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Application and Expression of Nonlinear Architectural Design Based on BIM Platform

Rui Ding, Meng Zang, Wenke Qin *

School of Civil Engineering and Architecture, Wuhan Polytechnic University, Wuhan, China

*Corresponding author e-mail: 547946906@qq.com

Abstract. The development of science and technology and social economy has made the continuous improvement of architectural technology, some representative design methods and technologies have also been derived in the architectural design method, BIM is a new type of design technology means, information data is used as the model basis, thus conducting modeling and information expression. This paper utilizes the BIM platform to design the nonlinear building "mountains and rivers qintai", the application of BIM technology on information interoperability and information expression of nonlinear architectural design is explored, combined with the advantages of BIM, the scheme is deepened through data and information control, analysis and simulation and so on, thus exploring the information expression and transmission of the 3D visualization of nonlinear architectural design information under the BIM platform, and an ideal physical building model is established.

Keywords: BIM; nonlinear building, architectural design, parametric design, three-dimensional visualization.

1. Introduction

The rapid development of science and technology promotes the process of global economic and information integration, with the improvement of China's economic level, the continuous deepening of socialist construction, and the continuous improvement of the socialist market economic system, China's construction industry has been greatly stimulated in recent years, the construction industry is also developing to the direction of scale and standardization. At the same time, architectural design technology has also made great breakthroughs and presents diversified characteristics. This kind of architectural design like nonlinear design, it is highly complex and difficult, which also brings a certain degree of challenge to the designers. The BIM technology brings a good technological basis to the nonlinear design, which greatly promotes the improvement of the design effect. BIM(Building Information Modeling) is a new type of architectural design method. First of all, the site structure of nonlinear building can be analyzed in detail through BIM. Because some factors affect the design accuracy in the site analysis process of nonlinear architectural design, moreover, there is delay condition in some information data, which affect the quantitative analysis of the data. BIM can be combined with GIS, through the virtual technology; site molding design is carried out to improve the accuracy of site analysis. The layout planning of nonlinear buildings can be more reasonable under the influence of BIM.

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Finally, the digital models in BIM platform are used for architectural design, and "digital building" is established, through the input, storage and expression of data information, building information is controlled and transmitted comprehensively. Therefore, the BIM platform and the nonlinear architectural design have a good combinability, the BIM platform is used to store and transmit all the information of the nonlinear building in the design stage, and the information expression is carried out in the nonlinear building.

This paper is based on the combination of BIM platform and nonlinear architectural design, through literature research of correlation theory and development of BIM and nonlinear architecture, this paper attempts to design by combining BIM platform with nonlinear building, explores the establishment of form model in nonlinear architectural design under BIM platform., deepens scheme, information interoperability and information expression, opposite building processing and construction, etc., and it provides lesson and reference for studying the application of BIM in nonlinear architectural design. The research ideas in this paper are shown in Figure 1.

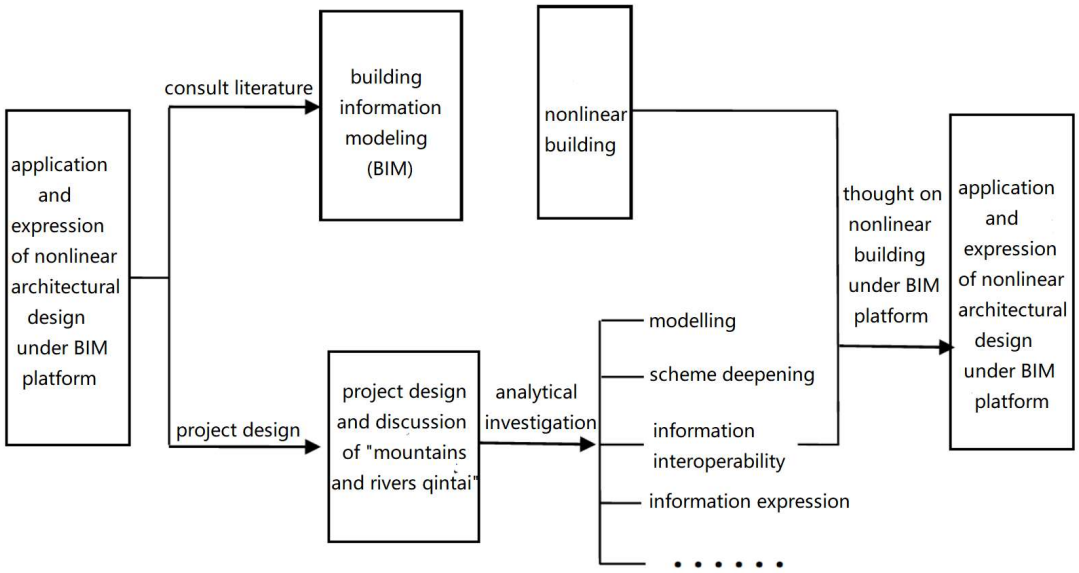


Figure.1 thought of non-architectural design from literature and design to BIM platform (image source: created by author)

