BIM APPLICATION IN PIER CONSTRUCTION

by

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ABSTRACT

This paper presents the results of applying Building Information Modeling/Management (BIM) in the port facilities construction work in Japan. In this Pier construction work, BIM was applied for the verification of Pile foundation, interference check between the structural elements and safe operation of crane ships. Even though the application of BIM had issues like securing 3-D Operators, it was found that the 3-D information can be efficiently utilized in all the phases of construction, even in port facilities construction work.

1. INTRODUCTION

BIM is used in the construction of 3D model to adjust the 3D positions of the material and is being utilized as a database for design, construction planning and maintenance by recording the construction procedure and member specifications.

Initially it was mainly used for the construction of building structures. In recent times the application of BIM to civil engineering structures has begun to get progressed to be utilized in structures such as roads, bridges and tunnels. However BIM has never been applied to port facilities in Japan. This paper presents the result of applying BIM in the construction work of Liquefied Natural Gas receiving pier.

2. SUMMARY OF CONSTRUCTION AND PURPOSE OF BIM APPLICATION

Pier construction is in the northeastern part of Japan, Soma port in Fukushima prefecture. In order to overcome the energy depletion immediately after the Great East Japan earthquake 2011, it was necessary to secure diverse energy sources. The petroleum resources company has pushed forward the pier mooring the imported ship by advancing the import of Liquefied Natural Gas in about 2 years. The aerial view of the receiving pier is shown in **Figure 1**.

Figure 1: Aerial view of the receiving pier

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During initial stage of construction, there were few concerns such as, the abundant rise and fall in bearing layer under the seabed as shown in **Figure 2**, that drives the foundation pier, the facilities making up the pier were close to each other and the equipment installation of the platform was complicated.

In this pier construction, we aimed at achieving the following three by applying BIM.

1. To confirm and predict whether the pile foundation certainly attains the bearing layer.
2. To confirm that the structures do not interfere with each other before construction and to explain the workaround measures to the workers in advance.
3. To calculate the vessel position where the pier could be constructed safely and to decide appropriate anchor placement position in advance.

