BUILDING TRUST

Offshore Wind Energy

CASE STUDIES

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BUILDING TRUST

Type of work:
Offshore Wind Energy
Location:
Taiwan Strait, Taiwan
Materials used:
MT 12,440 bulk supplied SikaGrout-9800
Client:
Boskalis Offshore International / Changfang and Xidao Offshore Wind Project
Project date:
May – Aug 2023
Number of foundations grouted:
52
Grouting operation:
47 days

CHANGFANG AND XIDAO OFFSHORE WIND FARM CAMPAIGN 2, TAIWAN

DISCIPLINES:

- Project Management
- Material Supply
- Grouting Services

The Changfang and Xidao Offshore Wind Farm is a 589MW offshore wind farm project in Taiwan developed by Copenhagen Infrastructure Partners. This new wind farm has the capacity to power 650,000 Taiwanese households with renewable energy.

Boskalis were responsible for the transport and installation of the WTG foundations, which consist of three pre-driven piles onto which a jacket was installed. The water depth ranges between 25m and 40m. Campaign 2 consisted of 52 foundations with the installation campaign taking place between April – August 2023.

JOB SCOPE

Supply of SikaGrout-9800 and grouting services for 52 WTG Jacket foundations for Campaign 2 of Changfang and Xidao Offshore Wind Farm.

SERVICES

Boskalis transported and installed the WTG jacket foundations in water depths ranging between 25 - 40 m.

Between 2021 - 2022, we supplied more than 3,400 tonnes of SikaGrout-9800 for campaign 1.

SikaGrout-9800 was used in the structural connection between the pre-driven piles and WTG jacket foundation.

In 2023, we fast-tracked the material and application services for 52 jacket foundations by delivering a turnkey solution consisting of both onshore and offshore project management, supply of 12,440 tonnes of SikaGrout-9800, offshore grouting equipment, experienced personnel, offshore QAQC and 28-day onshore cube testing of specimens at an approved third-party laboratory.

SIKA SERVICES AG I Tel: +41 58 436 4040 I www.sika.com

CHALLENGES

Due to the unpredictable weather and lack of subsea visibility at the project site location, a short installation campaign was envisaged by the customer between April to August 2023. Sika was required to supply and apply 12,440 MT in quick succession and offered our bulk product solution SikaGrout-9800 and state-of-the-art mixing technology to apply our product to the highest quality.

SOLUTIONS

We provided the customer with best-in-class product and mixing technology to meet the high demands of the project installation schedule and applied 12,440 MT to 52 jacket structures in just 47 offshore grouting days. The fastest grouting operation recorded during the campaign was up to 45m^3/hr.

PROJECT PERFORMANCE

- Our supply of groundbreaking offshore grout mixing technology and experienced crew made the fast tracked delivery of this programme possible.
- All offshore deliverables were successfully achieved resulting in an efficient and high quality application of SikaGrout-9800 in Taiwan.
- Progress was such that 28 jackets were installed within one calendar month.

CLIENT TESTIMONIAL

"The knowledge and client focus of Sika in providing SikaGrout-9800 to their customers, made us request them a turnkey solution covering supply, application and quality control of the same product. And this very much to our satisfaction as the short communication lines, open attitude to approach us as a customer and drive to perform, lead to a project execution with very high output and very good quality application. This allowed us to complete the project ahead of schedule with the full satisfaction of our end customer."

Mr. Edward Meevers Scholte
Sr. Project Manager, Boskalis Offshore International

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We have documented the technical performance of our UHPC products through a large test program at MPA (Germany) which included creep and fatigue testing and we have carried out large-scale trials at low (European conditions) and high temperatures (Tropical conditions) to demonstrate the performance of our materials under severe weather conditions.

Our Premix Grouts are a portfolio of ultra high performance concrete and composites with strength and durability 10 times better than that of ordinary cement products.

