Application and Innovation of BIM Technology in Municipal Projects

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Abstract. In this project, BIM Technology is introduced into the design and construction of frame bridge to solve the problems of insufficient bearing strength of row piles outside foundation pit and collision between frame bridge and road. Making full use of the data of physical model, sensor update and operation history, this paper analyzes the project construction and operation, and optimizes the construction scheme with the advantage of "BIM + Digital twin". Finally, the application of BIM Technology in this project can effectively solve some problems in the design and construction process of frame bridge, improve the design quality and save the cost, which has a certain reference significance for the same type of projects.

1. correlation theory

1.1. BIM Technology
The software of Bentley company is used to build three-dimensional model and integrate the relevant information of various operations in construction engineering. The visualization, integration, simulation, coordination, optimization and plotting of BIM Technology are used to assist the construction deepening design and facilitate the simulation and analysis of the construction process[1].

1.2. Digital twin Technology
The digital twin is closely related to the generation of physical entities. In this project, the frame bridge entity and its process are digitally mirrored. In the process of creating digital twin, artificial intelligence and sensor data are integrated to build a "real" model that can be updated in real time and has strong sense of scene, which is used to support the decision-making of various activities in the life cycle of physical products.

1.3. Advantages of BIM + Digital Twin
In the field of architecture, BIM is a tool to create and use "digital twin"[2]. Through simulation technology, as like as two peas, the data of physical models in the real world are collected, and a number of typefaces that are exactly the same as the object are shown on the screen through these data. Through this "projection" to observe the operation of the digital entity in real time, monitor various operating parameters, and through a large amount of data accumulation combined with artificial intelligence to further simulate the virtual world, the deduction results are finally fed back to the real world.

2. Project summary
This project is a road engineering project in Tianjin. The total length of the road is 472m. The frame bridge is placed at 225.7m and 250.3m, and the frame bridge crosses the railway. The railway mileage
is K2 + 239.0, and the designed railway mileage of this project is 351.2m. The designed road speed is 60 km / h. The main design content includes the foundation reinforcement design due to insufficient foundation strength. The construction content is the reinforcement construction of the railway.

In the construction of the project, the integration of multi specialty and multi technology is adopted to ensure the accuracy of the design stage, the one-time of the construction stage and the accessibility of the operation and maintenance stage. The figure below shows the overall effect of the project in the modeling software.

3. Application in design phase

3.1. Foundation reinforcement design
The foundation reinforcement design in this construction project has been investigated. The soil layer is silt and muddy clay. PLAXIS software is used to simulate drilling sampling, and the soil layer analysis structure diagram is established, as shown in Figure 2. Through the open building designer modeling software, the foundation pit is modeled, and the established model is imported into the soil layer designed by PLAXIS software for optimization design. After analysis, the external row piles of foundation pit can not reach the design strength of 150kPa, so it is necessary to strengthen the foundation pit under the frame bridge, and adopt high-pressure jet grouting pile treatment. In order to solve the problem that the force is not up to the standard, it also needs to meet the requirements of durability and corrosion resistance. After analysis, the plum blossom pile layout is the most reasonable.

Figure 1 Overall schematic diagram of the project

Figure 2 Soil layer analysis
3.2. Soil layer analysis terrain analysis
The project is located in a remote environment with high exploration difficulty coefficient. Before the
design, GIS technology is used to extract the location of the project, and the location information is
imported into BIM modeling software to facilitate the project positioning. Then use civil 3D to establish
the corresponding terrain, as shown in Figure 3, to solve the problem that the frame bridge is higher than
the rail due to the height difference in the next design process, resulting in the normal operation of the
railway, so as to carry out the secondary detailed design.

