REAL-TIME MONITORING OF A DEEP AND MASSIVE OPEN CAISSON CONSTRUCTION

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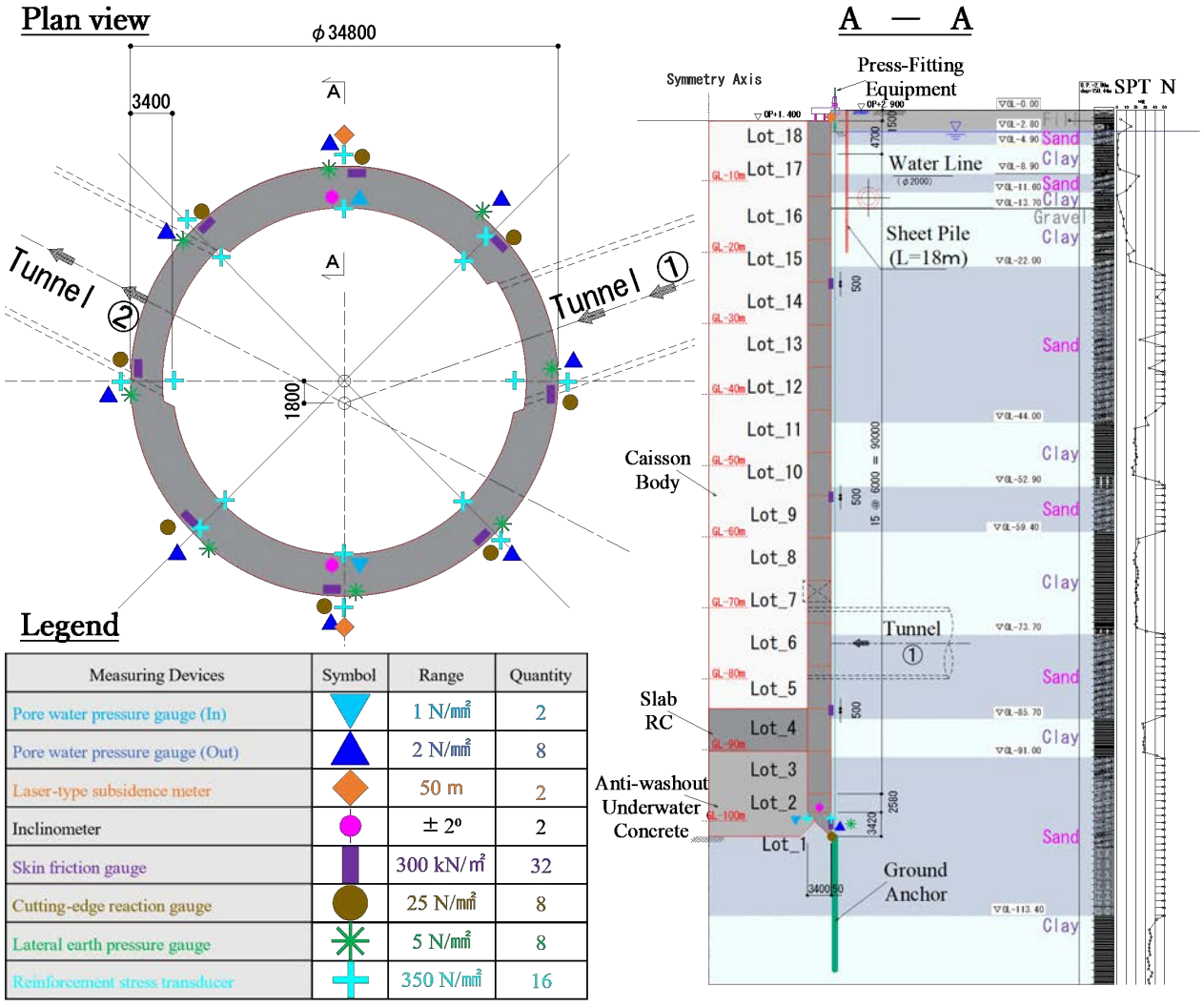
1. INTRODUCTION

The steady growth in urbanization, particularly in densely populated regions, has triggered great endeavors to utilize underground space for infrastructure. Open caissons are one of the facilities that can be applied to numerous underground projects, such as deep foundations, underground attenuation tanks, pumping stations, and tunnel reception shafts. They are practical and beneficial for spacious operations under the relatively narrow entrance. On the other hand, open caissons construction demands rigid monitoring and assessment to control the unplanned sink. This paper presents the monitoring system of a caisson with a 34.8 m external diameter and 102.2 m length; with these dimensions, it will be an enormous one in the world when it is finished. Fig. 1 shows the soil profile, dimensions, and monitoring system. The completed shaft will serve as a water storage junction for the underground river project in Japan. We hope this case study will provide valuable insight into the construction of deep open caissons and serve as an essential reference for future open caisson monitoring projects.

2. REAL-TIME MONITORING SYSTEM

The instrumentation system includes caisson settlement and tilt, soil-structure interaction stresses, pore water pressure, and reinforcement stresses (Fig. 1). Seventy-eight instrumentation elements are totally used. The aim of the monitoring system is: (i) to inform the construction process by providing real-time feedback to site engineers and operatives and (ii) to obtain record data during the construction process, to form a basis for improved future design methods.



