Feature ①

“CP-8001,” the First Japanese Multipurpose SEP Equipped with a Large Crane

Introduction

In December 2018, Penta-Ocean Construction Co., Ltd. completed the construction of “CP-8001,” the first Japanese multi-purpose self elevating platform (SEP) equipped with a large crane. By lifting the hull to the surface of the seawater, the vessel is able to carry out safe crane operation even under harsh marine and weather conditions. In Japan which is surrounded by the sea, the multi-purpose SEP “CP-8001” ensures to achieve high utilization rate, high-accuracy and safe operation in offshore civil engineering and construction of offshore wind power generation facilities.

Towards the Future of Renewable Energy

With the expansion of renewable energy, offshore wind power generation is spreading worldwide. According to the Global Wind Energy Council, as of the end of 2018, the world's offshore wind power output has more than tripled in five years. With the spread of offshore wind power generation, stiff cost competition has begun in Europe. Offshore wind power generation is also spreading in Asia, and offshore wind power projects are underway in Taiwan.

In Japan, the momentum to promote renewable energy has increased after the Great East Japan Earthquake, and the development of laws on offshore wind power has progressed. Many offshore wind power generation projects are being planned. However, there was no SEP equipped with a large crane that can install offshore wind power generation facilities in Japan.

As the "No.1 Contractor in port, coastal and waterfront areas," we built a multipurpose SEP equipped with a large crane ahead of other domestic construction companies.

Flowchart of Windmill Installation

In the installation work of windmill facility, a series of work of loading → sea transportation → monopile driving → windmill installation can be done only with CP-8001.

① Loading

The fabricated windmill components (towers, hubs, nacelles, blades, etc.) and foundation components (piles, etc.) are temporarily placed near the quay. We jack up CP-8001 on the quay and load the components on the hull with the main crane.

② Transportation

After loading is completed, CP-8001 is jacked down to float on water. The hull is towed and transported by a tug boat to the installation site. At the place where the windmill is installed, the legs are lowered, and the hull is jacked up with the hull position held by Dynamic Positioning System.

③ Installation

After placing the foundation, wind turbine components are installed in sequence. The windmill installation work is extremely precise and it requires high-precision crane operation. After the windmill is placed, the hull is jacked down to float and moved to the next location.

Offshore Wind Power Generation and CP-8001

Types of wind power generation

There are two types of offshore wind power generation: bottom-fixed type and floating type. CP-8001 is the first Japanese multipurpose self-elevating platform (SEP) equipped with a fully-revolving crane for the purpose of construction of a bottom-fixed type offshore wind power generation.

◆ **Bottom-fixed type wind power generation**

It is suitable for offshore with water depth shallower than 50 meters. With this method, wind turbine equipment is installed on the support structure (foundation) constructed on the seabed. Currently, more than 99% of the world's wind power generation systems in practical use are adopting this method.

◆ **Floating type wind power generation**

Floating type offshore wind power generation is more suitable for deeper seas than bottom-fixed type. With this method, wind turbines are installed on moored floating structures. It is effective for terrain with few shallow waters like Japan, but the installation of this type costs more than the bottom-fixed type, and it is still in the process of technical development.

Meaning of SEP

SEP is an abbreviation for "Self-Elevating Platform." It is a work vessel that lowers the four legs on the seabed and lifts the hull above the water surface.

Corresponding water depth

The maximum water depth in the port area is approximately 30m, where the bottom-fixed offshore wind power generation facility is planned to be constructed. Therefore, we tailored the length of the legs to be 66m at the time of construction. In the future, considering the possibility of operating in general sea areas with expected maximum water depth of about 50m, the CP-8001 is designed with the legs that can be extended up to 86m.

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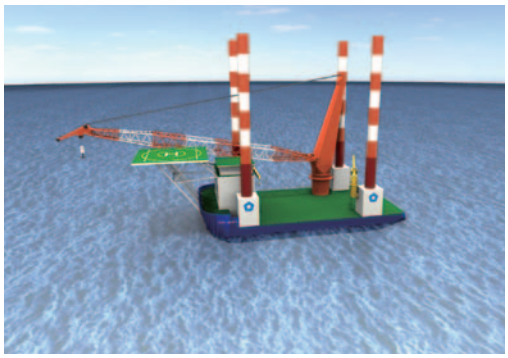
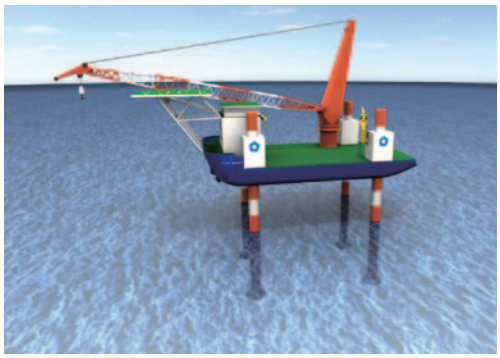
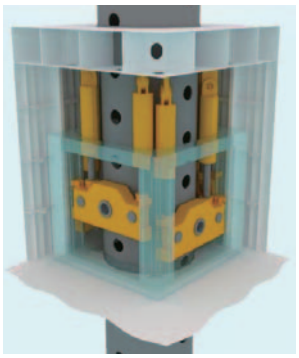
"CP-8001," the Multipurpose SEP

