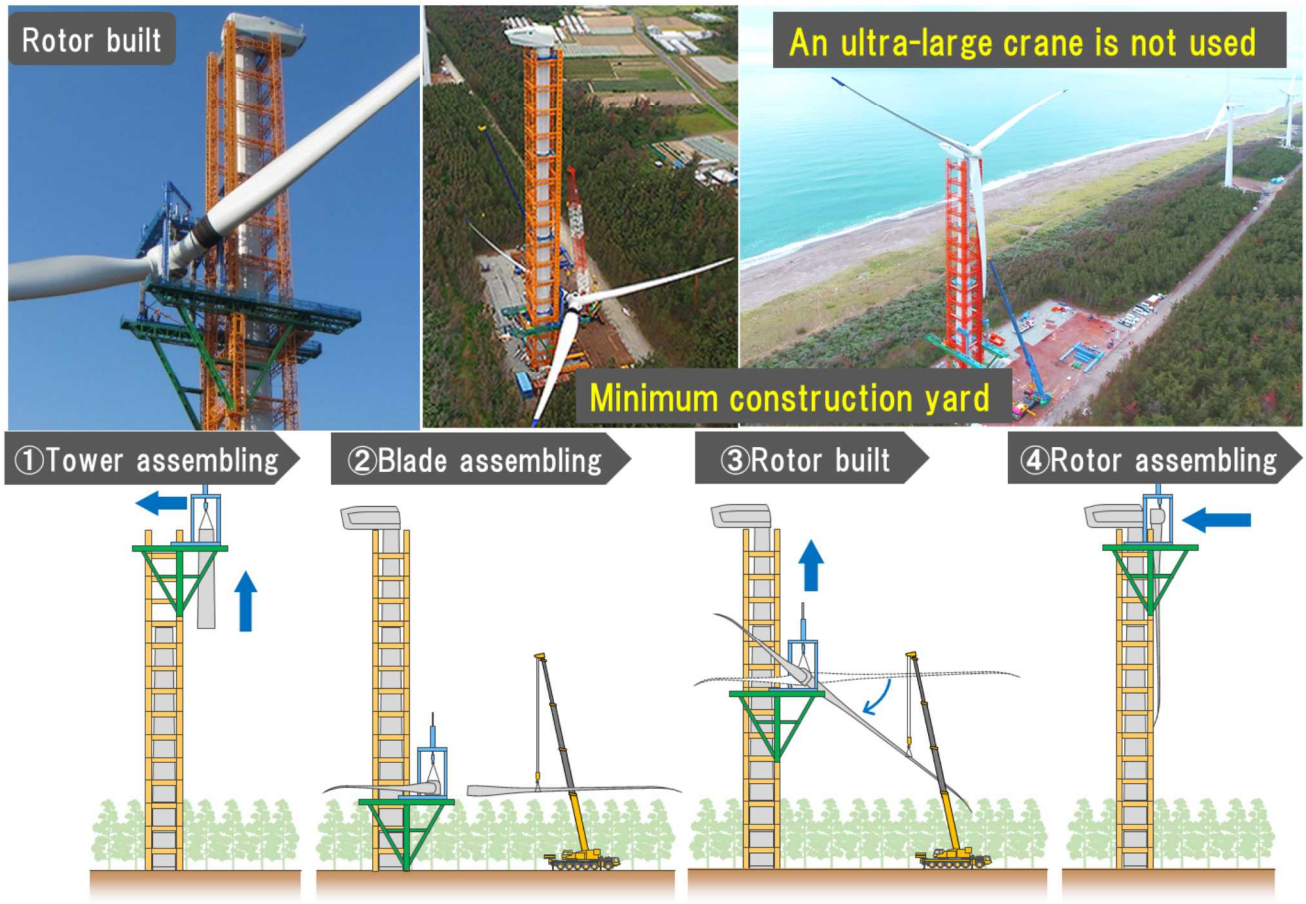
February 2019 No.83
Japanese Infrastructure Newsletter

