Offshore Wind Track Record

Assisting with method engineering and equipment design in offshore wind projects

Who We Are

TWD is well established in the growing market of Offshore Wind. Our transport and installation solutions, developed in close cooperation with a wide variety of offshore installation contractors, has contributed to the successful erection of over 100 offshore wind farms worldwide.

Our multidisciplinary team allows TWD a flexible and comprehensive way of working. We focus on future proof engineering designs that increase efficiency, and ensure your project will be completed safely and timely.

For a larger selection of offshore wind projects TWD has been involved in, visit our website at www.twd.nl.

What We Do

Every offshore wind project is unique and deserves tailored solutions. We always look for a creative approach to work out installation methods that are out-of-the-box and engineering designs that are the most suitable for your construction project. Our typical solutions include grippers, seafastening, templates, upending tools, and secondary steel installation tools.

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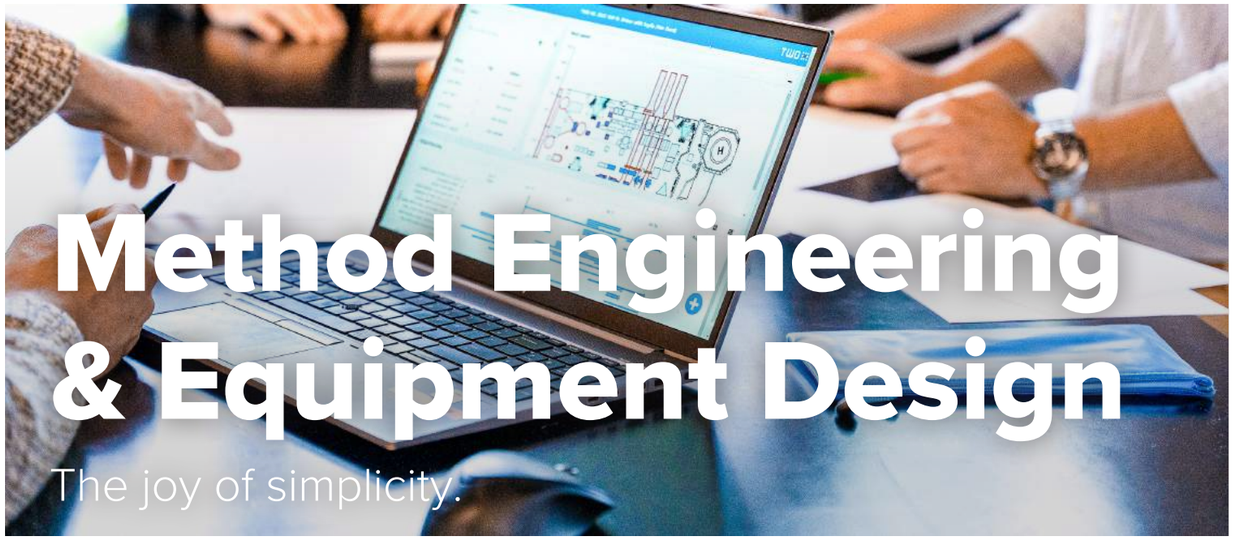
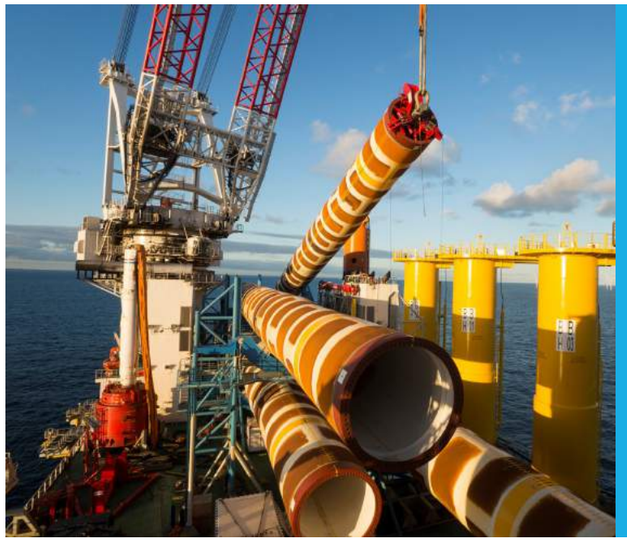


Method Engineering & Equipment Design

The joy of simplicity.



Our Services

Our multidisciplinary engineering teams develop fit-for-purpose solutions for any construction, transportation, or installation challenge. Combining different fields of expertise in a single team allows us to take an integrated approach for your project, covering technical risks at all critical project interfaces.

Starting from a robust method, we design ingenious mission equipment and reliable temporary works to ensure your project is executed safely, on time, and within budget.

Project steps

1 **Develop**
optimal construction / transport / installation method

2 **Specify**
required mission equipment / temporary works

3 **Create**
structural / mechanical design from concept to details

4 **Procurement**
assistance with broad supplier database

5 **Fabrication**
management & reporting

6 **On-site**
assistance & operator training

The challenge

Method Engineering

Equipment Design

Procurement & Fabrication Management

Field Engineering

Construction made easier

Our approach

Strategic
project planning & resourcing possible as construction method is defined up-front

Tailored
and smart construction methodology suitable for your project requirements

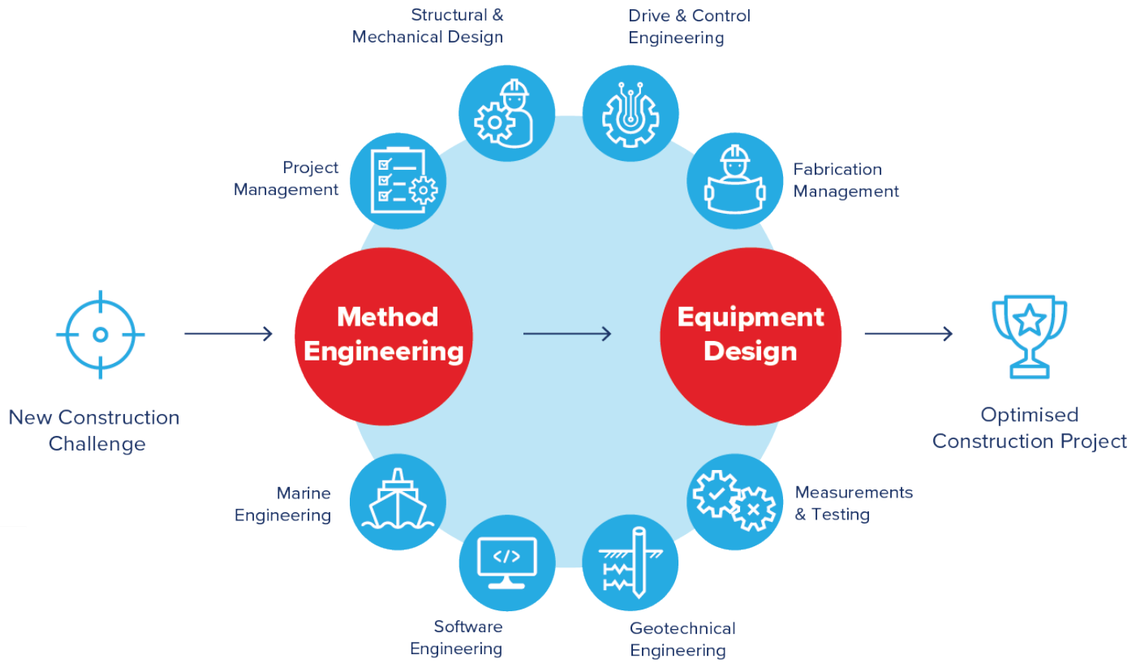
Transparent
and integrated working approach among our multi-disciplinary engineers and designers

Creative
and lean equipment design with cutting edge industrial knowledge and trends

Independent
design for fabrication that makes case-by-case fabricator selection possible

Assurance
in quality, lead time, and functionality through our fabrication management process

Experienced
in full project scope management from method engineering to mobilization assistance



We are ready to help you achieve your goals. No matter the complexity of the challenge, we will complement the capabilities of your team and facilitate a successful project execution from A to Z.

Monopile Gripper Track Record

Vessel	Pile Diameter [m]	Pile Weight [t]
Undisclosed	9 - 12	3000
Hyundai Frontier	7 - 8.5	850
Orion	6 - 12	2500
Innovation	6 - 10	1300
Svanen	6 - 10.5	2000
Pacific Osprey	4 - 8.4	1200
Aeolus	4 - 8.4	1200
Pacific Orca	4 - 8	1000

Photo Credit: DEME

Grippers

TWD has designed bespoke grippers on both floating installation vessels and jack-up barges. Our designs range from lean project specific tools to versatile ‘future-proof’ gripper designs to further enhance your vessel’s capabilities. Having designed grippers for pile diameters up to 12m and weights up 3,000t, provides us the extensive experience required to successfully deliver a smart and safe gripper design. Additionally, TWD has also to cooperated with various fabricators to ensure a smooth process and short delivery time.

JUV Innovation

TWD created a revolutionary monopile gripper that holds the gripper ring suspended in tension rods. This resulted in a logical and optimal load path that allows the stiffness of the system to be maximised while keeping the overall gripper weight down. The unique combination of gripper stiffness with the slenderness of the construction enabled our customer to maximise the useful payload on its jack-up. Our unique design increased the versatility and pilling accuracy of HLJV Innovation.

HLV Orion

In close cooperation with our client’s engineering team, TWD developed the basic structural and mechanical design of a motion compensated pile gripper (MCPG). Our motion-control engineers performed extensive dynamic simulations and validated those in scaled tank tests, leading to a detailed specification of Orion’s gripper and its robust installation method on DP. Based on the simulations, scale tests and results, our client has seen these results and principles as a confirmation of their business case and contracted Huisman for designing and building an MCPG.

TWD’s support continued with detailed analyses of the interaction between the vessel’s Dynamic Positioning system, the crane and MCPG, which resulted in the safe and stable installation of Orion’s first monopiles on DP. TWD also provided the design of a cantilevered “Lifting Tool Insertion Aid ”, adjustable monopile seafastening cradles, and the auxiliary crane pedestal and dual boom rest system. Our pragmatic approach and novel solutions helped contribute to the installation campaigns of Arcadis Ost OWF, Vineyard Wind 1, and Moray West.

JUV Aeolus

We designed the monopile gripper on the Aeolus to work at keel level. This allows the system to guide and stabilise the piles as close to the water as possible. Access all around the gripper enables the crew to use the gripper as a working platform at intermediate levels. In transit, the gripper can be folded by a winch and skidded fully inboard. This occupies minimal deck space and limits the amount of ballasting required.

The multi-step jacking and skidding processes are fully automated using integrated positioning sensors. With its highly efficient pile orienting mechanism and precise inclination adjustments, this state-of-the-art gripper outperformed all the existing alternatives at the time of designing. The successful collaboration and installation results encouraged our customer to return to TWD with a request for a mirrored version of the gripper on the jack-up vessel Wind Osprey. Both Aeolus and Wind Osprey were mobilised to install wind turbines on Gemini Offshore Wind Farm.