![Figure 3 Terrain modeling](image)

3.3. Build 3D model
BIM Technology is used for three-dimensional modeling, and the two-dimensional drawing information
is converted into three-dimensional model, which can quickly and effectively solve the problems
existing in two-dimensional drawings, and avoid the rework caused by improper design in the
construction process. Before modeling, it is compared with the common modeling software on the
market. After comparison, it is found that Bentley's software can better meet the requirements of the
modeling task in the traffic direction. So in the modeling process, all of the company's software is used.
In the modeling process, the elevation terrain of the project and the bridge type of the frame bridge are
established by using the open bridge designer software.\(^\text{[3]}\) Secondly, the center line of the road is drawn
in the open road designer software, and the elevation and terrain established in the open bridge designer
are imported into the software. Then, the contour of the road is drawn and the material is given. The two
models are integrated and modified in the open building designer software.

In the production process, the difficulty is that there are collision points in the process of the re
combination of the frame bridge and the central road. This is because the road elevation is not modified
and adjusted in time in the design stage, which leads to the collision between the frame bridge and the
road.\(^\text{[4]}\) In the process of modification, the embedded depth of the collision point is measured, and the
collision point is adjusted by modifying the elevation of the road until there is no error, and the modified
terrain is saved. For the special components in the project, the flexibility of MicroStation software
drawing is used to establish an exclusive family library to save, so as to ensure the uniqueness and
accuracy of the project.
4. Construction stage

4.1. Simulation of line reinforcement in construction stage

In order to ensure that the upper railway of the frame bridge can still reach the maximum bearing capacity after the jacking construction, the STAAD software is used to calculate the bearing capacity of the rail, as shown in figure 5 to ensure that the stress of each point of the spatial structure is balanced. After the calculation, it is found that there is an error in the system, as shown in figure 6. Therefore, it is necessary to carry out the line reinforcement design for the upper railway of the frame bridge in this project[5]. Considering the particularity of the soil layer of the project and the safety in the construction process, the railway line model is established by using the modeling software before the construction. Combined with the elevation points of the frame bridge, the elevation difference is found in advance. Bim-film construction simulation software is used to simulate the construction animations such as replacing sleepers, fastening rails, crossing beams and stringer reinforcement in line reinforcement, and technical disclosure is made to prevent the second rework waste caused by incorrect construction technology.
4.2. Construction site layout and schedule arrangement

In order to solve the construction waste caused by the untimely mobilization of materials in the construction process. Before construction, the scale, location and coordination of the external traffic and various construction facilities of the construction site shall be determined. The construction site layout shall be established in advance. Considering the layout and floor area of materials, slag yard, construction and production facilities, camp and project management area required by the project construction, the construction site shall be divided into material yard, slag yard, construction area, management area and living area, and special access traffic routes shall be arranged for special materials. As shown in Figure 7.

From the perspective of cost saving, enhancing the competitiveness of the project and reducing the risk. Before the construction, effective and reasonable schedule should be arranged in advance, the shortest construction period should be calculated, the optimal construction scheme should be deduced, the problems in the drawings should be found in advance by using BIM Technology, and the construction
period delay caused by the second rework and the quality decline caused by the rush period should be avoided. In the process of construction, the daily construction schedule is compared with the original schedule, and the reasons for advance or delay are summarized. For the delay time, the prepared schedule is modified in time, and finally the construction period is successfully and effectively shortened. By comparison, the project is 16 days ahead of schedule, as shown in Figure 8, which can save costs and enhance the benefits of the project.

5. Operation phase
With the advent of the digital era, people have higher and higher requirements for intelligent construction, which will not only meet the innovation in the design stage and construction stage, but also have new requirements for the intelligent management after completion[6]. In the era of big data, smart construction sites are more common. In the new development process, we continue to discover and explore the exclusive confidential platform belonging to the project, so as to facilitate the query and change of information and make the digital twin project.

