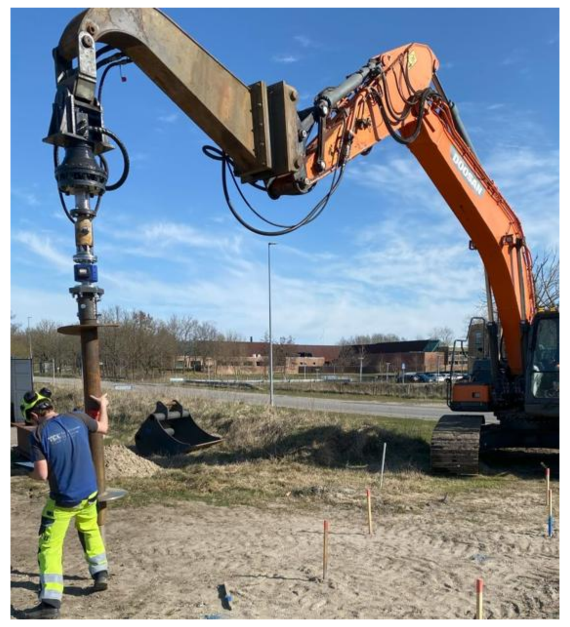
# Estimation and validation of static bearing capacity for helical piles in cohesive soil

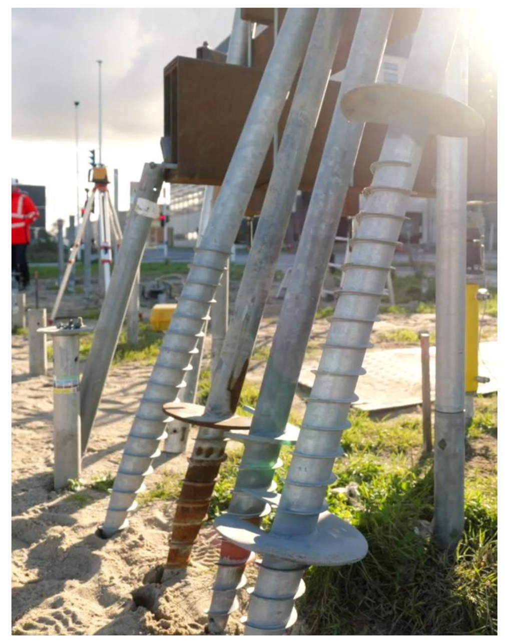
## Why?

### Easy installation

Helical piles are easy to install, using hydraulic rotary equipment. They can be installed in almost all locations, as they cause no vibration and utilize minimal area requirements for installation machinery.



### CO2 reduction

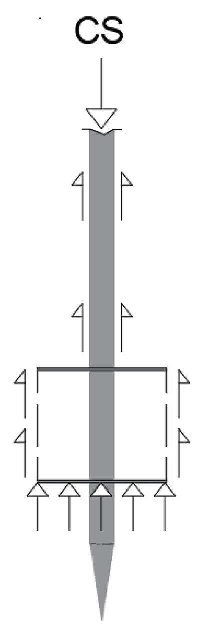


The use of helical piles can reduce the $CO_2$ emission by approximately 80 % compared to a traditional strip foundation. The installation method causes no vibration. There is no waiting period after installation, from which construction of the remaining building can begin, and if undamaged, the helical piles are reusable.

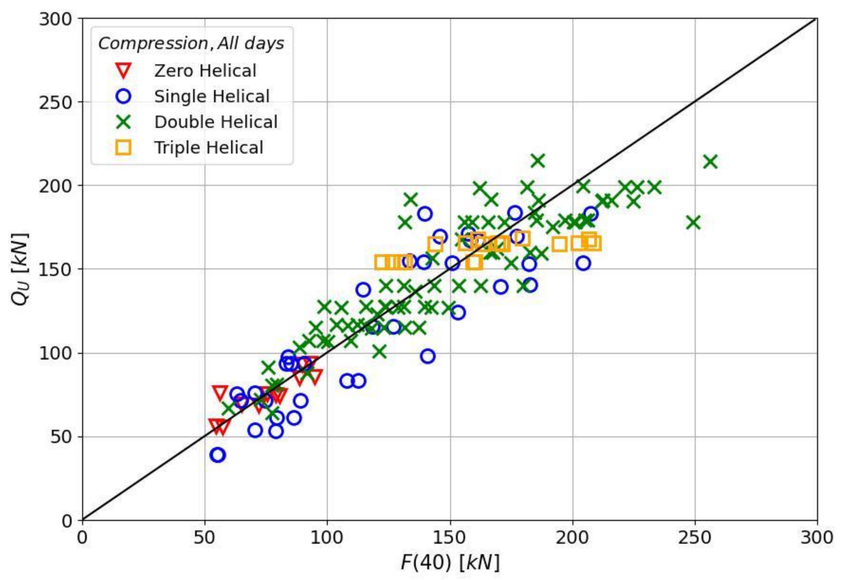
## How?

