



## *An Era of New Challenge Begins!*

*The path we walked will create our own destiny*

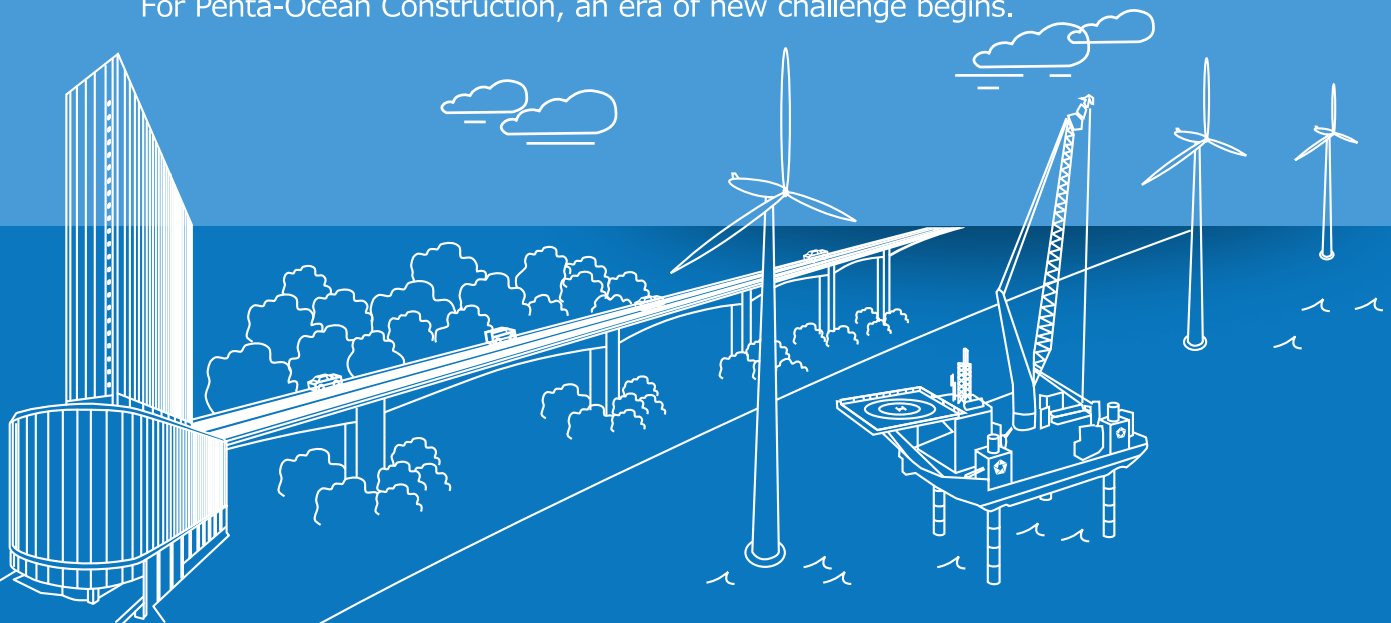
Penta-Ocean Construction is celebrating its 125th anniversary since its founding in Kure City, Hiroshima Prefecture in 1896.

Our initial business in marine civil engineering works has significantly expanded to land civil engineering and building construction works.

Beginning with the Suez Canal Dredging Project, our journey abroad has been marked by a number of memorable milestone projects, mostly based in Singapore.

With an enterprising spirit as part of our corporate DNA, we pursue challenges in new fields and technologies, paving the way for the future, as a genuine global general contractor.

For Penta-Ocean Construction, an era of new challenge begins.



Click here to view further details of our 125-year history →



# Special Feature 1: The 125th Anniversary

## Celebrating the 125th Anniversary of the Inauguration of our Business

### Establishing a Commemorative Logo for the 125th Anniversary

A commemorative logo was produced to mark the 125th anniversary of Penta-Ocean's founding. The increasing numbers and the geometric motifs of leaping waves and streams represent the company's dynamic and innovative spirit soaring into the future.



