Research on the Framework of the Collaborative Management Platform for the Reconstruction of Bridge Projects during Construction Based on BIM

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Abstract. This research is based on BIM technology, cloud computing and Internet of Things technology, and independently developed the BIM collaborative management platform framework during the bridge reconstruction project construction period, to achieve visual and refined management of the quality, safety and progress of the bridge reconstruction based on BIM technology. The research results can be found in Popularize and apply on the same type of bridge.

1. Introduction

Under the background of the supply-side reform of traffic construction, it is an inevitable trend for highway bridge construction to be "industrialized, standardized and intelligent". Under the current highway construction and maintenance system, the design, construction and maintenance of Bridges still remain in extensive management, with fragmentation in each stage, low degree of industrialization, serious loss of big data, island and information in the construction and maintenance of Bridges, especially the integration of bridge construction, management and maintenance in the whole life cycle. Under the new opportunity of highway transportation transformation and development during the 13th Five-Year Plan period, bridge construction and maintenance are developing towards lean quality and green longevity. BIM technology provides important technical support for this.

BIM technology involves the technology and management innovation of the whole life cycle of engineering projects from planning, design and construction to operation and maintenance, providing an effective collaborative platform for the management of the whole life cycle of engineering. From the perspective of the application and promotion of BIM technology in the field of construction, the integration of BIM technology with advanced technologies such as mobile Internet, cloud computing and RFID will make the implementation of professional technical standards and the management of engineering projects more transparent and smooth, and solve the problems faced by the integrated management of highway bridge beam construction, management and maintenance. At the same time, through the application of BIM technology and reasonable planning, the scheme during the construction period and operation, maintenance and maintenance period will be more optimized, the management will be more orderly, the data will be more accurate and reliable, the resource sharing
will be more smooth, the decision-making will be more timely and effective, and the contradiction between input cost and quality control can be solved.

This study carries out research on the framework of collaborative bridge management platform based on BIM technology, and takes the high-speed reconstruction project of He-Ning as the main research object to upgrade the bridge construction management technology and create a new highway management mode.

2. Engineering background
In the past decade, a series of technologies such as computers, informatization, and refined management have developed rapidly and have been widely used, and they have also had a huge and profound impact on the civil engineering industry. The building information model (BIM) is in such an environment. After going through the initial germination period and development period, BIM was quickly applied to project construction to solve various problems of project management.

This project is based on BIM technology, with the main research objects of He Ning Expressway, combined with modern information technologies such as big data, cloud computing, mobile Internet, etc., to study the basic architecture of the collaborative platform, build a BIM collaborative platform for highway engineering reconstruction projects, and provide technical support; The framework of the BIM collaborative management platform during the construction of the expressway has realized the real-time visual management and control of bridge construction quality and safety.

3. Functional analysis of the management platform architecture

3.1. Design of management platform
Highway bridges need a unified management platform during the construction process. The business functions of the management platform include file management, quality management, schedule management, and safety management. The platform architecture includes the following four parts:

(1) The BIM central database is the core of the entire system. The main functions include: information storage and management, a platform for connecting and binding information models, associated mobile terminals, and associated new tools developed in the future.

(2) The collaborative platform is the management entrance and adopts the B/S architecture to facilitate multiple users to log in at the same time. The main functions include: database management, main design information, construction information input and information release.

(3) The three-dimensional model of the bridge is displayed in the management platform based on BIM technology, and unity is the main function of the basic platform: the establishment and display of the three-dimensional model of digital ground models, roads, and bridges, and the connection of the three-dimensional model and the bridge information.

(4) The mobile phone terminal is based on HTML5 technology, and its main functions include: engineering information query, data upload, quality and safety on-site management, progress tracking.

3.2. Lightweight BIM model
The BIM model is a large platform model that gathers big data. The final representation is a visual multi-dimensional, multi-purpose, and multi-functional computer graphics model. The result is that the BIM model takes up a lot of space, ranging from hundreds of megabytes to even a few G. In this way, the computer configuration requirements are high and the results obtained are not ideal. Therefore, the BIM model needs to be lightened when rendering. The specific methods are:

(1) Export the first BIM model as the second BIM model, and save the component color and material information of the components in the first BIM model, so that the configuration requirements will be reduced when the second BIM model is run and displayed.

(2) Simplify the second BIM model and process the boundary representation to obtain the third BIM model.

(3) Render the third BIM model.
Through the above steps, the large-scale BIM model is lightened during rendering, which not only greatly reduces the size of the model, but also ensures the use of the BIM model.

4. Central database architecture and functions
The central database is divided into three layers: the storage layer at the bottom, the data layer in the middle, and the construction application layer at the top.