Jack-up Device





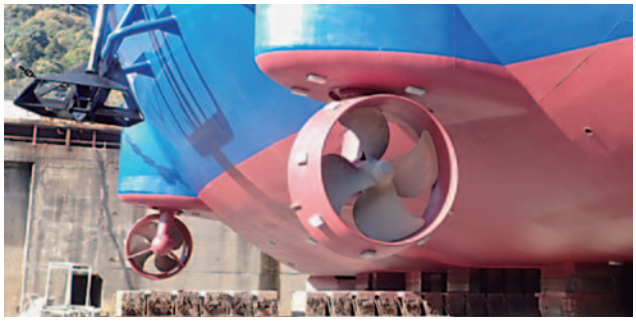


The leg has multiple holes in four directions into which the jack device pins can be inserted to raise or lower the leg.

The continuous hydraulic jack-up system installed on the ship is designed so that four pins are inserted at different heights, the leg is always moved up and down by three pins, and the remaining pin is inserted and replaced. As a result, there is no time loss to stop the jack for replacement, and the time required for hoisting is reduced by about 40% compared with the conventional jack system.

Azimuth Thrusters / Dynamic Positioning System

A total of four propulsion units and two sets of Azimuth thrusters, which can rotate 360° horizontally are installed on the bow and stern. CP-8001 is also equipped with Dynamic Positioning System (DPS). This device automatically controls the output and direction of the azimuth thrusters and holds the vessel at specified position while sensors and calculations detects external forces, such as tidal current, wind and waves that move the hull.



Senior Manager, Vessel and Machinery Management Division, M&E Group

Hideaki Okada

In 2013, I went to Belgium, the Netherlands and the UK to observe SEP vessels and wind farms and to learn about European offshore wind power projects. At that time, we had just completed the installation work of NEDO's offshore wind power generation facility for experimental study and offshore wind observation tower off the coast of Kitakyushu. Back then, Japan's offshore wind power generation business had many challenges in terms of technology, environment, infrastructure, and construction. Legal systems were not implemented yet. Compared to the situation in Japan, wind turbines were installed more efficiently by using SEP vessels in Europe. After seeing them, I strongly felt that we should have a large SEP vessel in Japan.

Although we adopted the overseas technology for the basic design, we could not just build the SEP vessels under Japanese construction conditions as is, because the overseas SEP vessels were tailored to their conditions. In Japan, there are different climatic conditions, such as earthquakes and typhoons that are not occurring in Europe, and there are a wide variety of seabed grounds, such as bedrock and soft ground. The submarine topography is also not as smooth as in Europe. CP-8001 is a SEP vessel well suited for Japanese construction conditions based on overseas technology.

