Tubular Pile Pull-out Testing Program

Publieke samenvatting / Public summary

Cause

The Tubular Pile Pull-out Testing Program uses the opportunity to execute additional tensile tests on four existing tubular piles (O.D Ø1.22 m with lengths of 33 and 38 m) that have earlier been tested in 2023 in a static compression test program that is funded by Port of Rotterdam and her partners. The additional test program includes static and dynamic tensile load test program. The test results provide better understanding of the soil-pile interfaces.

Short desciription

Special instrumentation in the piles will be used that continuously measures the strain development along the pile, the forces applied and pile displacements. Unified Cone Penetration Tests (CPT) are carried out to allow correlation between these soil strength test results and the pile measurements. The test program includes both open ended piles as well as piles closed with endcap to determine the impact of pile caps on the tensile capacity of the piles.

Result

The better understanding of the soil-pile interfaces serve as input to an update of the existing design guidelines or recommended practices for piles under tensile loading. The updated guidelines are expected to significantly reduce the foundation cost

Projectinformatie / Project information

Projectnummer / Project number
TKITOE_WOZ_2213_Deltares_TPPT
Subsidiebedrag / Grant amount
€ 100.000,00

Algemene informatie / General information

Penvoerder / Secretariat
Bluewater Energy Services

Publicaties en materialen / Publications and attachments

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required to moor offshore renewable floating structures.

Website

More information on this project can be found on the GROW website.

End of project summary

The Port of Rotterdam conducted full-scale compression tests on four open-ended steel tubular piles with the diameter of 1220 mm at Maasvlakte, Rotterdam from October to December 2022. Open-ended steel piles of tubular design, with comparable dimensions, have been extensively utilized in the Port of Rotterdam, often in similar soil conditions, reclaimed sand situated on natural Pleistocene sand. Hence, high-quality full-scale tests and production of field data provide insights into soil-pile interaction, thereby leading to optimized pile design. The tubular piles tested under compressive load were instrumented with two types of fiber optics. More instruments including total pressure sensors (installed on the pile wall) and pore water pressure transducers (embedded inside the soil close to the pile tip) were employed for some selected piles. The compression tests were conducted in static mode and the results were presented in terms of axial force- axial deformation of the piles and axial strains from fiber optics.

The current geotechnical practices use various methods like NEN9997-1, CUR2001-8, ISO 19901 (known as the unified CPT method), API, and DNV for designing driven piles. With the rising use of anchor piles in floating offshore wind farms, there's a growing industry need for more efficient pile designs that minimize material usage. Tubular piles experiencing tensile loads in floating wind farms can cause cyclic stiffness degradation in the interface soil, which might not be adequately addressed by the mentioned design procedures.

Following the compression load tests, the Port of Rotterdam agreed on the conduction of tensile static and cyclic load tests on the same piles under a JIP consortium consisting of several parties including Shell Global Solutions International B.V. Stichting Deltares, TotalEnergies OneTech SAS, Bluewater Energy Services B.V., Lloyd's Register Advisory Services B.V., Single Buoy Mooring Inc., SOFEC inc., and JERA Co. Inc. The project, which is called TPPT, was granted under the PPS subsidy from TKI Wind op Zee. Static and cyclic tensile load tests were executed on the piles in order to address the application of pipe piles in floating wind energy farms, particularly in a TLPs (tension-leg platforms) mooring configuration. The objectives of these load tests were to collect factual data of static and static/cyclic pile loading tests. In October 2022, TPPT was initiated, with deployment of a new test setup to measure pile holding (tensile) capacity and pile behaviour under cyclic tensile loading. Static tension test was conducted on the first pile (Pile D#3) while the other piles were subjected to multiple static and cyclic loads.

Factual reports have been prepared to present all testing procedure during both compression and tension testing programs and the associated recorded measurements including loads, deformations, strains, pore pressure, and total pressure. In addition, pile extraction data were measured during pile demobilization for some of the piles in terms of vibratory hammer data (D#2 and D#3) and axial strains (D#4). The test site was characterized by several Cone Penetration Tests (CPTs) carried out before and after piles installation, and after compression pile tests. A few CPTs were conducted inside the tubular piles. The factual report of TPPT involves 5 volumes describing the general procedures and specifications of the testing programs (Volume 0) and the measurement data per each pile under compression and tension tests (Volumes 1 to 4). The factual report involves an online cloud space containing all the measurements and weekly reports.

The TPPT project is advancing into a new phase (Phase 3), wherein the collected data will be interpreted to investigate the effects of prior loading history and cyclic degradation of soil on the ultimate holding capacity of tubular piles.

De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.
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