



## Northwind Offshore Windfarm

LICengineering undertook design of the 73 monopile foundations and associated structures such as tower flange connection, grouted transition piece. Installation of the Northwind offshore windfarm took place during 2013 and it was commissioned in 2014. The windfarm is located 37 km off the coast of Belgium in an area with very high sand waves. The foundation for the Offshore High Voltage Structure (OHVS) is also a monopile structure designed and analysed by LICengineering.

### Design Analysis

The design and analyses was carried out to determine the required wall thickness and penetration depth for the monopiles. Dynamic analysis including the vibrational behavior of the pile and tower subjected to combined wave and wind loads were carried out. The piles were designed to resist ultimate storm loads and fatigue loads in a 25-years operational lifetime. The integrated boat landing was analysed for accidental ship impact and operational ship impact. Monopiles were installed driving piles through to target depth and at a few locations are there a risk of refusal. Each pile driven through the layers is done by a large hydraulic offshore hammer. After pile installation is the transition piece landed. The transition piece bolted and grouted in place. The access platform was pre-installed and bolted in place before ship-out. Scour protection was installed prior to piling in a donut shape, allowing easy pile installation.

### Foundation Layout

The main components of the foundation consist of a monopile with an outer diameter of 5.75 - 6,5 m and a grouted transition piece landed over the monopile top section after pile installation. The monopile is mainly a bare pile only fitted with a flange. The flanged is the main connection between the monopile and the transitions piece. There are three internal platforms in the transition piece. A lower working platform, airtight platform and an upper working platform



Monopiles prior to installation



LIC also conducted on-site supervision

## Geotechnical Conditions

The geotechnical conditions on the location show high local variations. A number of geotechnical boreholes and CPT's were conducted prior to foundation installation. The upper seabed layer is sand. Layers of clay, silt and mudstone or sandstone are present below these top layers.

## Scour Protection

Due to very varying, scour potential the scour protection design was very important. Clays with extreme strength will erode very slowly. Therefore, can scour protection be omitted at positions with extreme strength clay. Scour analysis was carried out and the scour development envelopes predicted. The seabed variation is important because the installation of the array cable has a minimum and maximum clearing distance. Therefore, the seabed was analysed for the detailed design of the scour protection.

## Hydrographics

The windfarm is placed approximately 12 km from the shoreline. The seabed is relatively level at the location but subjected to very high tidal variations. The water depth is around 19-40 m with tide ranging up to 7 m.m

## Project Facts - Northwind

- Type of structure: Wind Turbines, 3.45 MW Vestas Type 12
- Location: North Sea Belgium
- Maximum Water Depth: 29 m
- Pile Diameter at Seabed: 5,2 m
- Soil Conditions: Dense to Medium Sand
- Installed: 2013
- Commissioned: 2016
- Installation Method: Driving with hydraulic hammer (IHC-S 1400)
- Number of Foundations: 73
- Maximum Pile Penetration Below Seabed: 31 m
- Connection Tower/Pile: Grouted connection with shear keys
- Special Feature: LICEngineering and NIRAS conducted a joint venture agreement to undertake the detailed design
- Scour Protection: Stones installed post monopile
- LICEngineering Tasks: Concept Development, Tender Design, Detailed Design, Specifications, Installation Design, Engineering Follow up, Supervision

For more information:

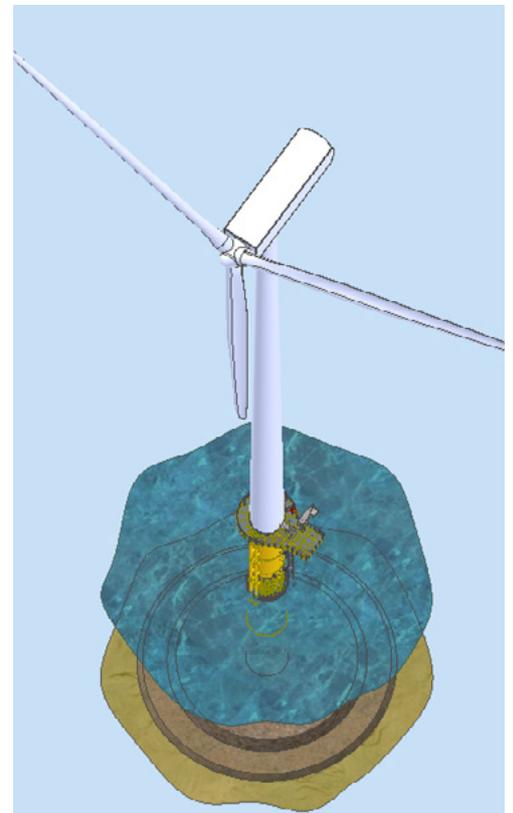
Hans Jørgen Riber, Head of Business Development

[hjr@liceng.dk](mailto:hjr@liceng.dk)

+45 51 51 29 16



Monopiles on-site



Drawing



Hellerup Office

Ehlersvej 24  
2900 Hellerup  
Denmark  
+ 45 39 62 16 42

Esbjerg Office

Kirkegade 25  
6700 Esbjerg  
Denmark  
+ 45 75 18 16 88

Svendborg Office

Kulinggade 31E  
5700 Svendborg  
Denmark  
+ 76 10 94 30