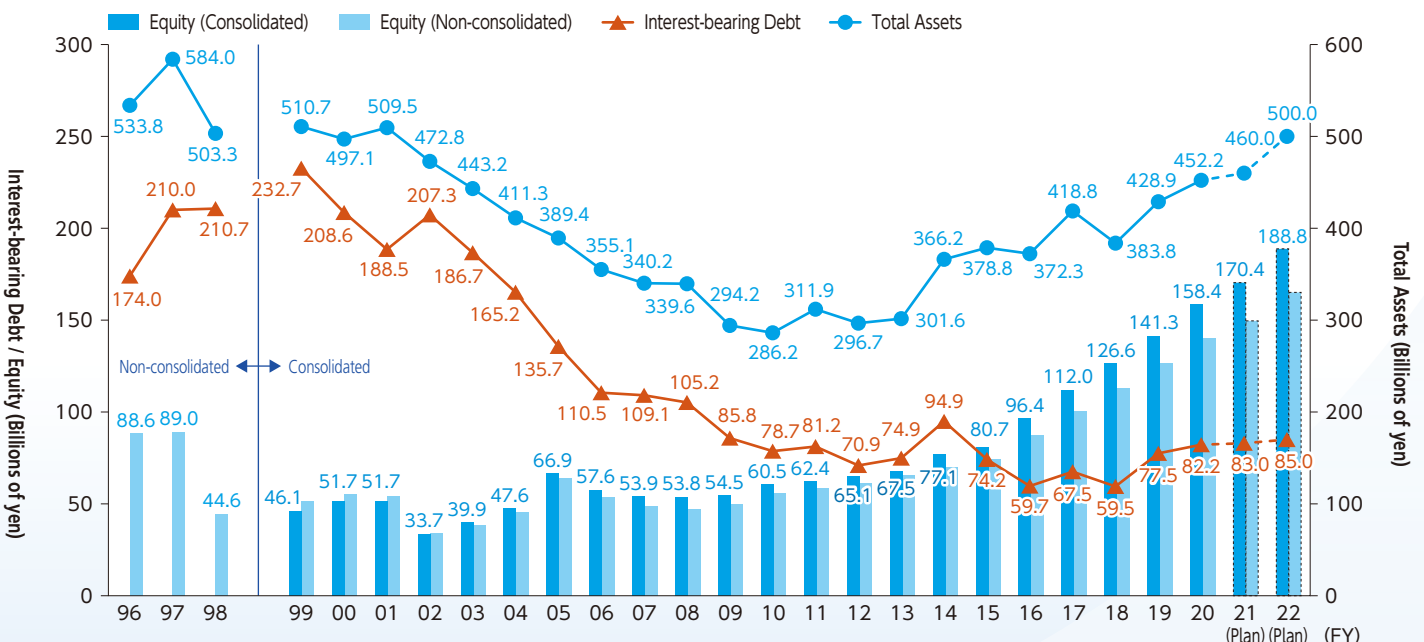
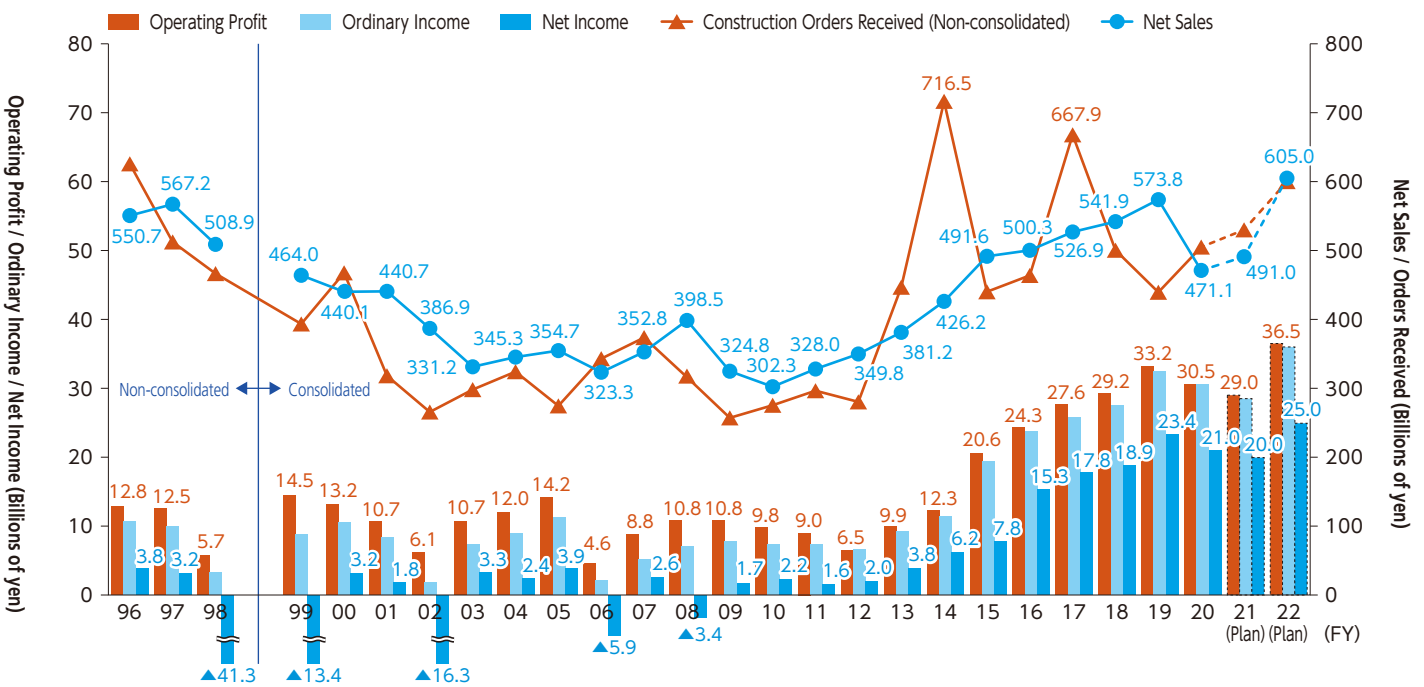
### Advertisement Commemorating the 125th Anniversary