HLV Svanen

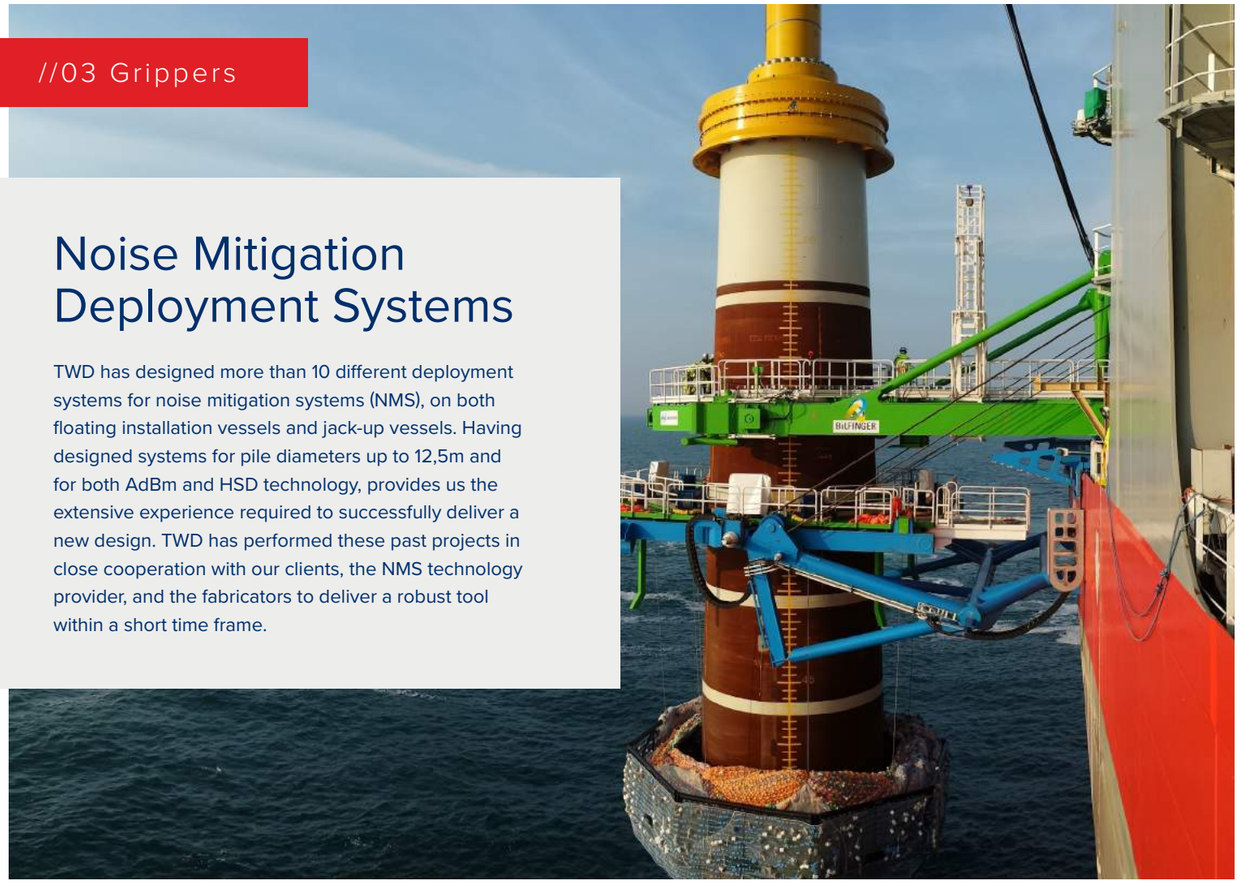
The Svanen central gripper performs floating monopile installation (albeit using an anchor pattern), capable of handling piles with diameters up to 10.5m. TWD designed this gripper to be placed over the moon bay of the Svanen. It serves multiple functions including handling monopiles, storing a hydro-hammer, and deploying a noise mitigation system which reduces the sound of hammering operations whilst also dramatically limiting disturbances to the marine environment. The hammer storage facility can allow for hammers up to 1,200 t. Both the gripper and hammer platform can skid along the moon bay of Svanen.

Our central gripper design assisted HLV Svanen in carrying out installation projects for Burbo Bank Extension OWF, Walney Extension OWF, wind farm Arkona, Danish Kriegers Flak OWF, and many others.

JUV Hyundai Frontier

TWD was contracted by HESI to design a monopile gripper for the Hyundai Frontier. The vessel required a lightweight, customized gripper to maximize its operational efficiency. Featuring a foldable design facilitated by a jacking system, it creates space around the monopile for transition piece installation. Designed to operate at the keel level of the Frontier, it guides and stabilizes piles as they penetrate deeper into the seabed.

Due to the short lead-time, TWD closely collaborated with the South Korean manufacturer Sambo C.M.C. during the fabrication of the monopile gripper. We ensured the delivery of the equipment to HESI within time and budget by providing fabrication management and technical support to Sambo. Together with Sambo C.M.C, TWD navigated challenges such as design adjustments, a tight fabrication schedule, and limited material availability.



Noise Mitigation Deployment Systems

TWD has designed more than 10 different deployment systems for noise mitigation systems (NMS), on both floating installation vessels and jack-up vessels. Having designed systems for pile diameters up to 12,5m and for both AdBm and HSD technology, provides us the extensive experience required to successfully deliver a new design. TWD has performed these past projects in close cooperation with our clients, the NMS technology provider, and the fabricators to deliver a robust tool within a short time frame.

Sandbank MP Gripper & NMS Deployment System

Next to the design of the monopile gripper, TWD worked on the design of an HSD deployment frame for Wind Orca to mitigate noise during the MP installation. This design was tailored to meet the tight area around the gripper with an advanced folding mechanism and automated leveling system.

Noise Mitigation Deployment System Track Record

Vessel	Pile Diameter [m]	Foundation Type	Technology	Opening System
JUV installation	Undisclosed	Monopiles	AdBm & HSD	Yes
JUV installation	Undisclosed	Jackets	Undisclosed	Yes
Bokalift 2	12.5	Monopiles	AdBm	Yes
Orion (concept)	12	Monopiles	HSD	Yes
Neptune	6 - 6.5	Monopiles	HSD	No
Innovation	6 - 10	Monopiles	HSD	No
Aeolus	4 - 8.4	Monopiles	AdBm	No
Svanen	6 - 10.5	Monopiles	HSD	Yes
Giant 7	3.6	Jackets	HSD	No
Pacific Orca	4 - 8	Monopiles	HSD	No

Norther OWF

For the 370MW offshore wind farm Norther, our client deployed the Aeolus and was able to reuse the monopile gripper engineered by TWD. For this OWF, the usage of a NMS system was required to lower the noise levels caused during the pile driving. As the gripper was not originally designed to deal with the vertical loads from a NMS system, the deployment system was suspended from additionally welded connection points on the hull of the vessel. During transit, the deployment system was stored on a seafastening frame on the Aft of the vessel. This project provided a successful test by our client of the new AdBm noise mitigation technology.

//03 Grippers

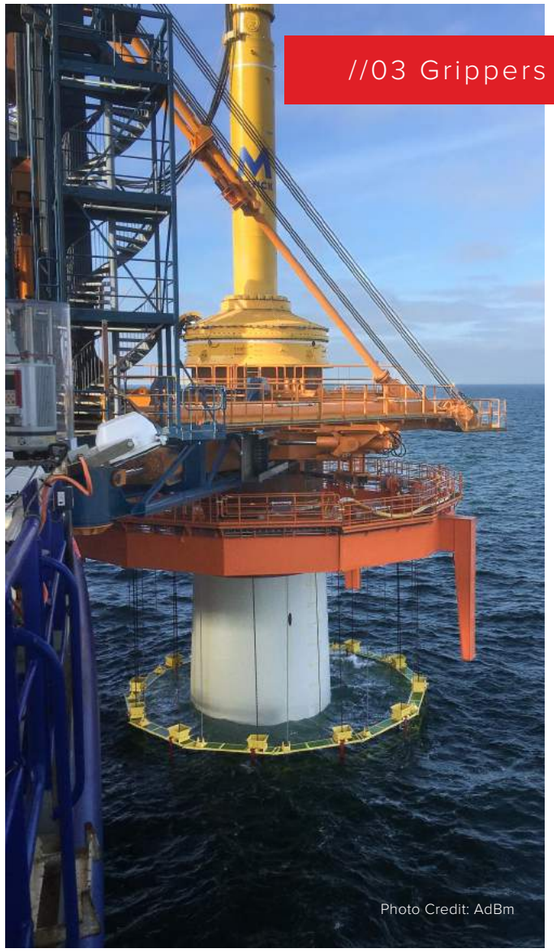


Photo Credit: AdBm

Svanen MP gripper & NMS Deployment System

The Svanen central gripper has an integrated NMS deployment system and deploys the HSD net around the maximum 10.5m diameter monopiles. For the operational sequence of the pile installation, it is required for the gripper to open. For this, TWD integrated opening mechanisms in both the gripper arms and the NMS deployment system. For a high-level noise mitigation performance, the HSD net should ideally create a closed circle around the full length of the pile. With the combination of the ballast box and the overlapping net, the HSD net positioning is guaranteed.

Seafastening

Our tailored seafastening solutions ensure safe and successful transportation of offshore wind installation pieces such as monopiles, jackets, towers, and blades. Many solutions allow for variation in size or diameter. This opens the possibility for you to transport varying diameters within one or even over several projects.

