The Creation and Research of Ancient Architecture Model Based on BIM

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Abstract. Ancient architecture is a cultural treasure that has been deposited in China for 5,000 years. Its exquisite shape and solid structure demonstrate the exquisite craftsmanship of the ancient craftsmen in China, and it has a high appreciation value. But the protection and renovation of ancient architecture is a difficult problem. The existing methods of documenting ancient buildings mainly use textual data, pictures, etc., which have certain deficiencies. This paper considers applying BIM technology to the study of ancient architecture, and establishes an information model for ancient buildings to repair ancient buildings accurately conduct cultural studies.

1. Research background

1.1. The status of ancient architecture
China is currently undergoing a period of development and transformation. Modernization has achieved great achievements. However, while paying attention to the development of modernization, we must also pay attention to the inheritance of our historical culture. There are still many ancient buildings throughout the country. These classical buildings are the products of various historical periods. These ancient buildings have different architectural dynasties and different modes of construction. They are unique and reflect different dynasties. The level of craftsmanship and the level of construction materials are valuable treasures left over from 5,000 years of history. Most of them are preserved in the form of temples.

In recent years, the state has paid more and more attention to the repair and protection of ancient buildings. However, China has not yet formed a complete management system. Most ancient buildings are old and do not have complete technical information, so they can only be repaired by folk artists based on their experience. However, it lacks a certain degree of professionalism and it cannot guarantee the authenticity of ancient architecture. Due to the large number of components and the huge amount of data, ancient buildings are mostly recorded by text and pictures, they are easily lost. Such two-dimensional drawing records are not conducive to the research and repair of ancient buildings. This issue needs to be solved.

1.2. The status of BIM Technology
In recent years, BIM technology has gradually matured, and it is widely used in the field of engineering construction in China because of its visibility, cost accuracy, and simulation of
information models. BIM technology can not only build an overall framework model of ancient architecture, but also can build an information model of local components of ancient architecture.

Through the three-dimensional visualization operation, the building model can be more intuitively displayed to the public, and the relevant data and information of each detailed component of the building can also be retrieved at any time. At the same time, BIM also plays a crucial role in the cost management of construction projects. Compared to the traditional method of manual calculation which are based on two-dimensional drawings, BIM technology can provide three-dimensional construction drawings and record the construction of each part., the process ensures the accuracy of the calculation of the quantity of work, thereby improving the accuracy and effectiveness of the cost. [1]

In addition, BIM technology can realize the full life cycle management and analysis of construction projects, including all information from all stages of planning, construction, completion and maintenance, and can form dynamic three-dimensional models in real time. BIM technology is applicable to all professions and can achieve collaboration between professions. It can be applied to the construction process of civil and industrial buildings, bridges, tunnels, and railways. It is also applicable to the establishment of models of ancient buildings with complex components.

2. The establishment of three-dimensional information model
This paper selects the ancient architecture of Lingyan Mountain in Dujiangyan City as the research object, and uses the core software Revit in BIM technology to establish three information models. The basic principle is to collate the measured data on the basic structure of ancient buildings, and combine the information such as “Creating the original method”, “Building the French”, and “Engineering Practices”, according to the specific structure, practices, and dimensions of the ancient buildings specified Relationships, calculate the specific size data of various parts of ancient buildings, build a two-dimensional information model based on Auto CAD platform, and then use Revit to build a three-dimensional information model. [2]

2.1. Overview of Research Object
The ancient building is located on the mountainside of Lingyan in Dujiangyan City. It faces the south and faces the south. The building is located asymmetrically. It passes through the mountain gate and follows the stone staircase. There are Changting, Heavenly King Hall, Weituo temple, and Daxiongtang along the way. Among them, Weituo temple and Daxiongtang are both hanging mountain type wood and stone structure.

