Regenerative Design Framework

A Case Study of Residential Heritage of Fujian Tulou in China

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Abstract. World heritage site Fujian has a number of traditional settlements named Tulou, which are existing historical records of family culture and local construction techniques in old times. In recent decades, most of them are abandoned by local occupants and then partly collapsed without any conservation. A rising number of researchers have realized that it is necessary to revitalize and regenerate those rural settlements from a long-term perspective in response to energy saving, carbon reduction, and heritage conservation. This study will discuss a regenerative design framework of a general Tulou deployed in Fujian. Sustainable and resilient solutions proposed in this study are: (1) spatial design to satisfy the demands of modern lifestyles; and, (2) constructive design to promote the abilities of environmental adaptation. This regenerative design framework is suggested as a potential principle, leading to further reconsideration of human-earth relationships.

Keywords: Heritage Tulou · Regeneration · Sustainability · Design framework · Natural light · Passive design

1 Introduction

Fujian Tulou, a world heritage, with a property of 46 residential buildings, has been well protected since it was identified by the United Nations Educational, Science and Cultural Organization (UNESCO) in 2008. However, despite these 46 world heritage Tulous, there are thousands of non-world-heritage Tulous in the rural areas of Fujian Province. These earthen dwellings, built over 100–1000 years ago, could no longer meet the living needs of people in the 21st century. As a result, most Tulous are heavily deserted in modern times, facing the danger of decline.

Over the past few decades, the concept of sustainability has been propagated in the architectural industries, aimed at fulfilling the demands of the present society while also considering the needs of future generations [1]. With the raising awareness of sustainability and heritage protection, the reusing value [2] of Tulou heritage has been proved in the local tourism industry and other industries.

To preserve and maximize the value of the remaining non-world-heritage Tulous, architectural regeneration has become one of the current research trends. The notions of "regenerative", "sustainable", and "green" are interpreted into the aspects of building design strategies, environmental performance, and associated assessment methods,

G. Ali et al. (Eds.): ISEMSS 2022, ASSEHR 687, pp. 3662–3667, 2022.
https://doi.org/10.2991/978-2-494069-31-2_429

respectively [3]. This case study will focus on a typical non-world-heritage Tulou—Guifang-lou—to describe the details of its regenerative design framework as a heritage conservation strategy.

2 Review

2.1 Tulou as a Type of Green Building

In ancient times, to avoid threats of natural disasters and racial disputes, family members in the mountains of Fujian Province chose to settle down and share living spaces. A Tulou of about 1000 square meters could accommodate a large family of hundreds of people. Such an intense building prototype was proved to reflect green design characteristics of resisting environmental hazards and relying on local material resources in ancient times for sheltering. Though limited by scientific technologies, it was a primary state of the interrelationship between human and natural systems that occupants had to create tough shelters through optimizations of environmental adaptation and resource efficiency.

2.2 Regenerative Practice of Tulou

The current architectural cases of Tulou regeneration projects are almost about functional transformation. A common practice is to transform out-of-use Tulous into public facilities, such as restaurants, hotels, and tourist sites, whose financial benefits could be expected from stakeholders. These short-term profitable projects are easier for investment and property development. However, it is a complex task that involves the multi-participation of professional teams, management agents as well as local government to reach a unified aim through cooperation. Nevertheless, these old houses might suffer secondary damages during the reusing period, speeding up to the end of the building life cycle. Considering the importance of sustainability and conversation in the reuse of heritage buildings, the challenges in incorporating it into practice remain unresolved [4].

Toward the goal of sustainability, livability, and resiliency, Tulou heritages need to raise innovation-driven cognition and take regenerative design as a breakthrough. Green design is concerned with basic issues of living safety, health, comfort, and energy-saving, while the regenerative design offers considerable potency for the partnering and coexistence of human and natural systems in the future.

3 Case Study

3.1 Study Background

A Tulou named Guifang-lou is selected for this research. Guifang-lou was built with raw earth and wood about 120 years ago in Nanjing County, Fujian Province, in which there are quantities of historical dwellings of non-world-heritage Tulous for regeneration. Guifang-lou is a three-floor building with a two-floor wing on the east and west side (See Fig. 1). It shows a typical space system with an introverted structure where

Fig. 1. Bird view of the Guifang-Lou.

rooms were arranged in a square order with intensive modular grids of 2–3 m. Previously, building durability, living safety, and blood relationships rather than individual privacy and living quality were much more taken into consideration. But, such a residential mode was not suitable and acceptable for modern life, thus, few occupants are willing to live in the Guifang-lou nowadays. This research aims to investigate which design values, materials, and constructive techniques might be environmentally adaptive during regenerative development, in order to recreate a sustainable system for the indoor environment. It might have the potential to provide insights into other Tulous and even other historical dwellings that are out of use in a similar situation.

3.2 Spatial Design to Reorganising Layouts

Natural light is considered a core element to give the old building a sense of fresh life and living energy. It is not only one form of solar energy to transfer heat, but also has a positive influence on space quality and human sensation. Such a light-oriented strategy had been applied in diverse building and heritage renovation projects. For example, architect Paulo M. R. once revitalized a deserted college building into a national museum in Brazil by controlling the amount of indoor sunlight and the ways they went. His regenerative design purpose was achieved through the building envelope, particularly the glass roof, and interior doors as well as windows.

The redesigned floor plan of the building is shown in Fig. 2, where a conventional pattern of layouts in Guifang-lou is reorganized into a compact pattern with addictive envelopes.