Type of work:
Greenfield - Renewables
Location:
South Korea (Mock-up Trial in China)
Materials used:
19 MT of SikaGrout-9550
Client:
HESI (Hyundai Engineering Steel Industries)
Trial date:
Dec 2023

JEONNAM OWF - MOCK UP TRIAL OF CPT45 AND UFIC 8.5 MT, CHINA

DISCIPLINES:

- Renewables
- Grout Mock-up Test
- UHPC Grouted Installation
- Material Supply

The trial was conducted to simulate offshore conditions and record data such as conveying, mixing, pumping, overall duration as well as QC testing of grout material. Based on the outcome, offshore grouting plan will be revised to achieve optimum results.

SCOPE

To prepare equipment and grout material, and then to perform a grouting trial on a test specimen with a diameter equivalent to the actual pile to be installed offshore.

GROUTING TRIALS

1. Grouting of annulus between Inner Pile and Rock
2. Grouting of annulus between Inner Pile and Mono Pile.

PROJECT HIGHLIGHTS

- Sika used the newly built CPT 45 grouting spread for the first time.
- The CPT45 is a one-of-a-kind spread capable of producing around 45 m^3 per hour using high

This was a mock-up trial conducted prior to the offshore campaign. Three monopile foundations are to be grouted during the offshore campaign.

density grout material and 8.5 MT UFIC bags

- The CPT45 facilitates high volume pile grouting in just a few hours.
- The trial was successful and assessment to increase grouting output is in process.

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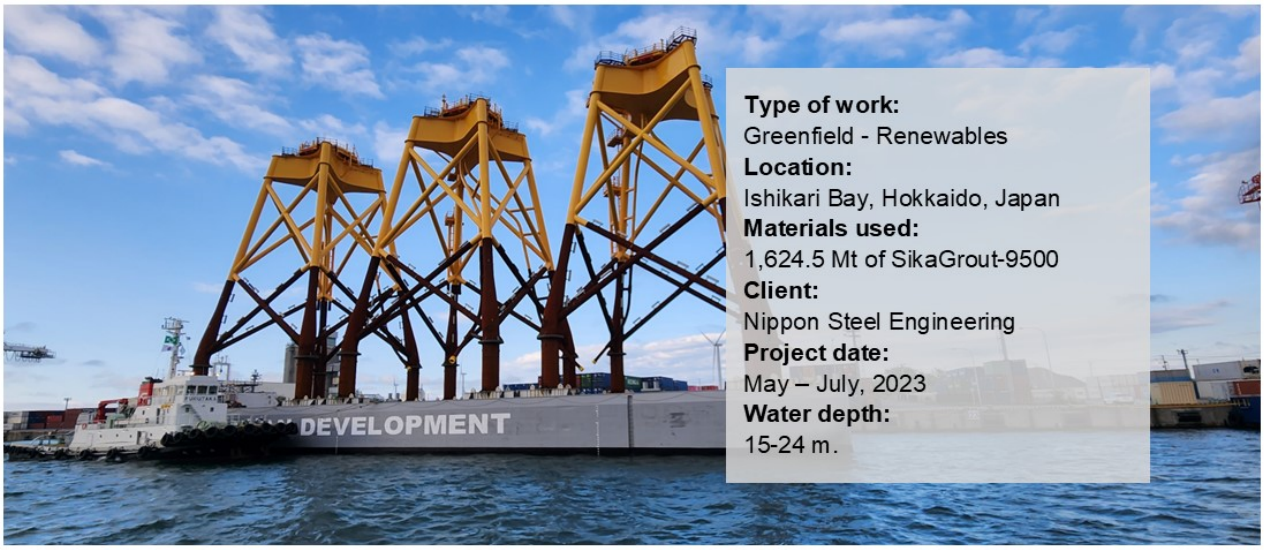
The CPT45 spread using high density grout material and 8.5 MT UFIC bags.



Type of work:
Greenfield - Renewables
Location:
Ishikari Bay, Hokkaido, Japan
Materials used:
1,624.5 Mt of SikaGrout-9500
Client:
Nippon Steel Engineering
Project date:
May – July, 2023
Water depth:
15-24 m.

