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Application Strategies of the Bracket Set in Modern Architectural Design

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Abstract: The Bracket Set (*dougong*) is an important aspect of traditional Chinese architecture known for its exquisite structure, complexity, and rich variations. This design element has been used since the Qin and Han Dynasties and is still prevalent today. It highlights hierarchy and spiritual connotations in the design of a building. This article explores the application of Bracket Set elements in modern architectural design. It analyzes the specific application strategies of this design element, highlighting its value in modern architecture. The goal is to provide modern architectural designers with multiple perspectives and strategies to fully utilize the advantages of Bracket Set elements in architectural design and enhance the artistic value of their work.

Keywords: Bracket Set elements; Architectural design; Stressed components; Decorative components

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1. Introduction

Bracket Set (*dougong*) originated from ancient Chinese architectural design as a typical component in traditional wooden structure construction. Based on historical evidence, this design has been widely spread to Japan, Vietnam, the Republic of Korea, and Southeast Asian countries. It has been applied in the construction field in various countries worldwide and has become an important structural feature of Chinese classical architecture and systems across cultures and borders. The bracket set is mainly composed of brackets and arches which is an important structure connecting purlins and column heads to disperse the building roof load to the columns. **Figure 1** shows the typical bracket set design in ancient architecture.

From a functional perspective, the bucket set can structurally function as a building truss, transferring the load from above to the column head below, which then distributes the load to the entire building base through the column head. This design mechanism can effectively expand the load-bearing area and reduce the stress concentration of the beam ends of the building, thereby effectively improving the stability and load-bearing capacity of the entire building. With the development of the architectural field in ancient China, the scale and spatial span of buildings continued to increase with the structural design of brackets became increasingly complex, thus improving their load-bearing and dispersion capabilities. At the same time, the bracket set

structure also has an earthquake-proof function as its staggered structure can reduce earthquake forces to a certain extent and protect the main structure of the building.

Figure 1. Typical bracket set design in ancient architecture

From an artistic perspective, in addition to being a functional component, the brackets' unique form, fine carvings, and rich decorative qualities all imprint unique cultural symbols and aesthetic elements on the building during the design stage. The application and evolution of bracket design reflect the aesthetic characteristics and technological changes of architectural design in different dynasty periods against the backdrop of China's historical development. From the initial application of brackets to the present, the forms have ranged from simple to complex, and the decorative patterns have ranged from abstract to concrete, all demonstrating the ingenious interpretation and artistic expression of architects' understanding of nature, the universe, and even philosophical thinking. The common dragons, phoenixes, curly grass, auspicious clouds, and other rich patterns on the brackets represent auspiciousness, authority, and the principles of heaven and earth, reflecting the cosmology and values of the Chinese nation [1].

The Bracket Set is an architectural design element that pays equal attention to structure and decoration and plays a pivotal role in the historical development of Chinese architecture. Applying Bracket Set elements in architectural design can show the wisdom and creativity of ancient construction artisans and reflect the characteristics and cultural connotations of oriental architecture to people worldwide. Exploring the application strategy of Bracket Set elements in modern architectural design can bring new meaning to Bracket Set elements and allow modern buildings to inherit the cultural and artistic value of ancient architecture while enhancing the functionality and aesthetics of buildings.

2. The application value of Bracket Set elements in modern architectural design

2.1. Demonstrate and inherit traditional Chinese culture

Bracket Set elements can express traditional cultural symbols, images, and stories in modern architectural forms and decorative elements, giving the building a unique aesthetic and beauty. The inheritance and continuation of these cultural symbols not only help promote traditional culture in modern architecture but also provide an effective way for the public to experience and recognize this traditional culture.

2.2. Utilizing the anti-seismic function of the Bracket Set mortise and tenon joints

Applying Bracket Set elements to modern architectural design can highlight the value of traditional Chinese culture while utilizing its earthquake-resistant tenon structure. The complex structure of the Bracket Set mortise and tenon joints is conducive to enhancing the load-bearing capacity of the building, especially against earthquakes. This design comprises multiple layers of wood that are cross-penetrated and spliced to form a highly solid frame structure. Therefore, applying Bucket Set mortise and tenon structures can greatly improve the external force resistance and the seismic safety factor of buildings in natural disasters such as earthquakes.

2.3. Establishing the connection between modern and traditional architectural culture

Applying Bracket Set elements in modern architectural design can enrich the cultural heritage of modern Chinese architecture and establish a connection between modern architecture and traditional culture. Integrating old and new cultures can significantly increase knowledge and understanding of traditional architectural culture in modern architectural designers. During modern architectural design where the functionality and practicality of the building are emphasized, the Bracket Set elements in traditional buildings can gain greater functional performance by combining with modern technology, thus achieving the practicality and functionality of modern buildings. For example, during the design of Bracket Set elements combined with advanced building materials and construction techniques in the field of modern architecture, the durability and safety of modern buildings can be significantly improved while highlighting the unique culture of Bracket Set elements [2].