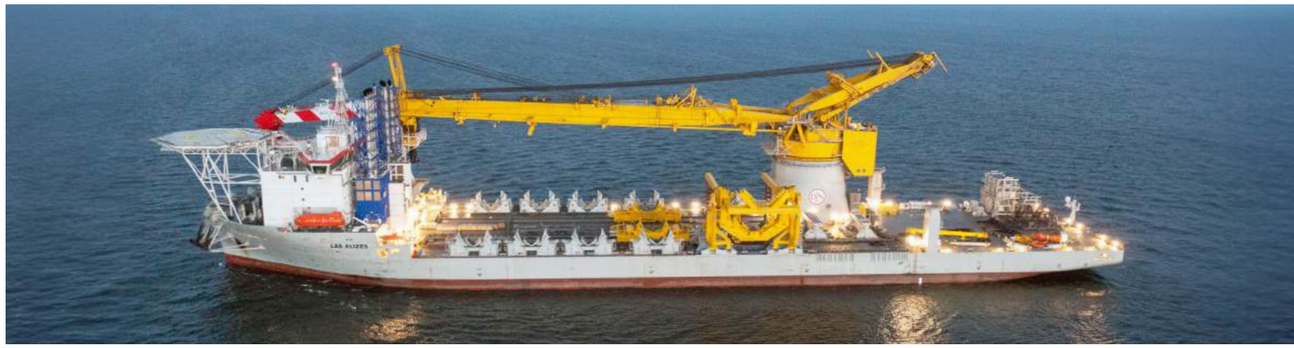
Monopile Seafastening Track Record

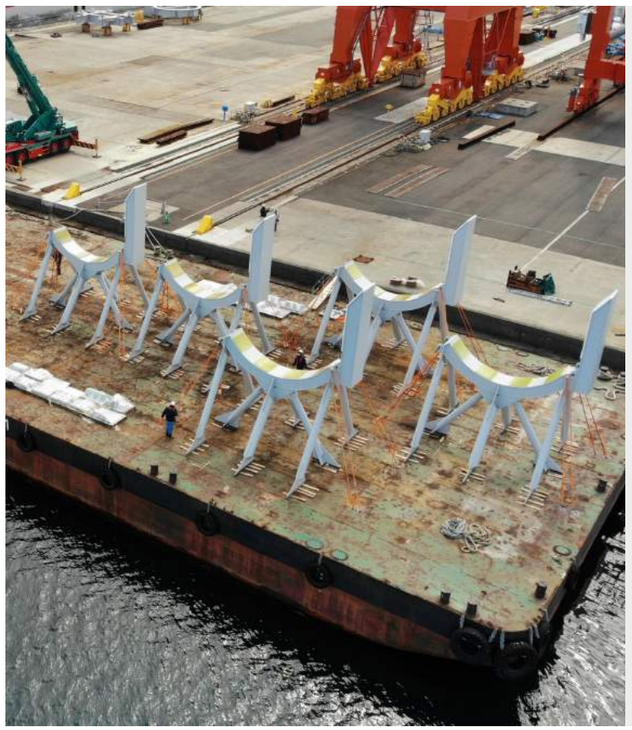
Windfarm	Vessel	Pile Diameter [m]	Pile Weight [t]
Undisclosed	Undisclosed	10 - 12	3000
Undisclosed	Undisclosed	9 - 12	3000
Undisclosed	Undisclosed	9 - 10	1800
Undisclosed	Undisclosed	8 - 10	1600
Moray West	Various	9.5 - 10	2200
Gode Wind 3	Les Alizés	-	3000
Arcadis Ost	Orion	8.0 - 12.0	2250
Hornsea 2	Innovation/Pacific Orca	8.0 - 12.0	2250
Dogger Bank B	Alfalift	8.0 - 8.6	2000
Multiple projects	Aeolus	6.5 - 8.4	1450
Hornsea, Merkur, Horns Rev, Seamade	Innovation	5.5 - 8.5	1300
Veja Mate	Scylla	7.8	1300
Undisclosed	Orion	8.6	1260
Hollande kust Noord	Innovation	7.4 - 7.8	970
Northwestern II	Vole au Vent	6.5 - 8.0	970
Vineyard	Orion	8.3 - 9.3	970
Borkum Riffgrund II	Vole au Vent	6.5 - 8.0	950
Gode Wind	Barge NB90	7.5	940
Gode Wind	Innovation	7.5	940
Gemini	Pacific Osprey	6.6 - 7.0	920
Saint Nazaire	Innovation	7.0	875
Akita/Noshiro port	Happy Star	6.0	800
Bligh Bank II	Vidar	5.0 - 6.8	800
Westermost Rough	Innovation	6.5	780
Sandbank OWF	Pacific Orca	6.7	770
Kaskasi	Innovation/ Blue tern	6.5	725
Borkum Riffgrund	Pacific Orca	5.9	680
Burbo Bank	Jubilee	6.2 - 7.1	655
Jubilee Burbo Bank	J-type	6.2 - 7.1	595

Les Alizés - Jan de Nul

Our client Remazel was awarded the delivery of the monopile deck spread for Jan de Nul's new heavy lift vessel, Les Alizés. TWD assisted Remazel with various design scopes, including monopile seafastening, monopile skidding system, and monopile upend hinge.

To facilitate the installation of XXL monopiles, the monopile cradles were designed to accommodate a range of diameters from 6m to 13m. Les Alizés has the capacity to transport five monopiles simultaneously. Four of these monopiles are securely held in the monopile cradles, while one is positioned within the upend hinge. In addition to the seafastening cradles, TWD designed a monopile skidding system that facilitates the transverse transport of monopiles on deck. The skidding system, which comprises of two cradles, is able to raise and lower the monopiles to position them on either the seafastening cradles or the upending hinge cradles.



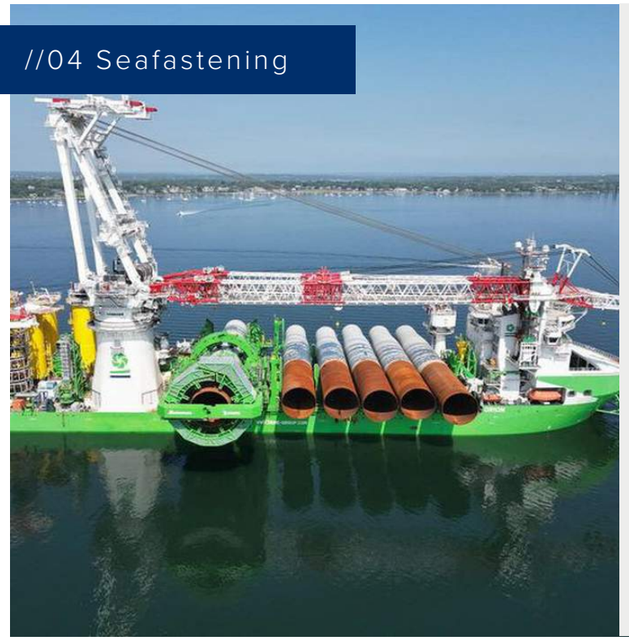


Blue Wind - Shimizu

TWD supported Shimizu Corporation during the installation of the Nyuzen OWF, with TWD Japan providing a comprehensive seafastening spread. The project entails installing three 3MW wind turbines off the coast of Toyama Prefecture, Japan.

Shimizu deployed their flagship SEP vessel, Blue Wind, which efficiently completed the solo installation mission in just four trips. The first journey focused on the foundation campaign, requiring seven MP cradles, six platform seafastening structures, and a hammer grillage. Subsequent trips involved WTG installation, with seafastening for two tower sections, a nacelle, and a rotor hub. The simultaneous presence of all seafastening structures on deck during both campaigns facilitated a swift turnaround.

To streamline rotor hub assembly, TWD designed an additional quayside grillage with a modular counterweight attachment, ensuring balanced attachment of each blade before transfer to a deck grillage.

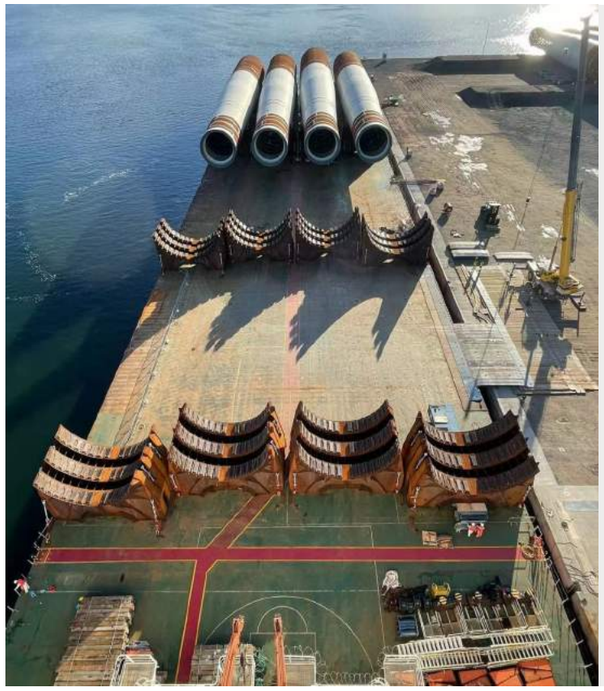


Orion - DEME

TWD designed both the monopile seafastening cradles and the skidding system for DEME's new heavy lift vessel, Orion.

The Orion has the capacity to transport and install six monopiles per trip: five monopiles on the seafastening cradles, with an additional one positioned in the upend line. To streamline the installation of XXL monopiles, the monopile seafastening system was meticulously designed to accommodate monopiles weighing up to 2250 tons. Furthermore, the cradles feature adjustable hydraulic actuators, allowing them to adapt to a range of monopile diameters from 8 meters to 12 meters.

Monopiles are efficiently transported transversely on deck using a cutting-edge skidding system. This innovative setup allows the remaining monopiles to be skidded closer to the crane for efficient handling.



Moray West OWF

TWD assisted OW Ocean Winds with a monopile transport method and a smart seafastening cradle design for the Moray West OWF. Our universal seafastening cradles were specifically developed for efficient loading and unloading operations using SPMTs, eliminating the need for cranes.

To load the monopiles onto the heavy transport vessel, the monopiles are picked up with the SPMT along with the cradles strapped around them. This method reduces both the complexity of the cradle and the time required for loading operations. To further decrease the load-out time, TWD optimised the required deck connections, minimizing welding time.

Furthermore, these versatile cradles are designed to accommodate monopiles of various diameters, enhancing their usability and flexibility.
The implementation of our smart seafastening cradle design ensures safe, efficient, and sustainable transportation.

Kaskasi OWF

TWD has contributed with multiple scopes of the foundation installation engineering on the Kaskasi OWF project off the German coast of Heligoland.

