Research on the Application Mode of Prefabricated Steel Structure Building Design Based on BIM Technology

Shuyu Shi

1Liaoning Jianzhu Vocational College, Liaoning, China, 111000

*Corresponding author e-mail: shishuyu@lnjzxy.com

Abstract. With the continuous maturity and improvement of BIM Tech, it has been more in-depth application in architectural design. However, the current application of BIM in prefabricated steel structure buildings still has some problems and shortcomings, such as the advantages of BIM Tech in improving the efficiency of building design, reducing the cost and reducing the workload. Based on this, this paper first analyzes the necessity of applying BIM Tech in steel structure prefabricated building, then studies the design of prefabricated steel structure building based on BIM, and finally gives the specific application of prefabricated steel structure building design based on BIM Tech.

Keywords: Prefabricated Steel Structure, BIM, Building

1. Introduction

With the iterative development of social economy, various types of buildings are emerging one after another. Among them, the application and performance of steel structure in construction engineering gradually highlights, and the architectural design and application mode gradually become the research hotspot in the field of architecture [1]. In the application field of architectural engineering design, prefabricated building is more and more widely used because of its advantages in many aspects. In the form of prefabricated building, steel structure has been greatly developed. However, due to a series of outstanding characteristics, such as more components and greater difference of joints, the design and construction of prefabricated steel structure buildings are difficult. On the other hand, with the deepening application of BIM Tech in the field of construction, it plays a great function and value in the information integration and expansion, the visualization of design process and the platform of information model in the life cycle of prefabricated steel structure buildings.

BIM Tech mainly contains two dimensions of information, namely building information model and building information modeling [2]. One is a model, the other is a process tech. At present, there are still many deficiencies in the application of BIM in prefabricated steel structure buildings. The specific performance is that the advantages of BIM Tech in improving architectural design efficiency, reducing cost and reducing workload are not fully exerted. These problems limit the further application of BIM Tech in the design of prefabricated steel structures. BIM data information needs to be participated and implemented by many related parties as shown in Figure 1, so as to realize the data information throughout the life cycle of the building.
In addition, prefabricated steel structure building has gained rapid development due to its advantages in weight, strength, construction period and industrialization. The organic combination of BIM Tech and prefabricated steel structure building can fully release the vitality of the construction industry, and conform to the development trend of informatization, data transformation and upgrading, energy conservation and consumption reduction of the industry. The application of BIM Tech in the design of prefabricated steel structure building helps to optimize the node of building structure and improve the applicability and stability of connection point. And the use of BIM Tech in integrated design, module design thinking, building information for effective modeling, so as to achieve the whole process of building design visualization and data, is conducive to the development of building space optimization, structural optimization, energy consumption optimization and a series of adjustments, and can find and avoid potential problems in advance. Therefore, it is of great practical value to study the application mode of BIM Tech in prefabricated steel structure building design.

2. The necessity of applying BIM Tech to fabricated steel structure building

2.1. Application value of BIM Tech in fabricated steel structure

First of all, the use of BIM Tech in prefabricated steel structure can improve the communication efficiency between different departments, and enhance the coordination of the quota between stakeholders, which helps to shorten the construction period of the building. It can be seen that the use of this tech can eliminate the disadvantages of relying solely on empirical construction methods, so as to improve the process and standardized management of construction process [3]. Therefore, the tech can significantly optimize the construction links, reduce the workload and improve the construction efficiency. Secondly, the application of this tech can improve the quality of prefabricated steel structure buildings. Through building modeling, BIM Tech can find out the weak links in architectural design in advance, carry out targeted optimization, and improve the construction tech to improve the overall construction quality of the building. And can give full play to the advantages of light weight and high strength of steel structure, so that the layout of building space can be more flexible.

In addition, the application of this tech can reduce the resource consumption in the construction link. On the one hand, it can realize the maximum utilization of building materials through the optimization of building structure; on the other hand, thanks to the implementation of standardized construction link, it can reduce the generation of pollutants, thus reducing the impact on the environment, reducing energy consumption, so as to reduce the construction cost and improve the comprehensive benefits of the building. Finally, as an innovative platform of fabricated steel structure, the tech can flexibly apply and verify the latest design concepts and technologies in the construction industry, so as to greatly enhance the intensive degree of construction process. And it is conducive to promoting the transformation and upgrading of the whole industry and promoting the optimization of the industry development structure.
2.2. Requirement of BIM application in steel structure fabricated building

First of all, in the design stage of prefabricated steel structure building, there is still insufficient information of component data, which leads to a large amount of design tasks of prefabricated steel structure building. Therefore, it is necessary to use BIM Tech to optimize the scheme design, realize the rapid modeling of building modeling, visual space planning, indoor space layout simulation and building performance analysis, and based on BIM Tech to build part information model for parametric design and visual collision detection. Secondly, in the production stage of steel structure assembly building, there is still too much manual participation in the processing process, which leads to the frequent occurrence of error events caused by human factors and the waste of materials. The BIM Tech can realize the statistics of material quantities, improve the accuracy of steel structure components and help to query the detailed information of components [4].

In addition, in the construction stage of prefabricated steel structure building, there is still steel structure component deviation, which affects the installation and construction quantity, so that the management is chaotic, and the construction period is delayed due to too many engineering changes [5]. These phenomena make the construction process cost control and optimization management of prefabricated steel structure buildings face greater pressure and challenge. Therefore, it is necessary to use BIM Tech to carry out 4D application combined with schedule, so as to realize the whole process visualization of construction progress, support plan preparation, negotiation and state feedback of all parties, and realize the coordination and optimization of multi-objective of the project. Through the analysis of optimization special scheme, the project quality and cost can be optimized and reduced. In addition, the application of BIM Tech in construction can improve the management efficiency of building materials and optimize the layout of construction site. The construction scheme simulation based on BIM is shown in Figure 2 below.