ISHIKARI OFFSHORE WIND FARM PROJECT, JAPAN

DISCIPLINES:

- Renewables
- Material Supply
- Grouting Services
- Equipment Rental
- Offshore Supervision

In partnership with our sister company Pozzolith Solutions, Sika was engaged by Bond Engineering and Nippon Steel Engineering, for the provision of equipment rental and offshore supervision for the Ishikari OWF Wind Farm Project.

Nippon Steel Engineering were responsible for the design and installation of the Jacket foundations for wind turbine generators (WTG) components, taking place off the coast of Ishikari Bay New Port, Hokkaido Prefecture, Japan.

JOB SCOPE

- Preparation of grouting procedures and project documentation for grouting.
- SAT/FAT trials of the equipment, provision of CPT-25-02 grouting spread, offshore supervision, technical support and troubleshooting during the grouting operation.
- Provision of offshore crew including grouting supervisor/engineer/technician.
- Provision of SikaGrout-9500 and SikaGrout-9000 Lube.

SERVICES

In close collaboration with our local team at Pozzolith Solutions, Sika delivered grouting materials, equipment rental and provided offshore supervision for the local grouting crew.

New innovative proprietary offshore grouting equipment was mobilized to the Project, which achieved an average output of more than 22Mt per hour and 24Mt at top pumping speed.

The grouting operation, troubleshooting and maintenance was monitored closely by Sika as part of the contract and for internal Grouting Field Record documentation.

Facilitated by Bond Engineering personnel, Sika was involved in the installation of fourteen (14) WTGs of the type: SG 8MW-167. The WTGs were installed on 4-legged jacket foundations and driven to the seabed by piles.

The team used Sika's containerized batch mixing grouting spreads with a capacity of 3 MT (2 x 1.5MT bags) per mix and applied SikaGrout-9500 ultra-high strength grout for offshore wind turbine foundations.

PROJECT HIGHLIGHTS

- This was Sika's first offshore grouting project in Japan.
- The grouting operation ran smoothly and without incident utilizing a new spread CPT25-02.
- Project completed successfully with zero personnel or environmental incidents.
- All deliverables achieved.

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Type of work:
Offshore Windfarm Installation
Location:
Off the coast of Shapa town, Yangxi County, Yangjiang City, Guangdong province, China
Turbine manufacturer:
Mingyang Smart Energy
Materials used:
880 MT SikaGrout-9550
Project date:
May - June 2019

THREE GORGES YANGJIANG SHAPA 300MW OFFSHORE WINDFARM PROJECT

DISCIPLINES:

- Renewable Energy
- Subsea Jacket Installation
- Offshore Grouting Services

This is Sika's third offshore renewable wind project and first major large-scale windfarm installation project to be carried out in Chinese waters. It is owned by China Three Gorges New Energy Co.,Ltd. The first project being Binhai North Phase 2 (2017) and second project being Dafeng (2018), both owned by State Power Investment Corporation (SPIC) of China.

This wind farm comprises 55 units of 5.5 MW wind turbines and a 220-kV substation, of which 10 are jacket structures requiring grouting, as well as the substation jacket. The water depth is approximately 30 m and it is currently one of the deepest in China.

Other types of foundations in this project are monopiles (36 nos.), suction-bucket (8 nos.) and 1 floating type. When fully connected, the wind farm will supply 840 million kWh of renewable energy.

