Geotechnical Analysis

LIC has worked within design of offshore foundations for wind turbines since the first offshore wind farms were installed mid 1990'ies, including the geotechnical engineering and modelling. Most projects have been within Mono pile foundation design, and in these projects, we have been responsible for the soil modelling. In the recent years we have been using more sophisticated soil models due to the fact that the L/D ratio has become smaller with larger diameter for the Mono pile foundations and 3D effects significant.

LIC has a strong group of in-house geotechnical engineers capable of using the most advanced methodologies within soil modelling. Apart from soil modelling, LIC has expert knowledge and long experience in other related areas such as scour, scour effect on soil resistance, liquefaction of soils in waves, consolidation of soil from pile driving, etc.

In-House Process for Geotechnical Studies

LICengineering is using a variety of methods in the analysis. In recent years the Pile Soil Analysis (PISA) has been introduced. This method is used primarily for Mono Pile and Suction Bucket foundations to establish soil models for our global design model, including soil, MP, TP, Tower, WTG in combination with the environmental load simulations for various limit states and load conditions

The numerical based methodology is described below in 7 steps:

1) Site specific data for all 100 locations

2) Soil constitutive model calibration and 3D FE analyses

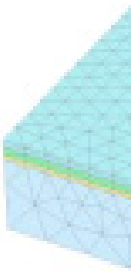
3) Soil reaction extraction and parameterization

4) Soil reaction curves, as computed by the 1D model

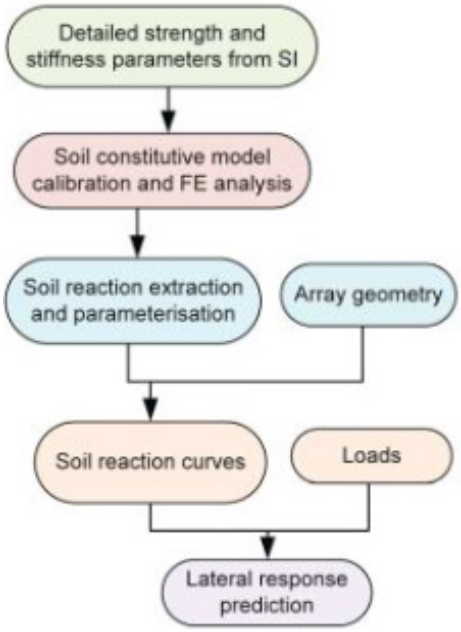
5) Prediction of lateral response.

6) 3D FE verification of selected locations/clusters to verify soil reaction curves and check of validity within acceptable ranges of parameters.

7) Potential calibration and update of soil reaction curves, i.e. step 3.



3D modelling
suction bucke



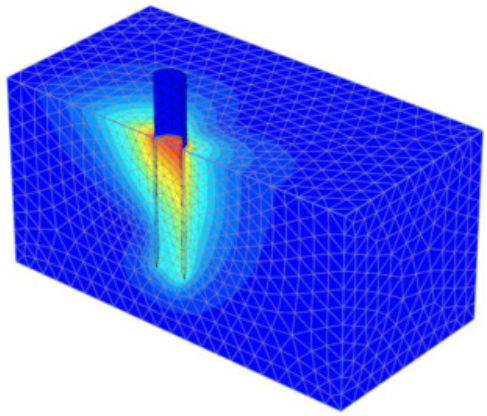
LIC in-house Process for PISA method

Software

LICengineering uses a variety of geotechnical methods in the foundation design of offshore structures. Also the “boot-effect” will be taken into account for some structures.

For projects where LIC apply the PISA method the commercial software PLAXIS 3D and PLAXIS MoDeTo are used. They enable an optimised monopile design method saving up to 50 % in the embedded length of the piles.

The enhanced design method of PLAXIS MoDeTo analyzes the ability of monopile foundations to resist lateral loads on the basis of a 1D Timoshenko beam finite element model, accurate even for large diameter monopiles, and realistic soil reaction curves, while retaining many of the assumptions of the more conventional p-y approach.



3D modelling in Plaxis of monopile

Project References

Vineyard OWF – Owners Engineer

Personell serving as Owners Engineer of the detailed Foundation Design of the Vineyard offshore windfarm (Client COP). LIC’s technical team supporting the client has been involved in and are familiar with all the geotechnical modelling and 3. part approval.

Dafeng OWF China - FEED & Detailed Design, Engineering Follow-up

LIC has carried out detailed MP foundation design for the Dafeng H3 OWF. For soil modelling LIC applied large diameter modifications to the soil springs (“Stevens & Audibert” for clay and “Kallehave” for friction material) to obtain realistic results.

Suction Bucket Foundation – FEED

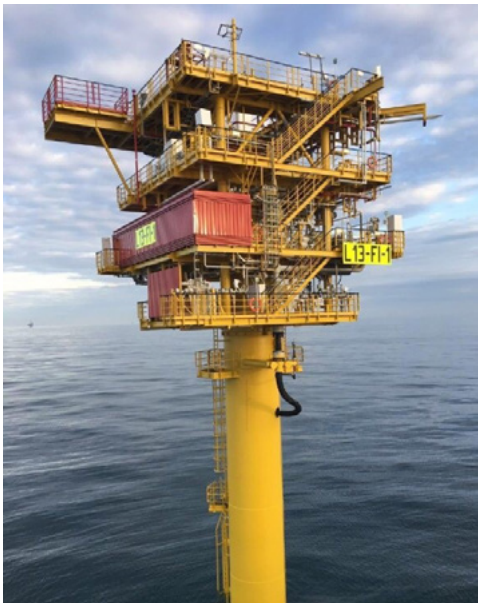
Engineering Support of suction bucket foundation for Lake Erie

SHELL/NAM Mono-towers – Detailed design, Engineering Follow Up, Interface Engineering

LIC has carried out 7 Detailed design for SHELL on Monopile types foundations.

NAM Riser Access Tower - Detailed 3D soil pressure analysis, Engineering Follow up. Installation

LIC provided detailed 3D modelling of riser access tower. This structure was a special suction bucket structure. “Boot-effect” was analysed and taken into account



L-13-F-I Platform operated by SHELL. LIC conducted Detailed Design and engineering folow up for this platform

Installation of DAFENG H3 windfarm in China.
LIC conducted the detailed design for the monopiles

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