Abstract Diana meeting Barcelona

Local buckling of large diameter steel tubes (partly) filled with sand

Marcel ‘t Hart, Dirk Jan Peters

In the Rotterdam harbour a series of large diameter steel monopoles need to be installed. Also existing piles need to be re-evaluated because of changed conditions.

Laterally loaded piles and dolphin piles have been subject of many investigations in the past. Nevertheless a number of knowledge gaps and potential issues for optimisation can be identified. Amongst them are: the effect of sand-fill on the pile stiffness and on the local buckling risk, the risk of local buckling at the transition of sand-filled and empty and at the transition of wall thickness.

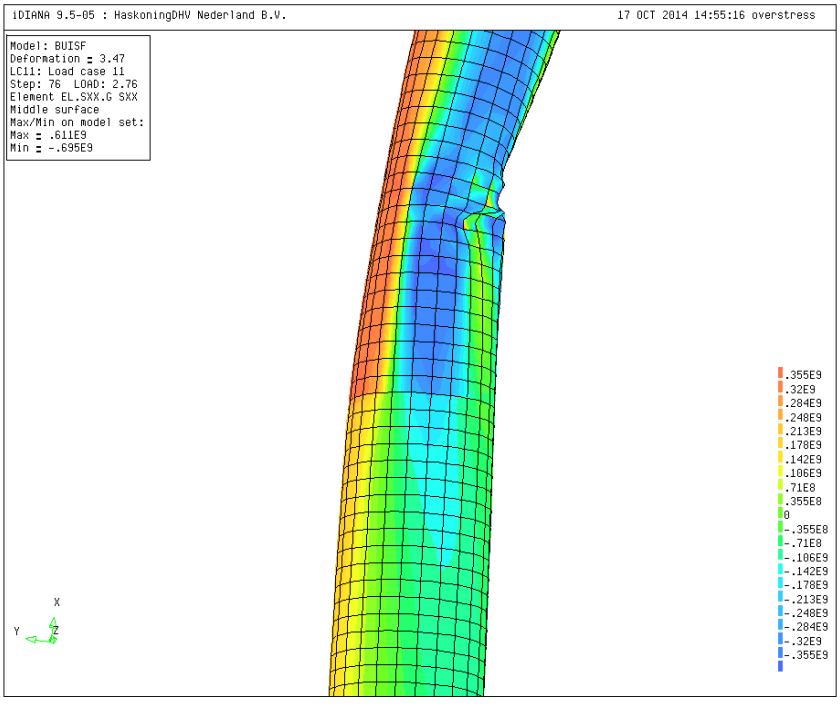
Due to the increased ship sizes and corresponding harbour depths, the piles tend to have larger diameters and lengths, which requires the advanced knowledge of the local buckling risks under pile bending.

Port of Rotterdam has decided to carry out a research program into the safety and economy of laterally loaded steel piles. In November 2014 a full scale test has been carried out on eight 914 mm diameter piles.

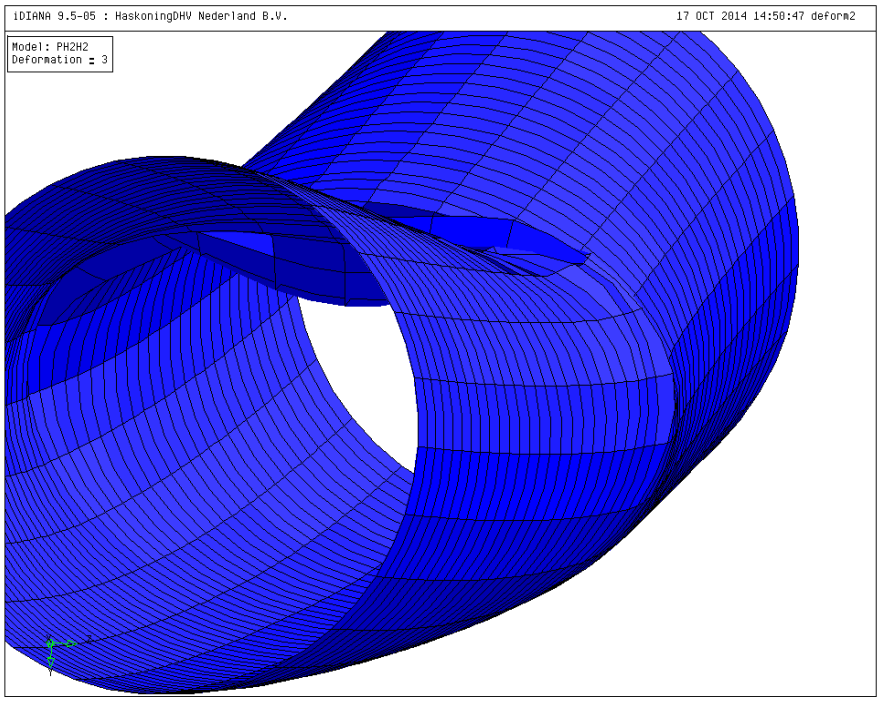
The available design methods and prediction methods for local buckling can be found in the applicable codes and in literature. The available methods are valid for uniform loaded, prismatic empty tube sections. Therefore the predictions were supplemented with DIANA modelling for sand-filled tubes and for wall-thickness transitions.

The predicted bending moments at local buckling calculation by DIANA were generally 15 to 20% higher than the codes. In many cases the local buckling occurred beyond the field limit. The measured bending moment in the tests confirmed the DIANA predictions.

Graphical presentation of the FEM bucling prediction calculation results



FEM results picture showing stresses and the deformed shape of a tube with a wall thickness transition



FEM results picture of a deformed shape