On April 10, 2021, Penta-Ocean Construction celebrated the 125th anniversary of its founding. On the previous day, April 9, we took out an advertisement in the morning edition of the Nihon Keizai Shimbun newspaper entitled "A new endeavor begins - The path we walked will create our own destiny." The two-dimensional bar code on the bottom right of the page gave access to a five-minute video showcasing the company's history. On the morning of that day, a bilingual video message from the president commemorating the 125th anniversary of the company's founding was uploaded in Japanese and English via the company's intranet.

On April 26, we posted a full-page English advertisement in the Singaporean newspaper The Straits Times.

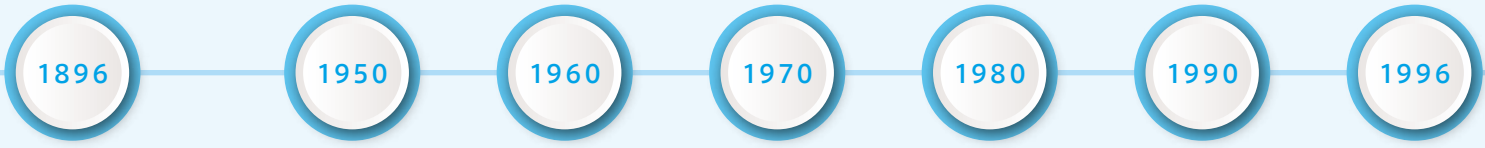


## Business Performance Over the Last 25 Years



# Corporate History

## The First 100 Years



Phase I From foundation to development

Phase II Recovery from WW2, overseas expansion and development in land civil engineering

Phase III Strengthening the building construction abilities and moving toward a three-pillar business structure

**1896**  
Mizuno Gumi was founded in Kure City, Hiroshima Prefecture

- Carrying out many civil engineering projects in ports, Mizuno Gumi gained a strong reputation as a leader in marine civil engineering

**From 1945**

- After the war, the company focused on land reclamation projects in coastal areas
- Within the construction sector, Penta-Ocean is among the first to expand overseas\*1
- By carrying out several mergers and acquisitions around 1970, Penta-Ocean was able to expand into the land civil engineering sector and begin operating business nationwide\*2

**From the late 1970s**

- Strengthening the building construction business unit and laying the foundation for Penta-Ocean's three-pillar business structure: domestic civil engineering, domestic building construction, and overseas
- After completing the Penta-Ocean Institute of Technology in 1980, technological development progressed



Contract awarded for construction of first large-scale quay walls and industrial facilities in the postwar era in Tsukumi Port, Oita Prefecture (1948)



Contract awarded for Tuas Reclamation in Singapore (1984)



Mr. Jinjiro Mizuno founded Mizuno-Gumi (1896)



Contract awarded for Suez Canal expansion (1961)  
Contract awarded for Suez Canal Widening and Deepening (1974)



The company renamed Goyo Kensetsu, and named Penta-Ocean Construction Co., Ltd. In English (1967)



Completion of the World Cargo Distribution Center (1993)



Contract awarded for construction of coastal industrial zone for NKK Corporation (currently JFE Engineering) in Fukuyama City (1961)



Contract awarded for phase I and phase II of construction of artificial island for Kansai International Airport (1986, 1999)



Undertook the construction of the pier at the Jurong Shipyard docks Foray into Singapore (1964)



