The application of BIM technology in road and bridge construction management

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Abstract—In the whole construction process of highway and bridge, strict engineering quality and safety management, to some extent, is to help promote the long-term development of highway and bridge technology, at the same time, can effectively guarantee the overall safety of bridge and highway construction projects, and reduce the occurrence of safety accidents. In this paper, the application of BIM technology in the safety management of highways and bridges is analyzed to effectively improve the quality and efficiency of construction safety management measures, in order to provide important reference value for bridge construction management safety.

1. INTRODUCTORY REMARKS
In order to improve the core competency of construction and engineering companies, we need to continuously improve the management level while utilizing existing management methods and adopt advanced BIM technology to focus on safety management during highway and bridge construction. The application of scientifically sound BIM technology in bridge construction safety management can establish a framework of safety management models compatible with highway construction in order to improve the level of construction and also play an important role in promoting industrial development.

2. BIM CONCEPT
BIM is a building information model based on 3D digital technology. At the same time, in order to construct a database, it is necessary to collect and aggregate various data required for construction. BIM models communicate with design units and project-specific functions and use digital methods. Currently, BIM technology is widely used in construction projects in various fields[1].

3. IMPORTANCE OF BIM TECHNOLOGY
BIM technology is the result of the continuous development of modern science and technology, which can be the main driving force for the rapid development of China's engineering industry. In the practical application of BIM technology, it is based on the content of CAD drawings. Creating a BIM model based on static road models and construction techniques (including major project structures) is an important step[2]. Based on the creation of the time dimension, the design plan of the project is added, its dynamic model is created, and the entire road operation process is proposed to simulate the operational state. Construction safety management is an important part of the construction management content of highway and bridge construction and has a better role in facilitating the achievement of the project's operational objectives. It is well known that according to the actual situation, operators need to increase the use of BIM technology at this stage. Effective use of the technology to improve the overall management of bridge projects and increase the efficiency of structural safety management in order to more effectively ensure the safety of road bridges. Based on the effective use of BIM technology, we
can build the appropriate highway information system to achieve real-time monitoring of the workplace, share real-time information, provide decision making, and provide managers with powerful data to promote the safety of highway bridge construction\cite{1}.

4. BIM TECHNOLOGY IN ROAD AND BRIDGE CONSTRUCTION MANAGEMENT APPLICATION

4.1. Implementation process of BIM technology in road and bridge projects
The construction of highways and bridges is a complex and dynamic process, and as the construction proceeds, the size and complexity of the project increases, and so does the difficulty of construction management. BIM technology can inform and visualize the entire construction process. First, we construct a 3D model and then study the application of BIM technology based on a logical construction sequence, including pre-construction collision checks and deep design and virtual construction during construction, as shown in Fig. 1\cite{3}. Through progress simulation, post-construction quality inspection and disaster emergency response, the whole process of highway and bridge construction is centralized on an information-sharing platform in order to predict possible problems during construction in advance and to develop measures to improve the efficiency and level of construction management.

![FIGURE 1. Implementation process of BIM technology in road and bridge projects.](image)

4.2. Pre-construction BIM application for road and bridge projects
Before constructing road and bridge projects based on 3D models, visualization techniques were used to perform construction aids such as collision inspection and depth design. In the existing construction drawings, the specialized components are separated from each other and the complexity of road and bridge construction makes it difficult to detect potential pipeline collisions. In the building information model, each component is matched with the corresponding parameter-driven information. The 3D model is collision-checked, automatically displaying the number of collisions, detailed drawings of collision points, and issuing collision detection reports to correct errors and save time. In addition to the components, BIM can also detect collisions between machines, workspaces, machines and structures during construction\cite{4}. BIM also supports traffic flow analysis, calculates performance parameters such as structural stability and load-bearing capacity, and can continuously perform full and partial refinement processes. All this helps to reduce construction costs, reduce construction risks and ensure building quality.

Due to the long roadways used to construct road and bridge projects, temporary construction facilities such as material storage yards and steel fabrication plants are easily concentrated in narrow construction areas and become more congested when encountering unfavorable terrain. Use BIM technology to model the measured 3D topography and integrate it with the general layout of the
construction area to determine the relative locations of highways, main bridges, platforms, trestles, large machinery and material processing plants. To set up a visual 3D layout of the construction site.

