Windplanblauw

A unique nearshore challenge

Ballast Nedam

Windplanblauw whitepaper

Sustainability and a tailored foundation concept

Ballast Nedam focuses on the delivery of specialty offshore wind projects which often require one-off solutions. Nearshore locations have limited water depth or are located in the surf zone near the beach. These locations are not accessible to everyone and require specific approach and equipment. On the border of land and water in the IJsselmeer, 28 outdated wind turbines have been replaced by 24 modern and powerful turbines. The wind turbines are part of the Windplanblauw project, which contains a total of 61 new onshore turbines of which 24 have been placed on the water. There were a number of challenges in this project, both technically and in terms of environmental conditions and protection in a Natura 2000 site. This resulted in innovative constructions and measures, such as a unique foundation concept.

The new wind turbines on the water are part of an initiative by SwifterwinT and Vattenfall: a wind farm in the municipalities of Dronten and Lelystad, in which 74 outdated wind turbines will be replaced by 61 modern turbines with more power.

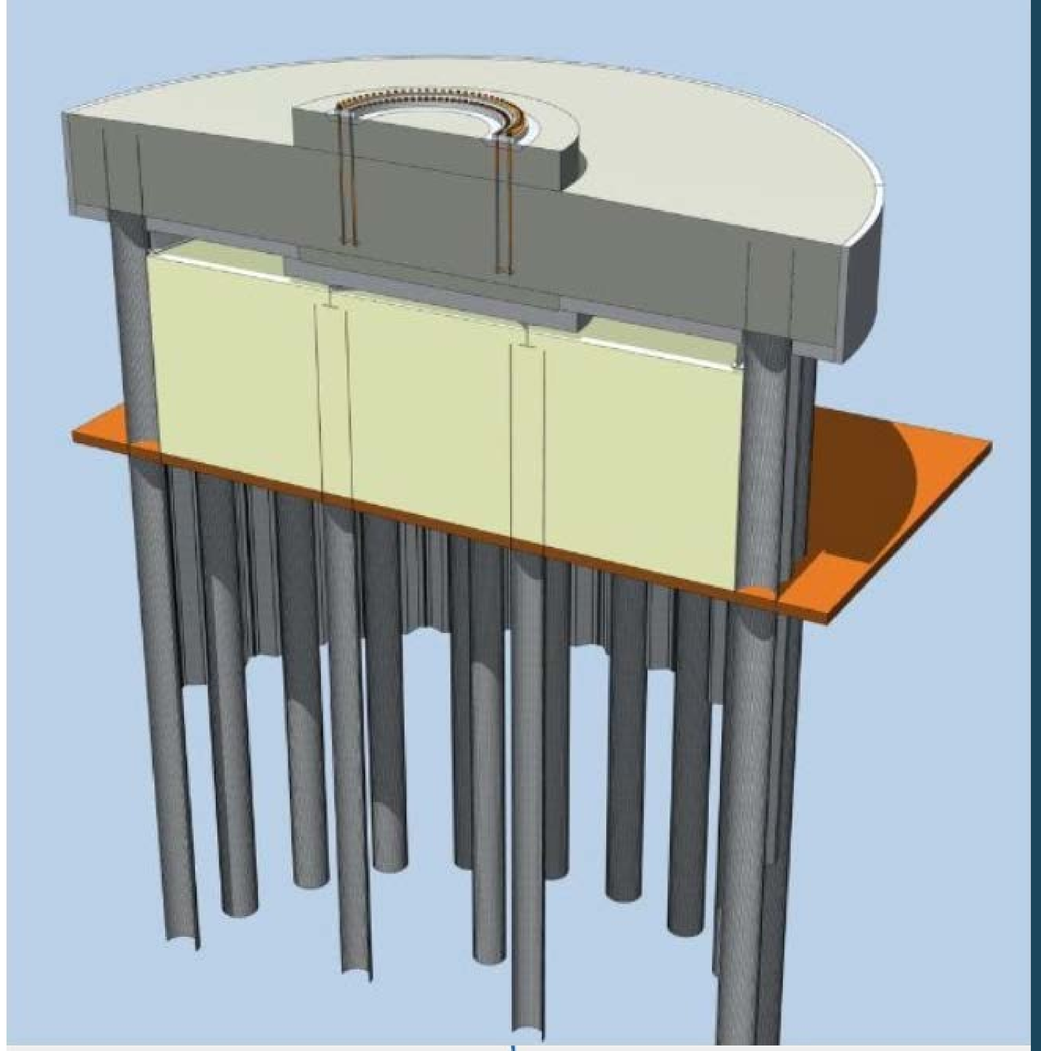
This concerns 37 turbines on land and 24 turbines in the IJsselmeer. In total, the wind farm will have an installed capacity of more than 335 MW. The 24 turbine foundations in the IJsselmeer were designed and built by Ballast Nedam, with Mammoet being jointly responsible for the transport and installation of the GE turbines. Due to the green energy produced by the wind turbines, this project makes a substantial contribution to the Energy Agreement in the province of Flevoland.

