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Research on the Application of Building Information Model Technology in Building Structure Design

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Abstract

In order to solve the problem of low comprehensive performance existing in the current architectural structure design, based on the introduction of architectural information model technology, the application research of architectural information model technology in the architectural structure design is carried out. After analyzing the building collaborative design theory based on building information model technology, a new building structure design method is proposed by constructing building BIM structure model, drawing flat construction drawing avoiding building information model technology, determining the relationship between building IFC spatial structure and standard information description of building structure design content. Through comparative analysis, it is proved that the new design method can effectively improve the comprehensive performance of the designed building structure in practical application.

Keywords

Architecture; Model: Design; BIM; Building structure.

1. INTRODUCTION

In deepening the design of building structure, it is found that BIM technology, namely building information model technology, plays an irreplaceable advantage in this work. R introduced this technology for the first time in 2002 [1], and applied it to the collaborative development and construction of the construction industry. In the following period of time, the A-position of architectural research continued to promote and apply the construction information model technology, and successfully realized the transformation of the domestic construction industry. It solves the problems of collision and poor co- N in the design of building structure. However, it can be seen from the application status of this technology that there are also some problems in the application of building information model technology, which to some extent affect and inhibit the development of con in the market [2]. Therefore, based on the concept of collaborative design of technology, this paper will carry out the comprehensive optimization design research of building structure design method.

2. THEORETICAL ANALYSIS OF BUILDING COLLABORATIVE DESIGN BASED ON BUILDING INFORMATION MODEL TECHNOLOGY

In 2000, a British researcher in the field of architecture published in an academic chapter for the first time that the design of architectural structure will affect the construction and development costs of the construction industry. When there are unreasonable problems in the structure design, the design, construction and follow-up costs of buildings will increase.

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Through a large number of simulation experiments and practical tests, Unreasonable building structure will increase the cost of engineering construction project by about 30% [3]. As soon as relevant theories were put forward in the construction market, they attracted the attention of many researchers. Then in 20(M), after completing relevant studies, the United States pointed out that data exchange problems occurred in a building structure design software due to improper operation and untested technology, which caused economic losses of 15 billion dollars.

In this context, building information model technology has been proposed and successfully entered the professional research category, which can be used as an architectural design technology based on three-dimensional model. This technology not only integrates the life-cycle information of buildings, but also realizes the integration and virtualization design of multi-channel data acquisition in the design stage of architectural engineering projects. It also solves the problems of traditional design work, such as interaction difficulties, poor expression ability, large amount of repetitive work and professional conflicts. In order to solve the unreasonable problems in the design of building structure, the collaborative work of building information model technology in the design of building structure should be increased.

Traditional collaborative design depends on two-dimensional graphic design. In different univariate design, design software corresponding to the major will be selected for professional design according to the different design requirements of different regions. In this process, AutoCAD will be used as the main drawing tool for structural design images, and two-dimensional graphic drawings will be drawn in different ways of operators. The realization will not N professional design results in the way of two-dimensional drawings display or presentation. Although this design method is feasible based on theoretical analysis, it cannot realize the interaction and information sharing among various design units in the professional design process. Especially in the case of technical change or drawing change in a design unit, the lack of effective communication between design science and elements will lead to the failure of timely transmission of design change information, which will eventually lead to rework or design conflict in design and construction results.

In the deepening study of Chinese building industry, it is found that more than 80% of architectural design teams still use two-dimensional drawing as their main delivery method, and because of this, the whole process dynamic and intelligent of building structure design can not be realized in our country.

Although the building information model technology indicates a new direction for the construction and development of the building field, the three-dimensional visualization technology needs the complete building information structure model as the support. Therefore, it is necessary to dock and integrate this technology with the theory of architectural cooperative design in the design of architectural structure, construct structural model through three-dimensional technology and architectural information model technology, and generate an accessible and editable architectural structure plan and section drawing by obtaining the physical property information, material information and mechanical parameter information of architectural structure. After the design results are changed, the information can be exchanged and shared timely according to the requirements, so as to ensure that multiple participants can participate in the design work timely and realize the comprehensive collaboration of the architectural structure design.

