Feature 1

Leveraging Collective Group Capabilities to Shorten Construction Time and Achieve High Quality

Yodobashi Umeda Tower

In October 2019, in the vicinity of the North Gate of JR Osaka Station in Kita Ward, Osaka City, we completed construction of Yodobashi Umeda Tower, a large commercial facility that includes a hotel. This project was planned as a collective development, involving renovation of the existing building in the northern area of JR Osaka Station, Yodobashi Camera Multimedia Umeda, and new building expansion utilizing the northern parking lot site.

Through the interdepartmental collaboration of our building construction business unit and civil engineering business unit, the construction of the new building with 35 floors aboveground and four floors underground, the pedestrian deck around the perimeter, and the renovation of the existing building were completed to a high standard in a short span of 27 months, all designed and built by Penta-Ocean Construction.

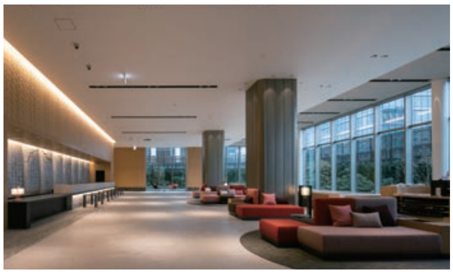
[Outline of the construction project]
Project name: Yodobashi Umeda Unit Development Project
Clients: Yodobashi Holdings, Yodobashi Tatemono
Structure/Number of floors: Steel construction (steel-framed reinforced concrete/reinforced concrete construction in some areas); four floors underground, 35 floors aboveground
Use: Department store, restaurants, hotel, parking lot
Date completed: October 31, 2019

A Place for People to Come Together Near Osaka Station

A large-scale commercial facility offering unprecedented convenience and amusement

Pedestrian deck along the building's perimeter
Completely changed the flow of people from Osaka Station by its opening

LINKS UMEDA, a commercial facility in the lower floors
Representing a facility that combines elegance and glam by creating a thriving commercial area and bringing people together



Hotel Hankyu RESPIRE OSAKA, a hotel in the upper floors
Luxuriously designed to let customers escape from the hustle and bustle of the city

Feature 1 **Yodobashi Umeda Tower**

Taking on a challenge to construct a largest-scale building in Japan

Leveraged Collective Group Capabilities to Complete the Arduous Construction Project

The Yodobashi Umeda Unit Development Project was the largest domestic design/construction project Penta-Ocean Construction has ever undertaken. Through interdepartmental coordination which is an area of strength of our company, we were able to construct a building that met the needs of our clients. We designed the building with the help of DAIKEN SEKKEI Inc. The characteristic of the project was the difficult conditions we had to work in, including the limited work space due to close proximity to other buildings and public transportations , as well as the soft ground caused by the high groundwater level. While surmounting these issues, in the short span of 27 months, we successfully completed the three key elements of the project, all carried out simultaneously: (1) construction of a new building with four floors underground, 35 floors aboveground consisting of a commercial facility with around 200 stores, a hotel with 1,030 rooms, and an underground parking lot with three levels, (2) construction of a pedestrian deck connecting the perimeter of the existing and new buildings, and (3) renovation of the existing building while stores remained open.

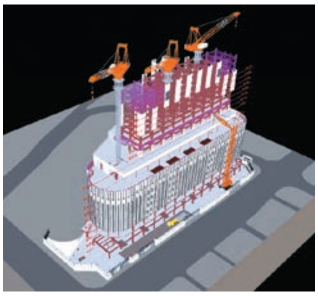
We aim to keep receiving orders for large-scale projects, by leveraging the construction expertise for high-rise buildings cultivated through this project.

Working to Achieve a Short Construction Time: Measures to Improve Productivity

The site was in an area with a high traffic volume nearby JR Osaka Station, and with many high-rise buildings and infrastructure. In order to achieve a short construction time under a safe and efficient work environment, we implemented numerous measures to improve productivity. Through site management initiatives such as pursuing labor-saving construction and utilizing the latest ICT, we were able to achieve the quality and construction time required by our clients.

