Research and Application of BIM Cloud Monitoring System for Open Caisson Construction of Super Large Bridge

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Abstract: Application of monitoring and BIM Technology in open caisson construction of super large bridge is analyzed. Monitoring method of open caisson construction is analyzed. Using BIM Technology to assist the monitoring of open caisson construction is studied. 2D monitoring system of open caisson based on mobile internet is studied. Monitoring system based on BIM, Internet and cloud platform is studied. Research achievements in this paper have been verified in engineering practice.

1. Introduction
Open caisson is widely used in shield shaft, water tower, chimney, water supply and drainage shaft, bridge and other engineering fields due to its advantages of good economy and large bearing capacity. Large and extra-large open caissons are mainly used for anchorage foundation and main tower foundation of long-span bridges, which has a long history of application in bridge engineering.

In recent years, a numbers of large-span bridge projects across rivers, seas and lakes have been built, while open caisson foundation have been widely used. The size of open caisson is also increasing. If the foundation of open caisson in water and on land is deep silt soil, it is very difficult to control the attitude of open caisson. Timely and high-precision construction monitoring of open caisson can facilitate the project department to make correct construction instructions. This research has great practical significance.

BIM stands for Building information modeling, not a theory, not a simple 3D model, it is application of many technologies. It is epitome of a series of advanced information technology, and embodies value through application of information technology. Practice of construction and mechanical engineering shows that application of BIM Technology can greatly increase expressiveness of structural state, ability of extracting information in each stage, and ability of business communication between owner, supervisor and construction unit. BIM model can directly reproduce construction process, it is convenient to find problems, optimize process, improve control accuracy and cut down construction period.

In the monitoring of super large open caisson, BIM technology is used to assist research and development of visualization 3D system, which can effectively support caisson monitoring data viewing, make full use of monitoring data, improve timeliness of monitoring, and ensure accurate and real-time control of caisson construction.

2. Monitoring method of open caisson
Open caisson monitoring is effective control of final construction goal, and technical means to correct various influences in construction process. Monitoring technology ensures that stress and elevation after completion of caisson meet design requirements.

In process of monitoring, stress, edge resistance, soil displacement and geometric attitude of steel shell and concrete section of caisson should be obtained to guide construction, so as to ensure safety. One of the most important is open caisson geometry.

Geometric attitude monitoring of caisson subsidence includes elevation, plane twist angle and inclination angle of caisson top, in which total station is used to monitor in general. Generally, four monitoring points, which location can be considered according to site condition, are arranged at midpoint of four sides on top of caisson. Measuring point sign is set up.

At the top of the super large open caisson, GPS points can be set up to obtain 3D coordinates. Data of plane, torsion and vertical attitude can be calculated based on coordinates. Monitoring data display, generally used data tables, floor plans and so on.

3. Research and development of BIM monitoring system

In terms of monitoring of open caisson, current problem is long period of monitoring data reaching field construction personnel. This has an impact on construction efficiency of front-line personnel, and is prone to construction errors. In addition, readability of monitoring data is low, which also has an impact on construction.

Based on BIM and mobile internet technology, design and development of monitor system for open caisson are carried out in this paper. Based on BIM, a 3D visual monitor system is developed, mobile data viewing and working system is developed, which is applied in construction. 3D platform is built with bridges and open caisson models to display monitoring data, as shown in Figure 1.

Combining mobile Internet with data display, we develop system for mobile terminals. The geometry and attitude data of open caisson can be quickly consulted, and on-site construction can be effectively supported. Construction efficiency has been improved and construction problems have been reduced, as shown in Figure 2 and 3.

Figure 1. Display of BIM 3D Monitoring Data System
4. Bridge engineering application
3D open caisson monitoring system and mobile system are deployed to an actual project. System functions support rapid display of two super large open caisson geometry and attitude data. Data can be real-time viewed, and data of construction site can be quickly obtained. Since open caisson transportation is in place, construction of system begins. At present, it has been serving construction for more than 2 years. System has been applied in various stages such as floating operation, precise
placement, sinking and final sinking of caisson, and has effectively assisted construction.

5. Conclusions
Construction of super large open caisson is complex, of which monitoring is an important technical means. Traditional caisson monitoring methods are widely based on data processing and graphic display. It may face the problems of low efficiency and data display.

By using mobile Internet, BIM, cloud services and other technologies, intuitive display of monitoring information and rapid utilization of monitoring data can be effectively improved.

References
[1] Pecker A. Design and construction of the Rion Antirion Bridge foundations. 2008
[2] Shunquan Qin, Zongyu Gao. Developments and Prospects of Long-Span High-Speed Railway Bridge Technologies in China [J]. Engineering, 2017 (6)
[3] Vito Getuli, Pietro Capone, Alessandro Bruttini, Shabtai Isaac. BIM-based immersive Virtual Reality for construction workspace planning: A safety-oriented approach [J]. Automation in Construction, 2020
[4] Fanlong Tang, Tao Ma, Junhui Zhang, Yongsheng Guan, Lifeng Chen. Integrating three-dimensional road design and pavement structure analysis based on BIM[J]. Automation in Construction, 2020
[5] Fei Gao, Hong Zhou, Hongjun Liang, Shun Weng, Hongping Zhu. Structural deformation monitoring and numerical simulation of a supertall building during construction stage[J]. Engineering Structures, 2019
[6] Nisha Puri, Yelda Turkan. Bridge construction progress monitoring using lidar and 4D design models[J]. Automation in Construction, 2019