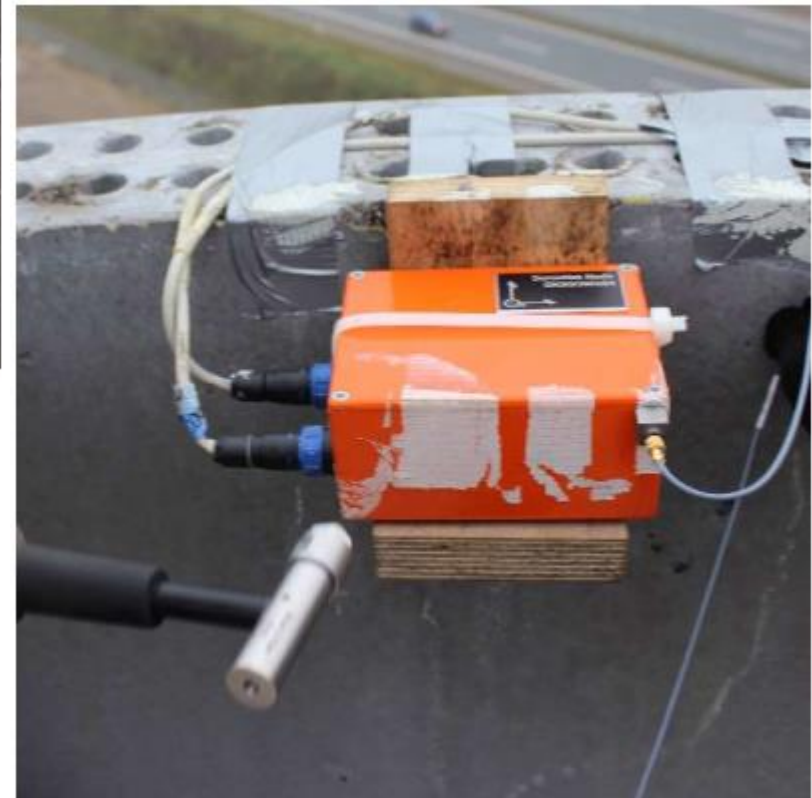
Conelto wind turbine tower using OMA

Tårnet - Målinger



Conelto wind turbine tower using OMA

The Tower



Conelto wind turbine tower using OMA

The Tower

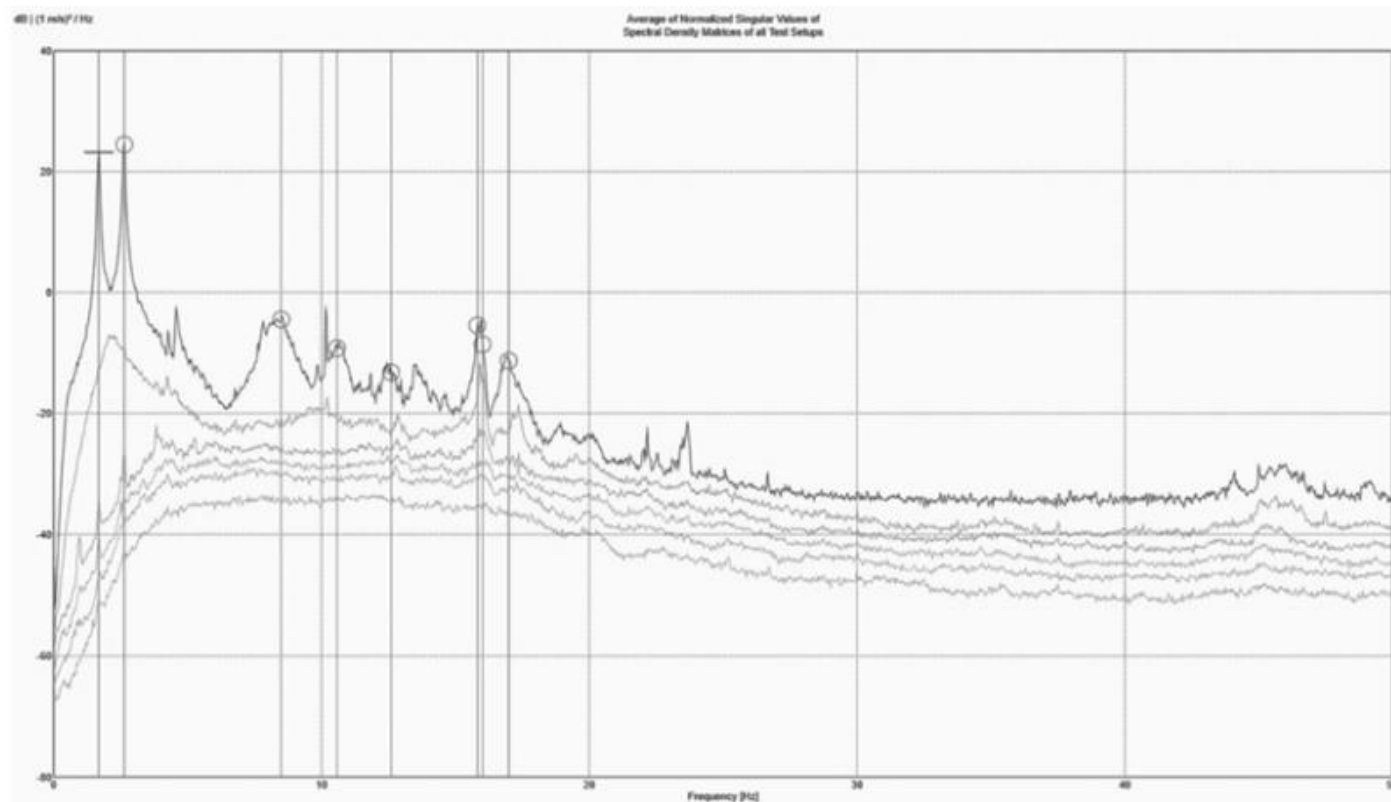


Figure 19 Averaged normalized SVD of spectral density.

