A Study of the Feasibility of Combining Traditional Green Earthen Buildings with Modern Architecture

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Abstract — Environmental problems have become increasingly more serious these days. In this paper we examine a possible solution based on traditional “Green earthen buildings” approach, an architecture which has not spread widely until now and where more attention is required. We analyze the advantages and disadvantages of green earthen buildings, explore the value that green earthen buildings offer in the modern era for sustainable development of human society, and propose innovative ideas and applications based on the traditional building method aimed at combining the green earthen buildings with modern building practices.

Keywords - earthen buildings; innovation of the earthen building; advantage and disadvantage

I. INTRODUCTION

With the rapid development of society, global environmental issues have become increasingly prominent, today we humanity all in the face of climate change, air pollution and resource constraints common crisis, sustainable has become the mainstream of the development contemporary. And consuming a lot of resources due to construction activities also created a large number of environmental pollutants at the same time, therefore we should pay attention to sustainable building development. In this context, energy conservation, construction-intensive society is strongly advocated. The “green earthen buildings” as one of the responses to the environment protection has been raised. [1]

II. THE ADVANTAGES AND DISADVANTAGES OF THE EARTHEN BUILDINGS

Earthen building material itself is a kind of green material, relative to the modern buildings such as reinforced concrete materials is environmentally sustainable. And, in the existing on the earthen buildings of the records are mentioned, it’s a kind of material which warm in winter and cool in summer, the buildings self adjustment function provide to human a good living experience, and soil as a kind of natural substances, itself also has a lot of good to human health, human beings live in such building also has promoting effect on promoting health.

Of course, because the soil has some fluffy features, the mud walls also exist some disadvantages such as low intensity, low bending, low shear, low bending strength, self-heavy, so the seismic performance is poor. However, as long as the structure design is reasonable, construction appropriate measures, it can also meet the seismic requirements. [3]

Wall base and the outer wall eroded away by water and durability is poor, as time goes by, many earthen buildings have collapsed in prolonged rain during the long time, the wall’s surface lack of effective measures to waterproof, led to the wall base severe erosion, part of the surface layer off, wall weathering serious corrosion, greatly reduce the bearing capacity of the wall. Its biological activity is frequent in the earthen buildings, especially the harm from ant and rat to earthen buildings can not be ignored, so, in the construction, the wall should have a certain preventive measures. [2]

The promotion of the earthen buildings in the future society still needs further experimental data support with the development of technology, many ancient earthen buildings’ problems can be improved by existing techniques for a better.

III. THE BENEFIT OF THE “GREEN EARTHEN BUILDINGS” BRING TO SUSTAINABLE DEVELOPMENT OF THE SOCIETY

With the people’s living standards improve, people are also increased in the enjoyment of consumption expenditure, the rapid development of the tourism industry is the best reflect, in the tourism industry, ecological tourism is hot today, people are more interested in the green, environmental protection, natural, and the green earthen buildings is such a form of architecture that can be implemented in the tourist attractions and consumption items.

In addition, from the perspective of consumer psychology, people's psychological difference can be very good to promote the development of this new type of architectural form, it is not only a new experience, but also is a cultural experience, more can reflect a kind of cultural value.

The reason why we advocate the study of earthen buildings is that the architecture is benefit for our health and the environment we live, so it’s necessary for us to know the benefit the green earthen buildings can bring to us. Meanwhile, it’s also can explore a new promotion way for earthen buildings, combine the crystallization wisdom with our modern technology, better to bring forth
the new through the old, explore a new path of development. This is also good for cultural heritage.

Although the old earthen buildings were abandoned by the fashion trend in twentieth Century. With the development of the technology, more and more people realize the importance of health, the soil—it’s a high environmental performance material with the low cost. Earthen buildings has good sound insulation, fire prevention, anti-virus and other characteristics, but also can avoid the wood, cement, iron and steel over exploitation of the natural ecology in the use process. In October 1999 America Association of the Architect Environment Committee in the state of Tennessee Chattanooga held a conference and the theme is “mainstream of green”.

Green buildings in America is no longer just a phenomenon, it has become a movement—very attractive in the beginning of 21th century, it’s the beginning and the representative which began as a residential design using non industrial construction technology.

Earthen buildings, the use of soil, clay, stone, wood, straw and other composite building technology and architectural form, had spread widely in earlier European. Especially in France, the whole city could be built with clay. After the first World War, Germany had made a test about built clay buildings, but fail. After the Second World War, only the Democratic Republic of Germany still implementation of the test. However environmentalists reconsider the clay building firstly because of the clay is an excellent building material, it’s beneficial to our environment. Besides, the clay is good insulators, it means the outer temperature heat is just gradually affect the temperature inside the house. It’s cool in summer and warm in winter when you live in the clay house, therefore, saving the energy. Because there isn’t enough specialists versed in clay construction method to boom the clay buildings in Europe.

"Green building" has grown from a small role neglected development become the focus of academic circles today, and the theory is enriching and developing.

