Numerical design concept for axially loaded grouted connections under submerged ambient conditions

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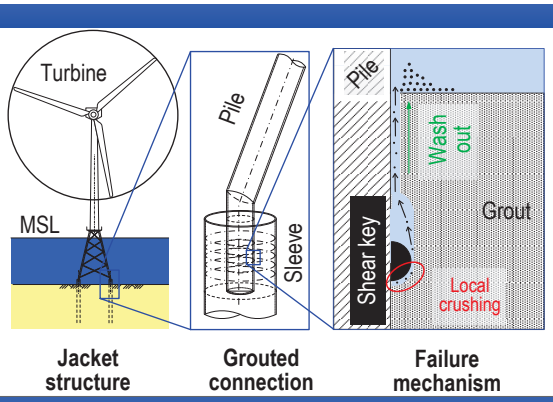
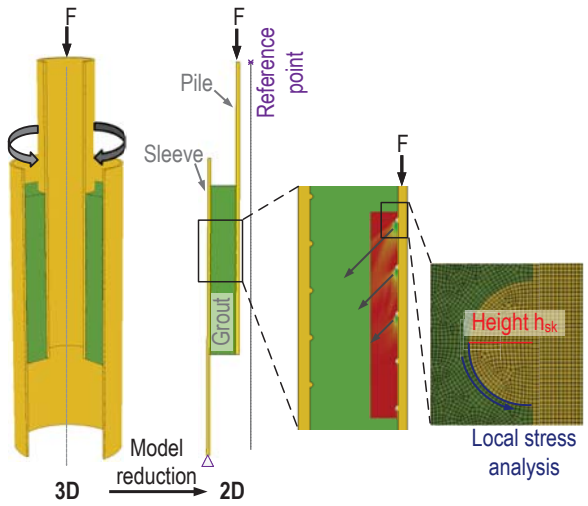
Motivation

Jacket support structures are fixed by grouted connections, a tube-in-tube hybrid connection, to the foundation piles. Current guidelines (e.g. DNV-GL and ISO 19902) base on experimental data of grouted connections tested in dry ambient conditions. However grouted connections of jacket support structures are completely covered with water. Raba investigated the influence of axially loaded grouted connections under submerged ambient conditions [1]. These connections show significantly less fatigue resistance compared to grouted connections tested in dry ambient conditions. As ingressing water washes out locally crushed grout material, which lead to a continuous vertical displacement and failure over time. With a change in failure mechanism of grouted connections in submerged ambient conditions current design concepts should be adjusted or changed.



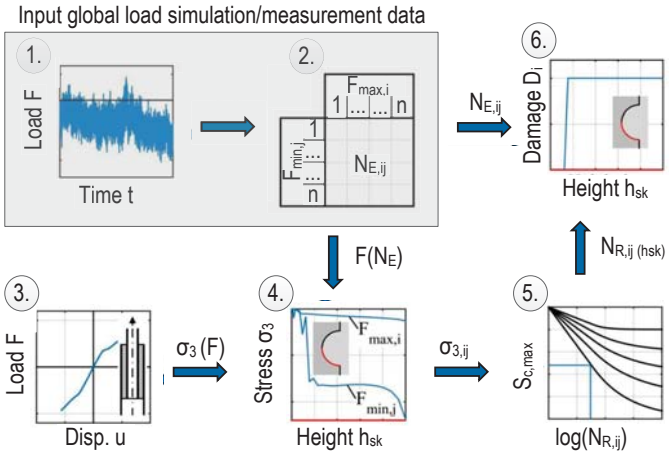
Numerical model

- Discrete depiction of shear keys
- Rotational symmetric elements (reduction from 3D to 2D)
- Fine mesh (mesh independent local stress analysis)
- Displacement controlled loading by reference point
- Contact interaction (hard contact and penalty method in tangential direction μ=0.4)



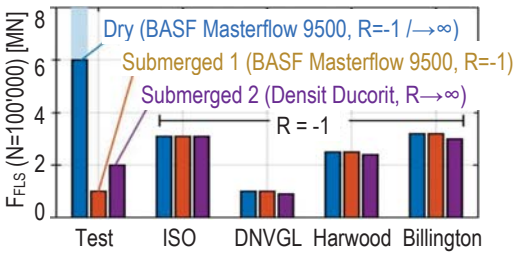
Design concept

1. Global load simulation or measurement data (loading of grouted connection)
2. Markov matrix
3. FEM simulation of grouted connection
4. Extraction of principle stresses σ_3 in grout material close to shear keys
5. S-N-curve according ModelCode 2010
6. Accumulated fatigue damage according Palmgren Miner

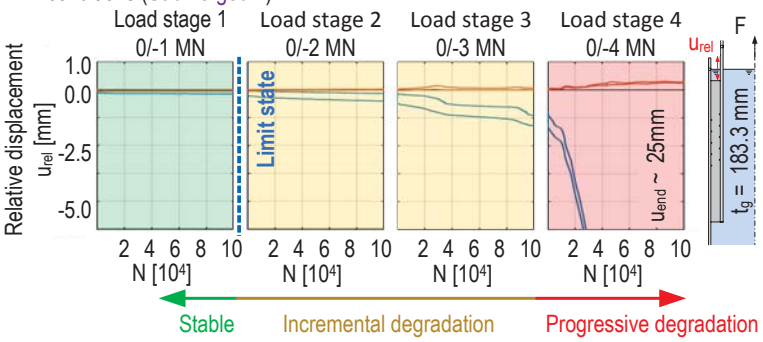


Experimental results and comparison of design concepts

- Fatigue resistance of tested grouted connections significantly reduced (Dry and Submerged 1)
- Current design concepts (excluding DNVGL) over estimate tested grouted connections' fatigue resistance for axial loading under submerged ambient conditions
- Further tests needed for statistical coverage of results



- **Limit state:** local crushing of grout material [2]
- Experimental test with cyclic axial compression loading under submerged ambient conditions (Submerged 2)



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References
[1] Raba A.: Fatigue behaviour of submerged axially loaded grouted connections. Dissertation. Leibniz Universität Hannover. 2018
[2] Schaumann, P. et al.: Axially loaded grouted connections in offshore conditions using ordinary portland cement, 12th International Conference on Advances in Steel-Concrete Composite Structures (ASCCS), Valencia, 2018

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