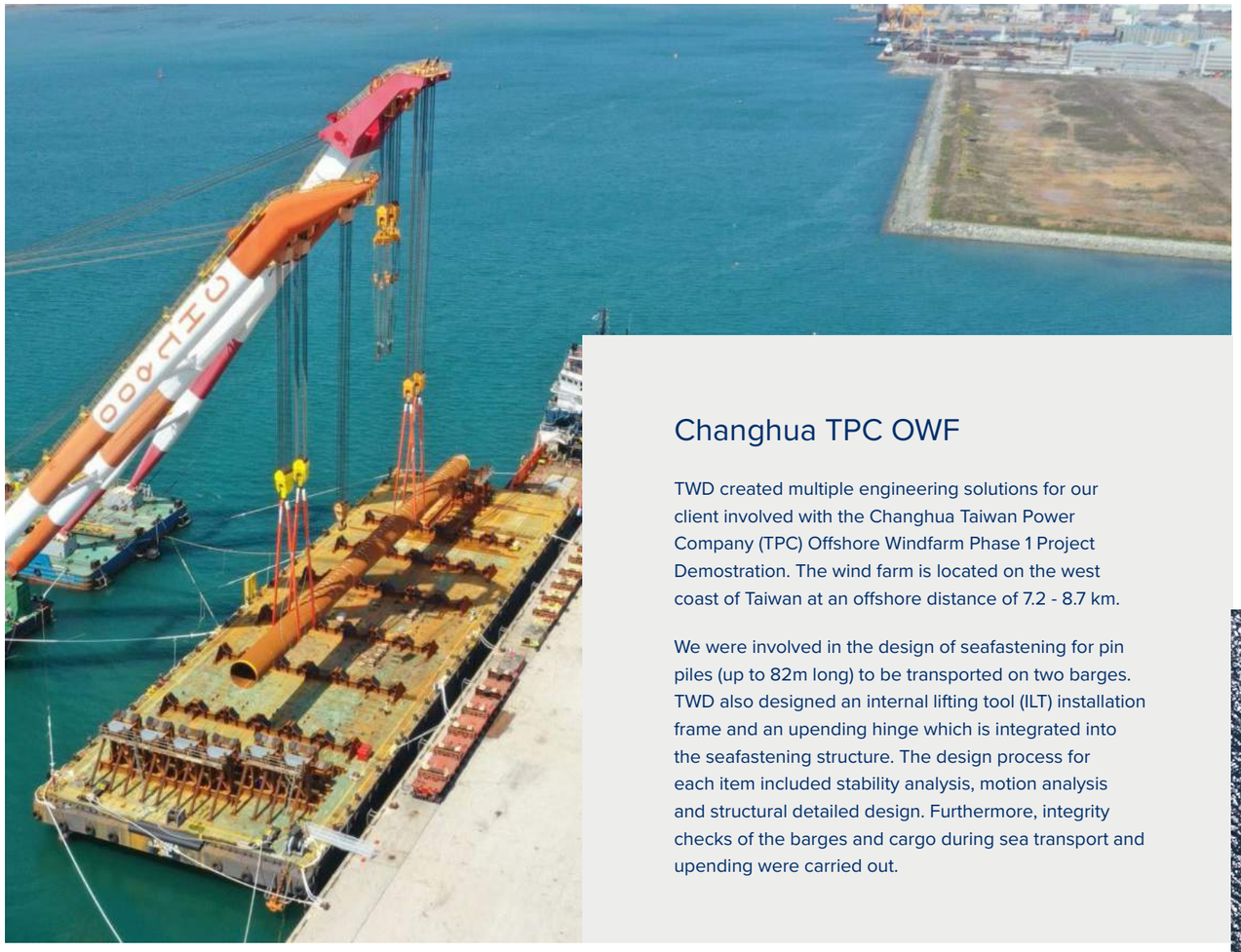
TWD developed a future-proof seafastening spread and Noise Mitigation Deployment system. These solutions were deployed across multiple vessels during the initial installation stage of 2023.

After a mid-2023 break in installation due to vessel availability, DEME group switched the installation to their JUV Innovation vessel, for which our monopile seafastening spread and customized gripper were repurposed. TWD takes pride in contributing to a wind farm that supplies green electricity to 400,00 German households.

Les Éoliennes Flottantes du Golfe de Lion (EFGL) OWF

TWD assisted Manora Logistics in transporting floater columns for the Les Éoliennes Flottantes du Golfe de Lion (EFGL) project. Our multidisciplinary team delivered both the concept and detailed design of the seafastening structures, ensuring the safe transportation of two sizes of floating columns. This included three large columns, each weighing about 800 metric tons, and six smaller columns, each weighing around 400 metric tons. Additionally, our team conducted a highly detailed analysis of the vessel structure to enable Manora to transport the columns under desired conditions. This strategic solution streamlined the production process.

//04 Seafastening



Changhua TPC OWF

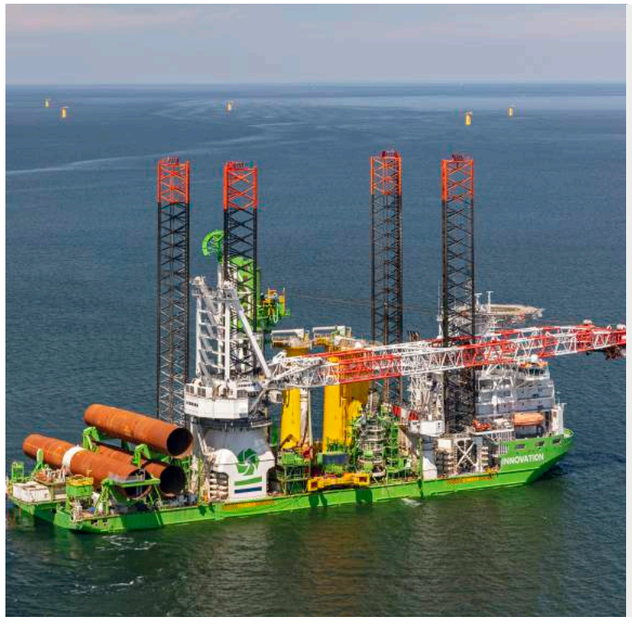
TWD created multiple engineering solutions for our client involved with the Changhua Taiwan Power Company (TPC) Offshore Windfarm Phase 1 Project Demostration. The wind farm is located on the west coast of Taiwan at an offshore distance of 7.2 - 8.7 km.

We were involved in the design of seafastening for pin piles (up to 82m long) to be transported on two barges. TWD also designed an internal lifting tool (ILT) installation frame and an upending hinge which is integrated into the seafastening structure. The design process for each item included stability analysis, motion analysis and structural detailed design. Furthermore, integrity checks of the barges and cargo during sea transport and upending were carried out.

Galloper OWF

The upgrade of our client's heavy-lift jack-up vessel, Innovation, reflects the industry's growing challenges due to increasing foundation sizes. TWD engineers designed the first ever skidding monopile seafastening on an installation vessel to handle the large foundations of the Galloper offshore wind farm. Together with the upend bucket and pile gripper, an integrated monopile installation spread was realised. Our designs contributed to the smooth installation of the Galloper OWF (353 MW) that powers 380,000 houses with green electricity every year. Furthermore, this future-proof monopile installation spread has been re-used by our client for many projects after Galloper, making it a truly cost-effective solution.

//04 Seafastening



St. Nazaire OWF

Our customer was contracted for the transport and installation of 80 monopiles (MPs) and transition pieces (TPs) for the Saint Nazaire OWF. The soil characteristics varied per location leading to the utilisation of multiple MP installation methods. The customer used HLJV Innovation for this operation.

We were contracted to perform the seafastening designs of multiple tools on deck: monopiles, transition pieces, drilling reel, hammer, and MODIGA gripper (i.e. Monopile Drilling, Installation and Grouting Aid). TWD's tailored and flexible seafastening solutions have significantly contributed to the foundation transportation and installation of Saint Nazaire.

Photo Credit: Navantia

St. Brieuc OWF

In the St. Brieuc OWF installation project, our customer was responsible for the transport and installation of 62 3-legged jackets. The jackets are scheduled to be loaded out in Fene (Spain) and transported to either Cherbourg (France) or directly to the field by a barge and/or Heavy Transport Vessel (HTV).

To assist with the transportation, TWD conceptualised and designed the detailed jacket seafastening required for this project. Our team came up with 2 types of seafastening solutions: bolted jacket seafastening for the barge and HTV, and quick release jacket seafastening for the Bokalift. In addition to these designs, jacket integrity check, motion analysis, and deck strength verification were also performed.

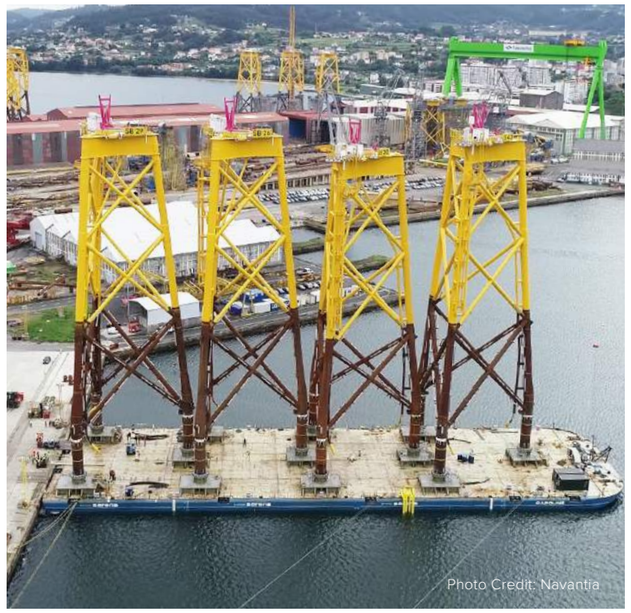


Photo Credit: Navantia

Jacket Seafastening Track Record

Wind Farm	Vessel	Legs	Weight [t]
Undisclosed	Undisclosed	3	4000
Undisclosed	Undisclosed	3	2500
Seagreen	OHT Osprey, Hawk	3	2210
Moray East	Semi-sub	3	1309
St. Brieuc	Barges	3	1195
Moray East	Barge	3	935
Baltic II	Innovation	3	745
Aberdeen Bay	Osprey Carrier II	3	615
Beatrice	Barge	4	397

Borkum Riffgrund OWF

For the test suction bucket jacket of Borkum Riffgrund, our customer required a seafastening solution. This seafastening would serve as a solid example for future suction bucket jacket seafastening operations.

TWD designed an innovative and operation-friendly structure that clasps the suction buckets to the deck. The relatively thin buckets were clamped by utilising pre-tensioned threaded bars to avoid welding or lashing. To prevent the buckets from getting damaged, the clamps were outfitted with a wooden interface. This seafastening structure has brought many tangible benefits, resulting in a more efficient and cost effective installation process.

Triton Knoll WTG

Our client was contracted to provide the installation of all WTG components in Triton Knoll offshore wind farm. TWD was requested to provide the motion analysis and all seafastening designs on the jack-up vessel Wind Osprey.

To maximise the usable workspace on deck without compromising safety, TWD conducted finite element analysis on the whole vessel. We also reinforced the deck and local areas where high compressive or tensile forces were present. Following the analysis and reinforcement, our team delivered a wide range of seafastening designs, including a cantilevered blade substructure which allowed all blades to be suspended over the aft of the vessel. The design enabled five full sets of turbines to be loaded on deck per trip along with all the required lifting and handling tools.