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3. APPLICATION OF BUILDING INFORMATION MODEL TECHNOLOGY IN BUILDING STRUCTURE DESIGN

3.1. Building BIM structure model

In view of the real building structure, the simulation model is generated, using the model can realize the exploration of the general law of building structure design, and realize the one-step analysis, to achieve the purpose of grasping the characteristics of the real building structure. In the design of building structure, BIM technology is introduced, and the constructed BIM model is used to transform the real building structure into a three-dimensional diagram model presented in the computer. The construction of BIM structural model can be used to describe the basic structure of the building structural model, and the two are the same in structure essence [7]. The construction process of building BIM structural model is shown in Figure 1.

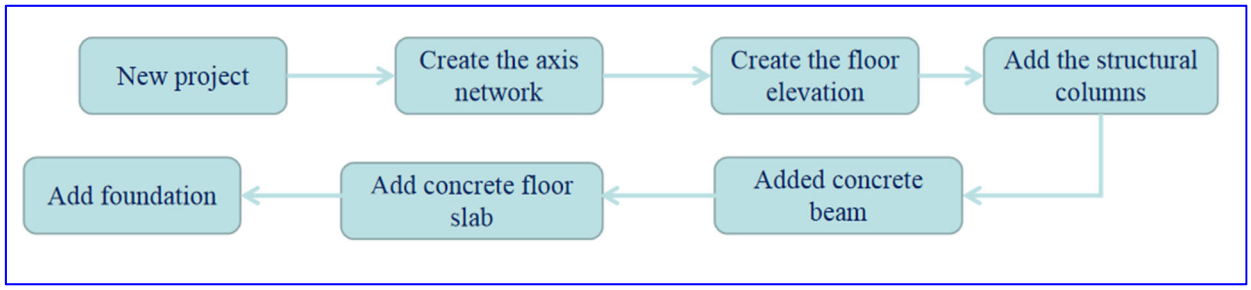

Figure 1. Flow chart of building BIM structural model

In order to facilitate the discussion, choose a villa building as an example. The known number of floors of this villa is 3. Due to the type of independent villa, there are a large number of buildings, and the housing type is relatively simple. The area of each building is about 300m2, including two above-ground floors and one underground floor. It has been known that the foundation structure of the villa building adopts an independent foundation. Although a large number of structural components are included in Building 3, there are many repetitive components [4]. After clarifying the basic structure of the villa building, the building information model technology is introduced. On the basis of ensuring the coordination of various professional works, the construction of building BIM structural model is completed. In the specific operation process, the construction information model technology is used to create the label family and label family of each structural component by the way of sharing parameters, and in this way, the whole process of each structure is expressed in plain method. Revit software is used to perform the above operations.

3.2. Flat construction drawing based on building information model technology

According to the modeling steps above, a model of the architectural structure design object is established, which includes the building foundation member, beam member, plate member and column member. When using building information model technology to draw flat method construction drawing, all designers should follow the design specification of flat method construction drawing, take it as an important premise, and realize the creation of shared parameters and label family. Figure 2 is the label family of beam members in the design of a building structure and the schematic diagram applied in the flat construction drawing[5].

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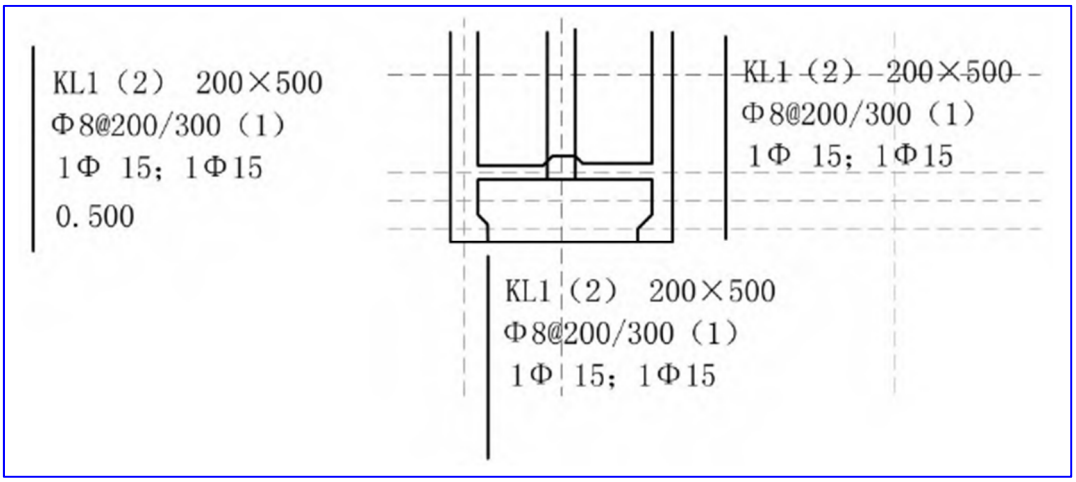

