

CONCRETE WORKING PLATFORM

An innovative solution



Horns Rev II CWP full-scale mock-up to demonstrate the CWP concept, November 2007.



AARSLEFF

Aarsleff has been involved in offshore wind projects since the 1990s with a special focus on the wind turbine foundations and associated technical developments, specialist equipment and structures. The first large scale project was the Nysted offshore wind farm in Denmark where Aarsleff fabricated and installed 72 concrete gravity base foundations. Nysted windfarm was one of the largest in the world when it was built back in 2003.

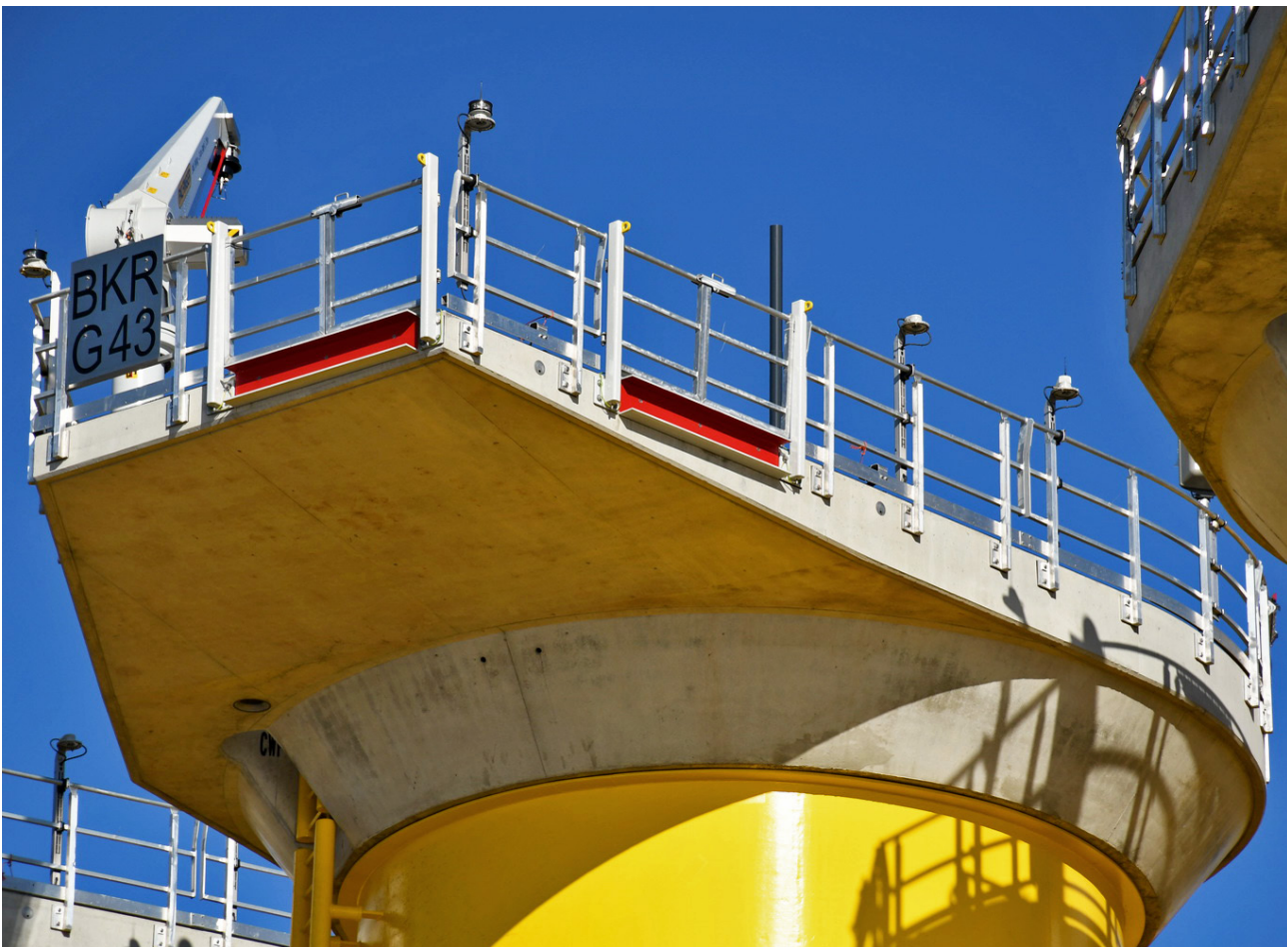
Aarsleff has since been involved in numerous offshore wind projects and designed, fabricated and installed several foundation types including monopile, gravity base and jacket foundations.