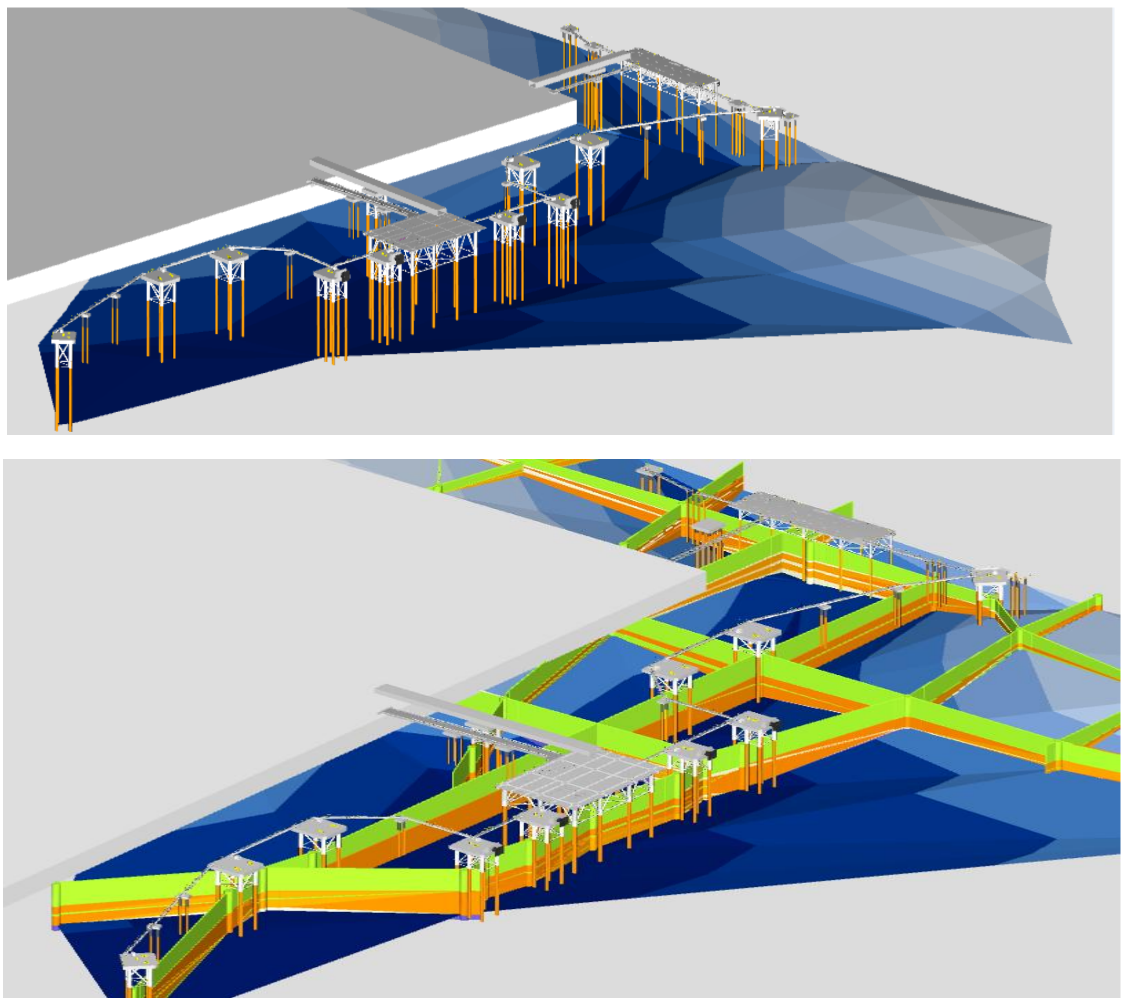

Figure 2: Bearing layer under the seabed

Key words: BIM, bearing layer, interference, safety operation

3. PROBLEMS AND MEASURES

By applying BIM in this construction work, we achieved the objectives by overcoming the problems/issues by the following procedures.

3.1 Bearing Layer

At first the depth of the bearing layer is represented by the 3D model from the boring data as shown in **Figure 3**.

After that each time a pile is driven, the electric resistance value of the piling installation is measured as shown in **Figure 4** and the height of the bearing layer of the 3D data is corrected sequentially. As a result of repeating this work and completely ascertaining the correct bearing layer height, we realized the necessary embedded depth is required for all piles.

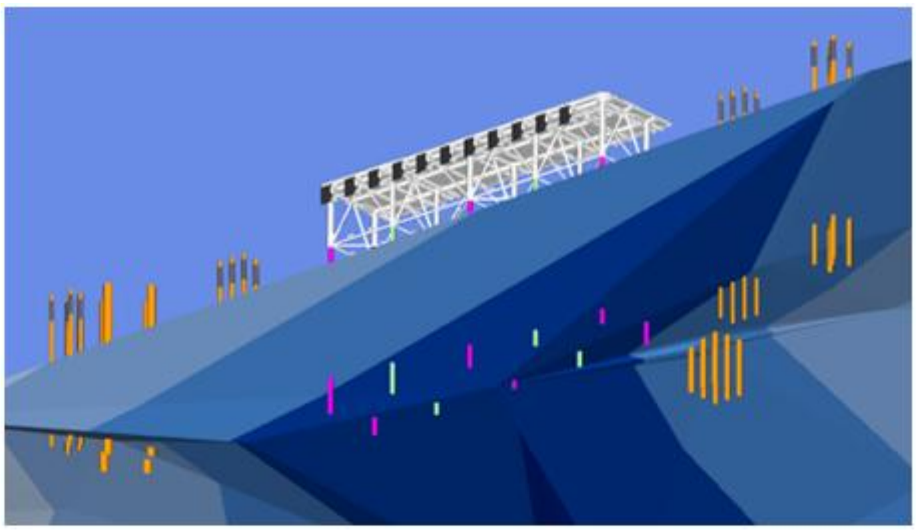

Figure 3: 3D Model of the seabed bearing substrate/layer

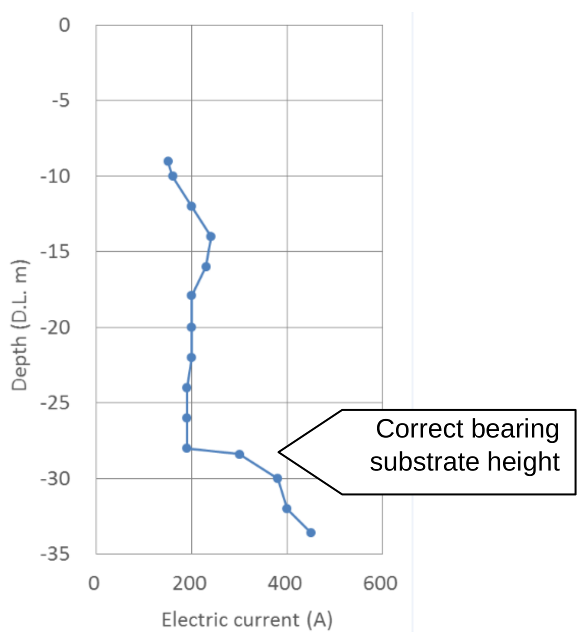

Figure 4: Current resistance value during pile driving

3.2 Interference Check

By inserting a jacket model into the reproduced pile shaped model, we confirmed that there was no interference with the data. In addition a surveillance camera was installed inside jacket sheath pipe as shown in **Figure 5**, to properly guide the jacket to the pile position.

A drone equipped with the digital camera flew and captured the shape of the wave dissipating concrete blocks under the bridge position as shown in **Figure 6** and **Figure7**. By superimposing the model of the bridge on this, interfered blocks were identified and removed.