After the completion of the project, the exclusive docking information platform will be established to facilitate the management and maintenance of the project and make the project more information-based. During the login process, the platform uses the login mode of exclusive account + password to screen the information of the login person, so as to avoid the disclosure of project information and ensure the confidentiality of the project. After logging into the platform, you can query the project information and the task arrangement and completion of members at different stages, so as to facilitate the personnel to find the quality problems in the future, and make the responsibility personalized[7]. The established
BIM model and two-dimensional drawings are placed in the platform for information disclosure. At the same time, it is convenient to query and change the information in the secondary design of the road.

6. The whole process production under the intelligent construction technology

With the popularization of 4G technology and the gradual maturity of 5g technology, we feel the convenience and quickness brought by science and technology to our life, and at the same time, we are breaking the traditional production process of all walks of life. More and more people call for intelligent construction technology to take root and germinate rapidly, and this project also combines advanced intelligent construction concept with traditional construction technology. With the advent of BIM era, once again break the traditional design concept, CAD brings designers convenient and fast, then BIM brings us higher and faster work efficiency.

In the design stage, we use PLAXIS foundation design software, STAAD structure design software, modeling software and other digital technologies to test the reliability, safety and accuracy of our design, and reduce design changes from the root. By improving the accuracy of BIM model, the construction party can better understand the design concept and intention of the designer, and better understand the drawings. In the construction stage, the construction simulation software is used to simulate the construction process of key nodes, and the three-dimensional animation technology is used to carry out the construction safety technical disclosure, so as to avoid the low benefit caused by the secondary rework and reduce the potential safety hazard caused by the incorrect operation. In the operation stage, the smart project docking platform is established to save the project information, which is convenient for the query before the project change and the information saving after the change in the future.

7. Conclusion and Prospect

7.1. Conclusion

This project reasonably uses Bentley design software to combine the BIM design of roads, bridges and projects with GIS, UAV and other technologies. By loading the three-dimensional real model into Bentley design software, road design can be completed in the real surface environment, and multiple functions can be realized. According to the specific coordinate information, we can determine the location of the red line in the model, so as to achieve accurate positioning, and then complete the overall data statistics.

By integrating the BIM design model and GIS data of municipal road, on the one hand, it can assist the construction of the model, on the other hand, it can realize the optimization of data and the visual analysis of the model. The combination of the two technologies in municipal road and bridge design optimizes the traditional schedule management process, improves the accuracy of data processing, and greatly reduces the risk of engineering construction.

This paper studies the municipal project method based on intelligent construction technology, which can be used as a reference for other engineering project design, but there are still some shortcomings in the current research process:

- According to the statistics of some cases, the closed water stop valve can not completely cut off the compressive water source, and there is still the risk of foundation pit settlement.
- At present, the project has not verified the application of BIM Technology. In the aspect of demonstration of important nodes, we plan to use the virtual reality technology of lumenrt to further select reasonable and effective engineering design scheme. At the same time, we only study the relationship between Bim and virtual reality Some problems related to the positive design, the next will focus on the road design, reinforcement design, safety simulation and other aspects of supplementary research and explanation. In addition, the technology also needs to continue to explore and innovate, and strive to achieve the life cycle management of municipal engineering projects.
7.2. Expectation

- According to the spirit of the 13th five-year plan, the relevant ministries and commissions have issued a series of beneficial policies for the popularization and promotion of BIM Technology. Based on the analysis of municipal infrastructure and municipal road planning project in each stage, this paper shows that each stage of municipal construction project is conducive to the application and development of BIM technology.

- In this paper, combined with the actual case, the municipal infrastructure project application Bentley software development, application and management process steps are simply integrated. And the next stage of the plan and experience. Only when all parties involved in the construction of the project jointly confirm the design standards and processes, can the municipal construction project run efficiently in all stages and the whole project cycle.

- At present, closely following the development trend of dimensional scanning technology and UAV measurement technology in the field of Expressway surveying and mapping, municipal construction projects also need to do further research on the secondary development of Engineering localization, and gradually establish the construction library, formulate unified specifications in the process of model design, and improve the efficiency of BIM forward design and municipal engineering construction.

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