# IDI QUARTERLY

Infrastructure Development Institute—JAPAN

## Construction of Large Onshore Wind Turbine by Lift Up Method
## “ Wind Lift “




## CONTENTS



**Infrastructure Development Institute – Japan (IDI)**
Plaza Edogawa-bashi 3F. 1-23-6, Sekiguchi, Bunkyo-ku, Tokyo, 112-0014, JAPAN
Tel: +81-3-5227-4107 Fax: +81-3-5227-4109 E-Mail: idi17@idi.or.jp Website: http://www.idi.or.jp/en/

# 20th Infrastructure Technology Development Award 2018

Japan Institute of Country-ology and Engineering (JICE) was established as a public interest corporation to promote construction engineering in Japan by conducting cutting-edge research and development activities.

As more incentives should be provided for construction technology researchers and research institutes to enhance the level of construction engineering more effectively, JICE commenced Infrastructure Technology Development Award with Coastal Development Institute of Technology (CDIT) under the auspices of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT).

Thirty-four technologies competed for the 20th Infrastructure Technology Development Award.

In principle, the applicants' technologies should have been developed within the past five years and applied to the real sites already.

As a result of examination, institutes and researchers with the following technologies were awarded 20th prizes.

The grand prize went to "Enhancement of Efficiency and Effectiveness in Maintenance and Management System by utilizing ICT".

And the three excellence prizes were awarded to "Wire Rope Barrier Systems", "Construction of large onshore wind turbine by lift up method", and "Caisson installation automation technology".

The grand prize and one of the three excellence prizes were introduced in the issue of IDI Quarterly (No.82).

And other two excellence prizes are introduced in this issue of IDI Quarterly.

For any inquiries/ comments please contact JICE :

Website: http://www.jice.or.jp/

(Japanese version only)

E-Mail: webmaster@jice.or.jp

# Construction of Large Onshore Wind Turbine by Lift Up Method

Subtitle: Wind Lift

## 1. Background and Motivation of Technological Development

With use of the conventional method that uses a 1200-ton class hydraulic crane to install a wind turbine, a vast construction yard was necessary to assemble a rotor on the ground and install the rotor in a nacelle. In addition, the conventional method is likely to be affected by wind when materials are lifted by crane. Especially when a rotor was installed in a nacelle, wind made suspended materials unstable, and the operation had to be stopped, which caused a process delay. In order to solve such problems, the Wind Lift System, a large-scale wind turbine assembly and lifting method, has been developed.

## 2. Technological Details

This method is an unprecedented assembly technique that makes use of an elevating stage vertically moving along the tower construction and by which a hub and blades are connected and a wind turbine is lifted and built (Figures 1 and 2).

Figure 1 Wind Lift System Assembling Affairs

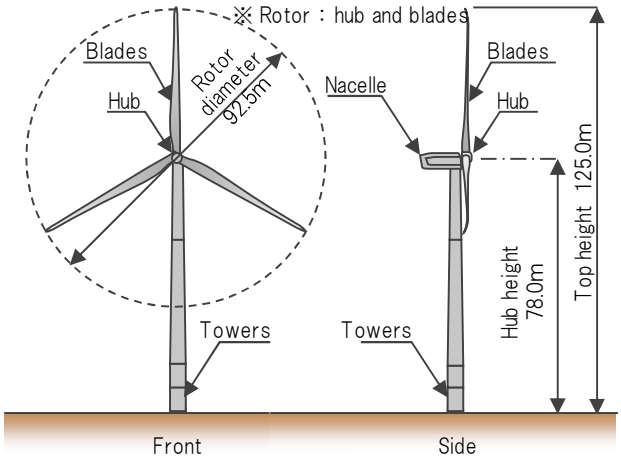



Figure 2 Front and Side Views of Wind Turbine

This system eliminates the necessity of an ultra-large crane; moreover, the area of a construction yard can be drastically reduced because only an auxiliary crane is necessary at assembling the hub and blades on the ground and raising them (Figures 3 and 4).