SCOPE

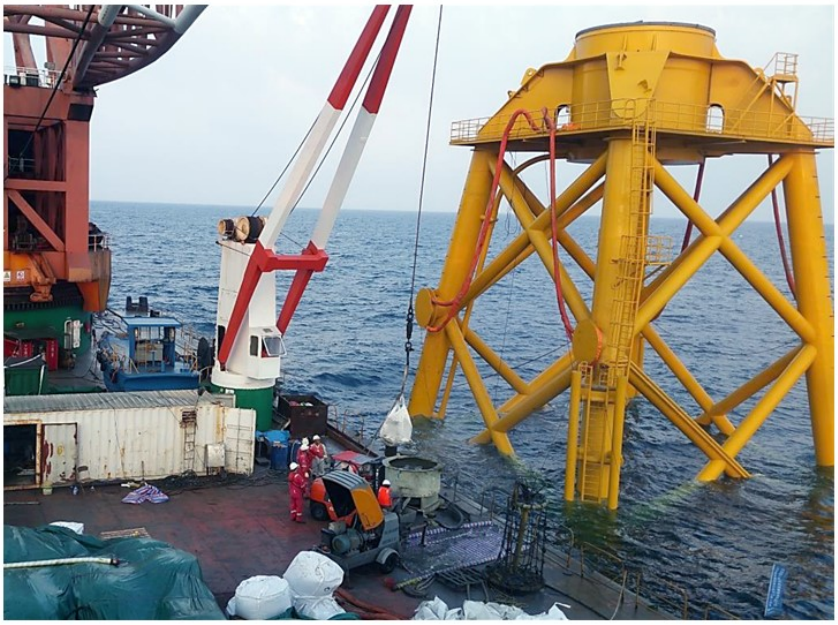
- Supply of grouting materials for a total of 10 turbine jackets and 1 substation jacket installation.
- Supply of technical expert for grouting operation in cooperation with Chinese local company, Zhuhai Ruifeng Offshore Technology Co. Ltd.

SERVICES

- Supervision of grouting operation carried out by local Chinese partner for 1 turbine jacket and 1 substation jacket installations.

CHALLENGES

- Rough seas and strong wind conditions as well as high temperatures reaching 35° C at the beginning of the summer season in Southern China.



CLIENT BENEFITS

- The team completed the Grouting of Offshore Jacket Foundation Installation using SikaGrout-9550 UHPC grout on schedule and without any delays.
- SikaGrout-9550 has been developed specifically for grouted structural connections for offshore structures including wind turbine foundations situated in extreme cold and in hot tropical climates.
- SikaGrout products have been used in more than 60 offshore projects primarily in South East Asia, Indian and the Middle East where the operational temperature often exceeds 35° C.
- The unique composition of our products allow us to pump the materials through several hundreds of meter of 2" and 3" hoses. This was verified in the DNV type approval for SikaGrout, where the hose temperature exceeds 35 °C.

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Type of work:
Offshore Windfarm Installation
Location:
Offshore Dafeng region, Yancheng City, Jiangsu province, China
Materials:
SikaGrout-9110
Project date:
June - July 2018

DAFENG H3# 300MW OFFSHORE WINDFARM SUBSTATION INSTALLATION

DISCIPLINES:

- Renewable Energy
- Subsea Jacket Installation
- Offshore Grouting Services
- Supply of HPC Materials

In Q2 2018 Sika performed Offshore Jacket Installation grouting using SikaGrout-9110 (High Performance Cementitious) grout at Dafeng H3# 300MW Offshore Windfarm Substation, a project owned by State Power Investment Corporation (SPIC), off the coast of Yancheng City, Jiangsu Province, China.

This was the second offshore renewable-related subsea jacket installation carried out by Sika in Chinese waters. The first project being Binhai North Phase 2, also owned by SPIC, was completed by our team in April 2017.

The grouting team used 110 tons of SikaGrout-9110 HPC grout materials for the installation services and completed the grouting operation in 4 accumulated days, with an actual grouting time of 36 hours, notwithstanding delays due to bad weather and leaking seals.

SCOPE

- Supply of grouting materials
- Technical expertise & manpower for grouting operation in cooperation with Chinese local company, Zhuhai Ruimiao Company.