4.3. Application of BIM in road and bridge project construction
BIM provides 3D visualization, 4D time, 5D cost, and accurate management at every stage of the construction process. BIM models integrate key information such as quantities, schedules and budgets with associated drawings, materials and contracts. Provide safety and other information and perform post-synthesis construction simulations. The use of digital management and real-time monitoring and other means to simulate project progress, material consumption, etc., to provide reasonable and accurate data for key nodes of construction, business, planning and other aspects of the construction, saving time and money, and improve construction management efficiency[2].

Highway and bridge projects have a unique structural form where quality, cost, safety, materials, etc. are usually controlled according to the construction schedule, and currently, most domestic highway and bridge projects use Gantt charts to schedule numbers and text. Despite the generation of auxiliary materials, it is difficult for construction workers to objectively and intuitively understand the construction schedule and the complex relationships between components. Based on the BIM model, various information about the construction phase is summarized, relevant data is retrieved as needed, virtual construction is performed at each stage of road and bridge construction, and actual and future comparisons are made for cost budgeting, resource planning, and transportation of construction materials based on construction progress simulations[4]. As shown in Fig.2, schedule and cost variances between plans can be adjusted in time to optimize road and bridge construction.

![FIGURE 2. Road and bridge construction optimization process under BIM technology application.](image)

In the actual road and bridge construction process, BIM technology can provide real-time guidance, advance prediction, to solve the next possible problems, and project management has changed from "passive" to "active". In the construction process, BIM information sharing platform can understand the relevant construction technology and safety risks in advance, so as to help workers to prepare, reduce problems, simplify the construction site management and improve the efficiency of field managers[5].

4.4. Post-construction BIM application for road and bridge projects
In recent years most projects have been built with a greater focus on schedule and cost at the expense of quality control. Even the final quality approval process has not been sufficiently standardized, leaving many potential safety risks. For highway and bridge projects, quality and safety are of paramount importance. Employees can readily provide feedback and oversight using BIM technology by entering information about the implementation of components into a shared platform via a 3D model information base during the configuration process. In addition, each building has a unique ID code, so
quality inspectors can quickly locate the components to be inspected during the approval process, obtain comprehensive information, perform standardized inspections, fully determine quality qualifications and write them down in records, and tightly control the level of quality acceptance. Deviations in test results due to random checks, problems of the quality inspectors themselves, etc. can be prevented.

For road and bridge projects, where different parts of the road are built in a specific sequence during construction, emergency management is highly demanding for finished parts that may be exposed to hazards such as fractures, collapses, and landslides. The data stored in BIM has spatial characteristics and can be accessed in real time. In the event of a disaster, a BIM system can help respondents locate and continuously identify potential hazards and other emergencies and provide specific information while emergency personnel are on the way. Not only does it help solve problems, but it also builds the capacity of operations and maintenance personnel in emergency situations. In addition, building information models can assess disaster losses to simulate disasters, develop rational solutions, and study and test their response plans.

4.5. Commonly used BIM software
The common BIM software used during the construction phase is shown in Tab.3.

| Software Name | Revit | Navisworks | Sketch UP | Fuzor | 3DS Max | Design Review | BIM5D | BIM calculations |
|---------------|-------|------------|-----------|-------|---------|---------------|-------|-----------------|
| software vendor | Auto desk | Auto desk | Google | BIMC | Auto desk | Auto desk | Quanlida | Quanlida |
| main function | Create and review 3D models | Model Integration and Collision Detection | Multi-disciplinary 3D concept modeling | Virtual roaming for site design | Dimensional animation rendering and productio n | Review of design documents | Integration of specialized models for management | Calculations using 3D models |
| Ho's category | Core modeling software | Collision Detection Software | Geometric modeling software | Deep Design Software | Visualization software | Release Review Software | Operation Management Software | Cost Management Software |

5. CONCLUDING REMARKS
When building roads and bridges, more effective methods are needed to increase the intensity and effectiveness of management, and information management models are more effective than existing management methods. The use of BIM technology is an important tool for achieving scientific and effective project management, which can further improve the efficiency of project safety management. To ensure the safe development of projects and to ensure the smooth running of road and bridge projects, managers need to develop correct construction plans and establish information-based risk identification systems to improve the efficiency of management work.

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