2. Related Concept Definition and Basic Theoretical Research

BIM is the abbreviation of building information modeling, building information modeling is based on the information data of architectural design, construction and operation, it establishes a geometric building model which can store professional digital information of building, and reflect the current status of physical buildings in real time. It has visualization, coordination, simulation, optimization and drawing output five characteristics, based on the parametric design model, professional coordination and digital processing can be realized by inserting, extracting, updating and modifying parameter information, and can call the relevant information to complete the target operation at any stage of the construction project life cycle [2]. According to definition of BIM of the US National BIM Standard: “BIM is a digital representation of the physical and functional characteristics of a facility (construction project); BIM is a shared knowledge resource and shared information on this facility, and provides a reliable basis for all decisions in the facility's life cycle from concept to demolition; in different stages of the project, different stakeholders insert, extract, update and modify information in BIM to support and respond to the collaborative work of their respective responsibilities[3].

3. Application of BIM in Nonlinear Architectural Design

Due to the particularity of the nonlinear architecture, expressions are, first, feature information of the architectural form is unique to nonlinear building. Second, feature information of architectural function, its design complexity is higher and more difficult; however, the BIM platform brings a good basis for nonlinear architectural design, scheme assistance design, scheme deepening, environmental simulation can be carried out for nonlinear building through BIM and so on, store and translate the problem with data information, it is possible to control the architectural design comprehensively by controlling the parameter information, the data can be effectively compared and analyzed and the program can be optimized and improved, from this it will improve the overall quality and cost performance of the architectural design. The application of BIM platform in nonlinear architectural design can store and express the complexity of nonlinear architecture with data information, and it reflects on the information model and can visually display the architects' design concept.

4. Nonlinear Architectural Design Practice

The design is derived from the allusion of "lofty mountains and flowing water", the mountain transitions to the water and unfolds a scroll painting of mountains and rivers integration. From the "high" of the mountain to the "short" of the water, the height is gradually gentle, and the water wave rises and falls. The shape of the large curve reflects a sense of suspension, The curve of the stable part of the lower part represents the "qin". The large curve which represents "mountains and rivers" rises from the small curve, the implied meaning is the tune from the "qin". The whole model is divided into three parts: mountain, water and qin, and expresses the flexibility and beauty of nonlinear architectural curves [7]

Mountain stands for stability and reliability. The "mountain" part is dug into a small cave from the back, and the gentle part that crossed the qin just become the chair in the cave and form a small space that can accommodate one person (Figure 1). The end part of "water" part is upturned, and the length is uneven at the end, it mimics the broken waves at the end of the spray, the "water" stands for bearing and support, so the transition arc the water is mainly the seat. Due to the long and varied lines, various sitting positions are available. They can be used by many people sitting side by side, and it can also be used for people to lie on their side. The small wave head in the front can be used as a side back. The slice of the "mountains and rivers" part is thicker than the slice of the "qin" part and the gap is large, and the slice of the "qin" part is small and thin. The slice of the "qin end" part is inserted and pierced from the gap of the wave end to form a fusion of two shapes. The "qin" part imitates the curve of Guqin, the second half is basically stable and can be used as a bench for people to use.

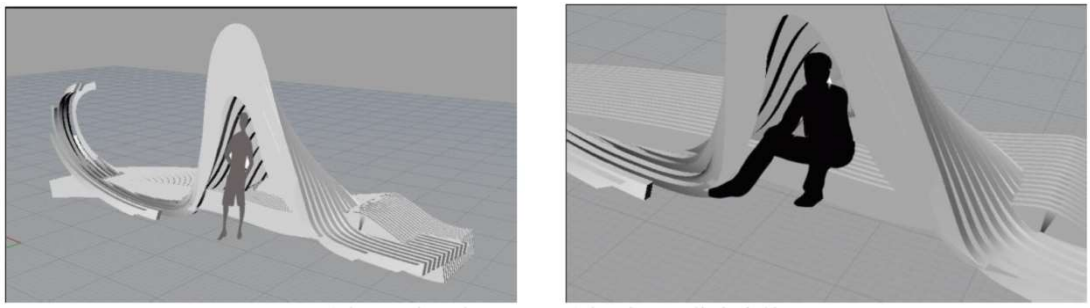


Figure.2 mountains and rivers qintai "mountain" (image source: drawn by author)

5. Create BIM Information Model

"Mountains and Rivers Qintai" firstly designed the basic shape of the model with the Rhino software when establishing the basic shape, and then draws the various detailed structures of the model, moreover, Rhino's shaping and vectorization functions are used to continuously adjust the rotational control points, the control line makes the model curve smooth, and the form tends to be ideal. The whole model consists of 107 single pieces, which are lapped successively according to the flow of the curve.