3. Application strategies of Bracket Set elements in modern architectural design

3.1. Application of brackets as stress-bearing components

In modern architectural design, the Bracket Set is used as a stress-bearing component. During the design period, the traditional structural characteristics and modern architectural needs and design concepts should be considered. In specific design practice, designers must consider material selection and structural improvement when combining Bracket Set elements with modern technology. During the application of Bracket Set elements in modern architecture, designers should not just consider the structure and decoration but also conduct design analysis from the perspective of functional and psychological needs in people to ensure that the use of Bracket Set elements not only pursues aesthetics in form but also reflects the significance of the times in the content.

First, in terms of material selection, traditional architecture differs from modern architecture with the widespread use of wood. By applying Bracket Set in modern architecture that uses new, stronger, and more durable materials, such as steel and fiberglass, the requirements of modern buildings for earthquake and weather resistance can be met. Hence, the traditional brackets' structural characteristics can also adapt to modern architecture's functionality and durability needs by utilizing modern materials.

Second, designers should optimize the geometric form of traditional Bracket Sets in the design stage so that the bracket structure can achieve better mechanical properties. In the modern architectural design stage, designers can use computer-aided design software to analyze and simulate the bracket structure to ensure that the bracket shape not only restores the traditional style aesthetically but also meets the stress requirements mechanically. The structural stability can be further improved in the specific operation stage by adjusting the Bracket Set inclination, staggering, and stacking method.

Third, in the design stage, the architectural designer needs to pay attention to the combination of the brackets and the connection form of the brackets with other components. The combination of Bracket Sets with purlins, rafters, and other components requires not only the traditional mortise and tenon combination method but also utilizing modern construction technology to make the entire stress-bearing system more firmly

connected while maintaining the unique appearance feature of traditional brackets.

Finally, the design also needs to emphasize the modern expression of the bracket as a force-bearing component. During the design of the building structure, designers can try to combine the form and functional requirements of modern architecture to perform modern deconstruction and reorganization of the form, proportion, and even decorative details of the brackets based on design software, obtaining the expression of the bracket set that is more suitable for modern architectural styles, thus modernizing Bracket Sets as a new model of architectural decoration that combines tradition and modernity.

3.2. Application cases

As an important part of Nanjing's modern transportation hub, Nanjing South Railway Station cleverly incorporates many Bracket Set elements into the design of its entrance. During the design stage, Bracket Sets not only play the role of traditional decoration but also serve as stress-bearing components. The reinterpreted identity shows passing travelers the possibility of combining the functions of traditional components and modern architectural structures as shown in **Figure 2**.

Figure 2. Photo of the Bracket Set elements at the entrance of Nanjing South Railway Station

In the design of the Nanjing station column with Bracket Set elements, the Bracket Set has undergone a modern interpretation which is represented by a steel structure combined with glass materials that not only inherits the original aesthetic value of the Bracket Set but also successfully surpasses the limitations of the traditional wooden structure. Through artistic interpretation and innovative design of the traditional shape of the Bracket Set, this element not only serves as a dimensional stress-bearing structure in the outbound hall of Nanjing South Station and undertakes structural functions such as supporting the roof but also provides the station with a highly recognizable visual marker [3].

4. Application of brackets as decorative components

When applying Bracket Set elements as decorative components to modern architectural design, the combination of form and function should be explored based on innovative design concepts while promoting the joint innovation of materials and processes, the integration of culture, environment, technology, and other elements.

4.1. Design concept innovation and strategy

From the perspective of design concept innovation, Bracket Set elements are used as decorative components in modern architectural design. Designers should pay attention when integrating modern architectural design by respecting cultural and aesthetic characteristics [4]. Therefore, during the design period, it is necessary to explore the historical and cultural connotations of the Bracket Sets as decorative components and innovate the traditional bracket forms and arrangement methods so that the Bracket Set elements are highly integrated with the modern architectural style.

4.2. Combination of form and function

Bracket Set elements are used as decorative components from the perspective of combining form and function. In the application stage of modern architectural design, designers should not simply replicate traditional forms but should deeply explore the functional potential of Bracket Set elements [5]. For example, Bracket Set elements can guide and block light in building facades and interior spaces, making it a practical decoration that meets the needs of modern architectural environment control.

4.3. Material and process innovation

Modern architects can choose modern materials different from traditional wood used in Bracket Sets, such as metal, glass, or composite materials when integrating Bracket Set elements into modern architectural design. Designers should emphasize aesthetics while ensuring their durability and environmental protection when selecting materials [6]. At the same time, designers can apply modern production techniques, such as 3D printing technology, CNC cutting technology, and so on to make the bracket decoration of modern buildings more personalized and refined.