Utilizing BIM*[1]: Formulating the Optimum Construction Plan

We used BIM construction simulations to carry out a pre-evaluation of labor-saving construction methods. This enabled us to examine our plans with increased accuracy and formulate a more effective labor-saving construction plan.



Examination of construction procedures by BIM

Examination results reflected in our construction plan

Utilizing ICT*[2]: For Encouraging Smooth Communication to Reduce Construction Time Loss

For efficient construction process without time loss, effective centralized information sharing between construction managers and subcontractors is vital. During the project, we created a system that immediately shares photos, blueprints, and videos of the site, as well as work instructions, among construction personnel via iPad.

Adopting Precast Concrete and Unitization

We actively adopted construction methods that would reduce the labor required for onsite work, such as using precast concrete for walls and parapets, and unitizing utility piping.

*1 An abbreviation for Building Information Modeling. A 3D model of the building is created on a computer, with all data related to the building design, such as costs and finishing elements, added into the model. A tool utilized throughout the entire life cycle (design, construction, maintenance, etc.) of the building.

*2 An abbreviation for Information and Communication Technology. Technology that helps connect people to people, and people to goods, services, and information.

Column: Applying BIM/CIM expertise accumulated in our international B.U. to domestic operations

In Singapore, where we have been conducting our business activities since 1965, the government began mandating the use of BIM in building permit applications for projects in the public sector from 2013. Operating under such environment, our international project has built up expertise in using BIM for large scale projects, such as the Sengkang General Hospital. In 2018, our company established the BIM/CIM Promotion Group in Singapore, which manages interdepartmental collaboration, such as the creation of BIM/CIM models in Japan and overseas besides Singapore.

Moreover, we created a BIM/CIM Group in the ICT Promotion Office established in April 2020, implementing a framework in which our overseas and domestic offices work together to promote BIM/CIM across the entire Group.

Our Struggles with Soft Ground: Interdepartmental Collaboration

The new building was constructed in Osaka's Umeda district, which is known for being extremely challenging in terms of underground construction due to the high groundwater level and soft ground, a result of being surrounded by the Kyu-Yodo River (collectively Yodo River, Okawa River, Dojima River, etc.). If adequate measures were not put in place when carrying out underground construction, groundwater could have flown into the construction area and had a major impact on our progress.

During construction, we collaborated with the civil engineering business unit, which has high technological capabilities and extensive experience in dealing with soft ground and water, and deployed specialized civil engineers to solve the underground construction issues.

Controlling Groundwater Level: Smooth Construction, Thanks to the Inverted Construction Method

To complete the construction of the underground structure smoothly, we needed to prevent the inflow of groundwater and keep the excavation equipment operating at high utilization rates. We controlled groundwater level by pumping up the groundwater ahead of excavation using a deep well system, enabling us to maintain high work efficiency throughout the construction.


Underground excavation conditions

Displacement Control of Subway Structures

To ensure the safe operation of the nearby subway, we needed to control displacement of subway structures caused by excavation work. We were able to control displacement of these structures by suppressing deformation of the earth retaining walls.

Solution 1
We ensured safety by installing sloped beams in the earth retaining walls to reinforce them, as well as employing an automatic measurement system to monitor displacement and stress in real time.

Solution 2
We added soil buttresses to the earth retaining walls to control deformation.

Project Member Interviews

Deputy Head of Osaka Branch and Project Director
Hiroyuki Ando

This was one of the most challenging projects Penta-Ocean Construction has ever carried out. When undertaking this design/build project, we evaluated design and cost estimations countless times over the course of a year and a half. While many proposals were adopted in the areas of design, structure, and equipment, we worked under tight construction time, cost management, and work conditions. We also faced uncertainty, in terms of upfront investments, such as the adoption of new materials. Despite all this, we kicked things into high gear and pushed forward with the project.

Tackling this project with the building construction business unit alone would have proved difficult. We were able to complete it through the collaboration of our building construction business unit and civil engineering business unit, one of our company's strengths. I think the success of the project owes to this collaboration. This success gave us tremendous confidence.