### Analytical solution

Various methods exists for estimating the static capacity of helical piles analytical. They generally differ in the way the load transfer mechanism is assumed. One of the methods analyzed during the project is the Cylindrical Shear model (CS). An illustration of the load transfer mechanism for the CS model is provided below.



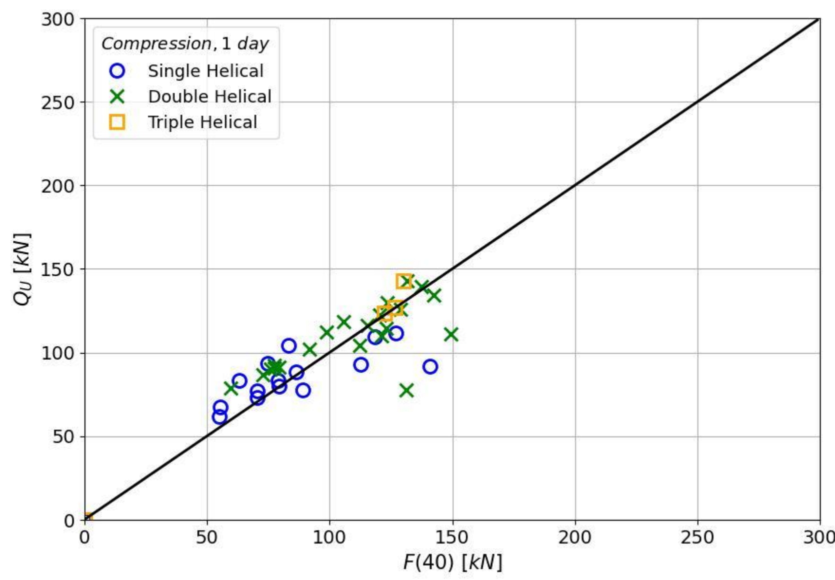

Input parameters for estimating the static capacity using the CS model, have been found by literature review, to not be well defined. A parametric study on the input parameters has been performed and a fitting of these to measured static capacities has been made. Static capacities have been estimated using the fitted parameters and compared with measured static capacities as illustrated below.




### Dynamic test

A general method for validating the static pile capacity, post-installation, is through the use of dynamic load tests. A series of dynamic load tests have been conducted on the installed helical piles, using the test setup illustrated below.

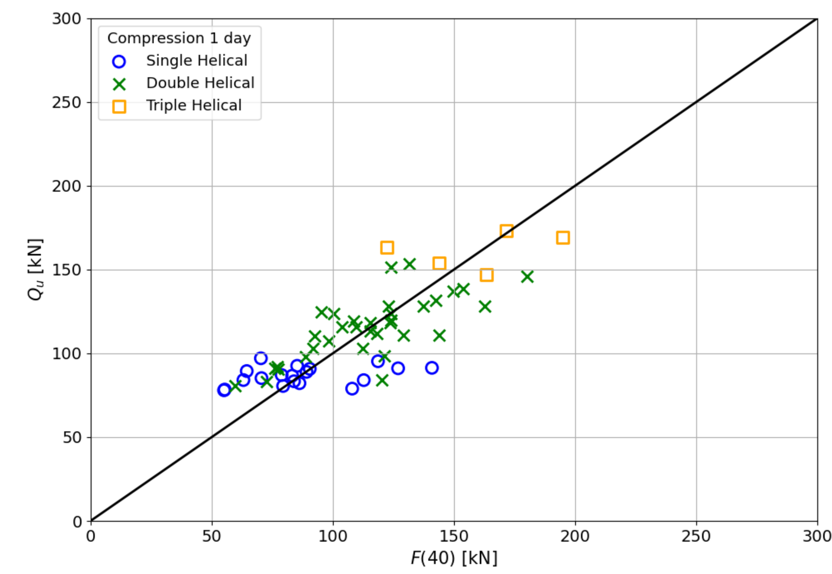

The dynamic capacity is generally evaluated through an energy consideration. In Denmark, it is most common to use The Danish Driving formula (DDR) for evaluating the dynamic capacity. The dynamic capacity have been evaluated using measured results from dynamic load test, along with DDR. A relation between the static capacity and the dynamic capacity has been found, and a comparison between evaluated static capacities and measured static capacities has been computed as illustrated below.