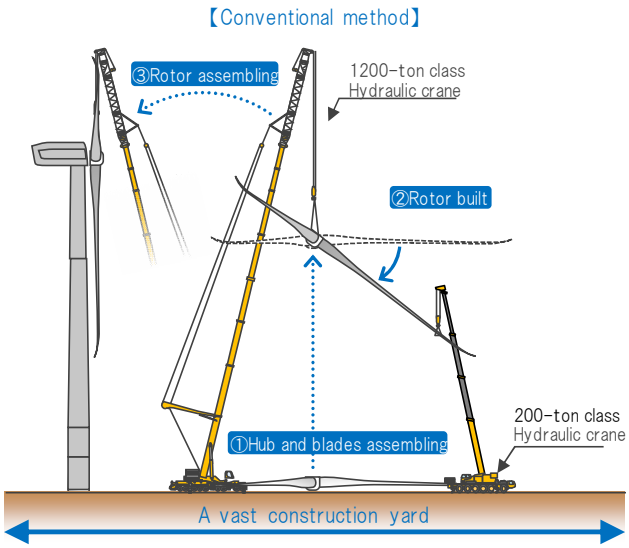



Figure 3 Conventional Method

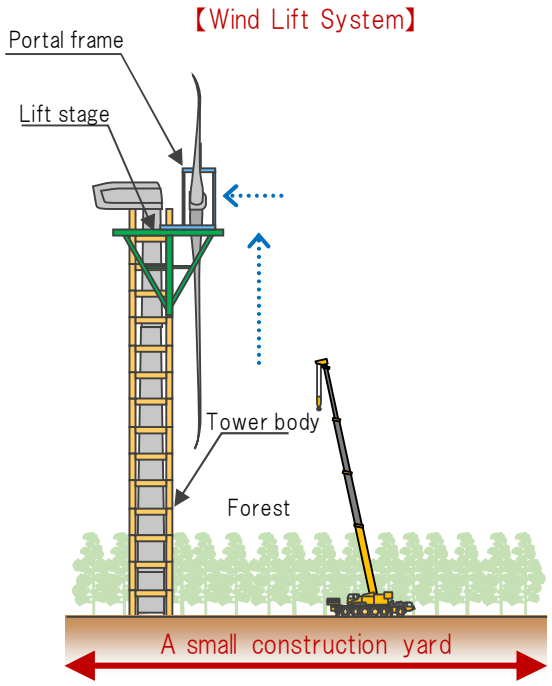



Figure 4 Wind Lift System

In consideration of the influence of wind, a rotor can be stably moved to the top of the tower by horizontally assembling it above a protection forest, raising it, and lifting it. What is more, the risk of a process delay can be reduced because a tower with a truss structure is highly rigid and is less subject to the influence of wind at material lifting (Figures 5 and 6).

Figure 5 Tower Assembling

Figure 6 Rotor Assembling

## 3. Application Scope of Technology

- Construction work of wind turbine in general
- Maintenance work and disassembling work for wind turbine
- Assembling work at harbor for offshore wind power

## 4. Effect of Technology

- A construction yard can be reduced by about 30% in comparison with the conventional method because an ultra-large crane is not used and the rotor is not assembled on the ground, and the reduction of site preparation work leads to decreases in manpower, construction costs, and environmental stress.
- With this method, measures can be implemented to prevent suspended loads from swinging because of the reduced influence of wind when materials of a wind turbine are lifted; therefore, the influence of wind can be reduced in comparison with the conventional method, and processes can be followed.

