Journal of World Architecture, 2022, Volume 6, Issue 3
http://ojs.bbwpublisher.com/index.php/JWA
ISSN Online: 2208-3499
ISSN Print: 2208-3480

Application of BIM in the Structural Design of Architectural Engineering

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Abstract: Structural design is an important component of architectural engineering. BIM is integrated into structural design to form a complete, linked, and information-based data platform. Therefore, in line with the features of BIM, such as interaction and coordination, information integration, as well as data simulation, this study analyzes the advantages of BIM in architectural structural design, proposes several optimization measures using BIM for architectural structural design, and promotes the rationality of architectural structural design.

Keywords: BIM; Architectural engineering; Structural design

Online publication: May 17, 2022

1. Introduction

The application of BIM in the construction industry optimizes the industry's construction design and management technology, thus reflecting its application value. Combined with information technology, the digital engineering design method can be reflected. In the design process, the construction of information models can timely control and monitor the architectural engineering design. BIM has pre-simulation characteristics. By applying BIM to the construction, operation, maintenance, and design of architectural engineering, its application effect is evident [1]. Through field simulation, scientific prediction is carried out to simulate the final effect, solve architectural construction problems, and improve the quality of architectural structural design. Architectural structural design is an important component of architectural engineering. It is necessary to constantly grasp the operation characteristics of structural design and integrate BIM into architectural structural design to form a complete and interconnected data information platform. More in-depth analyses of architectural structural design are required in hope to improve the overall safety of architectural engineering.

2. Features of BIM

2.1. Interaction and coordination

Engineering project management is a collaborative process among different departments. When there are obstacles in engineering construction, it is necessary to analyze the problems in a timely manner and take effective measures. BIM can generate accurate data for possible data conflicts occurring among different departments and solve problems in the cross-departmental process. In engineering design, design institutions and other departments should put forward operable adjustment suggestions for BIM visual model and maintain coordination with various departments.

2.2. Information integration

Information integration is obviously embodied in design information integration and design process integration. As a form of professional information model, the whole project has strong information construction. BIM's information integration has built a professional design platform, promoted the smooth development of architectural structural design, and improved the integration of architectural engineering structural design process [2]. The database generated by the 3D computer model is the core of the architectural information model. It contains data information centered on the geometric size and spatial information of architectural structures, which meets the differentiated information needs. The traditional architectural structural design is mainly operated by designers, using two-dimensional graphics to demonstrate the designs. The efficiency of this method is not ideal, and the engineering design intention and information are easily affected by human factors. The establishment of BIM models can realize the transformation from two-dimensional designs to three-dimensional designs. The software can generate architectural design models, convert abstract plane graphics into vivid three-dimensional images, and prevent design errors from occurring. Architectural drawings are created by professional designers. The 2D drawings created from CAD tools cannot vividly express the design effect or accurately produce the structural design effect of buildings [3]. Applying BIM to architectural structural design can overcome the aforementioned shortcomings and reflect the relationship between different components in the form of visualization. In the process of creating BIM models, all design processes can be visualized. The design results automatically generate renderings and build design tables, allowing project participants to display the design process and effect under the condition of visualization.

2.3. Data simulation

BIM models can realize the numerical simulation of building structure and also simulate the experimental environment. In engineering design, BIM can simulate various intelligent modes of structural design. The reasonable use of BIM models in project bidding and construction can simulate the construction layout and determine the best construction scheme based on the designs by construction organizations [4]. BIM uses modeling and data processing to simulate the numerical value of structural design. In the process of parameter change, it can fully simulate various architectural forms according to people's needs and adapt to the individual characteristics of the architectural environment. The model can also simulate the building structure in the real environment and improve the efficiency of measurement. BIM can be used to form three-dimensional graphics from data prior to the actual construction. These virtual graphics are the simulation of real objects, including internal structures, such as steel frame and wall frame. Employees can carry out dynamic test according to the input of previous construction data or the survey data of the construction site, so as to observe the changes in the data model before and after, as well as timely adjust it according to the changes, thus avoiding problems in the actual construction. In traditional graphic design, designers use CAD drawings. This method not only has errors in the actual data [5], but also ensues difficulty in correcting problems, which prolongs the construction time and wastes the team's energy. Through the 3D model design plane graphics provided by BIM, this technology ensures the accuracy of drawings and allows for changes in the design parameters. In the project implementation, the parameters of drawings are very important because any drawing errors will delay the progress of the entire project [6]. It has the function of automatically creating and replacing when there are problems in the parameters during the design process as well as modifying the remaining data to create a new model. It not only ensures the correctness of data, but also prevents the loss of drawings [7].

3. Optimization measures using BIM for the structural design of building engineering

3.1. Creating a schedule and optimizing the design parameters

The structural complexity of residential engineering projects is increasing, and the engineering quantity of residential structural design is increasing. In order to provide effective guidance for subsequent construction, the 3D model component schedule generation function can be used to create residential walls, columns, beams, and other building components. After selecting a wall, column, or beam from a category and clicking "OK," the software will display a dialog box on schedule properties, where formatting, fields, and appearance can be set. Clicking the dialog box will help create the model, structure, purpose, function, volume, and other contents [8]. After creating a schedule, one can set ungrouping, attribute, grouping, and so on in the left, upper corner of the schedule. In the existing two-dimensional design method, the structural analysis of the model can be checked in the process of dividing the structural model units, and the structural model of residential buildings can be optimized and adjusted according to the architectural structural model. However, the structural parameters of residential buildings are high; hence, complex and single structural element analysis cannot guarantee the design process [9]. In this case, it is necessary to use the structural optimization processing ability of BIM to directly export architectural drawings and geometric information from the analysis and evaluation of its database. At the same time, the rationality of construction drawings is analyzed by inputting the corresponding BIM database. One can then optimize the architectural structural design process, effectively review and analyze each design link, as well as timely identify and solve the architectural structural design problems.

