Research on adaptive application of traditional lingnan building materials – taking Macau as an example

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Abstract. With the rapid development of the economy in our country, modern new materials and new technologies have emerged, which have gradually replaced the use of traditional building materials as well as related technologies. However, as the most intuitionistic embodiment and cultural carrier in the process of architectural design and expression, the congenial construction materials will inevitably reduce the architectural diversity and culture connotation, and make the regional differences disappear gradually. Based on this, this paper explores the combination of traditional building materials with modern technology and techniques to realize the renewal and utilization of the traditional construction materials, better reflect the regional culture of Lingnan architecture and enrich the diversity of modern architecture.

1 Application status of Lingnan traditional building materials

With the rapid development of global economy, new technologies and materials are constantly emerging, it has promoted the improvement of modern architectural design systems. In Lingnan area, due to the continuous updating of modern building materials, the expression of Lingnan traditional building materials in modern architectural design is replaced gradually. As the carrier of historical culture, traditional building materials play a very important role in traditional culture and regional architecture. At the same time, the expression of regional architecture cannot be replaced by other building materials. Lingnan is one of the regions with great regional and cultural characteristics in my country, and its architectural design inadvertently reflects the regional culture.

As one of the important components of buildings, building materials determine the nature of buildings. Different building materials can endow buildings with different characteristics and cultural connotations according to the regional characteristics. In the process of architecture design, architects need to fully consider the regional characteristics of building materials, through the use of Lingnan traditional construction materials, enabling the building to show more cordial feeling. Let people appreciate the traditional Lingnan culture contained in the building while admiring it, which embodies the construction of regional, make the

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building appear to be better able to its cultural characteristics, so as to feel the heavy sense of Lingnan culture on the building. Nowadays, with the rapid development of modern building materials, how to apply the traditional building materials in Lingnan region to modern architectural design, make the development of China's architecture more diversified through regional architectural design, it is an issue that should be considered by architects deeply.

2 Modern new processing of Lingnan traditional building materials

There are five kinds of traditional building materials in Lingnan: soil, wood, brick, tile and stone. The stone is durable, the wood is light and easy to process, and the brick is decorative. The following is an overview of the new processing methods of traditional building materials, in the process of using Lingnan traditional building materials in modern buildings (Fig.1).

Fig. 1. Location of Macau.

2.1 Brick

The clay brick has good heat insulation and sound insulation properties. However, it consumes a lot of resources during the firing process, causes environmental pollution. Therefore, as a kind of environmentally friendly material, Non-burnt Brick is favored gradually. Non-burnt Brick is a new type of wall material that can be manufactured without high temperature calcination, which main raw materials are fly ash, coal gangue, chemical slag, coal slag, tailings slag, etc. This material possesses the advantages of high strength, good durability, standard size, complete appearance and uniform color.

2.2 Raw soil

The durability and mechanical properties of Lingnan traditional raw soil are poor. In view of these problems, people improve the processing technology of raw soil. Taking rammed earth wall as an example, new tools are helpful to improve the compacting degree and strength of rammed earth wall. In the proportion of raw soil materials, by adding a certain proportion of sand and gravel, the mixture can form an aggregate composition similar to that of concrete, which can improve the strength and durability of the material greatly.
2.3 Wood

Glulam is one of the most commonly used types of wood in modern times. It is made of 20–50 mm thick wood boards by drying and gluing. Compared with the Lingnan traditional wood, Glulam has great advantages, which is more stable in shape while its strength is greatly improved. This is because the drying process is added by chemical means in the processing of Glulam, which reduces the moisture in the Glulam and ensures the stability. The performance of wood preservation and fire prevention is also greatly improved.

![Fig. 2. The Mandarin's House in Macau (photographed by the author).](image1)

![Fig. 3. The Mandarin's House in Macau (photographed by the author).](image2)

![Fig. 4. The Mandarin's House in Macau. (photographed by the author).](image3)
3 Modern forms of Lingnan traditional building materials

Compared with modern building materials, the structural properties of traditional materials seem powerless. It is more reasonable to use traditional materials as veneer to show their sensory characteristics. The following is an overview of the expression forms of Lingnan traditional materials from four aspects: material texture, surface texture, color and form.