IV. THE TRADITIONAL METHOD OF MAKING EARTHEN BUILDING

A. Assemble Method Buildings

The raw soil is constructed by adobe, straw, soil clay mud drying molding made, and then use the brick build wall. The method has the rolling, mud and other, more in the rice field place, do brick by adopting rolling mode.

B. Ramming method.

Rammed earth buildings is the earliest and most common way in the raw soil construction. By semi wet (optimum water content) of the cohesive soil, in the wooden splint in subsection and layer (every 30 50cm) plate wall rammed into, also known as rammed earth wall. Wall thickness varies from region to region vary, commonly used 40 - 60cm. In the 70’s of last century, some local Chinese rural is still used this way.

C. Earthen buildings pouring method

Pouring process with respect to the above two kind of method is relatively simple, and rammed construction method is very approximate, is stirring composite slurry material good into advance to build a good model, using the model of wall of beating and vibration, the mud from the air, increasing the density of slurry, using this method, can also be materials to implant in the mud wall of bamboo, wood, hemp rope, increased wall’s connectivity, shock resistance, robustness. So to build houses good connectivity, integrated and strong, relatively strong, and the wall of the modeling is not restricted, can be the face can also be curved surface modeling is rich.

V. THE TECHNOLOGY INNOVATION OF THE “GREEN EARTHEN BUILDINGS”

A. the combination of the grass and mud clay

Humans have long learned to use grass and mud as the architecture material to build house, we can easy to find some house’s wall is made up with the mixture of grass and mud. There are two types: one of the adobe is mix the straw with the mud, this kind of the brick not only own good connection but also very hard, have good compression performance, the other one is used to make the outside wall, mix the mud with Lime and straw according to a certain proportion, Mixing uniformity, apply into the outer, it’s useful to prevent the erosion of the wall under the natural force, improve the service life of the building., the fig.(1)shows what the walls looks like.

![Figure 1. The outer of the wall made by the mixture of mud and grass](image)

We mentioned some disadvantages of the earthen buildings before, the major shortcoming is the building of its own weight, the seismic resistance is not good. There is a good solution for this problem—a new form mix—the mixture of mud and grass, half mud and half straw, put the straw like the net, like the fig(2) shown, why we connect the straw vertical? Because it could increase the weight capability. The new processing method not only reduce the 1/2 weight of the wall, but increase the earthquake resistance and the use rate of the straw. The biggest advantage probably is there’s no trouble in how to deal with the waste disposal, no matter. Whether it is
in the construction period or after the buildings abandoned, this consists of soil and crop fiber wall, easily and quickly will be environmental absorption and assimilation, and not to leave any toxic or adverse environmental effects.

Figure 2. How to mix the straw in mud to build the wall

B. Surface treatment method of earthen wall

The biggest problem when people build with the mud is that the mud wall don’t have good corrosion resistance, greatly reduce the service life of the building, there are three ways to solve the problem. The first one is using the modern industrial technology, smear the resin glue on the outer surface of the wall, so that the wall will not be destroy by rain erosion easily, can also attach a layer of fine sand in the outer resin adhesive, beside we can also attach a layer of sand in the outer resin glue, so the resin glue can be protected at the same time. The second one is grow green plant on the outer wall to prevent external weathered wall, and purify the air, adjust the moisture, decorative building, fig.(3),is one of the forms. The third one is attach oil on the outer and inner surface of the wall and polish it for more than 3 times, it can effectively prevent the the erosion of rain water, and looks very beautiful, especially for indoor decoration, and the earthen floor can also be polished. It is no exaggeration to say that the mud wall is warm in winter and cool in summer, after polishing treatment, the surface usually looks like leather luster.

C. The combination of the earthen wall and modern architecture technology

According to the living environment concept of sustainable development and ecological civilization level, we must re-examine and innovate “Earthen”—the ancient building materials, combine the modern building technique with traditional excellent building technique, for example: now, the mostly buildings are frame houses of reinforced concrete wall, so we can fill the wall with the natural earthen material, not only increase the consistency and seismic of the house, but provide a pleasant indoor environment for people, get comfortable building environment in human and to minimize damage to the environment.

Especially this green earthen materials are more suitable for the houses built in steel frame, the steel and the mud can be 100% recycled when construction abandoned, at the same time, the earthen buildings can make a progress on adjusting temperature indoor, and the steel frame can make up the disadvantages of the earthen buildings which bending strength is low. It’s a perfect combination. At the same time, there are more suitable methods for this kind of excellent building material use, it also need more architects and researchers work together, make it possible to find a perfect balance in the environment and construction, finally get win-win. [4]

VI. CONCLUSION

Green building is an important topic in the development of today's society, it is an inherent requirement of the human natural health, but also the future of residential design. It is an important development direction. The goals of sustainable development, ecology-oriented, the harmony between man and nature, modern science and technology and artistic support, create a healthy, green, efficient, comfortable and sustainable development of human settlements environment.

This green building may let many city dwellers began to re-examine our habits. Turn off the computer, untie our shoelaces, all day long straw soil as partners. This is the green building, natural building. This passion for nature, as if from our soul as deep and natural, like breathing as indispensable.

REFERENCES
