Original Research Article

Application of prefabricated building based on BIM technology in rural residential buildings

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Abstract: With the continuous promotion of the national "dual carbon" strategy and the construction of beautiful rural areas, the number of updates and renovations of rural residential buildings is gradually increasing. However, there are widespread problems with planning, design, construction quality, energy conservation and environmental protection. This article takes the rural houses of the Bai ethnic group in Dali as an example, summarizes the current status and main problems of the renovation of Dali houses through research, and elaborates on the advantages and characteristics of BIM and prefabricated technology. This paper analyzes the application prospects of BIM technology in the prefabricated renovation of rural residential areas from the aspects of site planning, scheme optimization design, ethnic cultural inheritance, engineering project construction, and engineering cost. It can provide reference and guidance for the renovation of traditional rural residential areas, and assist in rural revitalization.

Keyword: BIM technology; Prefabricated buildings; Traditional residence

1. Introduction

With the development of rural areas, the construction and renewal of rural dwellings in China has gradually increased, but there are widespread problems such as aesthetics, quality, structure and environmental protection in the construction. In some places, the national characteristics of rural dwellings have been gradually rebuilt randomly, which is not in line with the concept of beautiful rural construction and development and the strategy of rural revitalization in China. At the same time, the actual residence and service life of traditional rural dwellings are short, and they need to be constantly updated and constructed. Such extensive construction not only wastes resources but also causes certain damage to the environment, which restricts the construction of beautiful villages and the improvement of rural living environment.

At present, the industrial prefabricated building has been popularized and applied in the urban construction of our country, but it is rarely popularized and used in the rural residential construction. Compared with the traditional construction method of residents, the small prefabricated type using BIM technology can solve the main problems existing in the construction process of residential buildings. Small prefabricated buildings not only reduce pollution, meet the requirements of green, low-carbon, energy saving and environmental protection, but also help promote the upgrading and renewal of the rural construction industry, respond to the national policy of "dual carbon" goals, help the construction of beautiful villages, and promote the development of rural revitalization strategy.

2. Construction status of self-built houses in rural areas

Under the background of rural revitalization, rural buildings and rural self-built houses have been springing

up. Although the engineering construction technology has been progressing, there are still some common problems and safety risks in construction. At present, the scale of rural self-built houses is uneven, there are problems such as destruction of land resources, scattered and chaotic layout, which increases the difficulty of management. Most of the self-built houses in rural areas have no design drawings, and are mostly constructed by construction teams without construction qualifications with experience. In terms of design, the layout is simple, the building structure is not clearly standardized, the structure is unreasonable, the material waste rate is high, the shock resistance of the house cannot meet the relevant standards, and the building quality and safety problems are difficult to be guaranteed [1-4]. The existing laws and regulations related to rural self-built houses are still imperfect, and there are loopholes and negligence in the approval process of self-built houses, and there are blind areas where relevant government supervision is not in place.

Take Dali Bai folk houses as an example. With the rise of self-built houses in rural areas and the influence of modern architectural culture, the houses are mostly modern buildings, while the traditional folk houses are constantly decreasing. The coexistence of modern and traditional buildings in a village leads to the continuous reduction of national characteristics, or makes it difficult to inherit national culture. The main problems are as follows:

Bai traditional houses are mainly civil structures, and many of them are traditional old houses or traditional buildings with a long service life, among which there are problems such as disrepair and disrepair. Moreover, Dali is located in the middle of Yunnan earthquake zone, which has high seismic requirements and low seismic resistance, stability and safety of houses, and there are serious security risks.

The lack of formal design and construction of rural self-built houses, no standard design construction drawings, resulting in unreasonable housing structure, there are serious security risks.

Some villages in Dali are built on mountains, with rugged roads and uneven land. The transportation and construction of construction materials require a lot of time and large manpower and material resources, and the cost is high. There is no professional treatment of construction waste generated by construction, and the solution is usually discarded outdoors at will, which will cause a certain degree of environmental pollution.