WTG Seafastening Designs Track Record

Windfarm	Vessel	Scope of Work	WTG Type
Empire Wind 1	New JUV & Barge	WTG transport rack	Vestas 15MW
Undisclosed	Undisclosed	WTG seafastening	Siemens 14 MW
Vineyard Wind 1	Sea Installer & Barge	WTG seafastening	GE 13 MW
Undisclosed	Undisclosed	WTG seafastening	Siemens 11 MW
South Fork	Aeolus & Barge	WTG seafastening	Siemens 11 MW
Hollandse Kust Noord	Scylla	WTG seafastening	Siemens 11 MW
Undisclosed	Undisclosed	WTG seafastening	Siemens 8 MW
Ishikari Bay	Blue Wind	WTG seafastening	Siemens 8 MW
Nyuzen	Blue Wind	WTG seafastening	Siemens 8 MW
Seagreen	Wind Osprey	WTG seafastening	Vestas 10 MW
Changua Demo	Taillevent	WTG seafastening	Hitachi 5.2 MW
Triton Knoll	Wind Osprey	WTG seafastening	Vestas 9.5 MW
Borssele 3 & 4	Aeolus	WTG seafastening	Vestas 9.5 MW
Norther	Aeolus	Blade rack seafastening	Vestas 8 MW
Merkur	Blue Tern	Blade rack design	GE 6 MW
Binhai North H2	Goliath	WTG seafastening	Siemens 4 MW
Rentel	Sea Installer	Blade rack seafastening	Siemens 7 MW
Nobelwind	Vole au Vent	Blade rack seafastening	Vestas 3.3 MW
Tahkoluoto	Vole au Vent	Blade rack seafastening	Siemens 4 MW
Trianel Borkum	Transport barges	WTG seafastening	Adwen 5 MW
Baltic II	Vole au Vent	WTG seafastening	Siemens 3.6 MW
Global Tech I	Vole au Vent	Blade rack seafastening	Adwen 5 MW
Nordsee Ost	Neptune	Rotor seafastening	Senvion 6.15 MW

Rentel OWF

For the Rentel OWF (309MW), TWD designed tower grillages, blade racks substructures, nacelles, and blade yoke seafastening structures on the Sea Installer. An existing tower adapter was utilized to significantly reduce fabrication time of the tower grillage. Our previous designs for Sea Challenger and Apollo couldn't be used due to vessel damages. Fortunately, TWD was able to design the new structures in record time to meet the tight deadlines.

Our flexibility and dedication to completing the seafastening on time resulted in the entire project being designed, approved, built, and fitted within 11 weeks. TWD is proud to have contributed to a wind farm that annually provides 300,000 homes with green energy.

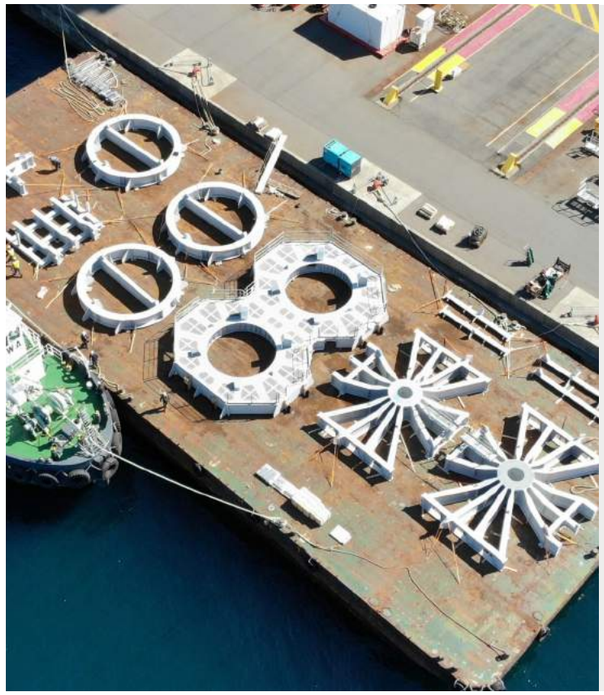
//04 Seafastening

Borsselle 3 & 4 OWF

TWD assisted two of our clients with the installation of the same wind turbine generators (WTGs) on multiple farms: Aberdeen Bay, Norther, Deutsche Bucht, and Borsselle 3 & 4. One of our clients used Wind Orca while the other client used their jack-up vessel, Aeolus. To reduce the fabrication time and installation costs, TWD made the first concept and rose to the challenge of designing seafastening structures that would fit both vessels.

As the grillages would be mobilized repeatedly, TWD was determined to create smart and easy connections to the deck. We also designed the nacelle grillages and the cantilevered blade support structure.

TWD's vast seafastening expertise resulted in the creation of smart designs for a single product that was able to perfectly meet the requirements of two unique vessels.



Nyuzen OWF

For Shimizu's relatively small windfarm, housing just 3 turbines of 3MW rated capacity, seafastening was essential for securing both foundations and turbine components. This project is particularly challenging as it coincided with the maiden voyage of the newly built Blue Wind Jack-up vessel, alongside a tight project timeline.

TWD performed a dedicated motion analysis to precisely determine accurate accelerations at the center of gravity of the components and the maximum roll angle of the vessel. This ensured that the blades' tips remained above water level during transit.

The design of the seafastening has an interesting feature: the rotor seafastening frame was used both on the vessel and during assembly at the quayside. While assembling the blades one by one, stability was achieved bwith the use of a ballast frame. Collaborated with our partner, TWD Japan facilitated the local fabrication of all structures at Mitsui E&S in Japan, streamlining the production process.

Ishikari Bay OWF

For the Ishikari Wind Farm, located off the coast of Hokkaido, Japan, Shimizu used their Blue Wind jack-up vessel for the turbine installations. The project featured the installation of the currently largest turbine in Japan, with an 8MW capacity, a 90-meter tower, and a 160-meter rotor diameter.

TWD played a crucial role by providing a tailored transportation and installation solution for this project. This included the design of seafastening for the nacelle, tower, blades, and lifting tool. Our experienced specialists were also on-site, playing an integral role in the site-mobilization process and the lifts of the first installation trip.

We are proud to be part of Japan’s effort to switch to cleaner energy with the Ishikari Wind Farm.

Vineyard Wind 1 OWF

Our client, DEME, were awarded the turbine installation campaign for Vineyard Wind 1. In compliance with the Jones Act, they utilized two Foss Maritime Company “feeder” barges to transport the 65 GE Haliade-X turbines from quayside to their installation vessel, Sea Installer.

TWD supported DEME with multiple engineering scopes in the feedering operation, including the seafastening of the tower sections, nacelle, and blade rack on both the feeder barge and Sea Installer. The tower sections were efficiently transported using Barge Master heavy and standard feeder systems. These systems provide motion compensating technology, ensuring the safe transport and lifting of tower sections from the barge to the Sea Installer vessel.

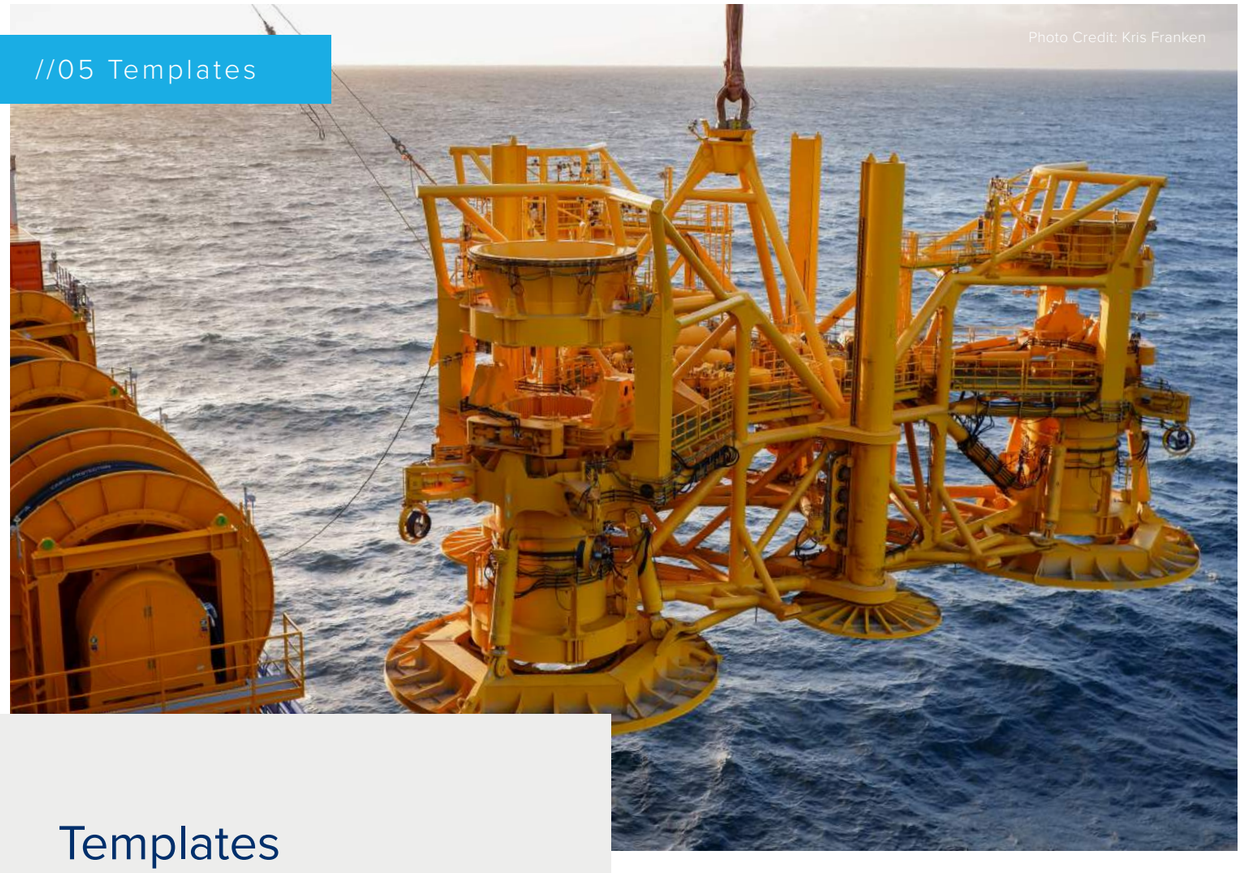
TWD provided assistance with other various scopes on the project, including the design of the blade rack for GE, as well as the fender systems on both the barge and Sea Installer.

South Fork OWF

Van Oord, our client, was awarded the turbine installation campaign for South Fork. To adhere to the Jones Act regulations, they employed one Crowley “feeder” barge to transport twelve 11MW turbines from the quayside to their installation vessel, Aeolus.

TWD supported Van Oord with multiple engineering scopes in the feedering operation. This included the seafastening of the tower sections on both the feeder barge and Aeolus. Notably, an innovative quick release system was engineered to ensure a safe and efficient offshore lift of the tower sections from the feeder barge to Aeolus. In addition to various seafastening scopes, TWD also designed the blade rack outriggers on the feeder barge.

Photo Credit: 3Drone Inspection Services LLC 2023

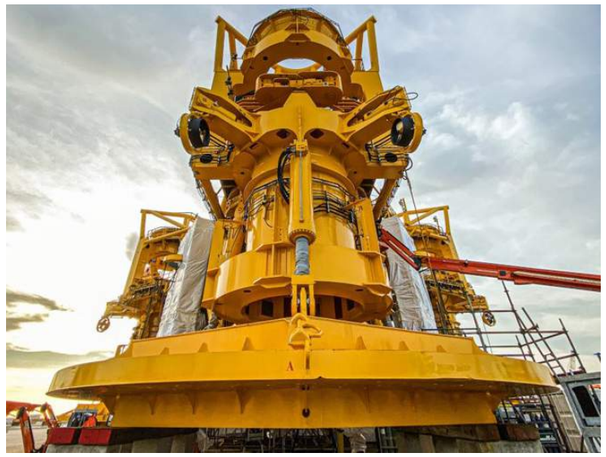


Templates

A pre-piling template can be used to maintain accuracy and to meet installation tolerances such as pile verticality and centre to centre distance in pre-piling campaigns. In recent years, TWD has designed multiple piling templates with self-leveling functionality. Together with Geotechnical and Structural engineering specialists, the soil and environmental conditions, along with the piling method, are taken into consideration and largely influence the requirements of these templates. TWD creates bespoke designs to optimise the templates to your project or client requirements.

