

# Application and Analysis of BIM Technology in High Speed Railway Track Engineering Construction

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**Keywords:** BIM technology, High-speed railway, Track engineering, Construction application.

**Abstract:** In recent years, with the development of China's high-speed railway track engineering and the growing market abroad, China Railway Design Corporation is facing great opportunities and challenges. By analyzing the current situation of BIM technology in the construction of high-speed railway track engineering, this paper finds that there are many problems in the construction of high-speed railway track engineering, such as engineering rework, the inability of two-dimensional graphics to visually represent specific images, the design results are not effectively used by relevant management departments, etc. On this basis, the application strategy of BIM technology in track design mode and track system design is put forward.

## 1. Research background

### 1.1 Literature review

At present, the construction level of high-speed railway in China is improving rapidly. Railway has been widely used because of its high speed, safety, comfort and convenience. Large-scale transportation in the transportation field is favored by people because of its low cost, long service life and short construction period (Deng, 2016). Modern railway engineering structure is becoming more and more complex, and BIM technology has been paid more and more attention in the field of railway engineering. In the field of railway engineering, the construction type is complex, the connection of nodes is complex and the degree of industrialization is high, which makes the railway design drawings inconsistent with the actual situation (Liu et al, 2013). There are still some hidden safety hazards in the construction process of high-speed railway. Because of the long construction period, complex and diverse project management, huge project scale and complex construction environment conditions, many problems arise. (Wang, 2015). Liu Dayuan and Yao Li proposed that the application of BIM technology in track engineering design can liberate human resources, promote the innovation and development of track system technology, solve a series of problems, and have significant advantages in quality control and efficiency improvement (Yu, 2017). Yu Di and Luo Dongbei think that BIM technology railway construction can be simulated, optimized construction scheme, multi-professional collision inspection, engineering quantity and material statistics, and has broad application prospects (Liu, 2016).

### 1.2 Purpose of research

At present, in the process of the development of Chinese society, the state has invested more and more in the high-speed railway. The application of BIM technology in high-speed railway engineering develops rapidly, and the related standard system is gradually improved. However, in the process of rapid development, there are still some problems (Li, 2017). According to the research and investigation, there are many related problems in the application of BIM technology, such as rework in engineering construction, two-dimensional graphics cannot represent specific images of objects, design results are not effectively used by relevant management departments, etc. Therefore, this paper focuses on the application of BIM technology in the construction of high-speed railway track engineering, in order to promote the development of high-speed railway industry.

## **2. Overview and characteristics of the related theory of bim technology**

### **2.1 Technical overview of BIM**

BIM technology is an important systematic technology in the construction of high-speed railway track engineering. Through BIM technology, we can integrate multiple periodic information resources which are fixed in the construction process of high-speed railway track engineering, and then optimize the track engineering model by means of simulation, coordination and visualization. By using BIM technology, the constructor can simulate the construction process of high-speed railway track engineering by computer before the construction, and can find the problems encountered in the construction process in real time, and draw up the corresponding disposal measures. The application of BIM technology in high-speed railway track engineering design involves many steps, such as estimating cost information, constructing track engineering building model, and arranging project occasions. BIM technology provides corresponding solutions to the problems that may arise in the high-speed railway track engineering and construction process, which will greatly improve the efficiency and quality of high-speed railway track engineering construction.

### **2.2 Characteristics of BIM technology**

First, the use of BIM technology can better statistical construction materials. At the same time, BIM technology can be used to predict the building materials used in the construction of high-speed railway track engineering, by reducing the cost of materials effectively, thereby achieving maximum economic benefits. In the construction of high-speed railway track engineering, the BIM model will automatically simulate the matching and efficiently restore the problems that may occur in the construction site by introducing the material data of the construction site into the system with the model technology of BIM technology. Compared with the two-dimensional design model, BIM technology can lay a solid foundation for the later stage cost budget of high-speed railway track engineering by estimating the project volume.