The ancient architecture of Lingyan Mountain is similar to that of other ancient buildings. The wooden members are used as load-bearing structures. In the direction of the building, pillars are used to form pillars, pillars are placed on five beams, beams are placed on pillars, and melon pillars are placed on three shelves. The beam, the uppermost form of the spine and the ridge, forms a series of roof trusses, and finally combines the array of roof trusses with each other to form a complete house structure. [3]

2.2. Model Core -Building "Family"
The core of using Revit modeling is to establish the family files of the detailed components of the ancient building. It includes the process of creating a family, modifying a family, associating parameters, and optimizing. After the establishment of all ethnic groups, the families will be modified, combined, and optimized to obtain a complete information model of ancient architecture. [4]

The outline of the ancient building is very beautiful, and the details are very delicate. This also means that the components are complex and diverse. The complexity of the components makes the ancient buildings have a wide range of family files. The creation of the roof families is particularly complex, and it requires to build and combine the purlins, tiles, and Different shapes of ornaments. Therefore, it is more difficult to establish an information model of an ancient building than an information model of a modern building, and the space modeling capability of the designer is more demanding.
Figure 1. Complex components of ancient building

Prior to the establishment of a family file, the types and quantities of the basic components of the ancient building shall be counted, the orientation and size shall be determined, and the family files shall be established according to a certain order and type. In understanding the details of each detailed structure of an ancient building, it is analyzed whether it can be modeled as a whole, whether components are divided into pieces, and whether a single component is composed of a plurality of materials.

There are many components in ancient buildings, and there are special-shaped components. The premise of modeling is to assign parameters to the families of each component, so the process of building information is more complicated. However, this is the advantage of Revit. Unlike other 3D modeling software, Revit can create family files for heteromorphic components, which can be used repeatedly. At the same time, family files can be modified as needed, and automatically updated in real time. It facilitates follow-up work of subsequent model revisions.

In addition, in addition to drawing the family files one by one for each component, the identification method can be used to identify the lines of the two-dimensional information model to save time for building a family.

2.3. Modeling Essentials- Parameterized Design

Ancient building components are complex, so the process of building a family is complex, however, the Dynamo visual plug-in included in the Revit software provides a great degree of convenience. Special surface design and bridge design can be performed.

Dynamo plug-in and Revit are interlinked with Revit API, use Dynamo plug-in to create complex components, read and write their data, and then follow-up import, export, and other operations, which undoubtedly provides a powerful guarantee for Revit's building information.

In addition, the Dynamo plug-in can change the parameters of the Dynamo plug-in simply by re-running the script, enabling automatic placement and updating of components. By arranging a certain implementation path, component association can be achieved, batch processing can be performed, and the layout of the components can be completed.
The size of the components of an ancient building and the relationship between them are both specified. Using the Dynamo plug-in to set parameters and find the coordinates of the placement points of components, and then the components can be automatically arranged which instead of the manually arranged one by one, greatly improving the Modeling accuracy and efficiency.

2.4. **Form the final model**

After building the components of the ancient building and completing the parameters matching and modification, combine the components to form the overall framework of the 3D information model of the ancient building. After adding materials for ancient buildings and finally performing model rendering and exporting, the basic work of modeling is completed.

![Rendered three-dimensional model of ancient architecture](image)

**Figure 2.** Rendered three-dimensional model of ancient architecture

Establishing information model of ancient buildings based on the Revit, you can not only get intuitive, specific three-dimensional model, you can also view the specific information and data of each component anytime. The Revit model of ancient architecture can also be used as a follow-up GIS data platform to draw the flat distribution of classical architecture and improve the basic information of ancient architecture.

If all the ancient buildings in China are built with BIM models, besides analyzing the structure of ancient buildings, information management can also be carried out and a complete management system can be formed. This lays a technical foundation for future protection and restoration work. It is conducive to the study of ancient architectural culture, inherit our traditional culture, and open up a world of traditional culture under the large cultural environment of our country. [5]

3. **Conclusion**

With the country’s increasing emphasis on the protection and research of ancient buildings and the continuous development and optimization of BIM technology, the management of ancient buildings will become more complete and more systematic. This paper is based on the BIM technology, building information models of ancient architecture based on Revit. We study ancient architecture from a new perspective to contribute to the research of ancient architecture.

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