In this case, similar light effects are designed through additional roof windows by using glass facades over the inner courtyard, which turn the central open place into an interior space for living activities. Besides, bridges of steel structures and glass roofs link the main building with two wings as a whole, where each separated room is combined on a larger scale with lights constantly passing through from the glass roof.

Fig. 2. Reorganized floor plan of Guifang-Lou.

3.3 Passive Design to Improve Environmental Adaptations

Robinson suggests that sustainability is an integrating concept of actively creating synergy, not just a summation of the past construction experience [5]. Obeying the original types of Tulou is a basic way of learning ancient wisdom. Although conventional construction is precise with inherited value, it is equally important to introduce advanced technologies and then create new forms based on today's wisdom. However, such an awareness of reincarnation has not accumulated sufficient experience and practice in Tulous yet. To reach the goal of historical Tulous' constructive innovation, practicable applications such as solar chimneys [6], Trombe walls [7], and bamboo facades will be taken into account as soon as the spatial design process starts (See Fig. 3).

Those green technologies have been tested in the other ecological buildings with effective performance in different seasons. For example, a Trombe wall applied outside the existing earth wall could regulate solar radiation through the air space in between, which helps to keep warm in winter as well as keep cool during the summer months without consuming energy for air conditioners and fans [8]. Besides, a solar chimney automatically pulls out wind and takes away the heat when the air on top of relevant building components is heated on summer days [9]. At the same time, wind catchers on the ground letting cool air in, which flows through the rock bed and is cooled down and underground. It contributes to thermal pressure ventilation and self-cooling in a large dwelling.

Not only do those constructive details added to the old building contribute to its climate adaptation and temperature-humidity control, but also act as architectural representations glossaries. In the passive design stage of heritage regeneration, environmental concerns of solar radiation, wind, rain, and even plants play essential roles but are in a co-existed state with the human system. Moreover, these passive design points require lower mechanical control and maintenance expenses, which are more adaptive and available than high-tech design solutions in rural areas. Therefore, combining the thinking of science, engineering, design, and art as soon as the regeneration process starts poses higher requirements for architecture designers and constructors.

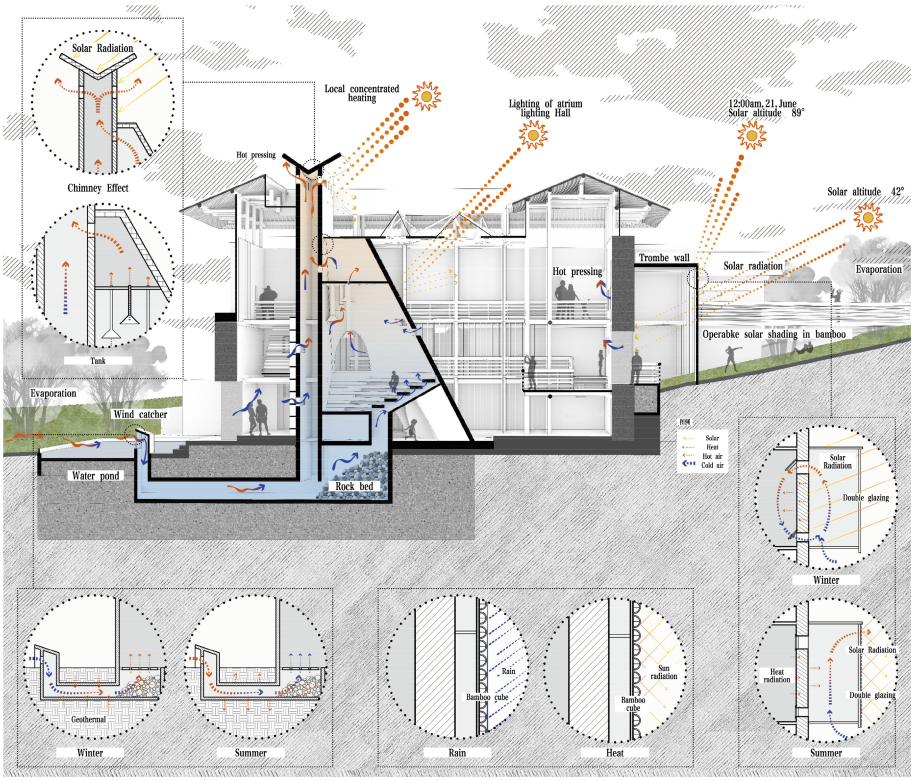

Fig. 3. Passive technologies applied in the regenerative design.

4 Conclusions

Regional design and construction practices reflect social cognition and local culture for a particular period, as Tulous represent the physical combination of ancestors' wisdom and techniques of environmental adaptation. With regards to heritage settlements regenerating, it does not mean merely giving new functions to the dying buildings, but improving their abilities to adapt to the current natural environment and human living demands autonomously [10]. It puts forward higher demands on design and construction complexity, strengthen by modern passive design strategies.

In a word, the generative design framework in this study is still at a strategic level, but it aims to improve the relationships between individual historical buildings with their shifty natural surroundings, as well as synchronize the spatial design with the passive design process. It is hopeful that such a regenerative proposal of heritage buildings will become a role model for a wider range of studies and applications in rural areas, to raise the awareness of both local occupants and architecture practitioners.

Acknowledgments. Not applicable.

Authors' Contributions. Both authors have read and approved the final manuscript. Yuan Sun proposed the theoretical analysis while Zhu Wang contributed details and specific suggestions to the research.

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