Figure 2. The label family of beam members in the design of a building structure and the schematic diagram applied in the flat construction drawing

To create a new project in Revit, select the "Manage" option in the menu bar and click the "Share parameters" command below. In the pop-up "Edit Share parameters" window, create a new instruction, create share parameters and create a new group, and finish parameter sharing in the subsequent parameter creation window. At this time, the creation of shared parameters for the architectural structure method is completed. The shared parameters created by the above process are well coordinated. As you make changes to the design, only changes are made to the other parameters, and the parameters are coordinated based on the building information model technology.

After creating shared parameters in Revit, you can create a label family. In Revit software, the establishment of label families can be added to the structural column positioning and the flat reinforcement drawings of building beams. Through the compilation of BIM models and family files of building structures, the flat construction of corresponding building structures and related detailed drawings can be extracted from Revit software: drawing description. Two - dimensional CAD can be used to express the generated results. On the basis of combining building information model technology, the construction drawing of building structure is obtained, and the construction drawing is used to realize the management of construction design and promote the improvement of design efficiency[6]. As can be seen from the construction drawing of structural flat method created in Revit software, the construction drawing contains a number of building structure information. If the actual application of building item H has a simple structure, the rapid application of building structure information can be realized, so as to improve the efficiency of design work.

3.3. Determine the IFC spatial structure relationship of the building

In order to ensure that the follow-up X work is carried out on a more standard basis, so as to realize the connection between various professional participants, various work is carried out on the BIM platform on the basis of building information modeling technology, so as to reduce the serious consequences caused by the incoordination of data exchange and data loss. The IFC spatial structure relationship of the building is shown in Figure 3.

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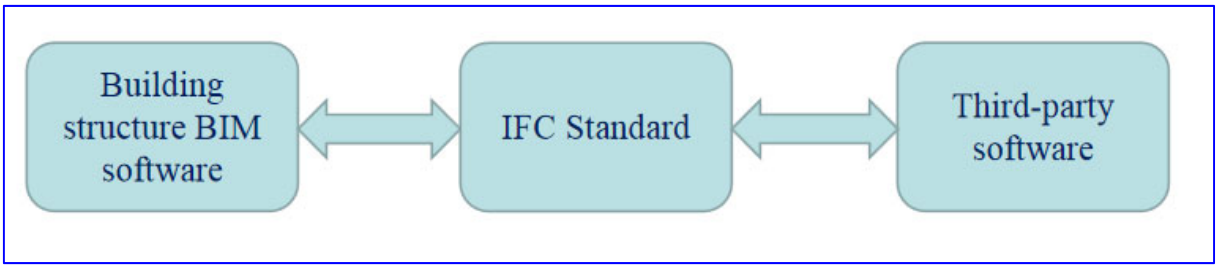