Senior Project Manager (Building Construction B.U.)
Takuro Haneda

The building is located in the heart of the city, right in front of JR Osaka Station, and is situated on a narrow space of land with soft ground. We were able to overcome these obstacles and complete construction in the short span of 27 months thanks to the combined efforts of our building construction business unit and civil engineering business unit. I take pride in being involved in the biggest project our company has ever undertaken. At one point, around 100 personnel were stationed at the worksite, and the interaction fostered between personnel is something that I myself and everyone else greatly valued. I'm sure the experience and expertise gained through the construction of a building with four floors underground (20 meters below ground level) and 35 floors aboveground (150 meters above ground level) and underground construction in such close proximity to the subway structure led to the growth of all personnel involved.

Project Manager (Civil Engineering B.U.)
Kazuto Hata

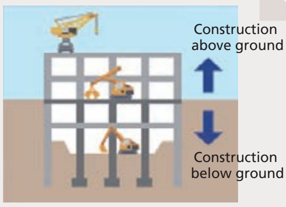
Around the north side of JR Osaka Station, groundwater level is high, and soft ground is widely distributed throughout the area. Due to this, past underground construction carried out in the same area, particularly works involving the excavation of soft ground, experienced submersion of heavy excavating equipment and major deformation of retaining walls. The project, which faced such highly challenging technical difficulties, was successfully completed within a significantly reduced construction time after overcoming various obstacles. This was thanks to interdepartmental collaboration, which is an area of strength of our company, which combined the technological prowess of the civil engineering business unit and building construction business unit.

There were many difficulties with round-the-clock construction operation, but those were fruitful days, uniting with everybody for our goal.

Column — **Inverted construction method**

The top down construction method enables above ground construction work to be carried out simultaneously with the excavation and construction of the basement. The basement slabs that are constructed as the excavation progresses will act as lateral bracing for the perimeter earth retaining structure, ensuring safety to nearby structures by minimizing soil movement.

The constructed slab of the first floor acts as a lid that reduces noise and dust. Also, since the upper and lower floors can be constructed at the same time, this helps shorten construction time.



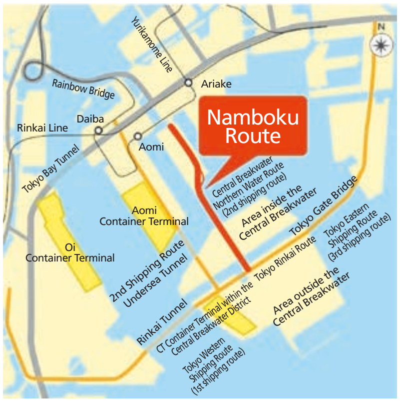
Feature 2

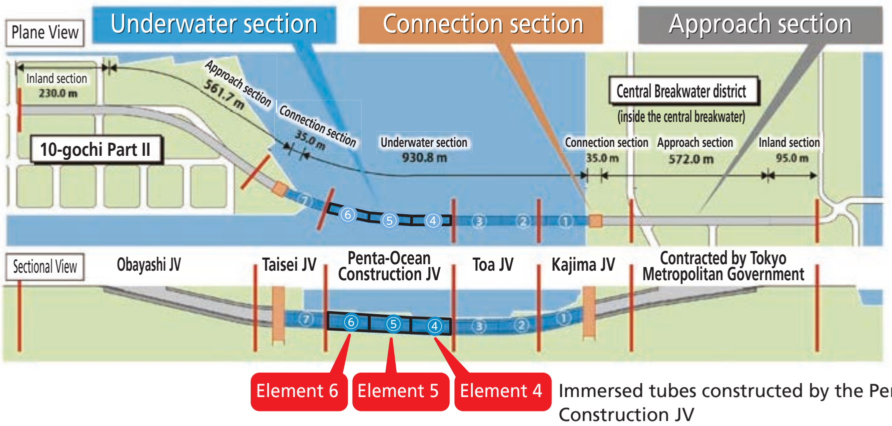
Leveraging our Patented Technology to Shorten Construction Time and Achieve High Quality

Tokyo Umi no Mori Tunnel in Tokyo Bay

The Tokyo Bay Rinkai Road Namboku Route Project is the construction project of a roughly 5.7km four-lane road connecting the Central Breakwater district and Ariake district, which are areas that will serve as venues for the Tokyo Olympics and Paralympics. With the opening of the Namboku Route, the main road connecting Ariake and Aomi district to the Central Breakwater district will become a concurrency (i.e., multiple routes on one roadway). This is expected to improve its logistics functions and enable the road to serve as an access route to the Tokyo Olympics and Paralympics athletes' village and sporting venues, constructed in the Harumi district.