There is no professional quality acceptance system in the construction process of rural self-built houses, and the quality and safety performance of most houses cannot meet the housing standards, and the life and property of residents cannot be guaranteed.

With the development of The Times, the modern culture is constantly impacting people, while the traditional culture of the nation is constantly fading. Most of the self-built houses in rural areas are modern buildings, which will not be specially designed. They blindly follow the trend and imitate the trend, with a single style and lack of characteristics. As a result, the traditional folk houses are gradually replaced due to backward development, which gradually weakens the national characteristics.

3. BIM technology and prefabricated building

3.1. BIM and prefabricated benefits

The overview of BIM technology for small prefabricated buildings is based on the combination of building information modeling (BIM) and prefabricated construction to achieve comprehensive information sharing and multi-professional cooperation, which can greatly improve engineering efficiency and engineering quality, and realize green and simulation of design and construction [5-7]. Realize the information integration and collaborative

work in all stages of building design, construction and operation. There are many characteristic components and special designs in ethnic dwellings, which need detailed data and information summary and record for application. In multi-specialty synchronous design, compared with traditional design, information modification and sharing are not timely, and problems such as error, omission, collision and lack are easy to exist. BIM technology can solve this problem by using its working set, and finally unify and present the design by linking models. All kinds of building information, such as the size and model of building components, the installation position of prefabricated components, the materials of components and other parameters, can form a database and can be used in the whole building cycle [8-9]. There is an important problem in prefabricated buildings - the transportation of prefabricated components. The residential buildings are mostly in the countryside, and the roads are rugged and the mountain roads are difficult to walk. The BIM database can also solve the transportation problem of prefabricated components. Through the data analysis of road transportation and construction site, the original size of the prefabricated parts can be changed and pre-animation simulation can be carried out to improve the construction feasibility and efficiency, and the linkage of various specialties and the precision and efficiency of design can be greatly improved.

3.2. BIM and prefabricated features

Improve building performance. BIM technology has the ability to strengthen the integrated design of building, structure, electromechanical and interior integration. Residential buildings are traditionally brick-concrete structures, and there are problems in residential security caused by unreasonable structures. In the design stage of the project, BIM technology is used to model the architectural engineering design drawings, and then the building model and building parameters are imported into the system, which can intuitively present the appearance characteristics and internal design requirements of the residential buildings, timely adjust the irrational and existing performance problems in the construction, and effectively adjust the size parameterization through the model. It can provide accurate data for prefabricated technology construction. The construction process of traditional residential buildings is basically carried out in the open construction site, which is small, and the construction process will be affected by various factors such as safety and weather, while BIM+ assembly type can directly simulate the installation process and transport the produced prefabricated parts to the construction site for direct assembly, greatly shortening the construction period. Improve engineering accuracy, safety and scientificity.

Build green energy saving and environmental protection throughout the life cycle. Compared with the traditional cast-in-place mode, the prefabricated building adopts the factory production mode to make the production process more controllable and reduce the generation of construction waste. It only needs to transport the prefabricated parts to the construction site for installation, which reduces the dust pollution caused by the traditional construction and the waste of resources and environmental pollution caused by the building itself and the construction process [10-11]. Prefabricated buildings break the traditional construction mode, transfer a large number of on-site operations to the factory, reduce the loss of resources in on-site operations, improve the utilization of materials, and play a significant role in energy saving, material saving, environmental protection and other aspects, in line with the concept of green development. From the perspective of material selection, prefabricated building materials can use materials that meet building requirements by recycling waste resources, so as to achieve green and environmentally friendly recycling, save natural resources, protect environmental resources, and improve the environmental protection function characteristics of the project [12-15].