Figure 3. IFC spatial structure diagram

Since the IFC standard itself is open to some extent, and the readability is more open to the public, anyone can use and find it, which is convenient for all participants of the construction project to use. At the same time, IFC standard is currently mainly applied in the field of industrial buildings and civil buildings, so it is highly feasible to use IFC standard as the connection condition of building structure BIM software and third-party exchange software, and IFC standard itself is designed for data exchange. Therefore, the application of IFC standard to other software can further improve the utilization value of data resources. In the formulation of IFC standard, combined with the integration and nesting relationship, the construction information, floor information and building information in the building structure are mutually structured, and a set of systematic frame structure is formed. In the IFC standard, nesting rules are at the heart of the definition of each architectural entity through nesting. IFC interstructure of architecture contains four different hierarchical structures, namely site level, building level, floor level and space level, from which it can be seen that IFC standard follows the general hierarchical relationship[7]. The construction project contains t multiple sites, which in turn contain/contain multiple buildings. The building as a whole is composed of multiple floors, and each floor can be regarded as composed of beams, plates, columns and various components. According to this standard, it is used as a design idea to complete the design of the building structure.

3.4. Building structure design content standard information description

The standard information of architectural institution design content is divided into four basic levels, from high to low, they are domain layer, sharing layer, core layer and resource layer. The similar project information is summarized in the same layer of the same module to complete the description. On the basis of the above IFC standard, when describing the standard information of the design content, the situation of overstepping the level should not occur. For example, the resource layer should not use the information in the domain layer to describe the design content & the Settings specified by this description can effectively avoid the confusion caused by structural changes. For the specific information description content of each level, the domain layer contains all the information of other fields; The shared information layer contains the information that needs to be exchanged under different specialties. The resource layer contains the most basic architectural structure information, such as geometric information and material information. In the actual description of the content of architectural structure design, it should be combined with the design needs, from the corresponding level of the field of information in line with the description, and the summary of it to form a complete architectural structure content standard description information.

4. COMPARATIVE ANALYSIS

In order to prove the feasibility of the design method, the structural design method based on building information model technology will be tested by comparative experiment. Before the design study, the general situation of architectural design should be described first. For details, see Table 1.

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Table 1. Description of architectural design overview

Serial number	An overview of the architectural design	
1	Name of the building	A large residential building in an area
2	Location of construction site	The city centre is a lofty place
3	Construction status	Some real estate development company
4	area of structure	28 452.56m^2
5	building area	5158.40m^2
6	Grade of construction works	secondary-class structure
7	design working life	fifty years
8	building storey	four-layer
9	fire rating	First level
10	Roof waterproofing class	First level
11	earthquake fortification intensity	7 degrees

After completing the description of the basic information and general situation of the architectural design, the original design method and the traditional design method are used to design the architectural structure, and the comprehensive performance of the two methods after design is compared. The comparison results are shown in Table 2.

Table 2. The design method in this paper and the practical application effect of traditional design method

Serial number	Comparison index	Design method of this paper	Traditional design method
1	Expected cost	69million yuan	78million yuan
2	Expected construction period	307days	354days
3	The expected number of changes	1~2	5~7
4	Number of pipeline collisions in design	0	135
5	Whether risk expenses are incurred	No	Yes/Maybe
6	Combination property	Good	Average

From the above comparison results, it can be seen that the comprehensive design of building structure by using the design method in this paper can reduce the cost of design results, shorten the construction period of the building project, reduce the frequency of design change behavior, control the frequency of pipeline collision in construction, avoid the risk of subsequent construction of the building project, so as to improve the comprehensive performance index of the building project. To sum up, the architectural structure design method proposed in this paper has more significant advantages after the introduction of architectural information model technology, which can fully or completely solve the shortcomings and shortcomings of traditional design technology.

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5. CONCLUSIONS

In the design method of building structure studied in this paper, the technology of building information model is introduced. Compared with the experimental results, it is proved that the design method has more optimized comprehensive performance and can solve the shortcomings of traditional methods in application[8].

However, there are also some defects in this design, including the failure to build a model sharing platform for architectural information, the realization of the application and transformation of this model in more fields, the failure to innovate and integrate this technology with multiple technologies, and the failure to achieve further update and optimization of modern design products. The questions raised above will be optimized in the subsequent study, therefore, the development and construction of our country construction industry is bound to progress in the direction of more optimization.

The research of this paper is affected by many factors, and there may be some unclear arguments. It is hoped that in the follow-up research method, the design results can be optimized and the related theories can be improved by further research on the related design works in the architectural field.

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