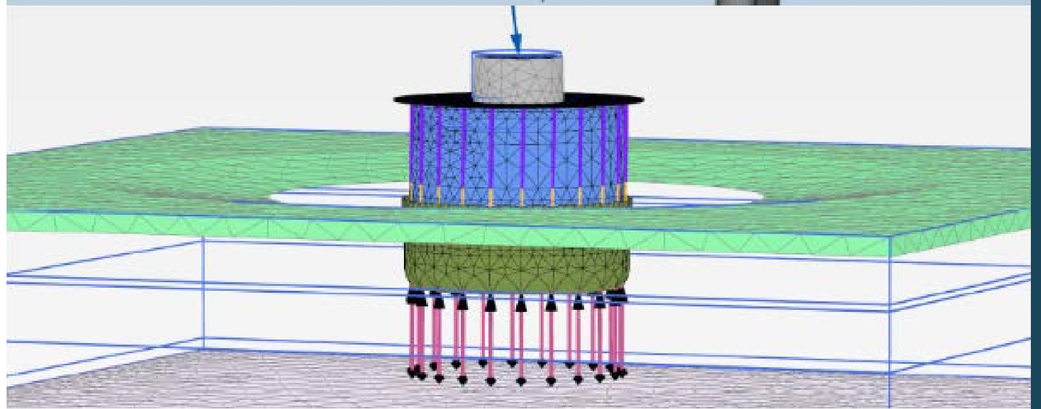
Nearshore

The project part of Windplanblauw that takes place in the IJsselmeer is located on the border of onshore (land) and offshore (sea), 100 to 500 meters from the shores of the IJsselmeer. This location is called nearshore. The specific soil conditions of this nearshore area creates challenges. In addition, the water is relatively shallow. In combination with the limited width of ships that can enter the IJsselmeer because of the locks, this meant that the foundations had to be built piece by piece, with small work vessels and pontoons. As a result of the limited availability of offshore turbines, a solution has been devised for the installation of onshore turbines on water for this particular project. The superstructure of the foundation solution, which is normally used on land, is combined with the substructure of a marine solution. This creates a unique cofferdam construction that forms the basis for the turbine foundations.

Land constructions in the water

Because some of these foundations were placed on water instead of land, a new approach was needed. For the use of onshore turbines, the foundation must have a minimum stiffness of 400 MN/m according to the specifications of the turbine supplier in order to prevent unacceptable resonance. The IJsselmeer is characterized by a water depth of about five meters and a very soft peat and clay soil of also about five meters thick. In order to achieve sufficient rigidity, a circular combi wall was devised: a construction of open steel tubular piles with a sheet pile, with sand filling inside and sometimes also a layer of soil improvement. In addition, the weak layers were removed from the steel tubular piles and replaced by a concrete filling. The steel concrete-filled tubular piles were integrated into the 2.5-metre-thick concrete slab turbine base for extra rigidity. To calculate the total stiffness, the PLAXIS 3D program was used. Various time-dependent effects such as settlement have been taken into account, and for land turbines unusual loads such as wave loads, ice loads, collision loads and scour. In addition to PLAXIS 3D, calculation models have also been made in SCIA Engineer and DIANA for determining the reinforcement. The civil models have also been used to verify results from PLAXIS 3D. This combination of clever design work led to small artificially created islands with sufficient rigidity for the application of a land turbine on the water.
The first step in the construction was to place the 22 tubular





piles of the structure, using auxiliary piles and a piling frame. In this way, the cylindrical shape could be guaranteed. When the piles were in place, the sheet piles were placed inbetween them. The tubular piles are mainly there for strength, the sheet piles for the retaining of the sand filling. Subsequently, the water level on the inside was lowered, so that a steel purlin could be applied to the waterline. This purlin prevents the wall from bulging and falling over. This created sufficient strength, after which the inside of the cofferdam could be excavated. Subsequently, the J-Tubes were installed for the power cable by replacing some sheet piles with sheet piles with a recess. After this, sand and concrete filling could be applied, which creates the island on which the foundation of the wind turbine could be built. Accessibility on the water is difficult. This has been taken into account in the design by carrying out as many activities as possible on shore. For example, prefab concrete elements have been used as lost formwork and a large part of the reinforcement has been prefabricated.

Building in a Natura 2000 area

In 2022, the Dutch government decided to realize approximately 21 GW of offshore wind energy by 2030. Offshore wind is one of the driving forces behind the energy transition that the Netherlands is striving for. By 2050, nearshore and offshore wind energy will be a substantial source of energy to bring the Dutch economy's CO_2 emissions to zero.

During the implementation of the Windplanblauw project, everything revolved around minimizing impact to the environment during both the construction and the operational phase. Sustainability and preservation of nature is therefore an important aspect in this project. Also because the wind turbines are located in a Natura 2000 area. Animals, plants and their natural habitat are protected here to preserve biodiversity. The Natura 2000 network consists of sites designated under the Birds and Habitats Directives. Both directives are important tools for protecting European biodiversity. All sites have been selected on the basis of the presence of species and habitat types in need of protection from a European point of view.

Ecological measures

One of the most striking measures is the placement of about 200 reef balls on the bottom of the IJsselmeer, which ensure that organisms are not chased away by the new buildings in their habitat. The balls are made of PH-neutral and environmentally friendly concrete. A reef ball has the structure of a piece of coral, and is made to mimic natural coral reef where organisms can hide and nest. These organisms are food for fish, which in turn are eaten by birds. In this way, the reef balls contribute to the preservation of the natural food chain in this area.

When building in a Natura 2000 area, newly installed structural elements must be compensated and fauna and environment must be protected. In addition to protecting organisms, the birds in the area were also considered. They were protected by grids placed on the open ends of the piles to prevent birds from getting stuck in them. Other special ecological measures included the installation of barriers, in the form of raised edges, on the pontoons to prevent any liquid contamination from flowing into the lake, the use of biodegradable oil and a special lighting plan, in which the construction lights only illuminated the works to minimize light pollution.

So Windplanblauw brought challenges. Both in terms of technology and in terms of the protection of nature in the area. Despite these challenges, the park cabling and the construction of the foundations have been completed.

Because of our innovative approach to this project and the experiences we have built over the years, we have become partner of choice for projects like these. Curious to see we can implement innovative solutions and ecological measures in your wind park development?Reach out for more information to:

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