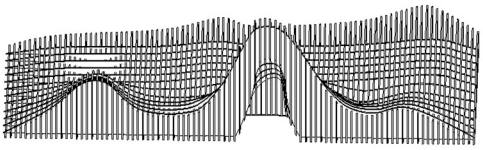
The key to the creation process is the expression of BIM information, we use the Rhino software to simulate the model to design buildings that fits people's normal life.

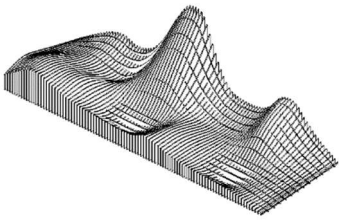
From the design of the 2D drawings to the 3D visualization expression; and the model positioning is imported into Autodesk Revit software for structural detailed parameterization design, the architectural shape is adjusted with the parameter control relationship, and finally achieve collaborative design, complete the expression of data, and realize real-time visualization. The essence of BIM technology is digital technology, the BIM model has core databases that integrate the professional parameter information added by each created component, under certain rules, it can rely on the computer for identification or manual addition and modification. In this way, the virtual building established by the information can call the relevant information of a detailed component at any time according to the design needs, and manage the building components in real time [4]. The 107 pieces is included in the "Shanshui Qintai", the volume, length, height and other parameters were added to each component for designing virtual construction.by using Revit manual work, The whole is divided into five single pieces: red, purple, blue, green and yellow (Figure.3).

Figure.3 single piece of mountains and rivers qintai (image source: drawn by author)

Model Component Information Table

A	B	C	D	E	F
Type	Position	Volume	Image	Cost	Comment
Red Single 1	Longitudinal piece 1	0.002 m³	Red Single 1.PNG	4.00	
Red Single 2	Longitudinal piece 2	0.002 m³	Red Single 2.PNG	4.00	
Red Single 3	Longitudinal piece 3	0.001 m³	Red Single 3.PNG	4.00	
Red Single 4	Longitudinal piece 4	0.001 m³	Red Single 4.PNG	4.00	
Red Single 5	Longitudinal piece 5	0.001 m³	Red Single 5.PNG	4.00	
Red Single 6	Longitudinal piece 6	0.001 m³	Red Single 6.PNG	4.00	
Red Single 7	Longitudinal piece 7	0.001 m³	Red Single 7.PNG	4.00	
Red Single 8	Longitudinal piece 8	0.001 m³	Red Single 8.PNG	4.00	
Red Single 9	Longitudinal piece 9	0.001 m³	Red Single 9.PNG	4.00	
Red Single 10	Longitudinal piece 10	0.001 m³	Red Single 10.PNG	4.00	
Red Single 11	Longitudinal piece 11	0.001 m³	Red Single 11.PNG	4.00	
Red Single 12	Longitudinal piece 12	0.001 m³	Red Single 12.PNG	4.00	





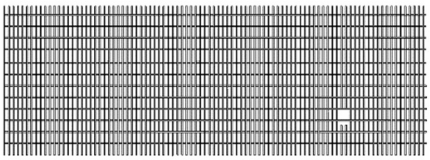


Figure.3 model component information of mountains and rivers qintai (image source: drawn by author)

6. Model Expressions

For the development of this project, first, a suitable nonlinear building space structure system is designed—mountains and rivers qintai, BIM platform is used to create BIM holographic model, moreover, deepening is carried out, modification is continuous, and component parameters are determined in Revit parameterization design, finally, the nonlinear architectural design and digital processing under the BIM information are completed, and the relatively idealized physical model is hand-made by combining the drawing print, finally, the expression of the model us completed, and it solves the problems of deepening the details and shape, the space curved surface fitting and the construction of complex components of nonlinear buildings under the BIM platform (Fig. 3).

Figure.4 model entity of mountains and rivers qintai (image source: created by author)

7. Conclusion

This paper applies the BIM platform to the practical application of nonlinear architectural design, with the support of BIM technology, it can accurately reflect the data information of the model, the data control of the information model can be very good, 3D visualization design can visually reflect related information of building visually, simulate the building's environment, help to optimize the program it mainly embodied in the following points:

(1) Combine the parameterization and create information model, which has the controllable, accurate and visual advantages.

(2) During the surviving phase of scheme, the change of data information is conducive to the modification and management of nonlinear buildings, the visual response of information models, and data simulation.

(3) Data information records all the information of the building, which is convenient for teamwork and design participation.

(4) Data information model is more efficiently and conveniently complete the processing and construction of nonlinear buildings and ensure construction quality.

Scheme aided design of nonlinear buildings can be conducted through BIM, in this way, it can make the whole building design richer, moreover, some diversified elements can be put in it. The BIM parameters are used as the basis for data adjustment, when the parameters change, the architectural form will also change accordingly. The corresponding architectural form is obtained by listing a series of data parameters, the results of these data are compared and analyzed, and the scheme is optimized and screened, so improve the overall quality of the design scheme. BIM brings a good solution to design problems with high complexity and larger repetitiveness, and improves design efficiency.

Acknowledgments

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