Throughout our involvement, innovative solutions and new concepts have been developed to improve safety, bring down cost and ensure high quality and low maintenance solutions suitable for the harsh offshore environment. One such innovation is the introduction of the Concrete Working Platform (CWP) for the Horns Rev II project back in 2007.

Since then numerous tweaks and developments have been introduced, and the platforms have increased in size and complexity to comply with increased foundation sizes and additional equipment and installations. Today the platforms have multiple purposes and are critical components with regards to wind turbine access,

HSE and Operation and Maintenance. As a result, the platforms are typically equipped with a long list of supplementary structures and equipment, e.g.:

- Davit Crane
- Navigation aids (lights, signboards, fog horns, radar reflectors)
- Boat Landing access and fall protection systems
- Walk to Work access (docking for motion compensated access systems)
- Wind turbine tower access stairs
- Laydown area for heavy loads
- Railings with removable sections or sliding gates
- Lightning protection systems



Fully outfitted CWP installed on TP, Borkum Riffgrund 2 2017.

The robust concrete structure provides a safe base for all these structures with stainless steel embedded parts and cast-in cable ducts effectively protecting the installed equipment from environmental loads. The design lifetime of the concrete structure far surpasses the 25 years normally required for offshore wind foundations.

Aarsleff is a co-owner of the EU patent 02011924 for offshore platforms, and the

CWP is today a tried and tested solution that has been installed on more than one thousand offshore foundations. The solution has been applied by major offshore wind developers like Ørsted, Vattenfall and E.ON on both nearshore and offshore projects.

The Aarsleff CWPs are manufactured at the Aarsleff BIZ production site in Swinoujście (Poland) in an industrialised process and according

to recognised standards. This in combination with in-house design capabilities and concrete experts ensures a high-quality solution.



Aarsleff BIZ production facilities in Swinoujscie, Poland.

Preparing the CWPs onshore at a fabrication line separate to the primary steel production, also benefits the primary steel fabricators. The CWPs will not take up storage and production space from the steel production, which will enable the steel fabricators to increase production rates and reduce time and space requirements for outfitting and Factory Acceptance Testing of 3rd party equipment.

THE FUTURE OF AARSLEFF CWPS

Lately and with the introduction of the so-called "TP-less" or "No-TP" offshore monopile foundation, design solutions have been developed aimed at installing the completed CWPs offshore, i.e. fully outfitted platforms complete with all secondary structures and equipment. Aarsleff has prepared concept and tender designs for TP-less monopile foundations since 2012, and the CWP solution has proven to be even more

advantageous for these foundations. Aarsleff facilities in Poland allow for mounting and testing of all components onshore, i.e. the CWPs leave the Aarsleff production facilities rigged and ready for "plug and play" installation offshore on the MP foundations. Combining Aarsleff manufacturing with our experiences from designing, planning and installing offshore wind projects ensures a high level of Design for Manufacture and Assembly (DFMA).

Traditionally, the connection between the CWP's and foundations have been via a grouted connection executed onshore at the steel fabricator's assembly area or at the project's base harbour. For CWP installations offshore, alternative methods have also been introduced in an effort to simplify and speed up the installation:

- **GROUTED CONNECTION**

The traditional method with grouting the annulus between the monopile and CWP. Loads are typically transferred by way of shear keys

on the primary steel structure and a specially prepared (rough) surface of the CWP towards the grout to create a strong construction joint. The method requires a grouting spread on the installation vessel including mixers, pumps, material storage, fresh water supply and laboratory unit for quality control.

- **BOLTED/TIE-ROD CONNECTIONS**

Mechanical connection applying bolts or tie rods to secure the platforms on the monopiles. The CWP is installed and resting on brackets

on the foundations and afterwards further secured by inserting and pre-tensioning bolts or tie-rods. The brackets on the monopiles are typically low profile and optimised to minimise fatigue impact and the stresses during pile driving.

- **PIN CONNECTIONS**

Mechanical connection with the CWP secured via shear pins on the monopiles and guide funnels/capture plate assemblies cast-in to the CWP structure mechanically locking the platforms in place.



Example of CWP-MP bolted connection.

Aarsleff has designed and/or delivered platforms with all above mentioned connection types. In addition to supporting the platforms, the connection system should allow for

fabrication tolerances and integrate guiding systems to ensure correct placement on the bearings. In particular for offshore installations using floating dynamic positioning

vessels, a robust guide system and offshore rated lifting arrangement is needed to allow for safe and effective installations.



Offshore installation of CWP's and other secondary structures (anode cages, boat landings, internal platforms etc.) on monopile foundation.

The Aarsleff CWP's are a proven concept, and we are confident that the solution and continued developments will ensure that it remains a preferred solution and a key component for offshore wind turbine foundations of the future.

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