## 5. Social Significance and Developability of Technology

This method can remarkably reduce a construction yard and contribute to decreases in manpower, construction costs, and environmental stress by reducing site preparation work. Wind power generation tends to increase the size and height of a tower; thus, preparation of an ultra-large crane is expected to be difficult. This method can be a solution for such preparation problem and can contribute to acceleration of the wind power generation industry. For construction of an offshore wind power station in which assembly at a harbor takes a long time, the rent for an ultra-large crane and ground improvement cost can be remarkably reduced thanks to this method, which leads to contributions to business development.

## 6. Applicable Track of Technology

Construction work of Mitane-Hamada Wind Power Station, April to June 2017

Applicant: Obayashi Corporation

Development Engineer: [Obayashi Corporation] Takanori Ezoe, Toshiaki Miwa

Joint Developer: Tomoe Research & Development, Ltd.

E-Mail: ezoe.takanori@obayashi.co.jp

TEL: +81-3-5769-1462

FAX: +81-3-5769-1925

# Caisson Installation Automation Technology

(Automate winch and pump operations in a caisson installation work)

## 1. Background of Technology Development

The i-Construction for ports has been applied to port construction work in Japan since 2017: it is aimed to save the labor and to enforce mechanization in the construction work with

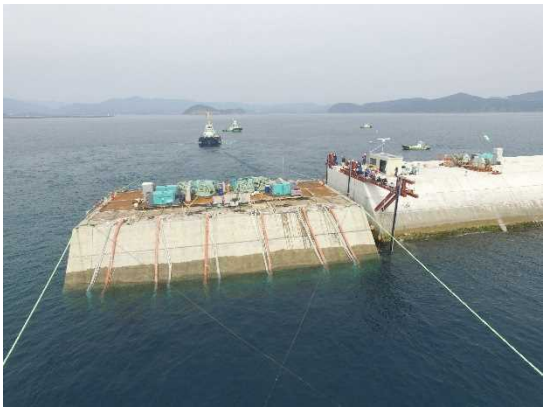


Photo 1 Construction Site

using three-dimensional data.

Because of the complexity of meteorological and oceanic phenomena in maritime construction, the most of the conventional construction works depends on the experiences and skills of workers.

Given such a background, the caisson installation system which enables to automate water injection, induction and winch operation in the installation of caissons has been developed.

## 2. Detailed Description of the Technology

The caisson installation system consists of the real-time position measuring system of the caisson and the automatic pump operation system. The real-time position measuring system of the caisson executes winch operation by position information data of the caisson; and the automatic pump operation system executes pump operation by water level measurement data.

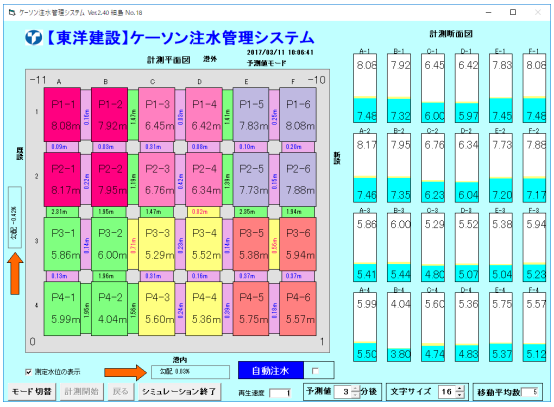



Fig.2 Automatic Pump Operation System

Movement of the caisson is controlled by four winches installed on the caisson. The winch reaction force is obtained from the weight block installed on the seabed, then the caisson is moved up and down by the winch.

The winding torque of each winch is adjusted automatically to make the winding force of the winches balanced.