![Figure 2. The construction scheme simulation based on BIM.](image)

3. Design of prefabricated steel structure building based on BIM

3.1. Design principle of prefabricated steel structure building based on BIM

The design of prefabricated steel structure building based on BIM should focus on the core design elements such as boundary leveling, modular kitchen and toilet and core tube design. Among them, in the level of boundary leveling, it means that in the process of carrying out prefabricated steel structure building design, the steel structure is taken as the stress core of the building. Therefore, in the process of carrying out the design, it is necessary to ensure the smoothness of the boundary, so as to realize the significant improvement of the efficiency and effect of the construction link. Secondly, in the modular kitchen and bathroom level, it is necessary to ensure the matching between the design index and the construction performance, so as to promote the kitchen and bathroom to maximize its due performance and function [6]. In addition, in the core tube design level, BIM is used to strengthen the stability of the core tube components, so as to reduce the building area coverage.
Moreover, the design of prefabricated steel structure building based on BIM should also be carried out based on the design principles of functional space module and facade module, so as to ensure the functionality and space of the building, as shown in Table 1 below.

| Module design                  | Design principles       |
|--------------------------------|-------------------------|
| Functional space module       | Comfort                 |
|                                | Variability             |
|                                | Hommization             |
|                                | Diversity               |
| Facade module design           | Standardization         |
|                                | Modularization          |
|                                | Combination & Aesthetics|

**Table 1.** The application performance advantages of this material.

3.2. **Modular design of functional space**
Firstly, the function of prefabricated steel structure building is analyzed at the composition level of functional space module, and each space module inside the building is modeled. Steel structure prefabricated building model modeling has the typical characteristics of high degree of model information integration, one-time modeling, reuse and parametric modeling, so it is necessary to create models with different depth levels. In the level of depth level requirements of steel structure fabricated building model, including scheme design model, preliminary design model, detailed design model and completion and operation and maintenance model. In addition, the modular design of functional space should be carried out according to the modeling process of prefabricated steel structure building model.

3.3. **BIM display of fabricated steel structure building**
BIM is introduced into the scheme design stage of prefabricated steel structure building, and the selection of each space is carried out by combining the structure and the three board system. Secondly, in order to realize the integrated design of structural system, peripheral protection system, interior system and equipment and pipeline system of steel structure building, it provides information support. Through BIM Tech, the relationship between steel structure system and building function is integrated, the structural system and structural layout are optimized, and appropriate internal and external wall system is selected to refine the construction of building joints, so as to realize the high standard requirements of fabricated steel structure buildings. A typical BIM model of standard floor layout is shown in Figure 3.

![Figure 3. A typical BIM model of standard floor layout.](image)
4. Application of prefabricated steel structure building based on BIM Tech

4.1. Application of BIM Tech in stress and structure of prefabricated steel structure building
First of all, at the level of creating the mechanical structure model, the three-dimensional model of the stressed structure is created to refine all the details of the connection of the steel structure in the building. Secondly, when creating the stress structure model, we should also block the large-scale special-shaped structure to strengthen the practicability and credibility of the stress structure model. In addition, on the level of collision inspection of prefabricated steel structure, on the basis of fully absorbing the construction design drawings of construction engineering, the three-dimensional information model are constructed to carry out comprehensive inspection for all components.

4.2. Application of BIM Tech in prefabricated steel structure construction
In order to scientifically plan the construction cycle of prefabricated steel structure building, it is necessary to use BIM Tech to build model data information, realize the organic planning of construction cycle, and promote the optimization of construction performance of prefabricated steel structure model. Secondly, in the process of creating the stress model, the 3D model is strictly controlled, so as to realize the simulation of steel structure construction process and steel structure construction progress of prefabricated building. In addition, the construction schedule control structure is added in the construction process to realize the construction schedule planning expected by the building.

5. Conclusion
In summary, the application of BIM Tech in the design of prefabricated steel structure building helps to optimize the node of building structure and improve the applicability and stability of connection point. In addition, the integrated design and module design of BIM Tech are used to effectively model the building information, so as to realize the visualization and data of the whole architectural design process. In this paper, through the analysis of the necessity of applying BIM Tech in steel structure prefabricated building, the value and demand of BIM Tech are studied. Through the research of BIM based prefabricated steel structure building design, the design principle and process are analyzed. Through the analysis of the application of BIM Tech in the design of prefabricated steel structure building, the specific application of BIM Tech in the design of prefabricated steel structure building is studied.

References
[1] Fan Jianwei. Research on prefabricated steel structure building system based on BIM Tech [J]. Building engineering tech and design, 2018 (29): 3523.
[2] Hao Jiping, sun Xiaoling, Xue Qiang, fan Chunlei. Research and application of green prefabricated steel structure building system [J]. Engineering mechanics, 2017, 34 (1): 1-13.
[3] Jin Zhanyong, Tian Yaping, Kang Xiaohui, et al. Research on prefabricated steel structure building system based on BIM Tech [J]. Value engineering, 2018, 37 (34): 203-204.
[4] Shen Zuyan, Luo Jinhui, Li Yuanqi. Promoting the coordinated development of green, industrialization and informatization of construction industry with steel structure building as the starting point [J]. Progress of building steel structure, 2016, 18 (02): 1-6, 25.
[5] Yu Hui, Sui Xinjie, Bai Ge, Jiao Mengfei. Research on public space design of long-term rental apartments for young people: a case study of Vanke Park Apartments [J]. Architecture and culture, 2018 (07): 164-165.
[6] Yue Qingrui. Resolve steel overcapacity, promote construction industrialization and take the road of steel structure [J]. China Economic Weekly, 2016, 4: 77-79.