### Torque to capacity

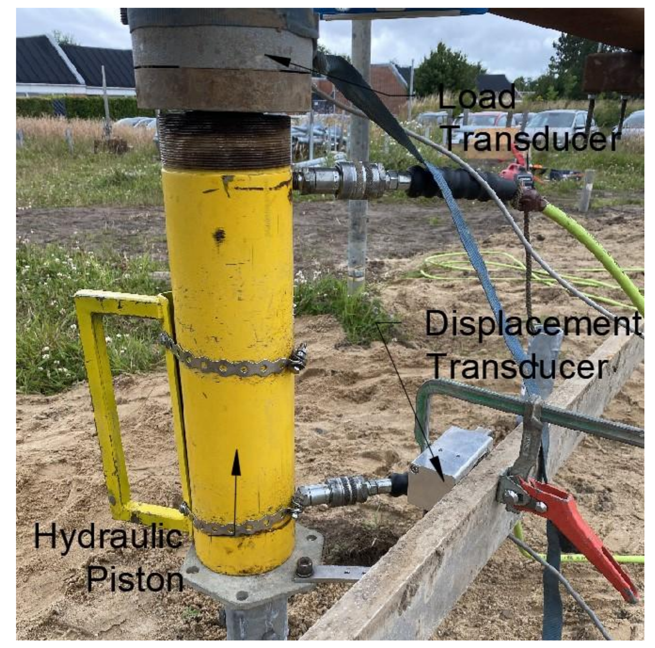
A method of determining the bearing capacity is by relating the installation torque to the measured static bearing capacity via the registered installation data from the Pilar Unit illustrated below.

The Pilar unit registers the speed of the installation, advancement ratio, and the applied torque. An investigation of how many rotations the torque should be evaluated over has been made, and the best correlation is found when using 10 rotations, differentiating between the shaft sizes, using the mean, and multiplying the torque by the helical plate surface area. An increase in the torque gives a corresponding increase in bearing capacity. The static bearing capacities have been estimated by the correlation found and compared with the static capacity in the plot below.

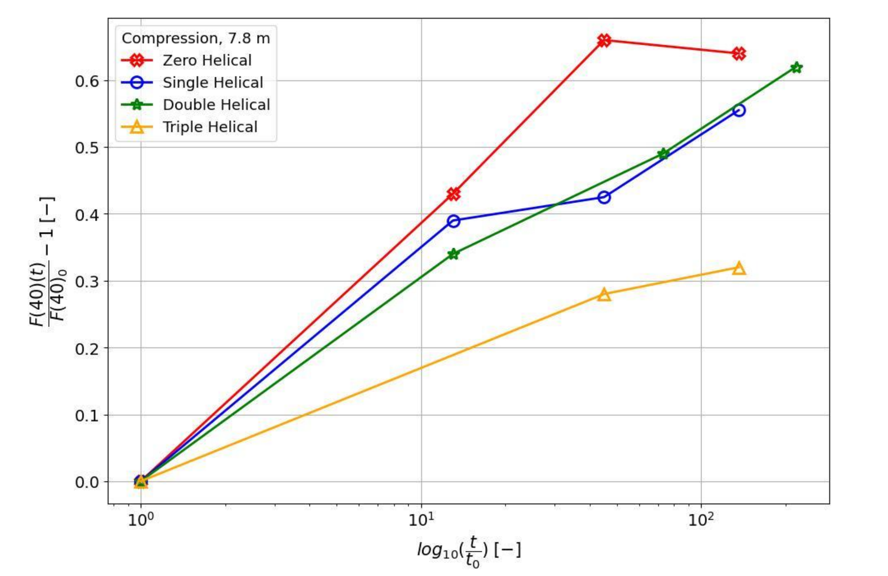



### Time dependency

A number of static load test were conducted over a time period of more than 200 days, to evaluate the time dependency of the bearing capacity. The test setup included a rig, hydraulic piston, load transducer, and a displacement transducer to capture the load displacement curve. The setup is illustrated below.




The force applied at 40 mm data from static load test is used in a semi-logarithmic linear correlation to describe the relationship between time and bearing capacity. This analysis is applied to piles with varying geometric parameters. Statistical evaluation is performed on compression test data at a depth of 7.8 meters, and the mean values of the confidence interval are presented in the figure below

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