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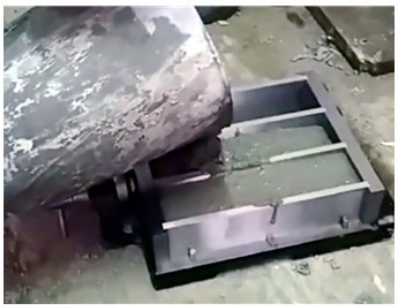
CLIENT BENEFITS

- SikaGrout-9110 HPC grout, part of Sika's proprietary High Performace Cementitious grout product range, has been developed specifically for annulus grouting in offshore structures. A rapid strength development ensures high early-age strength.
- The project required moderate grout compressive strength of 80 MPa before subsequent installation of topside module onto jacket structure could be carried out. This was achieved within 3 days after grouting at 20°C.

CLIENT BENEFITS

- The team used a simplified grouting spread, which eliminated the need for a crane, by having mixers placed directly on deck to facilitate loading of grout bags using forklift and then lifted over pump using forklift.
- The grouting services were completed ahead of schedule for the installation of the topside module despite some bad weather days and leaking rubber seals.



Type of work:
Offshore installation
Location:
Offshore Binhai County, Jiangsu province, China
Materials:
SikaGrout-9550
Grouting operation:
30 hours
Project date:
April 2017

BINHAI NORTH H2#400MW OFFSHORE WINDFARM SUBSTATION INSTALLATION

DISCIPLINES:

- Renewable Energy
- Subsea Jacket Installation
- Offshore Grouting Services
- Supply of UHPC Materials

In April 2017 Sika carried out its first offshore grouting operation for the renewable sector in China using SikaGrout-9550 UHPC grout.

The Binhai North Phase 2 is being developed by the State Power Investment Corporation (SPIC) of China. The wind farm comprises 100 units of 4MW wind turbines and a 400MW substation, which will be installed some 22 kilometres off the coast.

The newly installed jacket structure will be supporting the 400MW substation, which weighs 3200 tons, the largest of its kind in Asia.

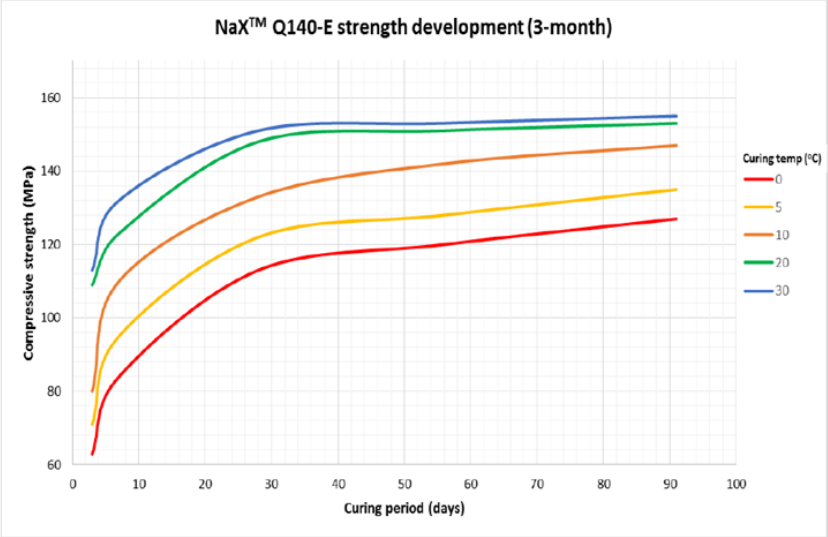
Danish engineering, design and consultancy company Ramboll are designing the wind farm, which when completed, will rank among the top five largest offshore power generation capacities in the world.

SCOPE

- Supply of grouting materials
- Supply of technical expertise and manpower for grouting operation in cooperation with Chinese local company, Nantong Jubo Offshore Company.