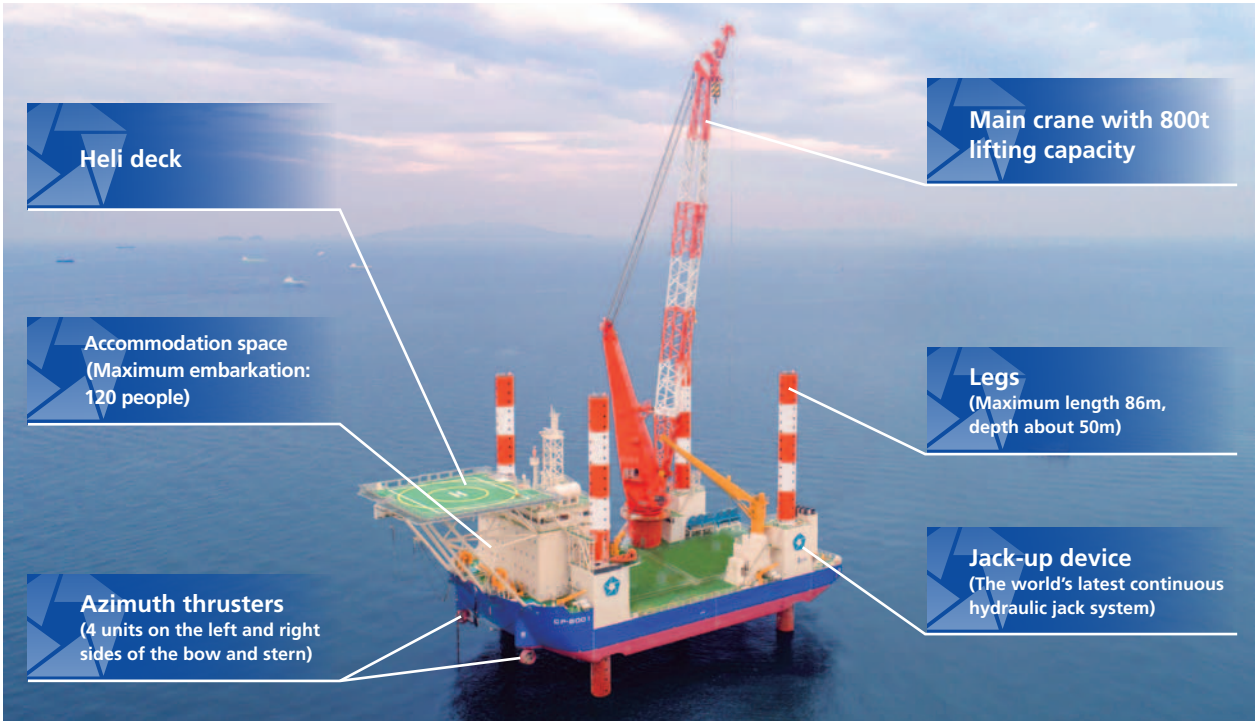
Vessel and Machinery Management Division, Vessel Management Group

Masaya Ishikawa

With a limited knowledge I had on vessels, I had a hard time understanding the specifications and manuals written in English. The terms were so technical that I could not understand even if I searched them. But my supervisor and partner companies always helped me. I felt the expectations from my company and other parties around that they would like young engineers like myself to grow by gaining experiences and learning skills from the seniors. Each action of selecting on-board equipment or the crane layout has a meaning and is based on precise calculations to maximize the vessel's potential. I believe we were able to complete the first SEP equipped with a large crane in Japan because our company has the extensive expertise from building many work vessels in the past.

In addition, although there was regulation for SEP vessels in the classification of Japanese vessel it was difficult to apply it to a SEP equipped with a large crane, such as those used for offshore wind power generation in Europe. Based on this point, we had a series of meetings with the Vessel Classification Society together with the shipyard and solved the problems one by one while building CP-8001.

In the future, I hope that CP-8001 will become a pioneer to contribute to the development of the offshore wind power generation business and boost not only our company but the entire construction industry.



Feature ②
Promotion of i-Construction

What is "i-Construction"?

It is a technology that aims to improve the productivity of the entire construction production system by making full use of ICT* while creating more attractive construction sites. The promotion of i-Construction and improvement of productivity are expected to lead to "work style reform" and "securing human resources" which will play a vital role in the next-generation construction industry.

* ICT: Information and Communication Technology

▶ The Matarbari District is a region with a high turbidity level and very fast currents in the water. This is clearly seen in the difference in turbidity on the left and right sides of the embankment.

Labor-saving Construction Using 3D Information by Underwater Sonar, etc.

Matarbari Coal-Fired Power Plant Port/Site Construction (Bangladesh)

Overview of the construction

As part of the export of high-quality infrastructure promoted by the Japanese government, Bangladesh is building its largest coal-fired power plant located in the southeastern part of the country in order to meet their increasing power demand in recent years. As a part of this project, we are dredging an access channel for navigation of the coal ships spanning to a total length of 14 kilometers, constructing a sand dike to reduce siltation in the access channel after dredging, sand filling for reclamation of the power plant site including ground improvement.

Efforts to improve productivity in construction of sand barriers

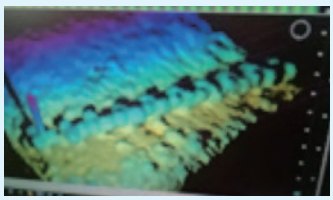
In this project, we will construct a 1,753-meter-long sand dike to prevent siltation into the port. The sea area has high tidal currents and 0-meter underwater visibility. There are also restrictions on the construction period due to weather conditions such as the rainy and monsoon seasons. Thus, it was necessary to take measures such as labor saving. Also, 24-hour work shift was required to perform rapid construction for a short period of 14 months. Therefore, manpower saving technology by mechanized construction was incorporated to operate during the night.