Conelto wind turbine tower using OMA

Egensvingningsformer

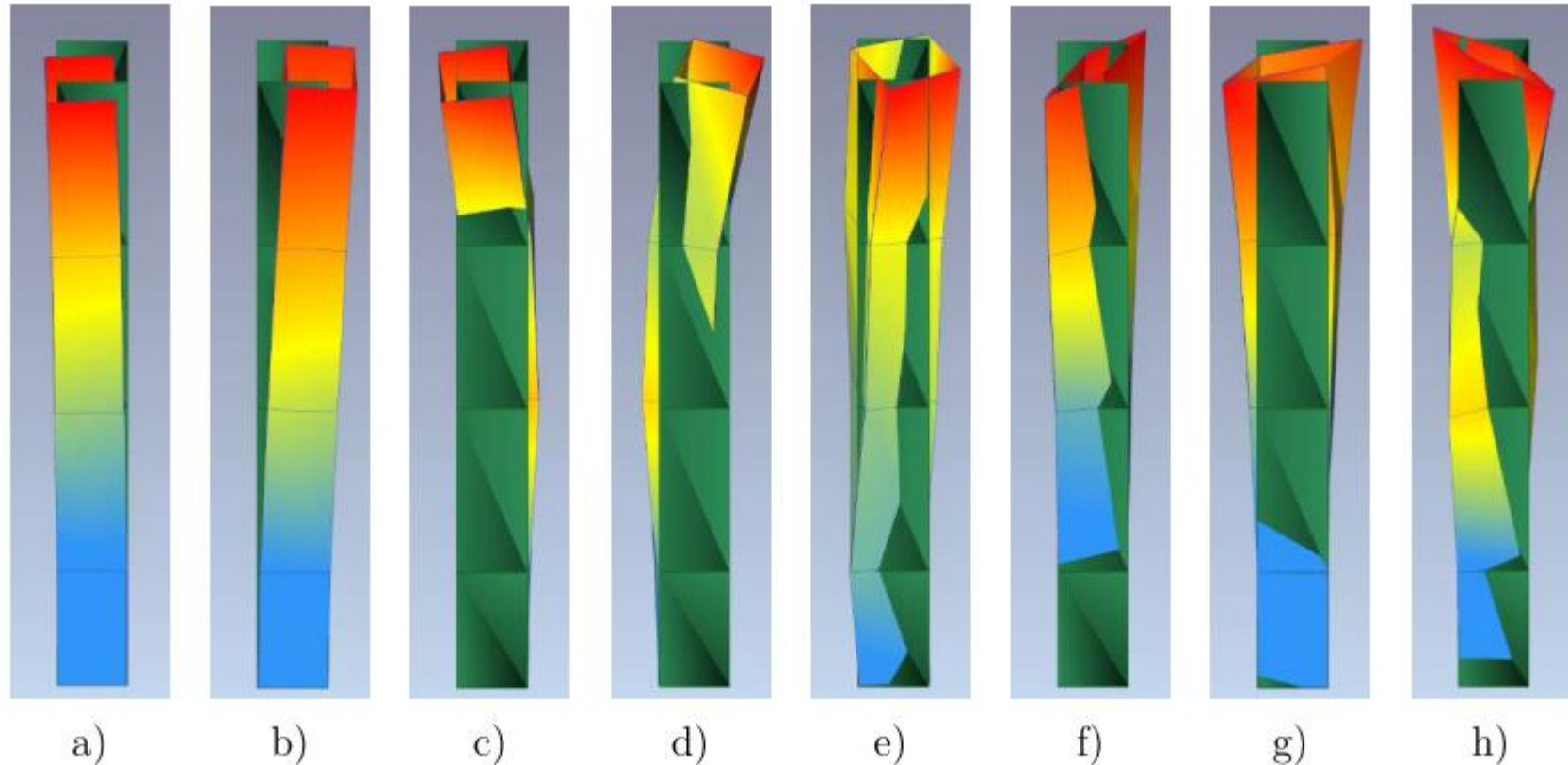


Figure 20 Estimated mode shapes: a) 1st bending, Y, b) 1st bending, X, c) 2nd bending, Y, d) 2nd bending, X, e) 1st torsion, f) 1st buckling (1), g) 1st buckling (2), h) 2nd buckling.

