Application of BIM Technology in the Construction of Long-span Suspension Bridge

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Abstract: The construction of bridge engineering projects is developing towards large spans, large volumes and more complex spatial structures. The current bridge construction based on two-dimensional drawings has been difficult to meet the needs of project construction. With the help of BIM software, this paper takes the construction project as the main body, integrates construction organizations such as the surrounding terrain and landforms and construction facilities of the construction site into the BIM software to form a complete three-dimensional simulation diagram, so that the entire project is modeled and parameterized. In order to achieve the project collision checking, heavy and difficult construction scheme simulation, engineering rapid statistics, information exchange and complete 4D construction simulation, effective guidance to the construction site, to provide an efficient and orderly construction management and technical support.

1. Introduction

With the rapid development of science and technology, economic development and the need to constantly upgrade the needs of human life, long-span, more and more large bridge projects, which put forward higher requirements for bridge design and construction. Bridge construction project not only involves complex spatial structure, bulky and numerous embedded parts\(^4\), but also by the constraints of topography, hydrology and traffic control and so on. Now based on two-dimensional drawings of the bridge construction, the construction process to grasp the great obstacles to efficiency and communication time and space environmental factors, the projects continue to cause downtime or rework repeat schedule overruns. The digital model enables designers and construction personnel to intuitively analyze how to organize more reasonable and how to optimize and other issues, and predict the occurrence and prevention of problems in advance\(^5\). Using BIM technology, the entire project can be presented on a unified project management platform. The construction data can be monitored and called in time on this platform, so that the entire bridge construction project can be carried out strictly, orderly and scientifically. Managers can understand the construction progress in time and realize multi-party collaborative work\(^6\). Thereby improving the safety, rationality and efficiency of construction.
2. Bridge core model establishment

2.1. Project overview
A bridge adopts a three-span self-anchored suspension bridge structure with two towers and two cable planes. The span combination is 44+96+44=184m. The bridge layout is shown in Figure 1. The main tower adopts the shape of a lighthouse, the rise-span ratio of the main cable in the middle span is 1/5.5, and the stiffening beam is a pre-tressed concrete structure.

![Figure 1](image1.png)

Figure 1 Mian bridge layout (unit: mm)

2.2. Establishment of the main bridge model
As shown in Fig. 2 and 3 are elevational and plan views of three-dimensional model. A bridge beam using a single box three rooms, characterized in that the box girder webs, top, bottom left and right of flange thickness and width along the longitudinal bridge have changed, the east side of the widened portion is provided with multi-channel stiffened board. Bridge structure contains a large number of horizontal and vertical complex curves, conventional modeling methods difficult, resulting in increased amount of data input quantities by Autodesk Revit parametric modeling software can greatly simplify the modeling, based on the multiplexing The level of performance divides the overall structure of the bridge into standard components and special components, and accurately establishes variable-section box girder families. Reuse level based on the overall configuration of the bridge member is divided into standard and special member, Group Box accurately model variable section. In order to simplify the model and move closer to the actual construction, the parabolic gradual change of the variable cross-section box girder is changed to “straight instead of curve” for transition[5]. For the complex curve model structure, the model structure is established based on the way of specifying the loft section shape and path. Comes with tool steel is placed in Autodesk Revit software, it can be reinforced in the housing construction for various conventional components, such as steel beams and columns are placed. But for bridge engineering terms, members are mostly irregular component, it is difficult to conventional steel configuration. This bridges the main column top curves are linear, single box girder section is a three-
compartment box structure reinforcing structure complex shape, not a control line, the first group of reinforced build, and then placed into the project. Figure 4 shows the main steel beam model.

Figure 4 Box girder reinforcement model

Figure 5 Import models from Navisworks

3. Application of BIM technology in construction

3.1. Collision inspection of a bridge model based on BIM technology

After establishing the model to ensure the accuracy of the size of the structure can be carried out with the use of BIM software to verify operation. This article uses Autodesk Navisworks to check the collision of the model. Using the cooperation of mass modeling in Autodesk Revit, a 3D numerical model of a bridge was built and imported into Navisworks Manage as a file in nwc format, as shown in Fig 5. Use its collision check function to detect whether there are collision points in the 3D model. Figure 6 is a collision check results, and other adjustments made or modified for the site in question, to deepen and improve the drawings mentioned, thereby improving the quality of design drawings.

Figure 6 Collision check

3.2. BIM construction simulation of a certain bridge

Autodesk Navisworks simulation using the construction of the main bridge made full use with Autodesk Navisworks in function of animation, it can be clearly seen in the construction of analog video to the maximum extent. So that construction workers can be intuitive, vivid understanding of the whole process of the construction process of their own, the key construction and dangers attention. Conducive to grasp the key technologies of tests, work, greatly improving the efficiency of construction [7].

As shown in Figure 7, this article carried out the construction simulation of the whole bridge and the local simulation of important sections of the main bridge. The construction of the bridge tower is not only the difficult part of construction, but also the most important structural part. As the bearing point of the entire main bridge, it is very important to ensure its quality. Using BIM simulation technology, these problems can be solved to the greatest extent and visual supervision can be made to further ensure the quality of construction within the visible range.
3.3. Simulation of construction progress of a bridge based on BIM technology

Autodesk Navisworks incorporated into the model, integrate 3D model data and time information, analog to the construction progress. As shown in Figure 8, using the Timeline module tool in Navisworks, choose to manually enter the construction schedule of the bridge component directly in the Autodesk Navisworks software, and add the start time, completion time and component type of the component construction to each sub, and give the 3D model progress, Set different display colors for components in different states and add codes to display information such as weeks, days, current work completion, and components under construction to complete the 4D progress model of the bridge. The final construction progress information is displayed in the form of video animation, from which construction managers can accurately and intuitively understand the components under construction, the whole process and the time spent in different time periods, and the minimum working time can be accurate to the hour. The realization of ultra-fine progress information management is conducive to strict management of construction progress and construction nodes, as well as reasonable allocation of resources [8]. In planning the implementation phase, the need to constantly track the progress of the project, comparing planned and actual progress, in time to take appropriate control measures to postpone the construction schedule or behind other issues, and to prevent potential problems.
3.4. Quantities of a Bridge BIM Technology Quick Stats

In the process of using Autodesk Revit software to build a BIM 3D model of an engineering object, build the construction properties for each component in advance. Then according to the actual construction design drawings and the specific conditions of the site construction, the actual attributes of each component are entered. Attribute information can be entered by the real-time query to each member geometry, material properties, casting / installation, geometric space location information, both for construction management, may facilitate management of post-operation. By Autodesk Revit software that comes with the schedule function, build, screen member attribute information to achieve accurate statistical breakdown of the whole project all kinds of components, completed work of precise calculation[9].

4. Conclusion

BIM technology in three-dimensional simulation model suspension bridge construction process of research, the following conclusions:

(1) BIM technology is an inevitable product of the development of the times and the development of science and technology. The application of BIM technology to the bridge construction process is a combination of different fields, and it is also an inevitable demand for the visualization and accuracy of bridge construction.

(2) The use of Autodesk Navisworks software for bridge construction simulation makes the construction process and procedures clearer, and is also conducive to the optimization of the construction plan.

(3) Autodesk Revit project to achieve real-time statistics and query capabilities will also bring high efficiency, high precision, low cost benefits to the construction.

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