Contract awarded for the Sun Plaza building Foray into Hong Kong (1986)

\*1: In 1961, we were awarded a contract for the Suez Canal expansion project, a national project in Egypt. Our stance of tackling difficult problems under adverse  
\*2: We absorbed Sakai Construction Co., Ltd. in 1968, Japan Land Development Co., Ltd. in 1969, and Jin Industrial Co., Ltd. in 1970



## The Last 25 Years

2000

2010

2021

### Phase I Reconstruction

### Phase II Recovery

### Phase III Evolution

1997 to 2004

Breaking away from the negative legacy Responding to the contraction of the construction market

2005 to 2013

Aspiring to be the number one company in port, coastal, and waterfront areas

2014 to 2021

Emerging as a genuine global general contractor with strengths in port, coastal, waterfront areas, and overseas



Self-propelling trailing suction hopper dredger, "QUEEN OF PENTA-OCEAN," (currently ANDROMEDA V) put into commission in Singapore (1999)



Completion of the Kyushu Shinkansen Tamanatsuru Bridge (2008)



Completion of MAZDA Zoom-Zoom Stadium Hiroshima (2009)



Completion of Kure City Hall(2015)



Completion of a Offshore installation vessel, "CP-8001" (2018)



Completion of Esplanade-Theatres on the Bay in Singapore (2002)



Opening of D-Runway of Tokyo International Airport (2010)



Completion of Sengkang Integrated Hospital in Singapore(2018)



Completion of ION Orchard, and the Orchard Residence in Singapore (2010)



Completion of Yodobashi Umeda Tower (2019)



Completion of the Mirai Shipbuilding Yard (2019)



Completion of Kogouchi Tunnel of New Tomei Expressway (2005)



Completion of the Kai Tak Cruise Terminal (2013)



Completion of a self-propelled cutter suction dredger, "CASSIOPEIA V" (2014)



Completion of the Tokyo Port Umi no Mori Tunnel (2020)

conditions has been handed down in our corporate DNA as our "enterprising spirit."

# Digital Initiatives

## Domestic Civil Engineering Efforts to Improve Construction Productivity and Quality Control

Utilizing the framework of the Cabinet Office's Public/Private R&D Investment Strategic Expansion Program: (PRISM), the Ministry of Land, Infrastructure, Transport and Tourism launched the Project on the Adoption and Use of Innovative Technologies to Dramatically Improve the Productivity at Construction Sites. This project aims to improve productivity and quality control at construction sites by fostering collaboration between construction companies and companies in different industries and sectors, including IoT, AI, and robotics. In addition to supporting i-Construction, which is aimed at improving productivity on conventional construction sites, the project also strongly propels public-private research and development aimed at creating scientific and technological innovation. Penta-Ocean is also actively engaged.

In FY 3/21, consortiums represented by Penta-Ocean were selected in the categories of both "I: Technology to increase construction labor productivity" and "II: Technology to improve construction quality control." A variety of advanced technologies using ICT were tested, centered on the "Penta-Ocean Construction Data Gathering and Sharing System (i-PentaCOL/3D)" at the site of Shitara Dam, which is to be built by Penta-Ocean, in Aichi Prefecture.

### <Consortium Members>

Category I: Penta-Ocean Construction Co., Ltd., Osaka University, K.K. Shoji, Atos Co., Ltd., NIPPON SYSTEMWARE CO., LTD., and NEXTSCAPE Inc.

Category II: Penta-Ocean Construction Co., Ltd., Osaka University Graduate School, K.K. Shoji, and NIPPON SYSTEMWARE CO., LTD.

### <Trial Technology>

Category I: Increasing labor productivity

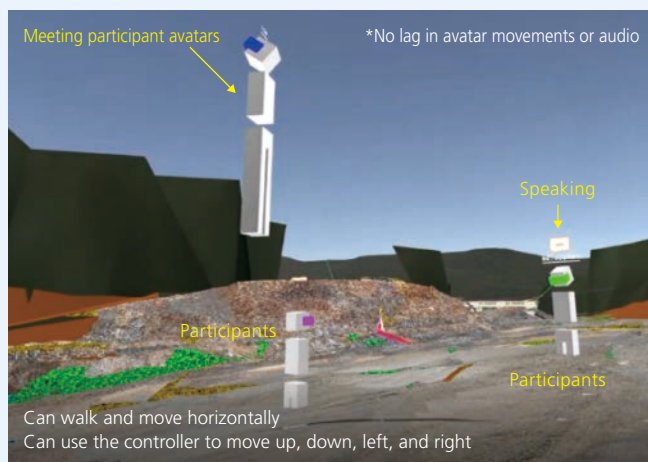
Category II: Improving quality control

- ① IoT/AI Backhoe ② Digital VR Conferencing ③ Advanced proof rolling ④ Surface assessment of soil and soft rocks ⑤ Total control of embankment spreading depth