St. Brieuc Drilling Template

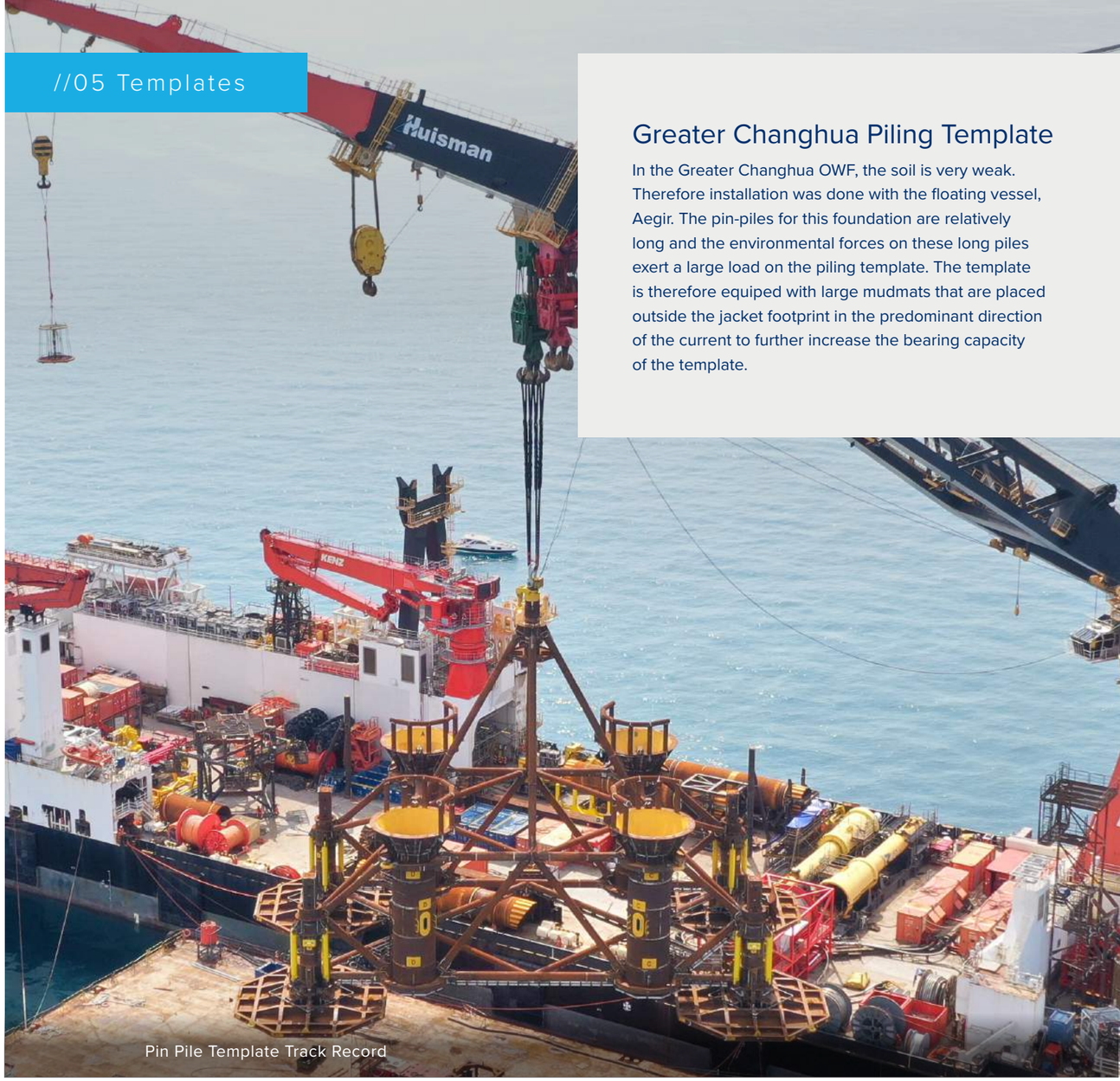
The drilling template for St. Brieuc was used to install the pin-piles of 62 wind turbines. Additionally, our engineers designed a separate offshore substation (OSS) template, in combination with the drilling template, which allows for the OSS pin pile installation. The template can lift itself to be horizontal and a dedicated lift-off system ensures that the pin-piles remain vertical and intact during template removal. This ingenious design was created using the expertise of TWD's multi-disciplinary teams for structural and mechanical design, including geotechnical analyses and dynamic and workability analyses by marine engineers.



//05 Templates

Greater Changhua Piling Template

In the Greater Changhua OWF, the soil is very weak. Therefore installation was done with the floating vessel, Aegir. The pin-piles for this foundation are relatively long and the environmental forces on these long piles exert a large load on the piling template. The template is therefore equiped with large mudmats that are placed outside the jacket footprint in the predominant direction of the current to further increase the bearing capacity of the template.

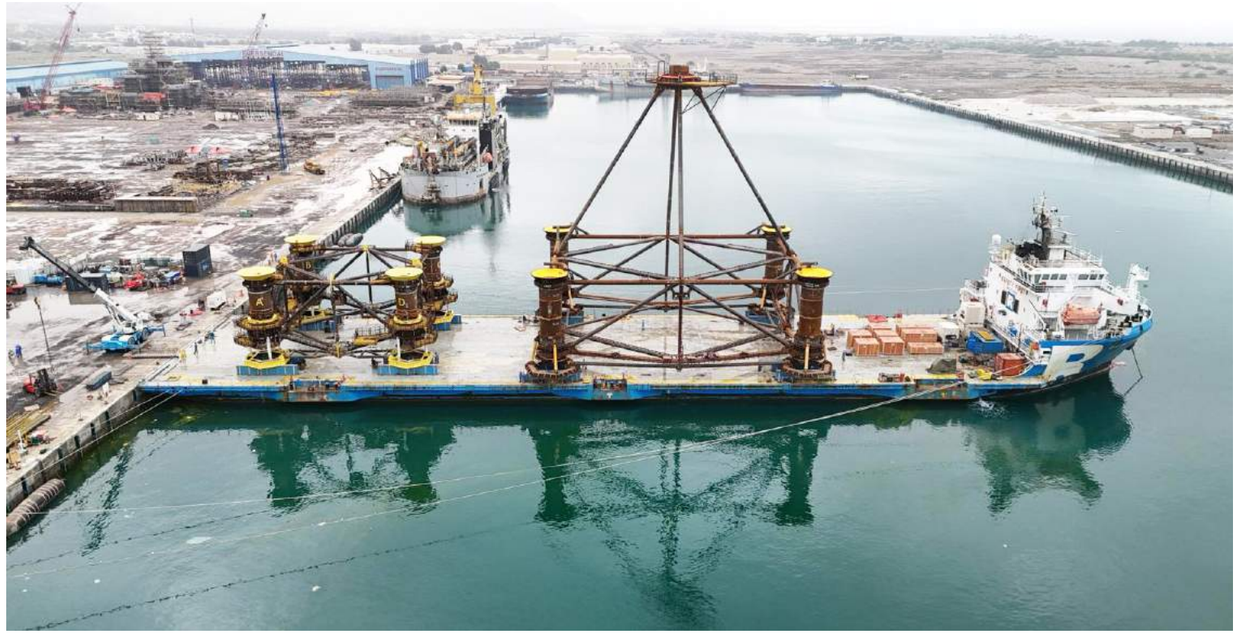


Pin Pile Template Track Record

Offshore Wind Farm	Jacket Legs	Leveling system	Type of operation
Undisclosed	3	Self Leveling	Driving
Undisclosed	3	Self Leveling	Driving
Le Tréport	4	Self Leveling	Driving
Hai Long	3	Self Leveling	Driving
Coastal Virginia Offshore Wind	4	Self Leveling	Driving
Zhong Neng	3	Suspended in Winches	Driving
St. Nazaire/Fecamp/Courseulles	4	Self Leveling	Drilling
Greater Changhua 1 & 2a	4	Self Leveling	Driving
Belwind	4	Suspended in Winches	Driving
Thorton Bank	4	Suspended in Winches	Driving
Ormonde	4	Suspended in Winches	Driving
St. Brieuc	3	Self Leveling	Drilling
Baltic 2	3	Suspended in Winches	Driving
Borkum West	3	On Seabed / No Leveling	Driving

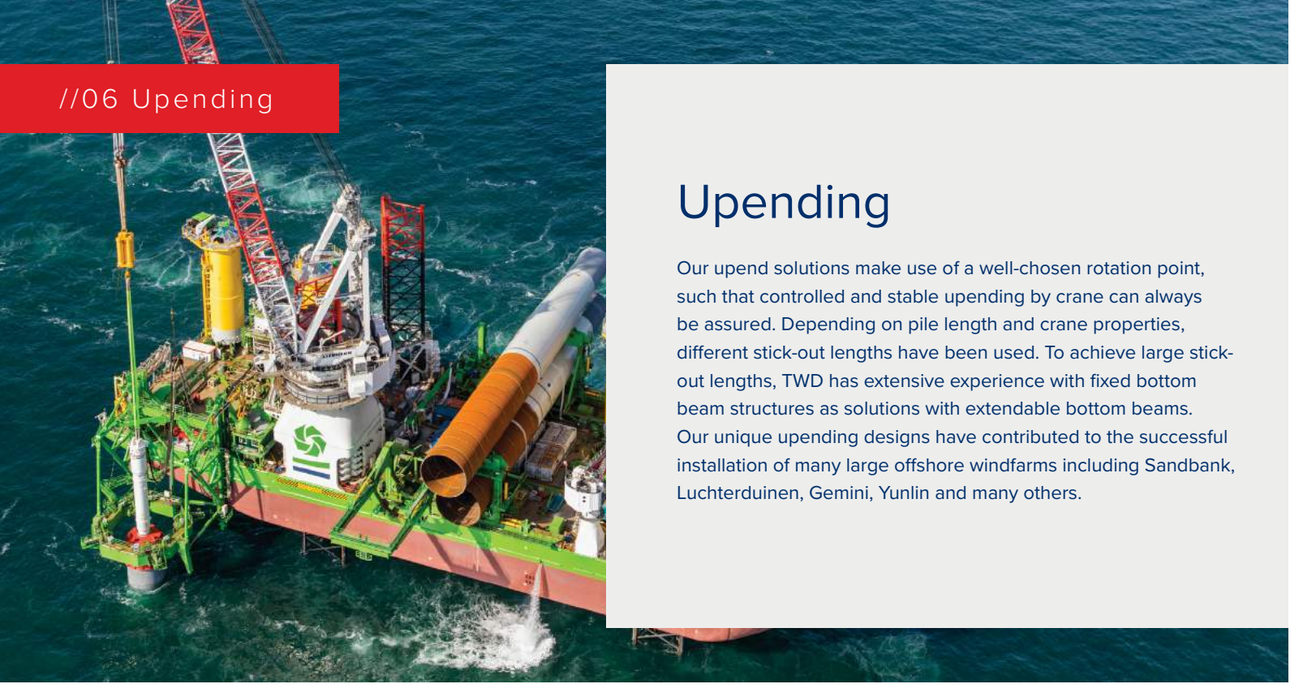
St. Nazaire Drilling Template

This drilling template was designed to install the pin-pile foundations of the offshore substation within tolerance. We designed the template with levelling cylinders to make sure it could accommodate the uneven seabed. This allowed for a safe and effective foundation installation. TWD is proud to have worked with our customer to install Saint-Nazaire (496MW). The offshore wind farm will serve green energy to 400,000 homes.