Measuring Devices	Symbol	Range	Quantity
Pore water pressure gauge (In)		1 N/mm²	2
Pore water pressure gauge (Out)		2 N/mm²	8
Laser-type subsidence meter		50 m	2
Inclinometer		± 2°	2
Skin friction gauge		300 kN/m²	32
Cutting-edge reaction gauge		25 N/mm²	8
Lateral earth pressure gauge		5 N/mm²	8
Reinforcement stress transducer		350 N/mm²	16

Fig. 1 Overview of caisson structure, soil profile, and monitoring system

Keywords: Open caisson, Caisson sinking, Geotechnical instrumentation
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3. MONITORING RESULTS

Fig. 2 shows the time histories of the monitoring results. As it can be read from the changing caisson depth, it has exceeded 40 m in the sand layer by 2023/01/01 without any problem. The variation in pore water pressure (PWP) is also represented. Fig. 2 confirms a logical tendency between the hydrostatic pressure and outside sensor reading. The average PWP differences between the inside and outside sensors remain constant, except for Lot_8 concrete casting. The sudden increase of the inside PWP is considered to cause by the excessive PWP which occurs inside the dense clay layer. The total anchor loads which are used as a reaction for the caisson sink do not reach the maximum design value of 60,000 kN. As expected, the average skin friction, cutting-edge reaction (end bearing), and lateral effective earth pressure (soil-structure interaction stresses) increase with the depth. In addition, these parameters are higher in the sand than in clay due to shear strength properties. The average skin friction value differs from the standard friction coefficient values which are specified by the Japanese road association. The inclination of the caisson and the contact loss between the friction sensors and the soil may cause this difference. Maximum reinforcement stress has reached -50 MPa (compression), which is well below the design value for the reinforcement concrete structure.

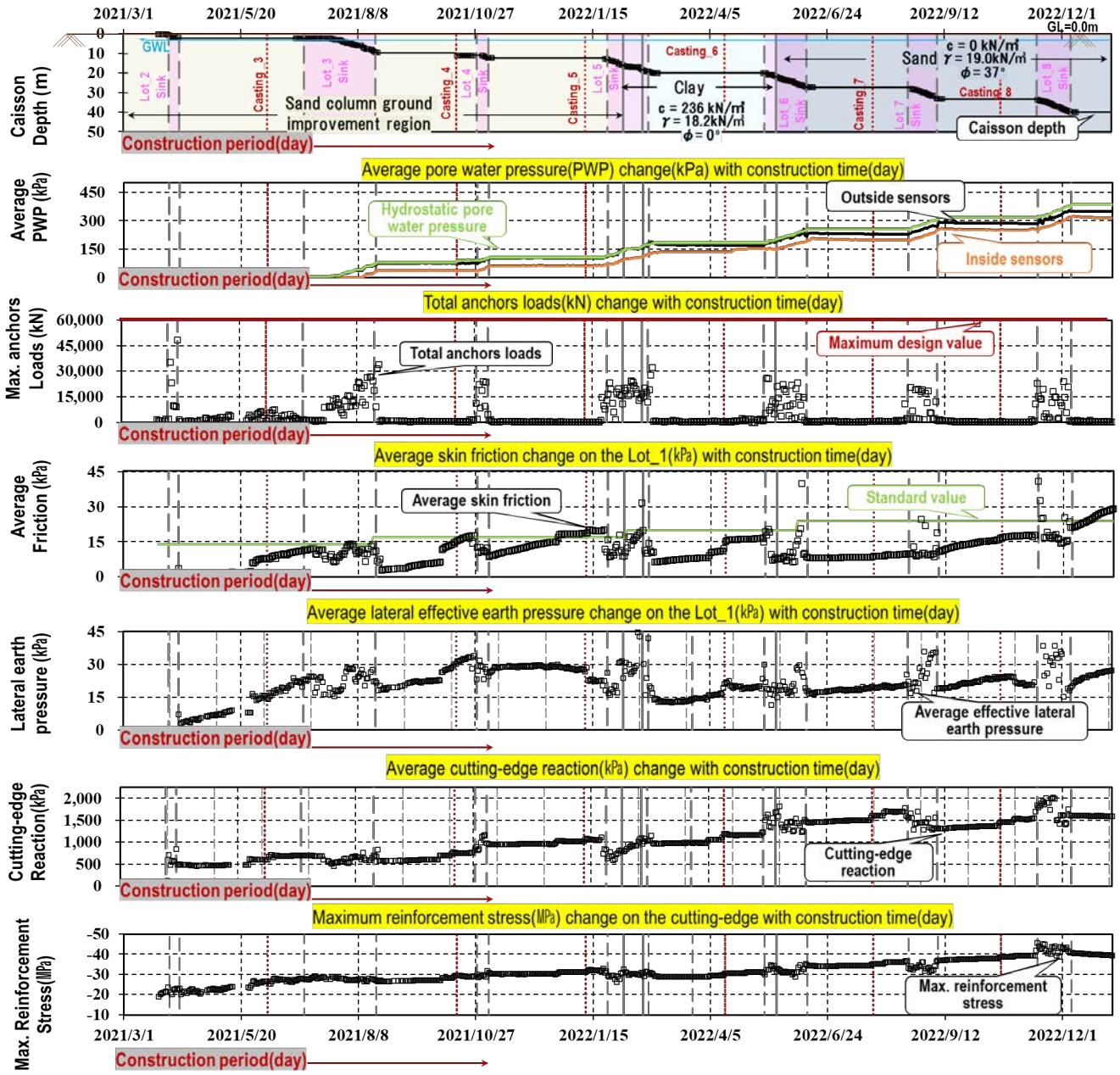

Fig. 2 Monitoring results

4. CONCLUSIONS

This paper summarizes real-time monitoring of a massive, deep, open caisson construction. The caisson is successfully being installed in a challenging soil profile and construction environment. The following conclusions arise from work; 1) A complex monitoring system was successfully installed without negatively impacting construction activities. 2)The system informed the site team for the caisson sinking. 3) The data obtained will contribute to understanding the caisson sinking mechanism, notably different soil profiles.