Storage layer: model information data, various types of data generated during construction include project progress, safety, and quality. Project archives including drawings, personnel, materials, equipment, and project information are stored at this level.

Data layer: The data layer uses a distributed database based on cloud computing and Internet of Things technology for storage and integrates all the data in the construction process. All engineering data is divided into structured data and unstructured data. Among them, structured refers to business data, model data and other related data, including lightweight model collection information, attribute information, progress information, quality information, and safety information. Such data can be stored in the model database to support multi-user Concurrent access, big data processing, data backup and consistent proofreading. Unstructured mainly refers to documents, pictures, videos, etc., including model files, drawing documents, such data can be stored and managed through files, supports the management of different versions of files, and supports the modification and checking of files.

Construction application layer: Provide project members with schedule management, quality management, and safety management. It provides real-time data query, statistical analysis and event tracking for project managers; provide reliable data for project decision-makers.

4.1. Collaborative platform architecture and functions
The collaborative platform can be divided into two levels: project collaborative management and project resource dynamic management. Project collaborative management is mainly oriented to macro business, which can be achieved through PC, mobile phone and other methods. The dynamic management of project resources is mainly oriented to the management of production factors, and at the same time provides data for project collaborative management.

4.1.1. Quality management. Establish a data reporting and approval process for each component of the bridge. The BIM platform provides data entry, uploading, querying and editing functions, and links the quality inspection data of the bridge with the BIM model. Through the BIM model, the quality inspection related information of each component of the bridge can be consulted at any time.

4.1.2. Troubleshooting for hidden quality and safety. Use the mobile phone terminal to record the hidden danger problems related to the quality and safety of the construction sites, divide the urgency of the problem, build a template library of quality and safety problems, so that the inspectors can conveniently and efficiently track hidden dangers and form a closed-loop management.

4.1.3. Progress management. The progress management module is mainly aimed at the relevant personnel of the project supervisor, the construction party, the owner's engineering department and the plan and contract department. Its main plan progress, image progress statistics, analysis and control are three modules.

4.2. Architecture and function of the information model platform
The information model platform includes a model layer and an application layer. Three-dimensional model display, file management, quality management, schedule management, and security management belong to the application layer. Its main functions are as follows:

(1) Model layer: The bridge engineer builds a three-dimensional model of the bridge based on the design drawings, and then performs lightweight processing on the model according to usage requirements.
(2) Model display: It is convenient for users to view the model in multiple dimensions, render, color, and screenshot the model, measure the distance, angle, volume, radius, and perimeter of the model. Walk, drive, and fly to roam.

(3) Progress management: statistic and display the progress, output value, and engineering quantity of the project.

(4) Quality management: mainly includes the first project, process inspection, quality hidden trouble inspection, test and inspection, and material management.

(5) Safety management: mainly including risk source identification, safety hazard investigation, emergency management, bridge daily safety site management records, including safety logs, safety education, and equipment safety inspection records.

4.3. Mobile terminal architecture and functions

The mobile terminal is divided into three structural layers: the bottom layer is the basic data layer, the middle layer is the construction data layer, and the top layer is the application layer.

(1) The basic data layer includes project engineering information, project personnel information, shared files, material management, and equipment management.

(2) The construction data layer includes quality hazards investigation, safety hazards investigation, safety violations, team management, etc., which greatly improves work efficiency and timeliness of information.

(3) Application layer: Provide project managers and builders with schedule management, quality management, safety management and other functions; provide project managers with real-time data query and statistical analysis functions; and provide reliable data for project decision makers.

5. Value of BIM management platform

The traditional bridge production management mode is mostly two-dimensional management. The previous information of the managers is isolated from each other, forming an "information island." It is embodied in the following aspects:

(1) For the owners, supervisors, and construction parties, the information is asymmetric to each other, and most of the information of each participant is delineated in a fixed range, and efficient collaborative work cannot be achieved.

(2) The purpose of the framework research of the BIM collaborative management platform is to establish a unified collaborative management platform for the expansion project of the bridge project, so that the participating construction units of the project can achieve efficient and collaborative work, and at the same time standardize the management and data storage of the bridge project during the construction period of the bridge. The data is centered on the BIM model for easy search.

(3) During the construction period, the BIM collaborative management platform should meet the needs of the participating units for query and analysis of business data. Therefore, the platform is divided into multiple functional modules, each functional module is used for specific businesses and users, and each module summarizes the business data into The BIM platform is connected to the 3D model. The platform develops relevant analysis functions according to the construction characteristics, and at the same time realizes the collection, query and analysis of the full business data based on the 3D model.

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