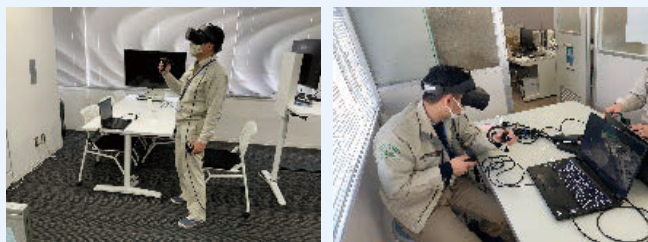
## ② Digital VR conferencing

Clients and construction personnel were immersed in a digital twin reproduction of a construction site, and held meetings in 3D realism

- ➔ Reduces travel and waiting time for inspectors



Example of a virtual space in a digital VR conference (earthworks)

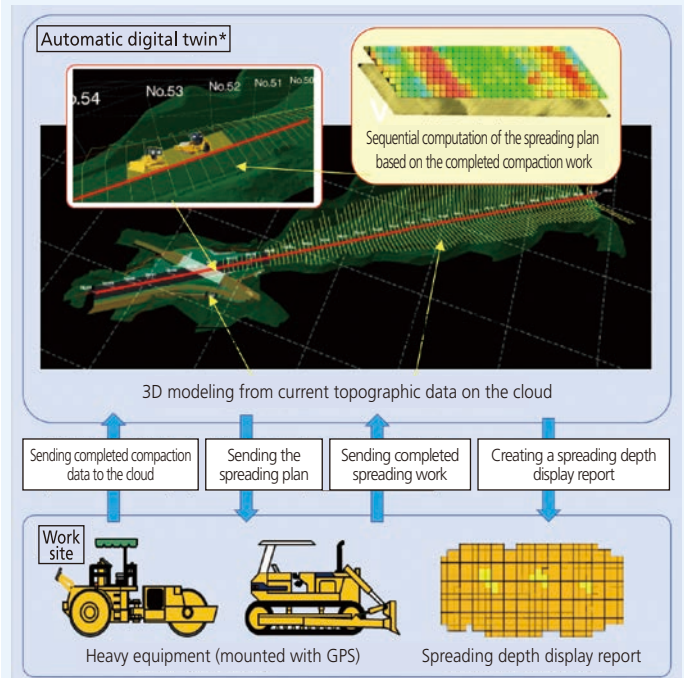


Conference participants (earthworks)

## ⑤ Total control of embankment spreading depth

The GPS-mounted heavy equipment has been used to gradually re-engineer the embankment spreading height and totally control the spreading depth

- ➔ Contributing to the improvement of quality control



\*A system that uses IoT, AI, AR, and other technologies to recreate a real-world environment in virtual space and link the real and digital worlds together in real time



The "Penta-Ocean Construction Data Gathering and Sharing System (i-PentaCOL/3D)" is a cloud system that uses BIM/CIM to collect and share a variety of information on construction sites. It reduces the labor on such tasks and contributes to the improvement of quality control.

The i-PentaCOL/3D system can be customized to fit on-site requirements, and the aforementioned trial technology was developed by improving its functions.



## Domestic Civil Engineering Utilization of BIM/CIM for VR Simulation in Port Construction

BIM/CIM is utilized as a tool for improving productivity throughout the life cycle of infrastructure, including research, design, construction, maintenance, upgrading, and disposal. With BIM/CIM as the core, we centrally manage installation and inspection records, and use data and digital technology to optimize the positioning of skilled workers and machinery in the field, aiming to carry out construction work quickly, accurately, and at optimum cost while maintaining high quality.



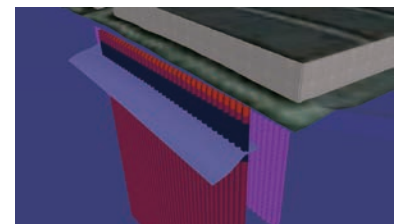
In addition, the BIM/CIM VR (3D/4D) simulations are used for safety training and occupational accident prevention.