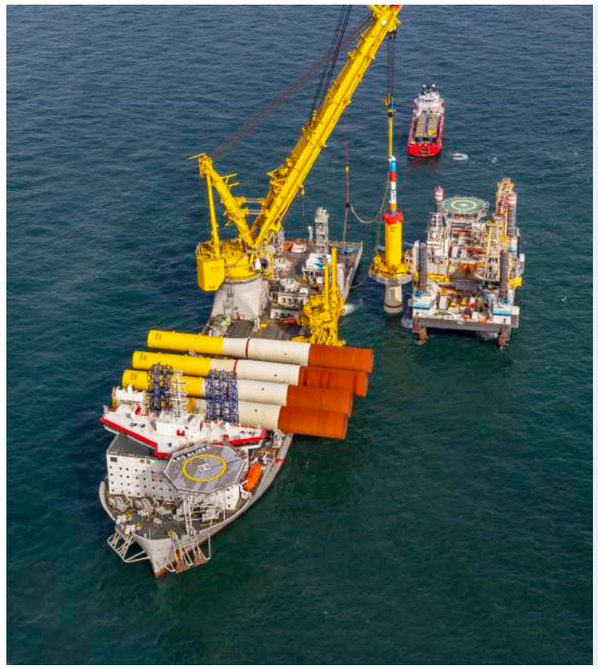
Baltic II Jacket Piling Template

To drive the piles at the Baltic II offshore wind farm, TWD designed a pre-piling template for the jack-up barge, Goliath. The most efficient operation was accomplished by our team, designing a 3-sleeve template specifically tailored to the jacket leg distance and pin-pile diameter. This was done to make sure the template constrained the piles, minimised pile inclination, and controlled the mutual distance. Our extensive expertise in piling methodologies resulted in an easy-to-use template leading to the most optimal foundation installation.



Upending

Our upend solutions make use of a well-chosen rotation point, such that controlled and stable upending by crane can always be assured. Depending on pile length and crane properties, different stick-out lengths have been used. To achieve large stick-out lengths, TWD has extensive experience with fixed bottom beam structures as solutions with extendable bottom beams. Our unique upending designs have contributed to the successful installation of many large offshore windfarms including Sandbank, Luchterduinen, Gemini, Yunlin and many others.



Les Alizés - Jan de Nul

Remazel was awarded the delivery of the monopile deck spread for Jan de Nul's new heavy lift vessel, Les Alizés. TWD supported Remazel with the design of the monopile seafastening, monopile skidding system, and monopile upend hinge.

The upend hinge was designed to accommodate XXL monopiles weighing up to 3500 tonnes and to allow for a range of monopile diameters from 7 to 13 meters. Additionally, to facilitate the upending process for monopiles of varying lengths, the upend hinge is designed to be adjustable with telescopic beams. Moreover, the upend hinge is equipped with a folding mechanism that allows the upend bucket to be folded up onto the deck of the vessel for load-out, and to fold up against the vessel's side shell during monopile installation.

TWD is proud to have played a role in the design of this upend hinge, which is set to significantly streamline the installation process for future XXL monopiles.

Innovation - DEME

With the use of jack-up installation vessel, Innovation, our client installed 97 foundations on the Gode Wind offshore wind farm. TWD's tailored solution for the upending hinge includes a rotating saddle and is attached to a skid frame which increases its lifting capacity. This solution helped overcome the challenging accommodations needed for this project including using the largest and heaviest monopiles ever installed in this part of the German North Sea. The versatility of this future-proof design has contributed to its use in an additional 10+ upending projects.

//06 Upending

Pile Upending Hinge Track Record

Wind Farm	Vessel	Pile Diameter [m]	Pile Weight [t]
Undisclosed	Undisclosed	9 - 12	3000
Gode Wind 3	Les Alizes	-	3000
Yunlin	LTS 3000	8	1845
Multiple	Aeolus	7 - 8.4	1450
Galloper	Innovation	6.5 - 8.5	1300
Gode Wind	Innovation	7.5	940
Multiple Projects	Innovation	6.5	780
Sandbank OWF	Pacific Orca	6.7	770
Baltic II	NB90	5	720
Borkum Riffgrund	Pacific Orca	5.9	680
Northwind	Neptune	4.2	560
West of Duddon Sands	Sea Installer	6	516
Taranto	MPI resolution	4.5	410
St Brieuc	Aeolus	3.1	280
Robin Rigg	Lisa A	4.3	265
CP-8001	-	1.2 - 3	96

Aeolus - Van Oord

TWD supported Van Oord in upgrading their upending hinge on Aeolus 2.0 for handling monopiles exceeding 90 meters in length and 8 meters in diameter. This upgrade featured longitudinally seafastened monopiles, which are upended using the monopile upending tool.

Our ingenious design has made the tool versatile. It can travel over a skid track to accommodate various pile lengths and has adjustable saddles that fit different pile diameters, enabling swift adjustments in support radius.

Since 2018, this upgraded upending hinge has been instrumental in the successful installation of several hundred MPs across Europe.

Yunlin OWF

TWD was commissioned by our customer to design an upend hinge, assisting monopile installation at Yunlin Offshore Wind Farm off the west coast of Taiwan. In this project, the upend hinge and the crane are not located on the same vessel. This results in relative motion between the crane vessel and the barge with the upend hinge. Our mechanical team delivered a robust yet efficient design solution for the upend hinge that follows the motion of the monopile during the operation. The hinge can adapt to different water depths and monopile lengths, by retracting and extending the bottom beam.

//06 Upending

St. Brieuc OWF

To help our customer install jacket foundations on the St. Brieuc OWF (496 MW), TWD developed 3 identical upend hinges on deck that can work simultaneously. The upend system is designed using hydraulic cylinders so that the upending operation can be conducted autonomously without the engagement of the main crane.

Our lean upending solution was designed to accommodate piles with varying diameters and lengths, with the ability to upend both casings and pin piles. Furthermore, the remotely controlled hook-up and release systems enable both simple and safe operations. This efficient design significantly reduced installation time bypassing a large part of the upending sequence without compromising on quality or safety.