3.1 Color

The colors of building materials are divided into inherent colors and artificial colors. Artificial colors are added to materials by hand, which are different from the original colors of materials in generally. Inherent color refers to the original color of the material. For example, the use of wood, stone, brick and other materials in nature often uses its own color. Through different processing methods of traditional materials, the inherent color of traditional materials may be changed. For example, when bricks are fired at different temperatures, their colors get different too. And they can be used as decorations for different buildings. Artificial materials, often in pursuit of modern beauty, usually keep their colors consistent. Because traditional materials are affected by various factors in nature, they usually show different colors, which leads to the changing characteristics of traditional buildings. In architectural design, it is necessary to make reasonable use of this characteristic of traditional materials, so that they can be properly expressed in modern buildings, so that modern buildings have stronger artistic expression.

Fig. 5. The Night Watch House in Macau. (photographed by the author).

Fig. 6. The Night Watch House in Macau. (photographed by the author).
3.2 Form

The form of traditional building materials refers to the external characteristics of building materials in the construction process, including shape, size, texture, etc. The same building materials can show different building forms when used in different buildings. Only with the right proportions and scales can the best characteristics of building materials be brought into play, so that they have the best stiffness, strength and toughness. Traditional building materials are divided into natural building materials and artificial building materials. The artificial building material is through the processing of traditional building materials artificially, so that they can meet the relevant requirements of the building, so as to ensure that they meet the needs of designers. Natural building materials are from the nature of local materials directly, do not change the original appearance of natural building materials, through the arrangement and combination of natural building materials, reflect the form of traditional building materials in modern architectural design, which is one of the extensive applications of traditional building materials in modern architectural design.

4 Material texture

Architectural materials have a certain material texture, that is, give people a sense of touch. Lingnan traditional building materials have great characteristics in material texture, and different traditional building materials show unique texture. Material texture is usually reflected in the vein, reflectivity and smoothness, and is also divided into natural texture and artificial texture. Brick, soil, wood, stone, and other traditional materials that come from nature retain a lot of nature and beauty. Many modern architectural cases pay attention to the expression of this natural texture.

Generally speaking, this material texture is basically the texture of the material itself. The architect presents the natural texture through unique techniques, the texture characteristics formed like building materials, such as marble, oyster shell, architectural wood, etc. For example, people feel cold and calm from the smoothness of the marble surface. And the roughness of traditional bricks and tiles can bring people a simple feeling, as well the oyster shells made from local materials can bring people a natural calm texture. Through the reasonable application of different textures of traditional building materials, it can bring people different feelings [1]. The artificial texture gives specific texture to building materials through modern processing methods, construction technology, and other artificial means, such as polished stone, etc. This artificial texture is another way to presenting the nature of the material, and sometimes reflects the aesthetic feeling of modern industrial products.

5 Surface texture

Surface texture refers to the texture structure of the object surface, that is, a variety of crisscross, uneven, rough and smooth texture, is to express people's feelings on the surface texture characteristics of the design. In architecture, the surface texture that people feel is usually determined by the construction method of facing, and different construction methods usually depend on the properties of different materials. According to different construction methods, it can be divided into masonry, weaving and ramming [2-4].

5.1 The Surface texture of masonry

The Surface texture of masonry depends on different ways of masonry. As the basic unit of masonry, brick and stone are often used, and the horizontal and vertical gaps between the units constitute the most prominent texture feature of the masonry. The designer changes the
masonry texture by changing the arrangement of the units or changing the composition of the units.

5.2 The Surface texture of weaving

The original intention of weaving refers to the production process of arranging the organization with linear materials with strong tensile properties. Generally speaking, wood has obvious linear characteristics due to the shape of its material. As a building skin, the woven surface generally has a certain degree of transparency, which is determined by the density of the weaving and the size of the components.

5.3 The Surface texture of ramming

"Ramming" refers to the construction method of ramming the soil layer by layer with human tools. In generally, ramming texture is the surface texture expression of the material itself. The main factors affecting the texture of ramming are the way of ramming and the formula of materials.

6 Summary

Lingnan traditional materials have a long history, such as brick, earth, wood, stone, etc. Traditional materials are used in modern architectural design in a new way by modernization in the Lingnan area. In this way, it can not only renew the traditional architectural materials in Lingnan but also can reflect the regional culture of Lingnan architecture which enriches the diversity of modern architecture.

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