In the Namboku Route there is an undersea tunnel (around 930 meters long), composed of seven immersed tubes linked together. Three of these immersed tubes (segments 4, 5, and 6; around 400 meters of the route) were fabricated and installed through a joint venture between Penta-Ocean Construction, Toyo Construction, and Nippon Steel & Sumikin Engineering. Amid the need to open the route quickly, the tunnel was completed within about four years instead of the typical eight to ten years. The speedy completion owed to extending the length of each immersed tube, filling the steel shell immersed tubes with concrete while floating them on the sea, the application of Penta-Ocean Construction's own Key Element Method, and collaborating with the building construction business unit for the construction of the tunnel's facilities and the tunnel's electrical rooms.





Immersed tubes constructed by the Penta-Ocean Construction JV

What are Immersed Tunnels?: The Processes Involved in Immersed Tube Fabrication and Sinking

The tunnel of the Namboku Route is what is known as an immersed tunnel. To construct these tunnels, a trench is produced by dredging the bottom of the sea or the river, in which the prefabricated elements, known as immersed tubes, are sunk and connected, then covered with soil.

Dredging for producing a trench

Foundation construction

Sinking

Backfill

Fabrication of the steel shell

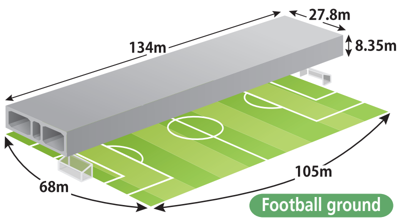
Concrete filling while floating

Towed to the sinking location

Opening

Extending the Immersed Tubes: The Longest Tubes in Japan at 134 Meters Long

To shorten construction time, we extended the length of each immersed tube. The immersed tubes sunken in this projects are the longest immersed tubes in Japan, with each one 134 meters long. The bigger and longer the tubes get, the more difficult it becomes to maintain quality. A high level of precision is required when installing the tubes, but our company's abundant experience in undersea tunnel construction and advanced technical capabilities enabled us to achieve the required level of quality and highly precise installation.



Collaboration of Advanced Technology and Divers' Expert Skills

Millimeter precision is required when sinking immersed tubes. Underwater sensing technology and other advanced technologies are used when constructing the tunnel, but the final adjustments are checked visually by divers.

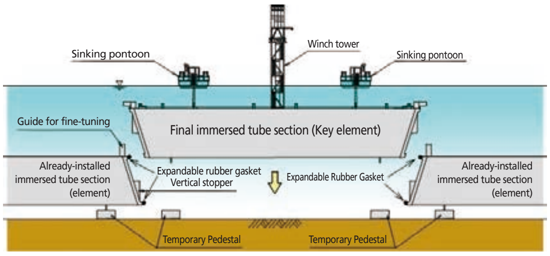
Confirming the accuracy of the installation in Tokyo Bay, which has a visibility of 30 centimeters, is no easy task. The technical brilliance of expert divers enabled us to overcome this difficulty and successfully install the immersed tubes with a high degree of precision.

Patented Technology for Undersea Tunnels

The Key Element Method

Element 6, the final element of the immersed tubes to be installed under our joint venture project, was installed using the Key Element Method, which was developed by our company. The procedure utilizes the final element itself, which is a trapezoid structure, as the jointing element, eliminating the need for conventional final joint construction work and greatly shortening construction time.