4.4. Multi-element integration

When applying Bracket Set elements to modern architectural design, attention should be paid to integrating multi-dimensional elements of culture, environment, technology, and creativity. During the design period, designers need to consider the building's geographical location, historical background, and surrounding environment to achieve harmonious coexistence between the bracket decoration and the surrounding cultural atmosphere through localized and contemporary design of the bracket decoration components [7]. At the same time, the combination of technology and creativity during the design of Bracket Set elements should be emphasized. Designers should use software simulation technology to dynamically simulate the Bracket Set components and constantly explore new expression forms and scale proportions so that the traditional Bracket Set elements can be expressed better in modern architecture.

4.5. Application cases

In the eaves design of the China Development Bank office building shown in **Figure 3**, the Bracket Set elements are cleverly integrated into the architectural context as decorative components, achieving the integration of traditional architectural aesthetics and modern design techniques. The integration of Bracket Set elements in the eaves not only revives but also captures the spirit of traditional architecture and improves the modernity of the building.

Based on the eaves design of the China Development Bank office building, the traditional form of the brackets was abstracted and simplified to harmonize with the modern style and lines of the office building. Moreover, the designer used modern building materials and construction techniques to visually present the decorative bracket sets with a layered and staggered effect while retaining the elegance and sophistication

provided by the traditional Bracket Sets, which highly reflects the continuity and innovation of architectural culture [8].

Figure 3. Photo of the China Development Bank office building

5. Display the design intention of the Bracket Set in architectural design

In the contemporary architectural design stage, the presentation of the Bracket Set aims to capture the spiritual essence of the traditional Bracket Set elements through abstraction and reinterpretation by integrating it with modern architectural techniques in a novel way [9].

On one hand, designers need to conduct in-depth research on the structural characteristics and symbolic meaning of the Bracket Set and extract its core elements, such as proportion, shape, layering, and so on to make innovative designs based on contemporary architectural needs. For example, the form of the brackets is simplified to make it iconic in a new architectural context. Moreover, designers need to emphasize the overall layout and visual impact intention of Bracket Set in modern architecture. Through the ingenious application of light, shadow, color, and structure, the intention of the brackets is no longer limited to surface decoration but can also affect the perception and experience of the building users and viewers more subtly and delicately [10].

In addition, the coordination between the geometric form of the Bracket Sets and the building structure system should be emphasized so that the bracket decoration is not only an additional layer but closely integrated with the building to effectively display the intention of the brackets. For example, in the facade design, internal space separation, or window detail design stage of modern buildings, designers can cleverly embed the geometric patterns of the brackets, which can demonstrate the aesthetic beauty of the Bracket Sets while also giving the building a unique symbolic connotation.

6. Conclusion

As an important aspect in ancient Chinese traditional architecture, the Bracket Set element contains rich cultural connotations and represents the wisdom and technology of construction artisans in China for thousands of years. Modern architectural designers should actively apply this element to the building structure during the architectural design process to utilize the unique artistic characteristics and functional value of the Bracket Set elements to enhance the overall value of the building, promote the improvement of user experience, provide

the modern public with a window to understand the historical architectural culture and adopt a good cultural technology for the sustainable development of construction industry in the country.

Disclosure statement

The author declares no conflict of interest.

References

[1] Zhang F, Liu MM, Liu Y, 2023, Prefabricated Installation and Construction Technology of Brackets Imitating Tang Dynasty Buildings. Construction Technology Development, 50(12): 58–60.

[2] Zhong WH, 2023, Research on Applying Traditional Architectural Design in Modern Residential Design. Urban Construction Theory Research (Electronic Edition), 2023(32): 74–76.

[3] Gong XH, 2023, Analysis of the Mechanical Performance of the Brackets of Guanyin Pavilion of Tiansheng Temple. Anhui Architecture, 30(09): 81–83.

[4] Zhong Y, Fu YH. Research on applying traditional architectural design in Modern Residential Design. Art Appreciation, 2023(23): 77–80.

[5] Zhou HX, Cui XX, 2023, "Translatability" of Architecture: the Possibility of Transforming Traditional Architectural Decoration. Decoration, 2023(07): 77–84.

[6] Li DY, 2022 Interpretation of Bracket Set Elements in Modern Design. Yanhuang Geography, 2022(3): 90–92.

[7] Xu JY, 2021, Research on the Design Characteristics of Bracket Set and its Impact on Contemporary Design. Ceramic Research, 36(2):76–78.

[8] Song J, Zhang JQ, Zhu RB, et al., Research on Applying Metal "Bracket Setes" in New Chinese-style Furniture Design. Furniture and Interior Decoration, 2019(6): 62–63.

[9] Yang JC, Ye YB, 2021, Analysis and Research on Brackets' Origin, Evolution, and Modern Design Application. Architecture and Culture, 2021(12): 49–50.

[10] Gao YN, Wang LN, 2022, Looking at the Driving Factors and Inheritance Paths of the Development of Traditional Chinese Architecture from the Evolution of Brackets. Urban Architecture, 19(24): 145–148.