Leibniz Universität Hannover

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Institute for Steel Construction
Prof. Dr.-Ing. Peter Schaumann

Stochastic modeling of geometric imperfections for buckling analysis of suction buckets

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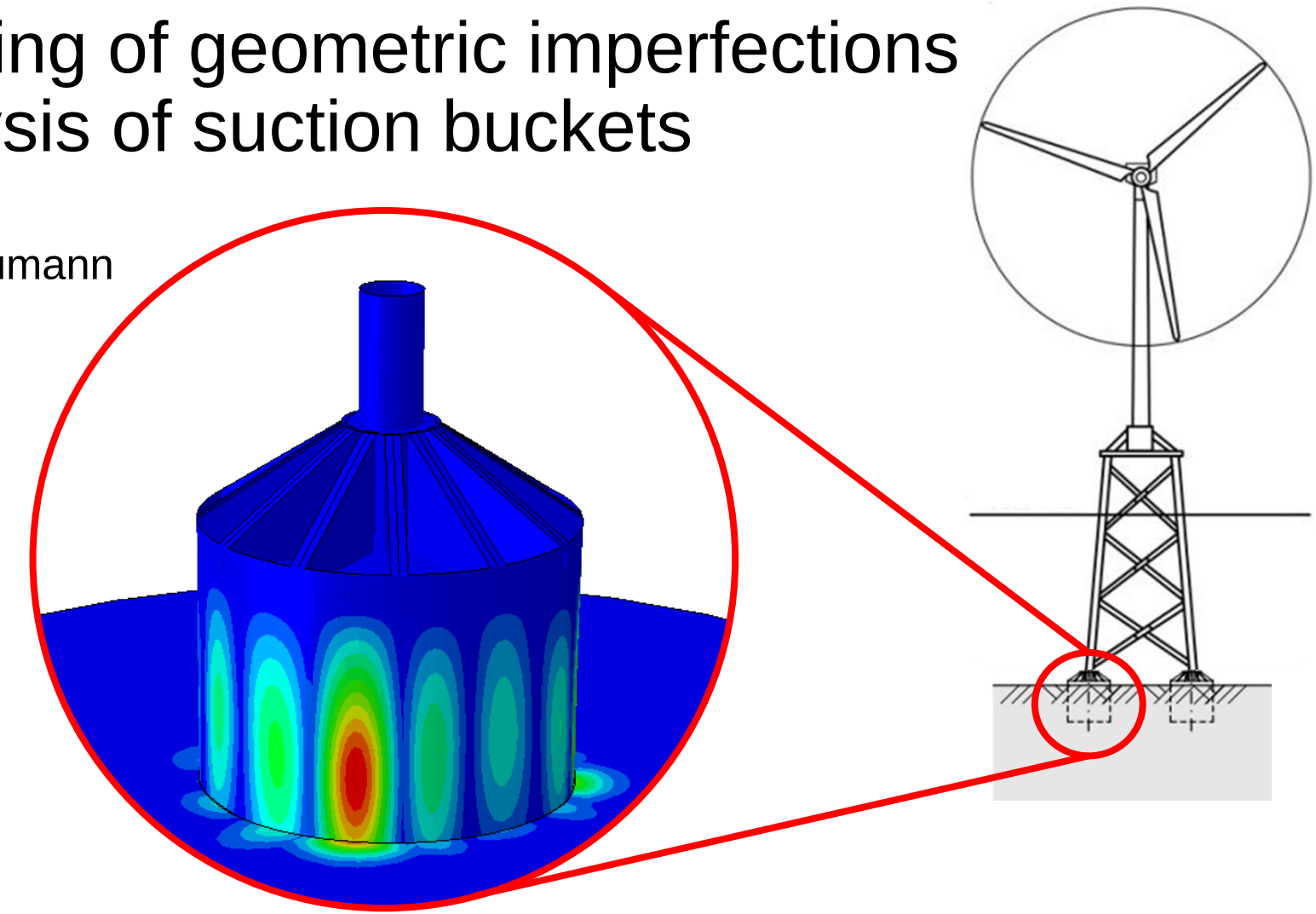

EERA DeepWind
19 - 21January, Trondheim

Introduction

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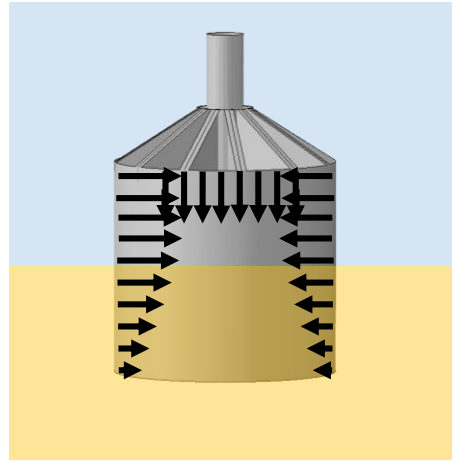
Suction bucket installation