SERVICES

- Provision of qualified and experienced offshore grouting personnel
- Provision of equipment i.e. mixers, pumps, downhole camera etc. for executing the work scope



- Supply of 270 tons of Ultra-high performance cementitious (UHPC) mix SikaGrout-9550 along with binder lubricant mix
- Subsea grouting operation at approximate water depth of -15m

CHALLENGES

- The team was faced with challenging weather and strong winds but completed the grouting operation without any technical or operational difficulties.
- A very high grout compressive strength of 120 MPa was required before the subsequent installation of the topside module onto the jacket structure could take place.
- The grouting of the pile-sleeve connections with internal shear keys design, using SikaGrout-9550 UHPC grout, ensured high early-age compressive strength to support the subsequent stage of the topside module installation within a relatively short time period, even with low sea temperature of 13°C.
- The long-term grout strength requirement is minimum 140 MPa.

CLIENT BENEFITS

- The professionalism and the operational knowledge of the grouting team won praise from the client as the grouting operation was completed ahead of schedule despite bad weather conditions.
- SikaGrout-9550 is the ideal material for offshore wind turbine foundations and ensures a long-term solution that is state of the art within the industry.
- SikaGrout-9550 has been verified by DNV GL, as well as tested and certified by MPA BAU under the DAfStb Guideline (Germany) and CE marked to EN1504-6.
- The product exhibits high early-age strength as illustrated in the above strength development chart.

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Type of work:
Offshore Windfarm Installation
Location:
36km off the coast of Binhai County, Yancheng City, Jiangsu province, China
Materials:
94 tons SikaGrout-9550
Grouting days:
3 days
Project date:
December 2019

BINHAI SOUTH H3#300MW OFFSHORE WINDFARM SUB-STATION INSTALLATION

DISCIPLINES:

- Renewable Energy
- Offshore Windfarm
- Subsea Jacket Installation

The substation is designed by British ATKINS and PowerChina Huadong Engineering Co., Ltd. with a total weight 3,000 tons.

PROJECT SCOPE

- Grouting of Offshore Jacket Installation using SikaGrout-9550 UHPC grout
- Supply of all grouting materials and equipment

SERVICES

- Supply of materials and offshore grouting.

CHALLENGES

- Due to challenging climatic conditions the project required grout compressive strength of 90 MPa prior to installation of topside module onto jacket structure.

SOLUTIONS

- Despite very low sea temperature at 5°C during project execution, the average compressive strength under identical on-site curing condition exceeded the strength requirement within the first week.

CLIENT SATISFACTION

- The professionalism and operational knowledge displayed by the grouting team won the praise from the main contractor's project manager as well as our client, after grouting was completed ahead of schedule despite bad weather conditions.

Type of work:
Greenfield - Renewables
Location:
Hibikinada trial site, Kitakyushu-city, Fukuoka Prefecture, Japan
Materials used:
54mt of SikaGrout-9500, 1.6MT SikaGrout-9000 Lubricant
Client:
Goyo-Nittetsu Engineering JV
Trial date:
Sept 2023

SIKAGROUT-9500 FOR HIBIKI PROJECT - MOCK UP TRIAL, JAPAN

DISCIPLINES:

- Renewables
- Grout Mock-up Test
- UHPC Grouted Installation
- Material Supply

In preparation of the Hibiki Project in Japan, our team conducted a mock-up trial at Hibikinada trial site in September 2023.

TRIAL OBJECTIVES

For the grouting of the connection between the wind turbine substructure (jacket) and the foundation pile (steel pipe pile), the grouting area (jacket leg/sleeve and steel pipe pile) is simulated on land in actual dimensions. Grouting is carried out using the actual materials used in this work (mixing plant + pump etc.) and tests are conducted to confirm the filling/ pressurisation/construction of the grouting material.

The purpose of the trial was to measure the behaviour of the SikaGrout-9500 grouting material from storage in a chilled warehouse to transit from the warehouse to installation in hot temperatures.

The technique of chilling the dry grout powder prior to mixing has been utilised previously in onshore wind turbine installations with success.

At 28-days, the overall compressive strength of the trial material exceeded minimum requirements, however the affect of the chilled grout powder was less than anticipated when compared with onshore grouting.

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