### <Examples of BIM/CIM utilization at the construction stage>

- Visualization (4D simulation made by adding a time axis to a 3D model)
    - Visualizing the situation at the construction site
    - Visualizing the positioning of the work vessel
    - Visualizing work procedures
  - Information sharing (sharing visualization data with related parties)
    - Sharing information on the work progress and positioning of work vessels → Safe and smooth operation of ships
    - Linking construction information to the BIM/CIM model → Utilizing the information when maintaining and upgrading the infrastructure
- } Optimization of construction plan = increased productivity

### Effective Verification Using BIM/CIM Models –Creating an Undersea Terrain Model

We created an underwater topographical model by taking the seabed data obtained by underwater surveys prior to the commencement of the construction, and applying it to the BIM/CIM model. For example, in the case of pile-driving, by making the seabed data three-dimensional in advance, one can better understand the condition of the pile pits (soil layer configuration and ground height). This makes it possible to identify and deal with areas where countermeasures are needed, during at the examination phase, eliminating the need to redo work during the construction phase (e.g., redesign).



### Allowing for Vessel Positioning Adjustments and Confirmation

When using a crane barge in port construction, it is important to consult with relevant parties so as not to impede the safety and smooth operation of ships in the vicinity.

Therefore, in addition to information on the positions and work statuses of the working vessels, the BIM/CIM model includes information on vessels in adjacent berths. This allow for everyone to intuitively understand the positions and relative distances between vessels, thereby reducing labor and increasing the efficiency of coordination efforts.



### Preliminary Review of Construction Plans –Increased Productivity Through Front Loading

By applying a time axis to the BIM/CIM 3D model, we can create a 4D simulation that can be used for the preliminary review of construction procedures. The construction procedure is visualized, making it possible to check areas of concern before construction begins, such as contact with existing structures and interference with temporary installations, thereby reducing the possibility that rework will become necessary during the construction phase. Additionally, as the simulation enables one to see how the construction site will change over time, it is easier to explain the construction plans to those involved.



Using a 4D simulation to verify the construction procedures

### Safety Experience VR –Simulation of Hanging Steel Pipe Sheet Pile or Heavy Machinery Spinning

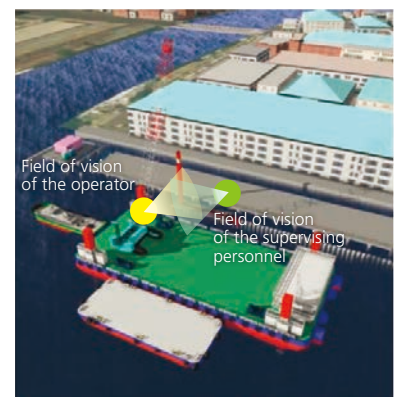
We carried out a VR simulation, which allows workers to experience a disaster that can occur while operating heavy machinery, namely when a hanging load begins spinning and hits a worker. The simulation was made from several different perspectives, including those of workers atop the guide frame, workers on the platform or crane barge, and employees of the prime contractor who have come to supervise the work. By allowing people to observe the situation from each other's perspectives and share their own views, the simulation raises safety awareness and contributes to the prevention of occupational accidents.



Perspective of the crane operator



Perspective of a worker on the pier



Full view of the work site

## Domestic Building Construction BIM Initiatives for High-rise Buildings

We have been implementing BIM\* since 2013, with the aim to improve quality and productivity in building construction. By using three-dimensional BIM models with time axes to simulate construction steps for realistic visualization, we can form a common understanding among parties involved and speed up decision making. In addition, digitized building information is used to ensure consistency between buildings and equipment, to minimize labor in drafting drawings, and to improve the accuracy of quantity calculations.

We are currently using BIM in the construction of a full-service hotel in the Fujimi-cho area of Naka-ku, Hiroshima City (provisional name).

\*BIM: Application of BIM during the construction stage

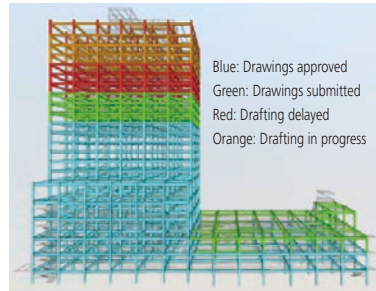


(Provisional name) Fujimi-cho, Naka-ku, Hiroshima City  
Conceptual drawing of the full-service hotel upon completion

### Labor-saving Progress Management with PiCOMS-S

PiCOMS-S, the steel frame construction edition of the "Penta-Ocean Integrated Construction Management System (PiCOMS)," is a cloud system that integrates the management of drafting, fabrication, and construction of structural steel frames, and allows related parties to check the status of progress displayed through BIM in real time. The system is designed so that it can be easily operated with a tablet without any BIM skills or specialized equipment.

