Research on Key Technologies of Construction Management of Large Swivel Bridge Based on BIM Technology——A Case Study of Dade Swivel Bridge

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Abstract. Swivel bridge is a special construction method in bridge engineering. It has the characteristics of difficult construction, complex environment and many benefits. The project needs fine management to overcome various problems in traditional construction management mode. Taking Kunchu Expressway over Chengdu-Kunming Railway Bridge as an example, this paper introduces the technical route and technical application points of fine management of construction of turning bridge of Expressway based on BIM technology. The main application points of this paper include: BIM collaboration, BIM collision detection, BIM project management application platform, UAV three-dimensional scene modeling, three-dimensional laser scanning. Practice has proved that BIM technology has incomparable advantages over traditional management mode in finding drawings errors, technical submission, engineering statistics, collision detection, information integration and so on. The implementation of BIM technology has brought enormous technical and economic benefits to project management and has good prospects for promotion.

1. Background
Swivel bridge is a special construction method in bridge engineering. It is usually used to cross rivers, valleys, railways and other obstacles. The segment of Kunming to Chuxiong Expressway is Minshan to Guangtong of national expressway net, connecting Anchu Expressway. It is 114.916 kilometers long, six two-way lanes, design speed of 100km/h, the wide range of the base of road is 33.5 meters, the total investment of this line is 150.7 million yuan, passing through Lufeng County to Kunming, the starting point K60+622 of the main line of Kunchu Expressway (Qinfeng to Peace Test Section), located in Dade Village, Lufeng County, this route is from east to west. The length of the route from the main line K61+395 to Peace town is 773m. Kunchu Expressway (Qifeng to Peace Test Section) over Chengkun Expressway overpass project (over Chengkun Expressway overpass project for short) is a key dominant project for this project.

The Over Chengkun Expressway overpass project is divided into left and right. The length of the left body is 254 m, the length of the right body is 294 m, and the cost is about 70 million. This project adopts swivel construction, making the whole body swiveled, and rotating the T structure turn of...
66° into the bridge’s position. The speed is 0.016~0.02 rad/min and the weight is about 15000t, with once-time forming, and the turning operation time is about 60 minutes.

BIM technology should be an application of the entire life cycle of the project, covering a series of applications from planning to design to construction, and finally to the operation and maintenance phase. In theory, it should be all-encompassing. The application of BIM technology in expressway engineering should be a huge systemic application involving tools and platforms. In recent years, the engineering application of BIM technology has been increasing, and there are many engineering practices in the field of construction. In the field of bridges, there are also some applications. For example, Hong Lei used Revit to carry out parametric modeling and rendering of continuous beam bridges. Huang Junxuan introduced a design case of cable-stayed bridge and archbridge which is using Catia. In general, BIM technology is more mature and widely used in the design and construction stages, while the use of operation and maintenance stage is less. Hu Zhenzhong proposed the application framework of bridge life-cycle management based on BIM technology, and discussed in detail. The application prospects of BIM in the rapid modeling, construction management, durability monitoring and cost analysis prediction of bridge engineering, but this framework lacks of specific engineering practices. Application of BIM for existing structures are issues that have attracted industry attention in recent years. Existing buildings often have problems such as missing drawings, incomplete information, and heavy design of BIM, which need to be further resolved. At present, some reverse modeling methods using laser scanning and photo reconstruction have some attempts in engineering.

2. Method
Based on the overall research ideas of “discovering problems—analysing problems—solving problems”, the overall research of large-scale swivel bridges based on BIM technology is divided into three parts, namely, current situation research, demand research and technical research. The research of the project mainly includes five contents: ①BIM specification coding system manual; ②parametric modeling model and family library research; ③Swivel bridge visualization data creation and management research; ④Swivel bridge BIM construction elaborate dynamic management research; ⑤Smart site and BIM construction elaborate management combined application research. The project combines theory, method, technology, experiment and construction to carry out research work. The technical route is shown in Figure 1 below.
3. Practice and Application of BIM Technology

3.1. Collaborative design application based on BIM technology

At this stage, the project works in accordance with the idea of “establishing model standards—building a coding system—BIM—complete data construction—expanding BIM applications”.