Conelto wind turbine tower using OMA

Egensvingningsformer af fundamentet

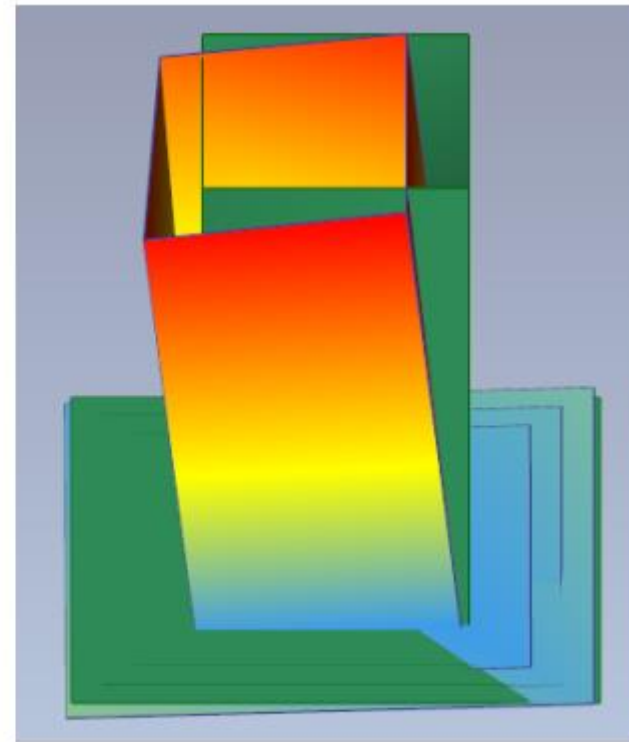
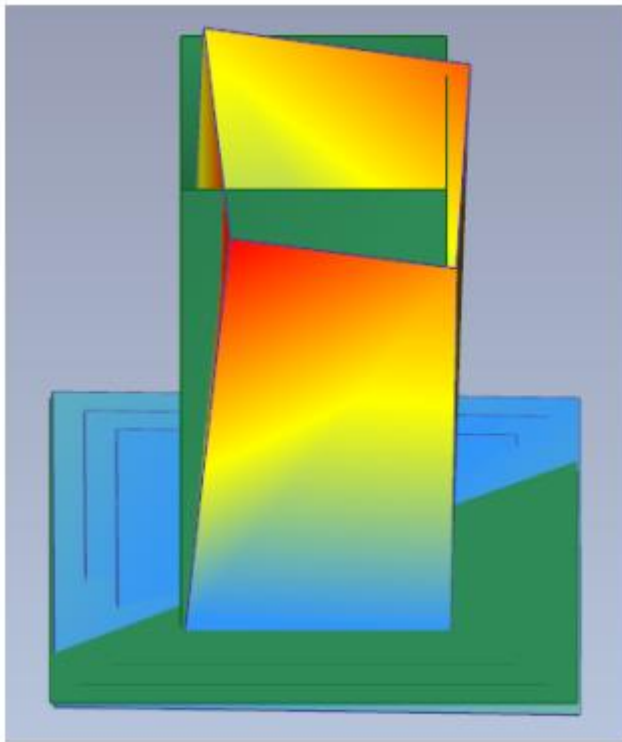


Figure 22 Illustration of foundation movement in measurement 10 through 11 for the first bending modes.