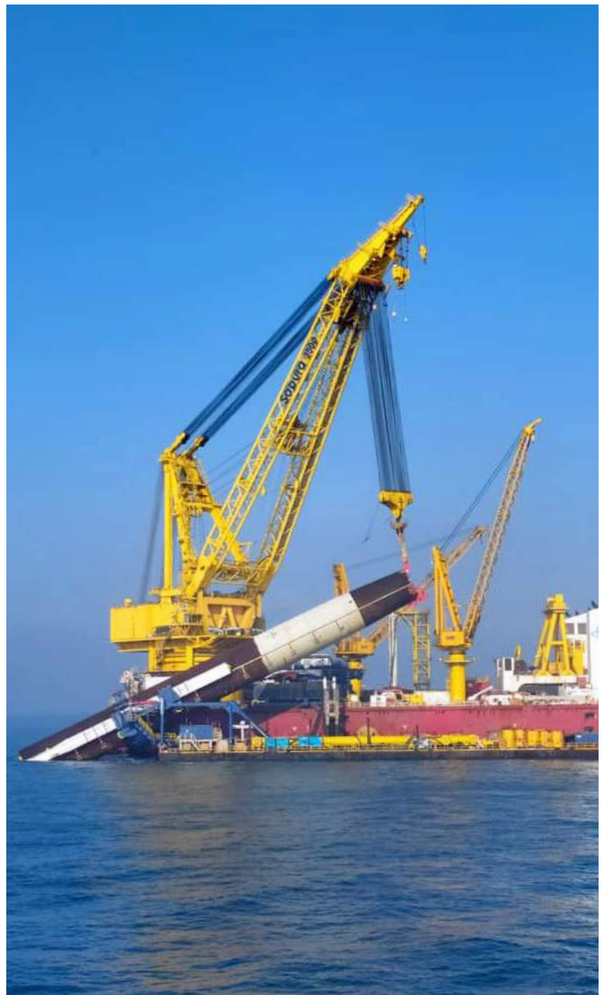
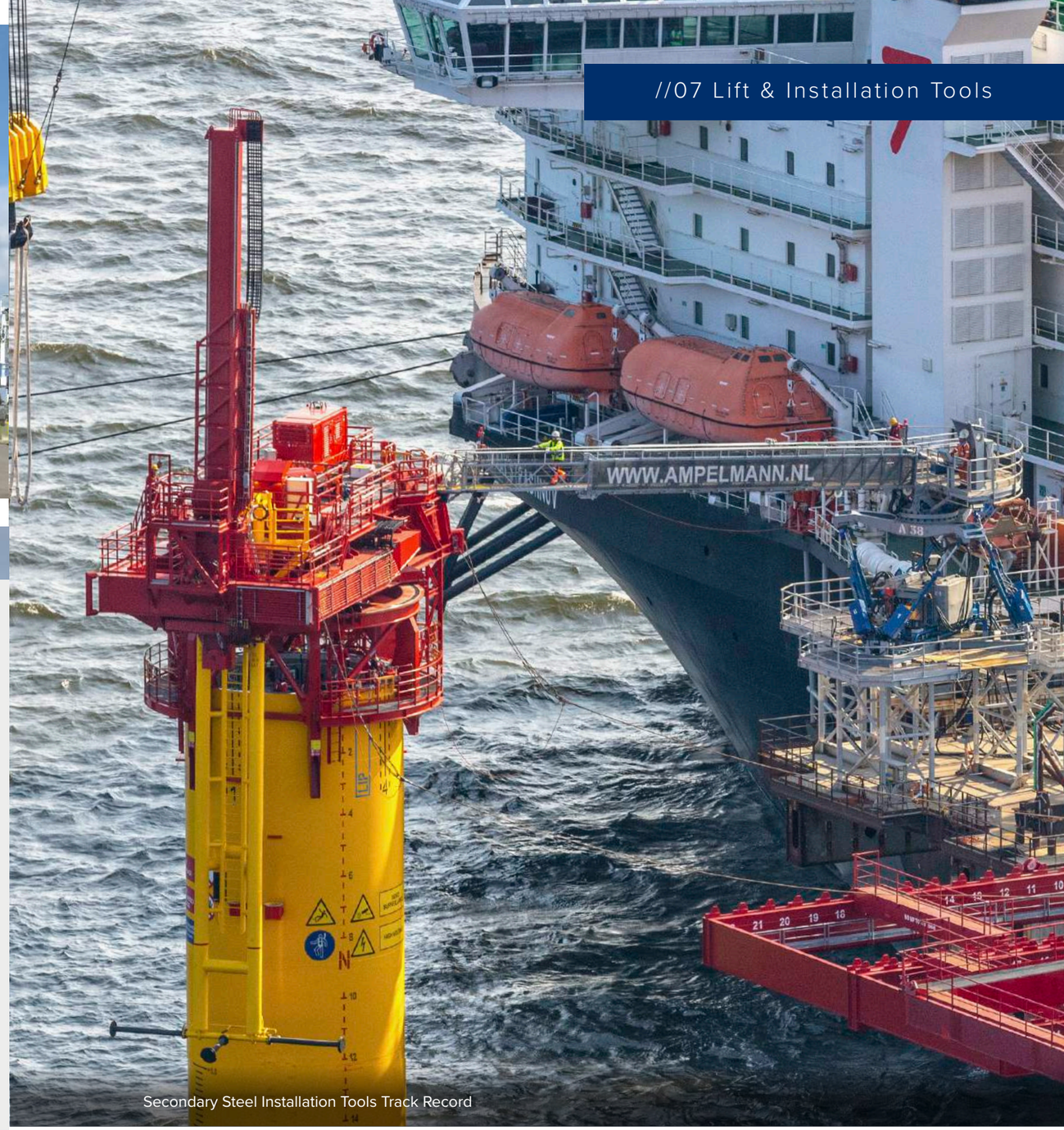
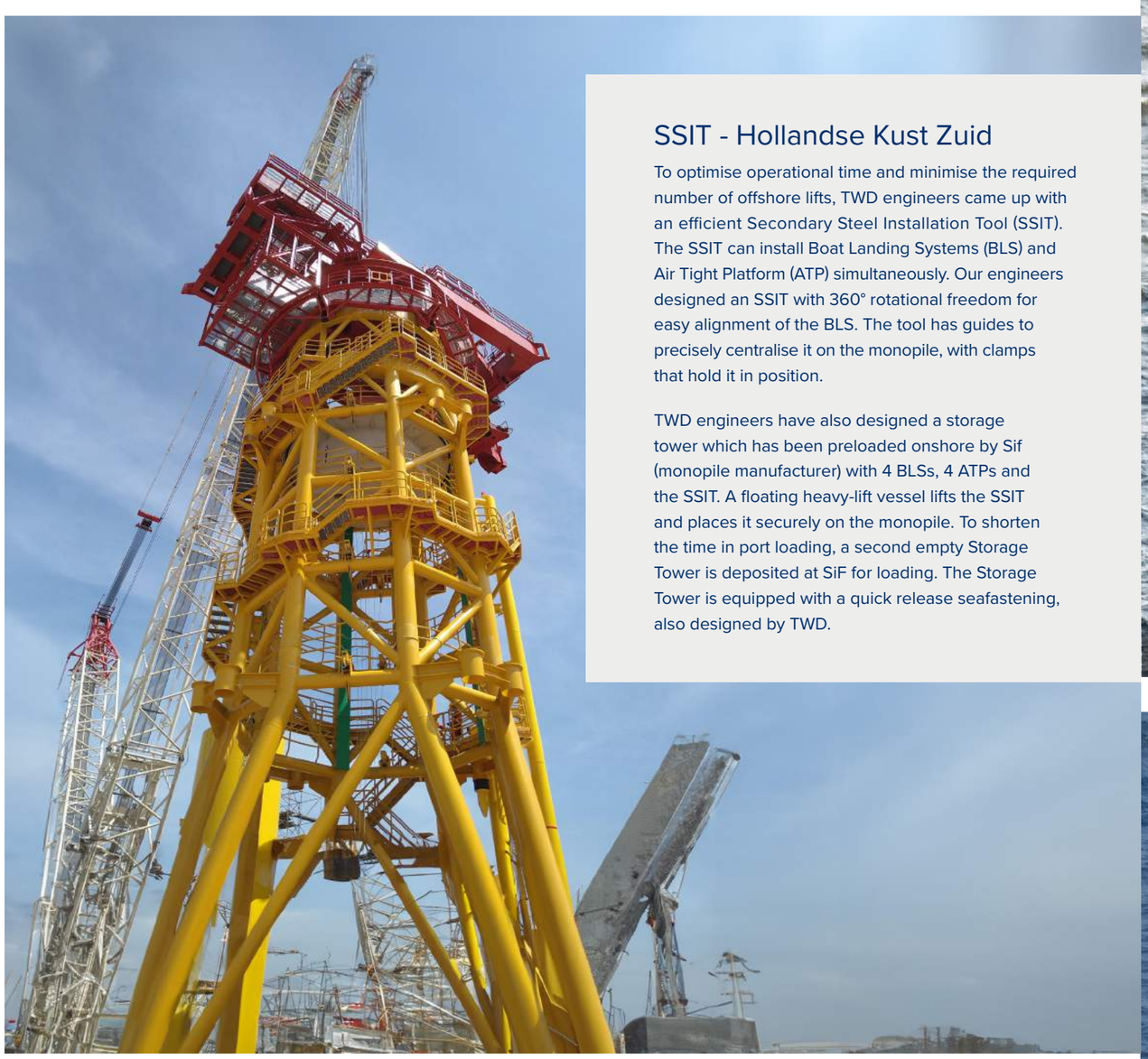


Photo Credit: Van Oord

Secondary Steel Installation Tools

Installing secondary steel without damaging components can be a challenging operation. TWD has designed multiple bespoke tools that enable and ease the installation of foundation secondary steel components.





SSIT - Hollandse Kust Zuid

To optimise operational time and minimise the required number of offshore lifts, TWD engineers came up with an efficient Secondary Steel Installation Tool (SSIT). The SSIT can install Boat Landing Systems (BLS) and Air Tight Platform (ATP) simultaneously. Our engineers designed an SSIT with 360° rotational freedom for easy alignment of the BLS. The tool has guides to precisely centralise it on the monopile, with clamps that hold it in position.

TWD engineers have also designed a storage tower which has been preloaded onshore by Sif (monopile manufacturer) with 4 BLSs, 4 ATPs and the SSIT. A floating heavy-lift vessel lifts the SSIT and places it securely on the monopile. To shorten the time in port loading, a second empty Storage Tower is deposited at SiF for loading. The Storage Tower is equipped with a quick release seafastening, also designed by TWD.

Secondary Steel Installation Tools Track Record

Wind Farm	Type	Year
Undisclosed	Secondary Steel	2026
Undisclosed	Secondary Steel	2025
South Fork	Secondary Steel	2023
GW & BKR 03	Secondary Steel	2023
Hollandse Kust Zuid	Secondary Steel	2021
Fryslan	External platform	2020
Borssele	Boatlanding	2017
Nordsee One	Boatlanding	2015
Kentis Flats	Cage	2014
Northwind	Jtube	2012

Boat Landing Installation Aid - Nordsee One

Our customer installed 54 wind turbine foundations at the Nordsee One offshore wind farm in the German North Sea, using their jack-up vessel, Innovation. To assist with the installation, TWD designed and provided fabrication supervision for multiple seafastening structures.

One of the most challenging features of this project was the installation of the lower boat landings. To ensure precise positioning of the boat landing through the splash zone without damaging the coating, TWD designed a boat landing installation aid (BIA). The BIA enabled the crew to perform a complex lift and remotely install the lower boat landings. This led to the quick, safe, and efficient installation of Nordsee One (332MW), which currently gives 400,000 households access to green energy.

PIT - South Fork

TWD collaborated with Remazel Engineering in the design phase of installation tools for transporting and installing secondary steel components in the offshore wind sector.

To optimize operational time and minimize project costs, TWD designed an efficient Platform Installation Tool (PIT). This remotely operated tool is capable of installing both internal and external platforms in a single operation, thereby reducing the number of required installation tools and offshore lifts.

TWD takes pride in providing our customer with an ingenious design that significantly reduces installation time while upholding high standards of quality and safety.

Monopile Lifting Tool - South Fork

TWD has collaborated with Remazel in developing the concept design of the Smart Monopile Lifting Tool. This innovative and robust solution has led to the development of an efficient tool capable of both lifting and upending monopiles while still maintaining a lightweight structure.

In addition to its exceptional lifting and upending capabilities, the tool features an adjustable diameter, ensuring compatibility with monopiles ranging from 7 to 8 meters in top diameter. Despite its lightweight construction, the tool has been engineered to handle monopiles weighing up to an impressive 2150 tons. To achieve this, meticulous consideration was given to efficient steel utilization. The integrity and durability of the tool under heavy loads were verified through plastic and elastic analyses. To meet the desired lightweight requirement, the team pushed the limits of the design while still ensuring its integrity.

Jacket Lifting Tool - St. Brieuc

The Jacket Lifting Tool (JLT), designed by TWD, effectively facilitates the installation of the next generation of wind turbines. With its innovative and lightweight design, the JLT boasts a Safe Working Load (SWL) up to 4000 tonnes while weighing only 1.5% of its SWL. It is adaptable to various crane capacities, ensuring seamless integration with offshore operations.

Fully remotely controlled, the JLT ensures safe and easy installation without requiring crew access to the top of the jacket. Its design prioritizes operational safety, velocity, and redundancy. TWD is proud to have designed this smart tool, which played a crucial role in installing the East Anglia OWF (714 MW), generating green energy for 630.000 homes annually. From design to DNV certification in just 10 weeks, it stands as a tailored and efficient solution for offshore projects.

Dieseko Vibro Tool

TWD designed the Dieseko upending vibratory hammer, assisting our client from the first concept to the final load-test. The tool can accommodate a WLL of 1388t and 42MN centrifugal force, vibrating at 1400rpm, for monopiles of up to 6m in diameter.

As only the second of its kind, the hammer unlocked new possibilities while posing unique engineering challenges. Key processes included refining the operational sequence through prototypes, conducting resonance analysis using advanced FEM modelling, and collaborating closey with DeMeyer on fabrication. These collaborative efforts yielded valuable insights, resulting in the design of user-friendly and high-grade equipment.

TP Lifting Tool - Kajima OWF

To assist Kajima Corporation in the installation of the Akita and Noshiro offshore wind farms in Japan, TWD developed a remotely operated lifting tool tailored for transition pieces (TPs). This project enabled the successful installation of foundations for each of the 33 turbines, comprising a monopile and a transition piece. The designs included two varieties of TPs: 5 weighing 400 tons and 28 weighing 340 tons.

The scope of the project encompassed both the conceptual and detailed designs of the TP lifting tool and TP covers. To enhance operational safety and control during lifting operations, the lifting tool was equipped with cameras and sensors. Additionally, TWD designed TP covers that provide long-term protection for the TPs during storage, both on land and at sea.

//07 Lift & Installation Tools

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