Secondly, compared with the traditional high-speed railway track engineering design technology, the biggest advantage of BIM technology is the visualization of three-dimensional technology. In the design of high-speed railway track engineering, designers can incorporate the basic concepts of design through BIM technology, so that the constructors can clearly understand the concept of design drawings. In the past, the two-dimensional design can only rely on CAD software, but the emergence of BIM technology solves this problem, greatly enhancing the visibility of high-speed railway track engineering components. Through the combination of BIM technicians to understand the designer's intentions, the efficiency of construction activities is effectively improved.

Thirdly, simulating the construction of high-speed railway track engineering is a very complex project, each link has a relatively complex relationship. In the design process, every minor problem will have an impact on the subsequent construction quality. BIM technology can also be based on logical algorithm, through the analysis and comparison of several construction schemes, ultimately determine the best scheme. At the same time, BIM technology can carry out pre-simulation planning in the construction activities of high-speed railway track engineering, judge the feasibility of the design scheme and construction scheme, and help technicians find out the minor problems in the construction process in time.

## **3. Current situation of bim technology in high speed railway track engineering construction**

In recent years, the rapid development of China's high-speed railway track engineering has brought tremendous opportunities and challenges to railway design-related enterprises. Therefore, it is necessary to design high quality products quickly. At this time, compared with the past manual drawing design, the use of Microsoft Office, AutoCAD and other track design application software has been greatly improved. At the same time, BIM technology is used to develop and apply professional track calculation and analysis software, such as seamless track calculation, track distribution and track laying mapping software, track dynamics analysis and so on, which greatly

improves the design efficiency. At present, the system of high-speed railway track design software, the interaction of design process, the expression of design results, and the interface coordination with front-end and back-end professionals have not been effectively improved.

Firstly, there are many interfaces for different kinds of work in the design of high-speed railway track engineering. If the input data of relevant specialties change, the track design will change accordingly, which will inevitably lead to the change of design drawings and the adjustment of the number of projects. In the design of high-speed railway track engineering, due to topographic factors, economic conditions and design schemes, the input data of designers often change, which leads to the rework of the project, thus affecting the production efficiency.

Secondly, in the design process and results, all drawings are expressed in two-dimensional form. Two-dimensional graphics cannot directly represent the specific image of the physical track structure to be constructed. In addition, the two-dimensional drawings cannot check the collision between components, nor can they directly clarify the relationship between components in the design of track frame. Such design inevitably has some drawbacks, which affects the construction and use of high-speed railway track engineering.

Thirdly, the design results cannot be effectively used by the high-speed railway operation and maintenance management department. The problems encountered in the process of high-speed railway track operation and management needs to consult a large number of design files and find relevant design information. It is difficult to solve the problems in the process of high-speed railway track operation and management in a timely manner. In addition, the archiving and preservation of design drawings is also a more difficult problem.

Fourthly, China's high-speed railway track engineering design is facing opportunities and challenges of “going out”. How to coordinate the engineering understanding differences between domestic and foreign high-speed railway construction companies is an urgent problem to be solved.

## 4. Application of bim technology in high speed railway track engineering construction

### 4.1 Track Design Model Based on BIM Technology

The difference between traditional two-dimensional high-speed railway track design and high-speed railway track design based on BIM technology is that BIM technology can realize the design of three-dimensional digital high-speed railway track model. When components change, all components associated with them will change accordingly. Then, according to the three-dimensional model, the required high-speed railway design drawings and related documents are automatically generated. When the model changes, the corresponding high-speed railway design drawings and documents will be automatically updated. In the core of BIM model, the basic objects are track, fastener, sleeper and ballast, not simply geometric objects, such as points, lines and surfaces. BIM software can compose a complete, systematic and logical three-dimensional model for many basic track structure components according to the requirements of track design. As shown in Figure 1.