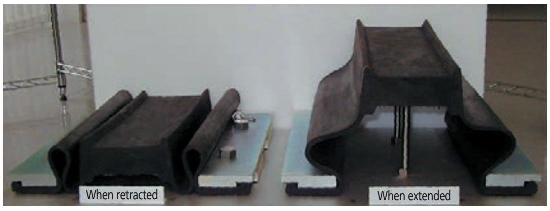
The use of the Key Element Method in this project marks the fourth application of this highly reliable method, which has also been applied for projects such as the Yumesaki Tunnel in Osaka.



Expandable Rubber Gasket

The expandable rubber gasket is a hollow structured water seal made of rubber. It can be expanded by filling it with air or mortar. Combining this with the Key Element Method can deal with measurement errors made during tunnel sinking and deformation of the outer edge due to water pressure, while providing a failsafe system for sealing water.

In this project, it was adopted for Elements 5 and 7, which were connected to Element 6.

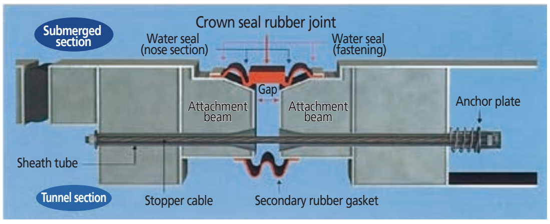


Crown Seal Method

The joint part of the Namboku Route immersed tunnel was installed using the Crown Seal Method in order to ensure high earthquake resistance.

Unlike conventional ridge connection structure, the Crown Seal Joint provides a free space (gap) between joints to absorb large deformations on the joint section caused by earthquakes, greatly reducing any stress the immersed tube body is subjected to.

To prevent water leaking from the gap into the tunnel, the Crown Seal Joint not only has a multi-layered water sealing function, but it is also coupled with a secondary rubber gasket to achieve high level water seal.



Construction of the Tunnel's facilities and Electrical Rooms: Interdepartmental Collaboration

- For the installation of ventilation, lighting, and disaster prevention facilities within the tunnel and electrical room construction, we deployed construction personnel specialized in building facilities and building construction
- Construction personnel from civil engineering, machinery and electronics, building facilities, and building construction worked together, making adjustments for clients and with other construction areas about technologies and construction processes


Tunnel construction


Electrical room construction

Project Member Interviews

Immersed tunnel construction and the technology involved are our forte. We undertook the project with a sense of urgency to complete the construction in time for the Tokyo Olympics. With a short construction timeframe and tremendous workload, particularly for tunnel's facility works after the sinking of the immersed tubes, it was crucial that we avoided any mistakes when carrying out sinking work, a critical point in the construction process. Also, we collaborated with the building construction business unit on construction of the electrical room and the tunnel's facilities, works that cannot be experienced through regular civil engineering projects, to successfully complete the tunnel.


Special Projects Manager
Naoki Kuwahara

This project was my first worksite since joining the company. At the site, in my role as one of the site foremen, I made every effort to gain the trust of my fellow workers by actively communicating with them and always providing well-grounded answers. Amid the tight timeframe, we all shared the same conviction to finish the project in time for the Tokyo Olympics. We managed to complete construction within the specified deadline without any major issues. I felt a huge sense of accomplishment once the project was complete. It made me feel so glad to have joined this company.