In this construction project, the schedule for each phase of drafting, fabrication, and construction was determined by consensus among the parties involved through simulation while sharing a PiCOMS-S screen. Each process was checked for timely progress according to schedule, and when delays occurred, causes were identified, improvements were made, and the schedule was revised.

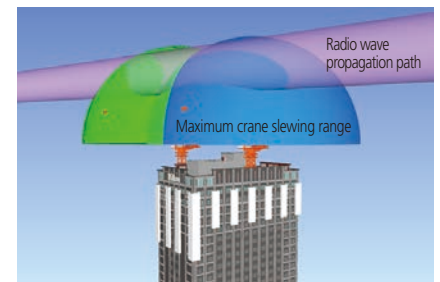


Screen for confirming the progress of structural steel frame works

### Discussion on a BIM-based Construction Plan:

#### Planning the location of the Tower Crane to Avoid Interference to Radio Wave Propagation Paths

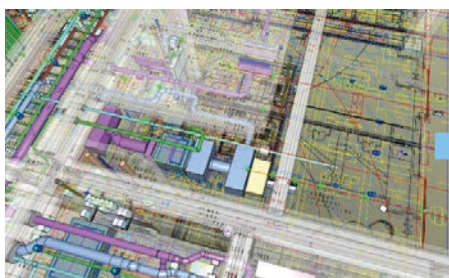
Since there was a possibility that during operation, the tower crane would interfere with public radio waves above the construction site, information on its propagation paths obtained from the broadcasting company was digitized and superimposed on the BIM model for assessment. As a result, it was found that the maximum slewing range of the crane would interfere with some of the propagation paths, but the BIM construction simulation revealed that the construction would not be hampered even if the crane was operated to avoid the propagation paths. We carried out the construction after sharing our findings with the broadcasting company for them to confirm.



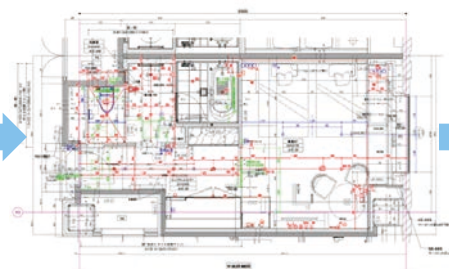
Confirmation of radio wave interference by the tower crane through BIM

### Production of Construction Drawings from BIM Models

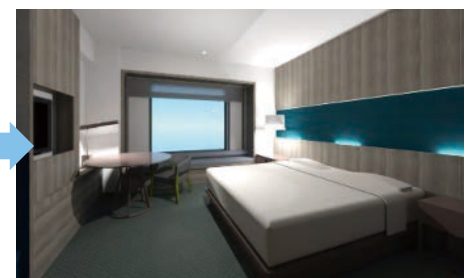
To produce construction drawings, we integrated the BIM models of the building and equipment, adjusted the fit. The construction and integrated drawings were drafted after confirming the fit of each section. Smooth construction work was made possible by producing construction drawings from the adjusted BIM models.



Fit adjustment using an integrated model of the building and facilities



Comprehensive drawing of the guest room plan



Example of digital mockup

### Utilization of Digital Mockups to Determine Finishing Materials

Digital mockups were created by using a cloud-based rendering system by adding information for finishing touches such as interior design, furniture, and fixtures to the BIM model used to produce the construction drawings. Compared to selecting finishing materials using samples for each area, it was easier to grasp the spatial image, and decisions on the materials could be made quickly.

### Fabrication of Components from BIM Models

In the fabrication of structural steel frames, PC panels for exterior walls, and ventilation ducts, the digital information from the BIM model with finalized layouts was reflected in the fabrication drawings. This has led to a reduction in labor and human error in factory fabrication.



## Overseas Coherent Use of Digital Data from Design to Maintenance Management

In Singapore, the digitalization of construction systems is being actively promoted, with BIM for the endorsement of applications being made mandatory in stages since 2013. This trend started with the introduction of BIM and has evolved into the digitization of the entire building process from design to construction. In recent years, the use of digital technology has evolved to include the entire lifecycle of a building, to operation and maintenance.