➞ Suction leads to pressure differential

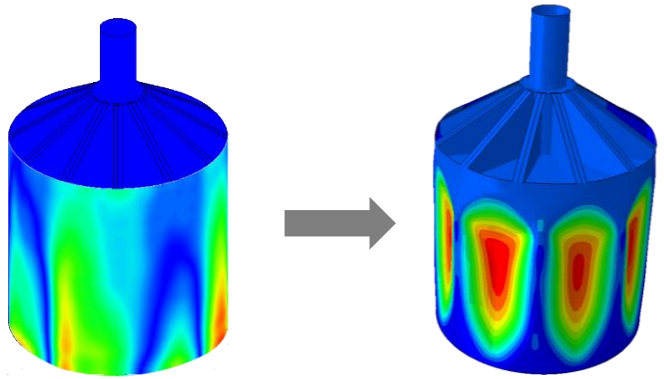
- Minimum pressure to overcome soil resistance
- Maximum pressure to avoid hydraulic failure
- Limit pressure (p_{limit}) to avoid structural buckling



Buckling strength

- Significantly reduced by geometric imperfections

➞ Challenge: choice of appropriate imperfection form(s)



Objective

Develop a stochastic modeling approach to consider more realistic imperfections

Stochastic imperfection modeling

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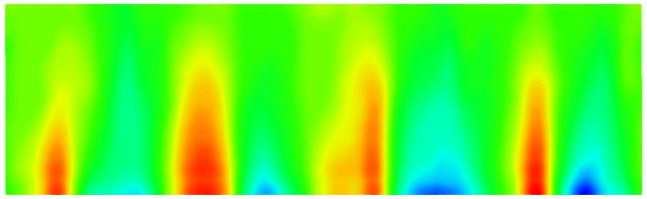
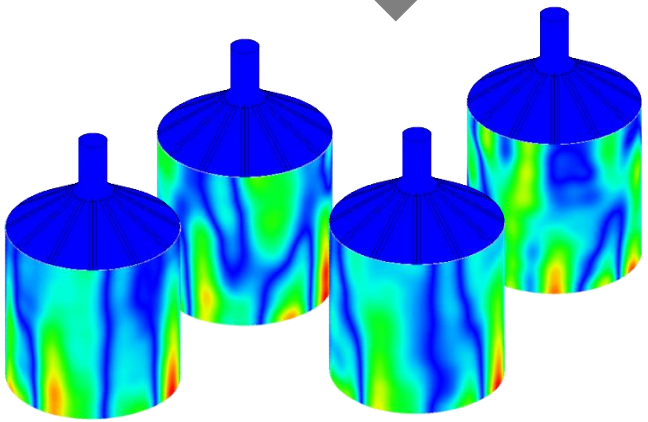


Measured imperfection

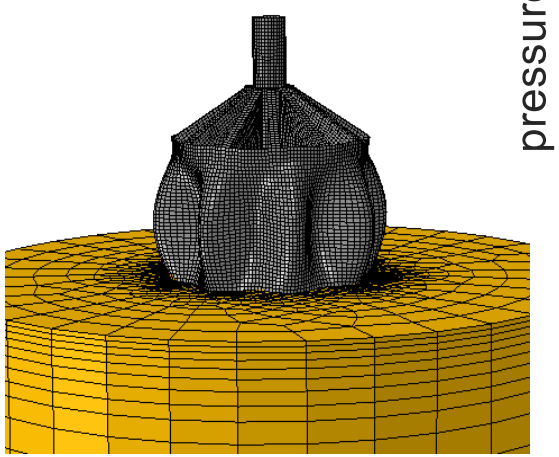
Half-wave cosine Fourier representation

$$w(x,y) = 2t \sum_{k=0}^{n_x} \sum_{l=0}^{n_y} \cos\left(\frac{k\pi x}{L}\right)\left(A_{kl}\cos\left(\frac{ly}{R}\right) + B_{kl}\sin\left(\frac{ly}{R}\right)\right)$$