Challenges to overcome	Solving problems using ICT
Turbidity with 0-meter underwater visibility	Underwater sonar installation for analysis
Highly difficult diving work due to tidal current	Unmanned underwater work through mechanization

Labor Saving Efforts through Mechanized Construction

- Block installation by remote control was conducted using underwater sonar
- Installation history management with sensors installed on trolleys
  - ▶ Realization of unmanned construction of the underwater parts during the night and in the turbid environments where visibility cannot be secured
  - ▶ Realization of 24-hour work shift because it was possible to carry out the work without relying on divers

Realization of labor saving by managing the history of the installed blocks by using the underwater sonar fitted on the part shown in red in the photo



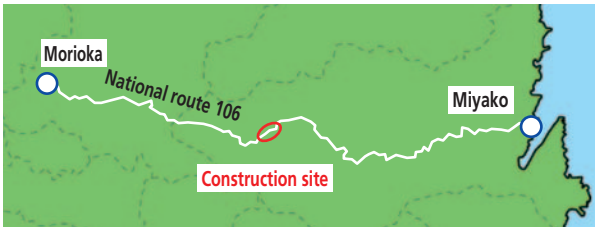
Images taken by underwater sonar

Initiatives to Improve Work Efficiency by i-PentaCOL (Penta-Ocean Information Sharing System)

National Route 106 Yobesawa Tunnel Construction

Overview of the construction

The Miyako-Morioka Crossing Road is positioned as a reconstruction support road promoting cooperation between the areas affected by the Great East Japan Earthquake and inland, and supporting early reconstruction and further expansion of the emergency transportation network. The Yobesawa tunnel project is a tunnel extension construction up to 1,039m of the Miyako-Morioka Crossing Road.



Trial of new technologies such as IoT and AI
-Public/Private R&D Investment Strategic Expansion Program (PRISM)

The Ministry of Land, Infrastructure, Transport and Tourism is promoting i-Construction, aiming to improve construction site productivity by 20% by FY 2025 by utilizing the "Public/Private R&D Investment Strategic Expansion Program" (PRISM*1) established by the Cabinet Office in 2018.

As part of this effort, a public offering of a "Project on the introduction and use of innovative technologies to dramatically improve the productivity of construction sites" was established. This project was designed for research and development to improve productivity at construction sites by testing new technologies such as IoT*2 and AI*3. A consortium represented by our company was selected. In the Yobesawa tunnel construction carried out by us, we made a trial of a variety of advanced technologies using ICT technology.

On-site trial technologies

① 3D surface survey
② Autonomous drone
③ Ahead of tunnel-face exploration cloud sharing
④ Remote inspection
⑤ AR*4 inspection
⑥ Flow line measurement
⑦ Information collection and sharing system(i-PentaCOL)

Consortium members

Penta Ocean Construction Co., Ltd.: ①~⑦
Informatix: ⑤
Osaka University: ⑤
Sooki Co., Ltd.: ⑦
Panasonic Corporation: ⑥
Bcore, Inc.: ⑥
Hitachi Systems, Ltd.: ②

* The number represents the trial technology that each company was represents charge of.

*1 PRISM: Public/Private R&D Investment Strategic Expansion PrograM
*2 IoT: Internet of Things
*3 AI: Artificial Intelligence
*4 AR: Augmented Reality

Improvement of work efficiency by i-PentaCOL

In this project, seven companies and educational institutions have formed a consortium and worked on the utilization of trial technologies. Since each trial technology measures and acquires data using different systems, it was necessary to integrate the systems using i-PentaCOL. The data aggregated in the cloud were shared with the clients and related parties, and the data from different systems were also utilized interchangeably.

Challenges to overcome	Solving problems using ICT
The complexity of managing multiple systems	Integrating and storing information in the cloud
The complexity of using data between different systems	Using the information for 3D data source management, AR, etc.

Flowchart of Information Management Using i-PentaCOL

Data collection

- 3D construction drawing/ survey information
- Autonomous drone image information
- Ahead of tunnel-face exploration information(horizontal boring etc.)
- Flow line measurement information
- Other on-site management information

Information from various trial technologies implemented by each company is imported in the cloud server.

Integration and sharing of data (practice of efficiency improvement)

i-Penta 五洋情報共有システム COL

Information was consolidated in i-PentaCOL in the cloud server. The information was used not only internally use, but also for examination of construction procedures with related parties through data sharing and remote confirmation with the clients.

Utilization of data (approach to advanced technology)

3D construction drawing information and survey information + Ahead of tunnel-face exploration information (horizontal boring data, etc.)

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Data integration/ conversion

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AR inspection

Using a dedicated AR inspection tool, we superimposed 3D construction information data on the real space and carried out experiential inspection.

*The Yobesawa tunnel construction project will continue to work on PRISM in FY2019. Based on the results of FY2018, we will exploit more advanced and efficient technologies.