The biggest feature of the BIM collaborative design of this project is to break the traditional modeling method. After practicing, a set of modeling methods suit for subsequent construction management explored, that is, the modeling is guided by the partial item acceptance rules. The construction integration collaborative design pointed out the direction and laid the foundation for subsequent research. The specific steps of this collaborative design are as follows:

Step 1: Component splitting according to the partial item acceptance rules. According to the bridge drawings provided by the owner, combined with the bridge quality acceptance specification. The model is divided, according to the sub-item acceptance rules.

Step 2: Encode the split components. In order to facilitate the elaborate management of the later construction. The project is set up, according to the following methods.

Step 3: Encode the model elements. The project is coded, using the engineering
part-material-extended description.

3.2. Bridge collision detection based on BIM technology
Collision detection of the project involves collision detection between components, between reinforcement, structural deepening models, reinforcement deepening models, electromechanical deepening models, and embedded parts. Each type of collision point may cause the project to rework. Even affect the project duration, so collision detection is an important application point of the project.

3.3. Project management platform based on BIM technology
In order to ensure the smooth operation of the project, which independently developed a project management application platform based on BIM technology. The platform takes the model as the carrier and the platform as the tool. The parties involved in the project carry out online project archives data management and query, schedule management, collaborative task management, and quality and safety issues. The platform uploads the model to the cloud server, and uses the PC and the APP for project management, thereby enabling multi-objective control of project management.

3.4. Exploratory technology applications

3.4.1. 3D real-time modeling of tilting photography of drones. With the continuous development of China's UAV technology, the visualization model that realizes the integration of BIM and GIS has reached the height of real-time construction management. Compared with traditional 3D modeling, the new technology has significantly improved the modeling quality, analysis accuracy, decision efficiency of the BIM based on richer image information and more advanced experience. The drone assists on-site real-time safety, civilization and progress supervision.

3.4.2. 3D laser scanner. The 3D laser scanning technology is constantly evolving and becoming more and more mature. Its great advantage lies in the ability to quickly scan the measured object and directly obtain high-precision scanning point cloud data without the need of a reflective prism. This enables efficient 3D modeling and virtual reproduction of the real world. Our school and Chongqing Jiaotong University strategically cooperate to explore the combination of laser scanning and BIM. Accurate models are generated by laser scanning to verify construction quality.

4. Application effect analysis of BIM Technology
Practice has proved that BIM technology brings huge technical and economic benefits to project management and has a good promotion prospect. The BIM application effect of this project is embodied in the problems of finding drawings, improving the accuracy of technical simulation, finding problems in collision inspection, site layout plan, engineering quantity statistics, project management platform and so on. See Table 1 for details.

| Table 1. Application effect analysis of BIM Technology |
|-----------------------------------------------|
| value | Concrete contents |
| Drawing problem | Found 26 problems, 5 design optimization and adjustment problems |
| the construction technology of model | installation method for simulation animation with swivel structure and cast-in-place support, optimized Installation Method for cast-in-place support |
| collision check site Temporary Facilities layout scheme | Found 354 problems, 213 design optimization and adjustment problems |
| quantity statistics | Use model and terrain, laying out and optimization of the installation plan |
| According to the statistics of the subentry engineering model, 52 inconsistencies were found, 38 were confirmed by design, assisted in |
establishing 0# machine account, and guided capital plan formulation such as period measurement.

1) Link construction management information to realize project information online consult and download.

2) Data management (realize online elite archiving and classification of data, and form completion data) Quality management (real time associative about test detection, concealment acceptance, quality evaluation, etc.).

3) Schedule management (simulates the construction process, schedule analysis and rectification, schedule automatic warning, etc.).

4) Safety management (real time associative about risk source recognition and preventive measures, a) safety inspection, inspection of equipments, etc.).

5) Investment management (real time associative about engineering change, receipt recorded, period measurement, etc.).

6) Collaborative task management system

5. Conclusion
This project integrates BIM modeling, collision detection, construction animation simulation, UAV 3D real-time modeling, 3D laser scanning and other cutting-edge technologies into the swivel bridge project, and integrates various data information to develop BIM-based technology. The project management information platform has laid a solid foundation for the elaborate construction management of the swivel bridge. Practice has proved that BIM technology has unparalleled advantages over traditional management models in terms of finding drawing errors, technical disclosure, engineering quantity statistics, collision detection, information integration, etc. The implementation of this technology brings huge technical and economic benefits to project management and has a good promotion prospects.

Acknowledgement
Thanks for the support of the fund: Research project of Yunnan Provincial Department of Transportation Yunjiao Science and Education [2018] No. 43

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