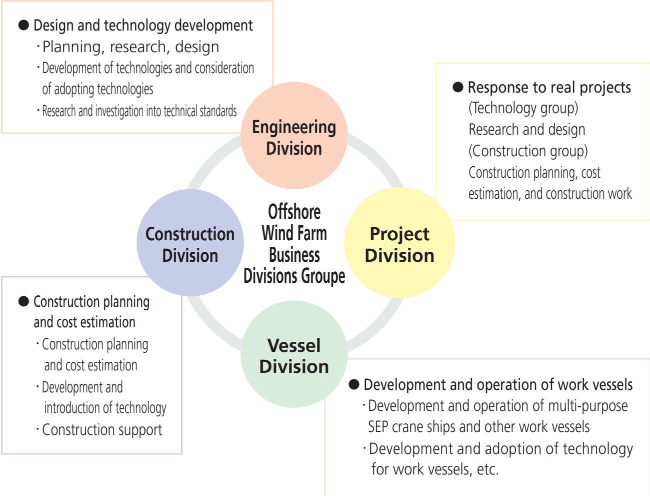

Chinatsu Tokimatsu

Tackling the Offshore Wind Power Field: Aiming to be a Front Runner

Laws related to operating offshore wind power generation plants in general sea areas have progressed, such as the amendment of the Port and Harbor Act in 2016 and enforcement of the Act on Promoting the Utilization of Sea Areas for the Development of Marine Renewable Energy Power Generation Facilities in 2019. After this, offshore wind power generation projects in Japan took off. Our company is aiming to become a front runner in the offshore wind power field by leveraging our strengths in marine civil engineering.

Establishment of the Offshore Wind Farm Business Divisions Group

Our offshore wind power generation operations first started in 2002, when we constructed Japan's very first offshore wind power facility in the Setana Port area of Hokkaido. From 2009, we planned and built an experimental wind turbine facility of New Energy and Industrial Technology Development Organization (NEDO) off the coast of Kitakyushu as part of a research project conducted by J-Power. In FY 2017, we began construction of CP-8001, a multi-purpose self elevating platform (SEP) equipped with a large crane. In June 2018, we established the Offshore Wind Power Project Team under direct supervision of the civil engineering, and have since been diligently working to enhance our technology. In April 2020, we established the Offshore Wind Farm Business Divisions Group with the aim of strengthening our initiatives for sales, technology, construction, work vessels, and real projects in order to better respond to offshore wind power projects, which continue to pick up steam in Japan. We will enhance our work by cooperation among newly made four divisions and aim to be the front runner in the offshore wind power field.



CP-8001, the Multi-purpose SEP Equipped with a Large Crane: Operating in Various Areas Across Japan

In December 2018, Penta-Ocean Construction completed the construction of CP-8001, the first Japanese multi-purpose SEP equipped with a large crane. The vessel is able to achieve high utilization rate, high accuracy, and safe crane operation even under harsh marine and weather conditions. After undergoing various sea trials in Japanese coastal waters and used in a marine project, the vessel was utilized for the removal of a bottom-fixed offshore experimental wind power facility and a wind observation tower off the coast of Kitakyushu in October 2019. It is now playing an active role in various areas across Japan, such as surveys of the seafloor.

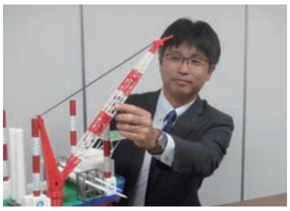
＜Features＞

- Designed to perform installation of large-scale marine structures, such as 10 MW wind turbines
- Operational in deep waters (up to 50 meters)
- Equipped with a latest continuous hydraulic jacking system developed by GustoMSC
- Designed to automatically control the hull position via Dynamic Positioning System (DPS)
- Carries adequate accommodation space and a helicopter deck for emergency human transport

Removal of the experimental wind power facility off the Kitakyushu coast

Project Member Interviews

The construction division, to which I belong, predominantly handles construction plan proposals for offshore wind power facilities and the drawing up of cost estimates for customers. However, we also handle operation planning of CP-8001 for marine projects and seafloor survey, as well as field trials and tests in the ocean. By accumulating expertise as the only Japanese company with a multi-purpose SEP equipped with a large crane, I believe we can enhance our competitiveness in the offshore wind power field, which is expected to take off going forward. Since joining the company, I have been working solely at offshore construction sites, being involved in marine work on outlying islands with difficult weather conditions. At CP-8001's first work site, I served as a supervisor. By utilizing this experience, I hope to play an important role in our company's efforts to become a front runner in the offshore wind power field by establishing our world-leading, high-precision Japanese technology.



