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Project data

Total amount of steel: ~25,000 t
Total amount of concrete: ~2,000 m³
Total amount of reinforcement: ~275 t

Monopiles

Length: 28 - 40 m
Diameter: 3.9 m
Wall thickness: 40 - 82 mm
Weight: 150 - 210 t

Transition pieces

including secondary steel and platform:

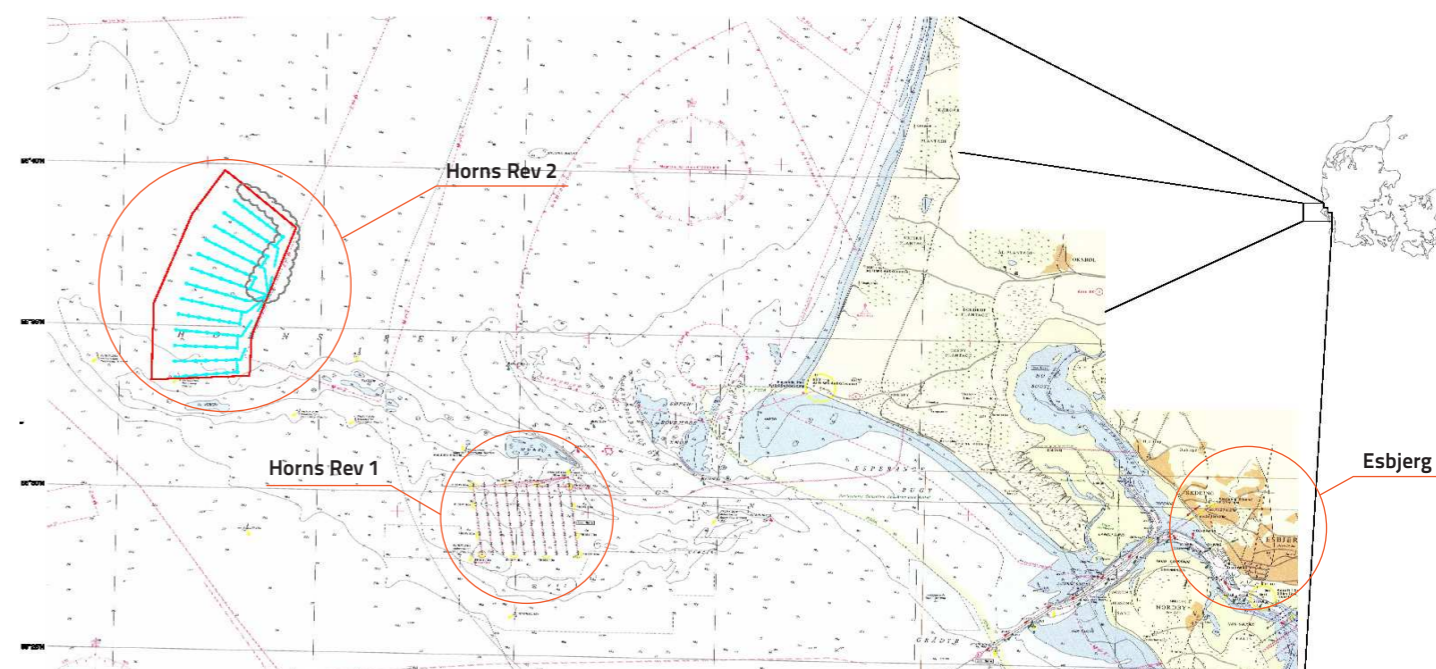
Length: 17 m
Diameter: 4.2 m
Wall thickness: 45 - 50 mm
Weight: ~ 170 t

Scour protection

Filter and cover stones: ~ 35,000 m³

Installation time offshore:
03/2008 - 09/2008

Offshore Wind Farm Horns Rev 2



1. General information

In 2002, the newly-elected Danish government approved the Plan of Action for wind energy to include two offshore wind farms, of which one was Horns Rev 2 with a capacity of 160 MW (91 wind turbines of 2.3 MW).

In June 2007, Aarsleff Bilfinger Berger Joint Venture (ABJV) was awarded the foundation construction contract for the world's largest offshore wind farm Horns Rev 2. The design of the founda-

tions was prepared by the client DONG Energy A/S.

Horns Rev 2 is situated in the North Sea about 27 km to 41 km off the west coast of Jutland, Denmark and in the northwest of the already existing wind farm Horns Rev 1.

The varying water depths of -7.0 m to -17.0 m main sea level and the investigated soil conditions allow for monopile foundations as foundation

structure. Therefore, the offshore wind farm consists of 91 monopile foundations, which are arranged in 13 parallel rows of 7 turbines each. Additionally, it comprises one monopile foundation for an accommodation platform. In total, the wind farm covers an area of approx. 35 km².