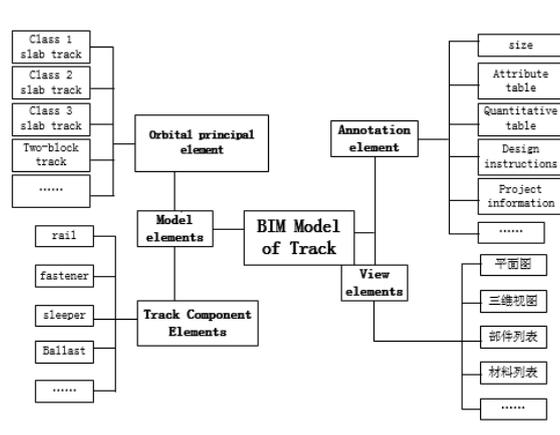


Fig. 1. Structure Diagram of BIM Model for Track Design

In the past, the design process of high-speed railway track engineering should first determine the track design scheme, then draw two-dimensional design drawings, and finally estimate the number of projects. According to BIM's track design of high-speed railway, it can be divided into three steps. Firstly, the track structure plan of high-speed railway is determined. Secondly, the track structure of high-speed railway is introduced into a three-dimensional model. Finally, documents and design drawings are made.

#### 4.2 Design of Track System Based on BIM Technology

First, the Abstraction of high-speed railway track components. Abstraction is to show the appearance of data and program through the semantics of data and program, and hide its implementation details, so as to reduce the steps of system program processing. Initial data and track data are two parts of track design. Initial data include line horizontal and vertical data, bridge and tunnel data, roadbed data and other data. The track data includes the structure of track data construction. If the whole orbital or part of the orbital is abstracted into a first-order object, the subordinate line parameters and the orbital components can be abstracted into secondary objects of the orbital structure. According to the composition of track components, secondary objects can also include their own sub objects, which is simple and full of system. At the same time, after the BIM model of high-speed railway track is generated, the related design results such as project quantity list, design drawings, data sheet, interface design data and construction documents of high-speed railway can be extracted from the three-dimensional digital model (as shown in Figure 2).

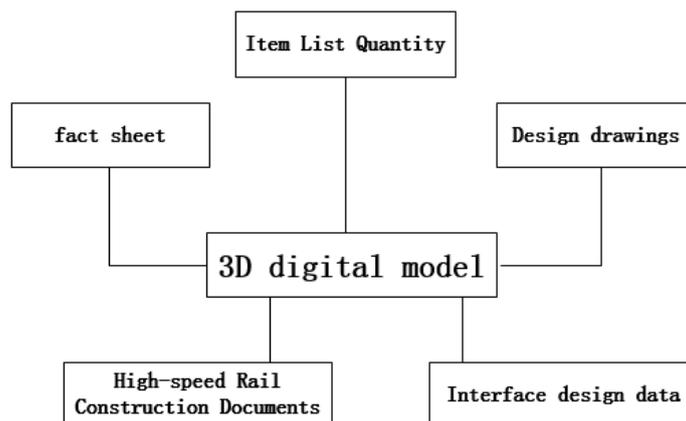


Fig. 2. The Sketch of the Design Results of the Three-Dimensional Digital Model

Secondly, the design and assembly of high-speed railway track objects. In the design process of high-speed railway track engineering, the corresponding track structure plan should be determined first. According to the line design standard, the track structure plan is formulated with other parameters such as bridge, tunnel, and roadbed and so on. Designers make track objects for high-speed railway according to the identified parts objects of standard parts library. Assuming that the standard part library does not need the fundamental object, the primary goal is to establish the corresponding fundamental object in the standard part library. In order to determine the orbital object and its placement area, various orbital objects can be placed on the line plane to form an orderly data combination and connect to the tracking object of the internal logical relationship to form a higher-level overall orbital information model. If the basic design data or track design parameters are changed during the design process, they can be adjusted at any time.

#### 5. Conclusion

With the rapid development of China's high-speed railway construction, the research on track construction and design based on BIM technology is extremely important. For high-speed railway track builders, the construction of three-dimensional digital mode is the key point of BIM technology. The application of BIM technology can greatly improve the accuracy of high-speed railway track engineering construction projects. At the same time, BIM technology, through

three-dimensional simulation analysis in advance, can find problems in construction as early as possible. However, the application of BIM technology in China's high-speed railway industry is still not popular, and there is still a lot of room for development.

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