Civil Engineering Business Unit
Offshore Wind Farm Business Divisions Groupe
Building Construction Division Manager
Daisuke Nakagawa

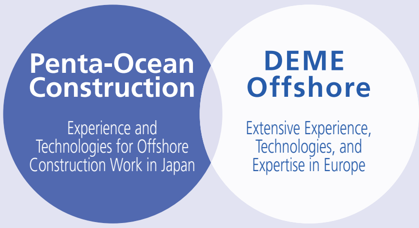
Enhancing our Competitive Edge by Forming Alliances

While developing our own core technologies and human resources as a basic policy, we have also promoted joint research and development with external companies for each theme and project, more actively than before. For the offshore wind power field, we have promoted alliances with external companies as necessary in order to enhance our competitive edge.

Strengthening Our Engineering Capabilities: Alliance with DEME Offshore

In March 2020, we signed a memorandum of understanding (MOU) with Belgium-based DEME Offshore concerning cooperation for constructing offshore wind farms in Japan. As the first step, our company and DEME Offshore will start with the introduction and development of technologies deemed useful and beneficial to the Japanese market, aiming to move onto the joint execution of offshore wind farm projects in Japan.

Combining the Strengths of Penta-Ocean Construction and DEME Offshore



Providing comprehensive solutions

Construction Conditions Particular to Japan

- Japan has a wide variety of seabed grounds, including a mix of sand and bedrock, as well as soft ground
- In addition to the harsh weather and sea conditions, such as high tides and strong winds caused by typhoons and sudden cyclones, seismic force must be taken into account

DEME Offshore

- A subsidiary of the DEME Group, a global offshore marine civil engineering company
- A pioneer in the construction of offshore wind farms in Europe
- Possesses a vast reservoir of expertise and the latest technologies for the construction of offshore wind farms
- Owns seven SEP vessels equipped with large cranes vital in offshore wind farm construction, such as foundation construction and turbine installation, as well as many work vessels used for cable installation, maintenance, etc.

Multi-purpose SEP Equipped with a Large Crane a 1,600t Lifting Capacity Crane: Responding to the Demand for Upsizing of Wind Turbines

Our company is currently constructing a second multi-purpose SEP equipped with a large crane to respond to the trend toward larger offshore wind turbines and their foundations. The construction of this vessel has been outsourced to Singapore-based PaxOcean Engineering. It is slated for completion and delivery in September 2022.

The SEP will be owned by PKY Marine (in which our company has a 65% stake), jointly established by Penta-Ocean Construction, Kajima Corporation, and Yorigami Maritime Construction in February 2020.

＜Characteristics＞

- Equipped with a fully revolving crane with a 1,600t lifting capacity
- Designed to install 10-12MW turbines and various foundations, including monopiles, jackets, etc.
- Can carry multiple 10-12MW class wind turbines for efficient installation works
- Operational in deep waters (up to 50 meters)
- Able to maintain the hull position by Dynamic Positioning System (DPS)

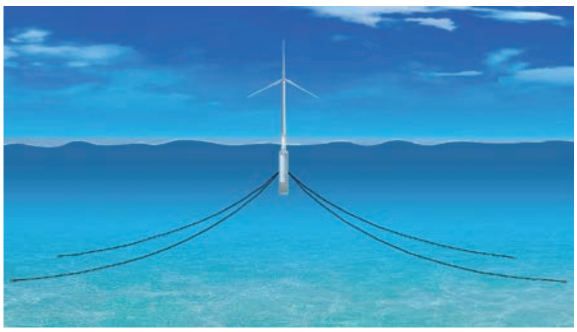
Conceptual image of completed SEP

Developing Technology to Reduce the Cost of Floating Type Offshore Wind Power Generation

In collaboration with TEPCO Holdings and the University of Tokyo, we were successfully selected by NEDO to participate in its "Research and Development on Technologies to Lower the Cost of Floating Offshore Wind Power Generation."

Amid the harsh weather and marine conditions faced in Japan, the installation of floating offshore wind farms is crucial in expanding offshore wind power generation. In order to achieve this, power generation costs need to be lowered. In our research, we will conduct a study on a rational and efficient construction method for spar-type floating structures* capable of mounting a 10MW class wind turbine under the severe weather and marine conditions in Japan.

* A cylindrical floating body which is less susceptible to waves due to the small penetration area in the water's surface.



Conceptual image of a spar-type floating structured offshore wind power