2. Project parts

The foundations consist of the following two main parts:

- Monopile
- Transition piece

The monopiles have a diameter of 3.9 m and a length varying between 28 m and 40 m. The transition pieces equipped with all appurtenances such as boat landings, platforms and ladders have a diameter of 4.2 m and a unit length of 17 m.

Monopiles and transition pieces are connected offshore by a grout joint. The annular gap between the two parts is filled with high strength grout mortar. In addition, the transition pieces are coated with a corrosion protection painting.

The high voltage cable from the transformer station is connected to the foundation by inserting the cable into a protective cable riser (J-tube) at the seabed and pulling the power cable to the turbine connection point above sea level.

3. Execution

3.1 Steel fabrication

Monopiles and transition pieces were manufactured at Bladt Industries A/S's production yard in Aalborg, Denmark. Due to the design of internal J-tubes guiding the high voltage cables through the foundations and due to the entire layout of the wind farm, each foundation is unique. The load out of the foundations had to strictly follow the installation schedule offshore. Therefore, high demands on the production schedule were made including the fabrication of 92 monopiles with a length of up to 40 m and 92 transition pieces equipped with internal platforms, boat landings, etc. as well as a corrosion protection.

3.2 Concrete platform

As part of the foundation contract, Aarsleff Bilfinger Berger Joint Venture (ABJV) successfully designed and installed prefabricated concrete work platforms instead of the client's original steel design.

In harsh offshore conditions, a concrete platform has various advantages

compared to a steel platform, such as corrosion and lifetime maintenance. The platforms are manufactured by ABJV at Bladt Industries's facilities in Aalborg and are grouted to the transition pieces before load out. Various tests were executed at a prefabricated mock-up to evaluate and minimise possible risks offshore as well as to demonstrate the feasibility of this innovative solution.



Monopile production in Aalborg



Concrete work platform

3.3 Transport

The foundations are loaded onto transport barges in Aalborg, seafastened and transported by tugs to the offshore base harbour located at Tauruskaj in Esbjerg, Denmark. Due to the unique design of each foundation, the transportation process had to be arranged in such a way that the installation vessel, waiting in Esbjerg for loading the foundations, could follow the completion schedule of the wind farm. Therefore, the entire logistics of production, transport and installation had to be mutually agreed between all parties involved and this was one of the major tasks in the early project stage.

3.4 Offshore installation

All offshore operations were coordinated from the base port in Esbjerg. The installation started with placing a filter layer on the seabed immediately after pile driving to avoid scour occurring around the monopile.

The foundation parts were loaded in sets of four onto the installation jack-up barge "SEAJACK", which was the main installation vessel. Upon arrival in the offshore field area, the jack-up

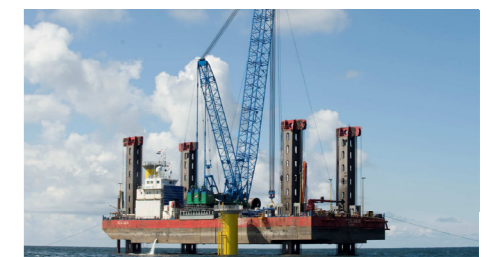
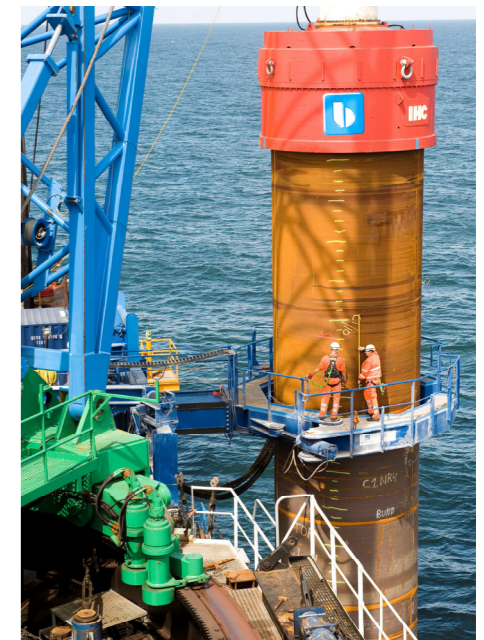
barge positioned itself within 1 m of the designated installation spot of a foundation by means of a four-point mooring system. The project-specific built pile guidance system was designed to compensate for positioning misalignments of the "SEAJACK" and to cover minimal installation tolerances offshore.

After up-ending the monopile from a horizontal to a vertical position and placing it into the guidance system, the monopile was driven into the seabed to the predefined installation depth by means of a hydraulic hammer IHC S1200.

The final step in the installation process was the installation of the scour protection around the monopile foundation. Afterwards, the foundations were prepared for the remaining turbine installation and grid connection works.

The offshore operations were executed 24 hours a day, 7 days a week from May to September 2008 to cope with the ambitious time schedule of installing all foundations within one season.

Monopile installation



Installation jack-up barge "SEAJACK"



Loading operations at Aalborg