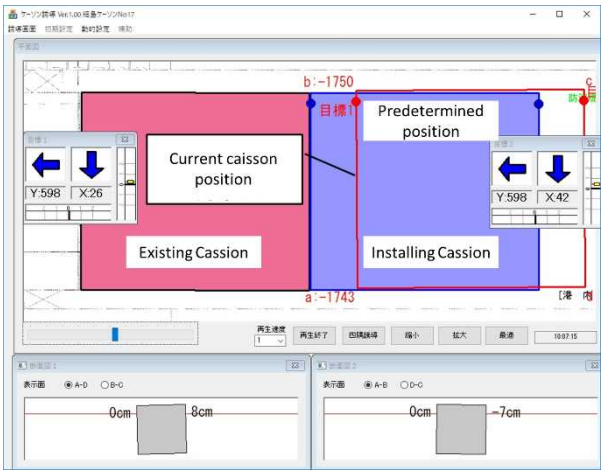



Fig.3 The Real-Time Position Measuring

The caisson is controlled by the automatic winch operation and moved to the predetermined position calculated from its three-dimensional position data.

The three-dimensional position data of the caisson is measured by two automatic tracking type total stations and a two-axis inclinometer.

The automatic pump operation system is operated based on the water level and inclination data measured in each chamber of the caisson.

The quantity of water injected into the caisson is measured by water level gauges in each chamber of the caisson.

By water injection of this system, the caisson can be held horizontally, and the water level difference between adjacent chambers can be also kept within the specified value.

## 3. Effect of Developed Technology

We developed the technology of automatic winch operation to stop / restart the water injection pumps and traction of the caisson during an installation of a caisson. By utilizing this technology, remote-controlled installation of the caisson becomes possible, and the workers' safety is secured.

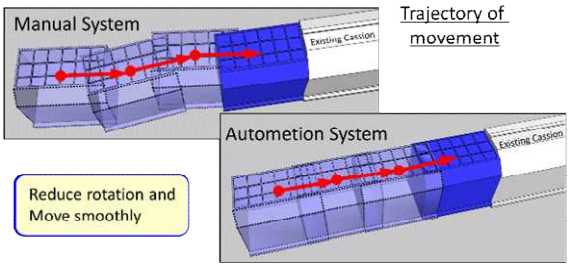



Fig.4 Images of Caissons' Movement

In addition, the automatic winch operation system in this technology continues its operation until the caisson being installed touches the existing caisson.

Furthermore, this technology will progress automatic immersion of a caisson, and then, this will help to develop the caisson installation technology without requiring workers' experiences and skills.


Fig.5 Conventional Method

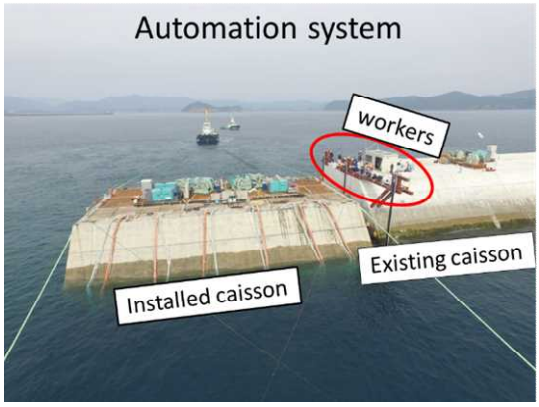



Fig.6 Automated System

## 4. Installation Record

Hosojima Port construction work, September 2016 - September 2017

Applicant: Toyo Construction Co., Ltd
Technology Developer: Naoyuki Kato
E-Mail : katou-naoyuki@toyo-const.co.jp
TEL : +81-3-6361-5450

# About IDI and IDI-quarterly

Infrastructure Development Institute-Japan (IDI) is a general incorporated association operating under the guidance of Ministry of Land, Infrastructure, Transport and Tourism of Japanese Government.
IDI provides consulting services to facilitate International Assistance to developing countries, to promote international exchange of information and human resources, and to support globalization of project implementation systems targeting both developed and developing countries in the field of infrastructure.

IDI has been publishing the free quarterly journal called “IDI Quarterly” since1996 to introduce information related to public works and construction technologies developed in Japan to foreign countries. We have distributed the journal to administration officials in more than 90 countries around the world by e-mail.

It is highly appreciated if you would send us your opinions, impressions, etc. on the articles.
We also welcome your specific requests for the following Quarterly issues.