4. Application analysis of BIM and small prefabricated type in rural self-built houses (rural dwellings)

4.1. Rural self-built housing site planning

In the planning and siting of residential buildings, villagers have unclear building restrictions and standards, and lack scientific data support for lighting conditions and climate conditions, resulting in buildings that do not meet building requirements and actual needs [16]. Through the investigation of the history, culture and infrastructure of the village location, BIM technology is used to comprehensively analyze the site selection environment and clarify the functional zoning within the site, providing references for the scheme design.

4.2. Scheme optimization design

On the basis of traditional residential buildings, the linkage effect of prefabricated BIM is applied to realize comprehensive information sharing and multi-professional cooperation for residential construction personnel. In terms of design, BIM modeling is fully utilized in combination with VR technology to conduct three-dimensional graphic modeling on architectural engineering design drawings, intuitively present the appearance characteristics and internal design structure of residential buildings, and analyze the building structure. Optimize the size and layout of components to improve the safety and stability of the house. Therefore, the optimal design scheme for green engineering [17-20] is proposed to solve the problems such as poor seismic resistance, unreasonable layout and hidden safety risks of the structural system.

4.3. Construction and operation and maintenance management

BIM+ small assembly technology can provide detailed construction drawings and assembly process, realize the advance simulation and precise positioning drill of the entire construction and assembly process, and guide the construction personnel to carry out accurate installation. At the same time, it can also warn potential problems in the construction process in advance, ensure the orderly development of construction projects, and improve construction quality and efficiency. The prefabricated system and modern mechanical facilities are combined for construction, and the unit hoisting, unit connection and other technologies are used to achieve simultaneous construction inside and outside, which can monitor the construction progress in real time, discover and solve problems in time, and ensure that the project is completed on time[21-24]. Secondly, the information of the building can be recorded to provide a basis for later maintenance and management; Monitor and manage construction equipment to improve its operating efficiency and life.

4.4. Cost control

3D modeling through BIM, accurate calculation of material consumption, avoid waste, reduce construction costs; The prefabricated components are produced in the factory and are not affected by the natural environment such as bad weather. The construction progress is planned in advance, and the human and material resources are reasonably arranged to reduce the cost overruns in the construction. The basic precision is high, the error is up to centimeters, and the design standard system is relatively complete. The transportation process adopts small transportation equipment, on-site assembly construction, material saving and environmental protection, which can greatly reduce manual dependence, more reliable quality, energy saving and environmental protection during the whole project cycle, and reduce project cost.

4.5. Cultural inheritance

Rural residential buildings are not only the display of aesthetic elements, but also the image of politics, ethics and folk customs. Combine people's modern needs, local culture and traditional national architecture to create a building complex with integrity, unity and humanistic flavor [25]. Help rural revitalization and realize the inheritance of national culture.

4.6. Challenges faced

Rural residents have low awareness of BIM technology and prefabricated buildings, and traditional concepts are often more inclined to traditional brick-concrete buildings, and their acceptance of prefabricated buildings is low. They may think that prefabricated buildings are not strong and durable enough, or do not conform to rural living habits. The construction of prefabricated buildings requires professional technology and equipment, and the construction team in rural areas often lacks technical personnel and construction teams. For example, the lifting and splicing of components need to be accurately operated, otherwise it is prone to quality problems. Rural infrastructure is not perfect, transport and installation conditions are limited.

5. Concluding Remarks

To sum up, the application prospect of small prefabricated buildings based on BIM technology in rural self-built houses is broad, which can not only integrate national characteristics with people's modern living needs, achieve cultural inheritance, but also save energy and reduce emission, reduce the generation of construction waste, and bring about a series of environmental pollution problems in the construction process, so as to realize the green life cycle of buildings. Improve the construction quality, reduce costs, shorten the construction period, improve the efficiency of construction, and ensure the comfort, safety and practicability of residential buildings. At the same time, in response to the policy of the national "double carbon" goal, adhering to the concept of sustainable development, promoting the green transformation of the construction industry, promoting the construction of beautiful villages, and revitalizing the development strategy of rural revitalization.

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