Figure 5: Jacket Induction with the help of surveillance camera

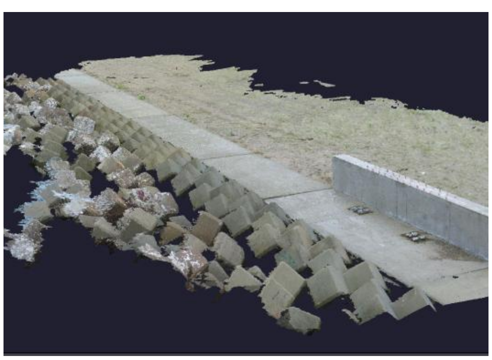

Figure 6: Digital camera image of wave dissipating concrete blocks

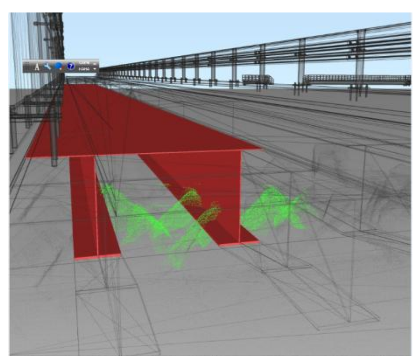

Figure 7: Interference of the wave dissipating concrete blocks and the bridge girder

As shown in **Figure 8**, the slab concrete reinforcing bars of the pier platform were reproduced on the model and the embedded metal fittings of the equipment were superimposed on this and confirmed that both did not interfere. In case of interfering, we moved the rebar before attaching the anchor. Showing these work procedures in a 3D model enabled the workers to have a deep understanding of the construction procedures.

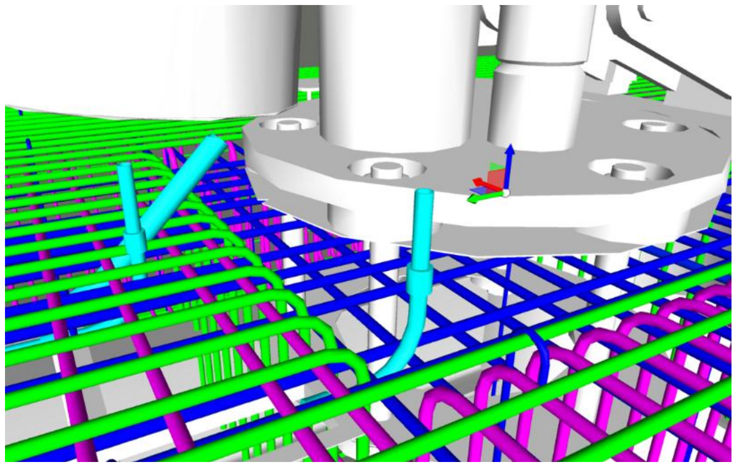

Figure 8: 3D Model of reinforcing bars of Slab concrete

3.3 Safe Operation of Crane Ship

According to the work process, the vessel position during construction is reproduced on the model and the anchor position was reproduced at the same time as shown in **Figure 9**. We confirmed that the crane ship can enter the installation position while hanging the jacket and the anchor of the work vessel can be placed in the required position beforehand. We also explained it to the vessel operator by an illustration. Through this series of procedures, the construction was implemented safely and smoothly.

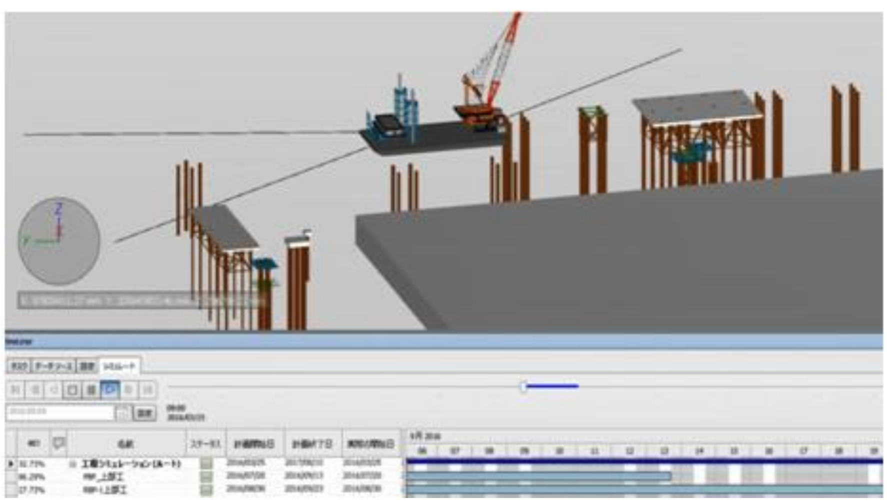

Figure 9: Positioning and anchoring of the crane ship

4. CONCLUSION

As described above, the BIM plan that includes the electric resistance value of the pile, monitoring with built-in camera, shape conformation by aerial photography and so on, were carried out concurrently and as a result the construction was done with high accuracy. In addition, even the complex events can be easily understood by the 3D model combining the BIM model and field verification results. Thus, it is very effective in giving work instructions to the operator.

On the other hand, it is also a fact that the data input into BIM needs time and experience. In case of civil engineering work, it is necessary to combine the construction ground data and the surrounding landscape data with the structure model, and the number of software to be handled becomes more. As a result, it takes time to learn the program operation. And since the number of operator expertise in BIM operations are still few in Japan, it is mandatory to train within the company for the time-being. While consensus on the application of BIM is progressing within the construction industry, securing human resource is an urgent issue.