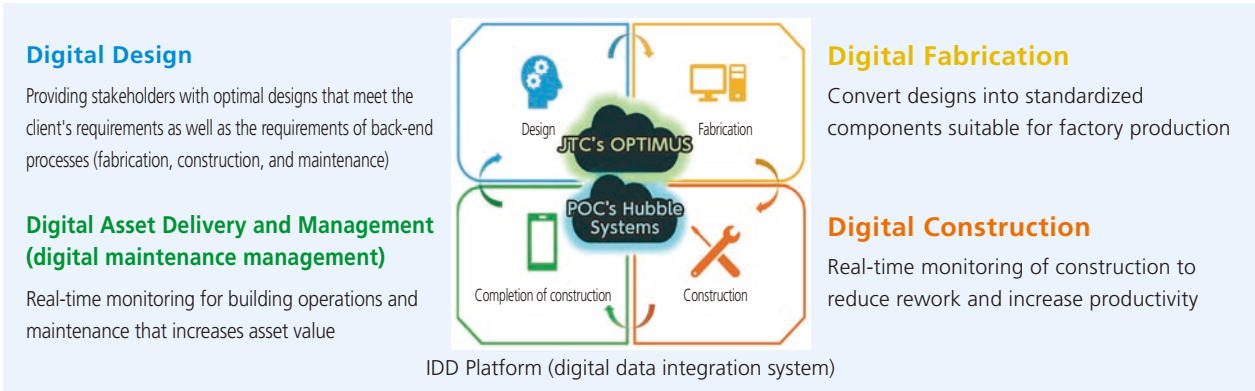
Integrated Digital Delivery (IDD) is the Singaporean version of construction DX, which refers to the integration of construction work processes and the use of digital technology to connect the parties involved in a project. It is expected to contribute to the efficiency of construction work by utilizing digital technology throughout the building lifecycle: design, fabrication, construction, and maintenance.

### Examples of IDD Initiatives – Integrated Management of Design to Construction Using BIM Models

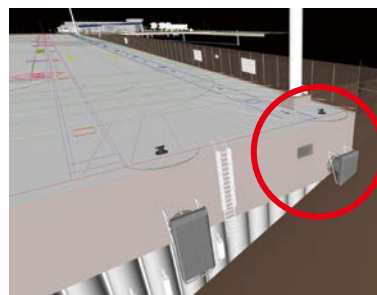
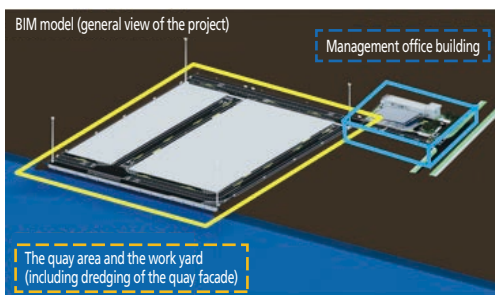
We are also accelerating our efforts in IDD. At Offshore Marine Center 2 in Singapore (construction of the quay area, work yard, and administrative office building), we are working to enhance construction management and improve productivity and quality through integrated data management (including BIM models) for design to completion using the IDD platform.

To reform our workstyles and improve productivity, we will further promote DX, by integrating construction DX in Japan and IDD in Singapore through inter-departmental collaboration, which is one of our strengths.

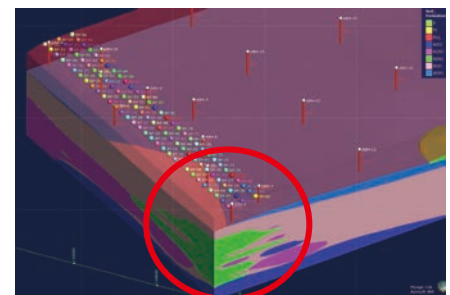
Offshore Marine Center 2 (construction of quay area, work yard, and administrative office building)  
(Source: Aurecon Group's website)



### Design Phase – Design Review Using the BIM Model and the 3D Soil Model



Design review and interference assessment using the BIM model



3D soil model created from soil survey records  
Visualization of complex and non-uniform soil properties

### Fabrication and Construction Phase

#### Real-time management of the progress of pile production and installation

Record pile production, quality, delivery, and the status of pile driving on an IDD platform by scanning QR codes



IDD platform and QR codes (pile surface)

#### Linkage between construction records (digital data) and BIM models

Link construction records (digital data) on the IDD platform to the BIM model, to assess progress and construction records on the BIM model

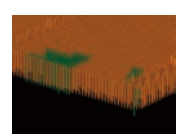
➔ Utilization in maintenance management and renewal



Digital inspection  
Construction records



Dynamo scripting  
(BIM link program)



Construction record model  
(pile length and progress update of actual construction)