3.2. Applying BIM in collision design

In the spatial collision design of architectural engineering, a BIM information model is used to accurately process the sketch model to ensure that the constructed information model is complete. For some applications, the collision model has a lot of basic information, so in this process, it is important to pay attention to the number of floors and create column drawings and walls to form beams, columns, and floors. It is also necessary to set the same number of layers and stack layers to ensure the scientificity of the number of layers, build a pillar network, and promote the improvement of the pillar network system [10]. While drawing walls, their parameters can be set in the dialog box. The toolbox can be used to select the method of drawing the baseline to form a plan, vertical view, and indoor elevation while drawing curtain walls. In the planning stage, the main contents of the BIM model are preliminarily completed, and other parameters are improved with the construction of beam, column, and panel. The high bearing pressure and high strength requirements of industrial buildings should be considered in the design process; the cross section of these structures is also larger than that of ordinary structures. In order to control the section height, it is necessary to use BIM to reasonably determine the reinforcement [11]. The quality of the beam column structure can be improved by the beam column at the same time. The load ratio applied on the cantilever beam is small and can be made by the section design method. The cantilever beam floor reinforcement design should ensure an appropriate safety system. Due to the large load, the reinforcement must be increased appropriately, and the length of the wall must meet the structural design. When designing a lintel, the stress condition must be simulated and verified. The integrated design of ring beam and lintel can facilitate operation and improve seismic performance [12].

3.3. Meeting the requirements of architectural structure and environment through BIM

The construction and design of large-scale projects are not only related to the construction process, but also affected by the selection of building materials to a certain extent, which has a certain impact on the quality of subsequent construction. In the structural design of architectural engineering, the geographical environment of each construction area can be measured in real time by using GPS, in which relevant factors

such as culture and geology can be considered in the process. It is important to ensure that the completed project meets the requirements of basic engineering design and plays an active role in its subsequent use [13]. After various inspections and evaluations, the design and integration of the overall structure of the project can be integrated in terms of planning, design, and improvement, so that the relevant contents of the construction project can be completed in a reasonable and orderly manner. In the functional analysis and application of buildings, BIM plays an important role in predicting and calculating the functional and local application requirements of buildings [14]. In the actual BIM model construction process, the model is reasonably planned through data measurement to control the stability and structural strength of buildings. At the same time, corresponding measures should be taken based on certain conditions. After the input of disaster data into the BIM system, it can be seen that when the external environment changes rapidly, the basic performance indicators of the model structure can meet the expected requirements [15]. At the same time, in order to identify the index configuration with the best performance, it is necessary to modify the model structure appropriately through repeated experiments. BIM can be used to effectively improve the stability of architectural structures in the design stage. Carrying out data test according to the requirements ensures that the building meets the local climatic and geographical conditions as well as realizes the safety and service life of the building [16].

3.4. Coordinating various professional designs through BIM

In structural design, BIM can realize the exchange of plumbing, electromechanical, architectural, and other systems through the digitally generated analog information model. The information conveyed by the model can be exchanged with other professional teams as needed. Whether construction companies, manufacturers, owners, structural engineers, equipment engineers, or architectural designers change the way it is used, all who are involved in architectural design will obtain the information they need and use this information for their work. Hence, they can work effectively with the same parameters as the basic building model [17]. By converting the BIM model, the equipment engineer will install the corresponding equipment based on the location, quantity, and mode of the new equipment, and then test it. If there is an anomaly, the overall design of the building is debuggable based on the data information of various equipment. The effective application of BIM in the coordinated design of various disciplines enables the staff of various disciplines to share information [18]. It is conducive to collaborative development and the smooth progress of architectural structural design and construction, thus achieving excellent quality. In addition, by using BIM to realize the integration of architectural structural design with various field data analysis functions, the design process of the analysis model can be improved, along with the measurement accuracy of the land and the information on the surrounding ecological environment [19]. Architectural structural design can better integrate external ecological factors, such as greening. The application of BIM information model enables architectural designers to use relevant performance-based simulation analysis to determine the annual sunshine and shadow changes at the site. In addition, architects can use multidimensional BIM tools and methods to simulate different structural design situations, make judgments and predictions, as well as establish preliminary concepts and standards to promote the economic benefits of architectural structural design [20].

4. Conclusion

In conclusion, the application effect of BIM in architectural engineering is evident. In order to better improve the effect of the structural design of architectural engineering, it is necessary to constantly standardize, scientifically apply BIM, and strengthen the overall research to lay a foundation for the development of architectural structural design. Architectural structural design is a very important component in architectural engineering. It is possible to fully comprehend the safety, stability, and

interoperability of the structure, as well as improve the overall structural design. It is necessary to improve the construction technology in line with the actual situation. In designing the overall layout, it is important to consider the geographical location and give full play to the role of BIM in architectural engineering.

Disclosure statement

The author declares no conflict of interest.

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