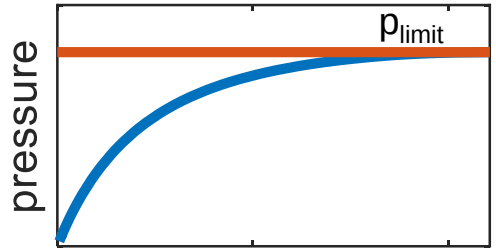
Monte Carlo

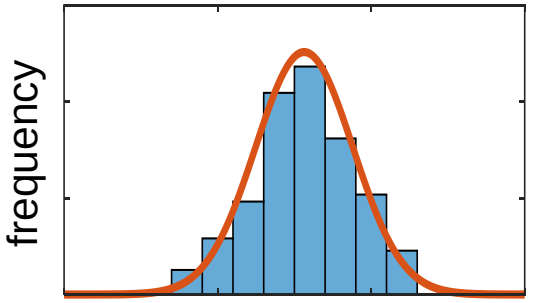


Realizations



Geometrically and materially nonlinear analysis with imperfections





Results

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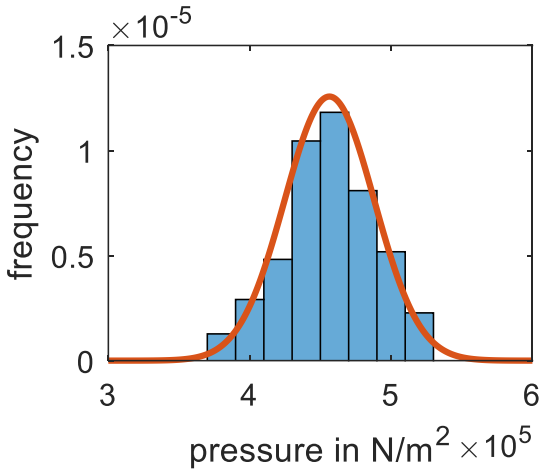
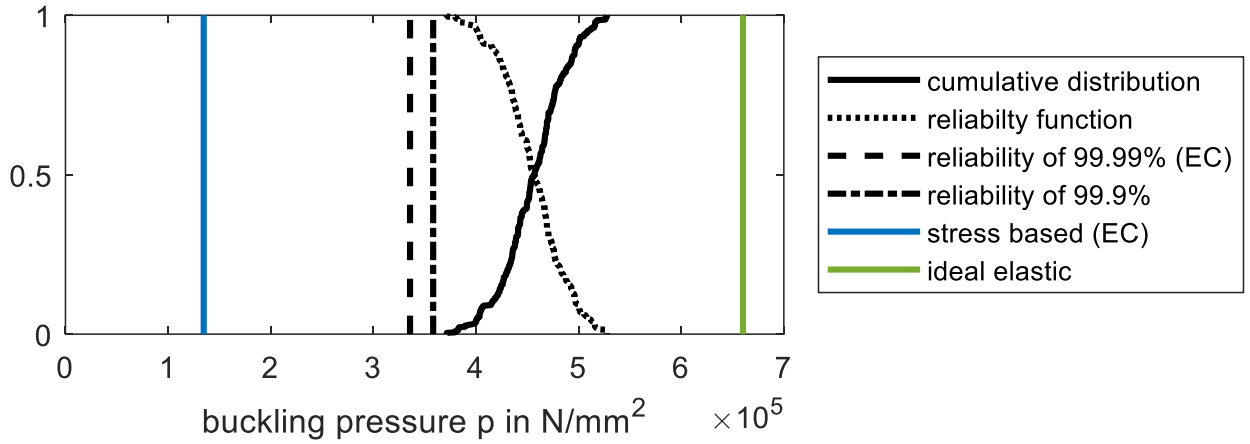
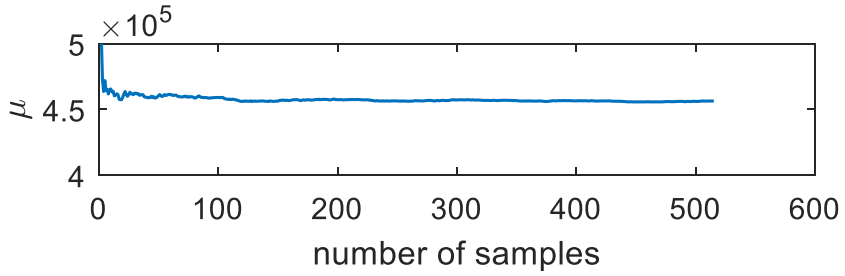
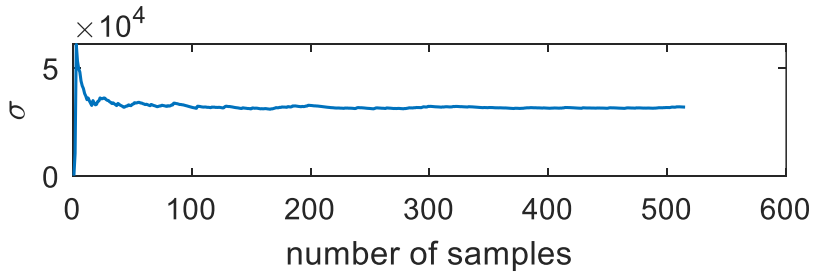
Probability density → Reliability function and probabilistic design pressure









➞ Convergence achieved after 100 simulations, required number of simulations manageable

Conclusions and Future Work

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Conclusions

- Stochastic imperfection modelling implemented for buckling analysis
- Consideration of more realistic geometric imperfections
- Forms basis for reliable and robust prediction of buckling pressure
- Probabilistic approach enables less conservative design and more slender shells

Future Work

- Integrate measured data from experiments and large scale steel cylinders
  - Improve the stochastic modeling scheme
  - Consider influence of non-geometric imperfections
- Implement and compare to approach with random fields
- Design optimization

FKZ 03EE3033B

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Questions? Remarks?
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