Research on Green and Ecological Strategy of Building Materials in the View of Low-Technology and Their Construction

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Abstract. Interpretation of green design concept by modern architectural design is always confined to high-end technology with no reference to the advantages of traditional building materials and construction technology. In the perspective of low-technology strategy and focusing on the expression of green and biological concept in building materials and construction, this paper discusses the current situation of architectural design and tryouts made by architects in the promotion of biological concept and the inheritance of regional culture and sprit of places in terms of building materials and construction modes.

Introduction

Before industrial society, the way to build houses is by traditional building materials and technology which enjoys wide popularization and environmental adaptability. While in modern time, traditional technology is still being inherited and developed regardless of obsolescence. The strategy to develop low technology combined with traditional technology is not only to absorb nutrients from traditional ecological ideas and express the affection to regional culture and spirit of places, but also to show modern features and put emphasis on green and sustainability. In a word, emphasis of the expression modes of green and biological concept in building materials and construction in the view of low technology strategy can be regarded as a kind of regression to architecture.

Importance of Material and Its Construction to Building Expression

From the huge stone bodies and mysterious wall engravings in the pyramid of Egypt to the complete space covered by concrete dome in the pantheon of Rome; from the colorful mosaics of Byzantine architectures to the outstanding structure systems of Gothic architectures; from the “Palladian motive” used to organized the visual order of architectural surfaces during the renaissance to the attentions academic architects paid to wall posts and skintled brick work, building materials and construction modes are always the everlasting topic related to architectural structure and expression. Along Chinese history, “buildings constructed with bricks of Qin Dynasty and tiles of Han Dynasty” are used to describe the architecture achievement of a certain historical period.

The “architecture” of buildings involves double concepts of structure and covering, and refers to the structures formed by binding of materials. On one hand, construction expression of materials relies on the form of architecture for presentation, and on the other hand, different materials will lead to different organizational relations and construction methods. Just as what we learn from the dialogue between Kahn and bricks, bricks are born for arches, and bricklaying can be heading bond

or stretching bond, the interest of material combination generated from bricklaying is irreplaceable.

Building Design Condition Focusing on Materials and Construction under the Dimension of Green Biological Concept

As the material carrier of buildings, recycle of materials is the main content of the substance cycle involved in architecture. Therefore, not only the safety, but also the influences of materials on ecological environment in the process of circulation should be taken into consideration during selection of building materials. In the view of low technology strategy and with respect to building materials and construction modes, we should focus on the ecological problems such as how to make building materials dissolve and return to the nature, how to recycle building wastes and how to select environmental friendly building methods.

Obtain Raw Material Locally. The selection of building materials under the direction of low technology strategy puts emphasis on “suiting measures to local conditions”. According to the green buildings standard, the transportation distance of materials should not be longer than 250KM, which sets restrict on building creation to some degree. However, the design strategy of suiting measures to local conditions can not only make the requirement of energy saving satisfied, but also make the spirit of places expressed in a better way.

In the design of Dominus Winery in California, U.S. (Fig. 1), Herzog and De Meuron ingeniously used local stones for construction of the architectural surface. The local basalts are of good heat-retaining capacity, and construction with basalts is suitable for the local climate feature of large temperature difference between day and night. The architects design a kind of metal wire mesh container to accommodate the stones of different sizes, and then the wire mesh containers are used as the special curtain walls hanging on the outside elevations of the building. In addition, the lighting and temperature of the building is adjusted by controlling of stone sizes through adjustment of mesh sizes, so that to realize the perfect fusion of the building and climatic environment.

New Use of Old Materials. The strategy of “new use of old materials” has always been the tradition of Chinese architecture. Chinese architects are exploring the road of practice of using old building materials to create buildings. Architectural design and creation with recycled old bricks and tiles not only demonstrate the concern and observation of architects on old Chinese town buildings, but also embody the subtle but spontaneous organic interaction between cities and villages. In a word, construction of new buildings with unique historical connotation with old bricks and tiles abandoned has become a new trend.

In the Xiangshan campus of China Academy of Art (Fig. 2), what impresses people most is the tiles laid layer upon layer, their uniformly arrangement seems like to breathe together with the buildings. Bricks, tiles and slates, wherever they are laid, are all collected from the surrounding demolition sites of the base. Although they are of different colors, shapes and specifications, their piling makes the building designed by Shu Wang demonstrate a restrained and indifferent disposition. Tile walls are built with various old and wasted materials such as bricks and tiles as the main materials, and with grass reinforced yellow mud or yellow mud and lime as auxiliary materials, in the masonry technology of layer upon layer. The tile walls not only show gentle and plain visual effect, but also have the function of regulating the micro-climate of buildings.

Fig.1 Dominus Winery
Image source: blog.sina.com.cn

Fig.2 Xiangshan Campus of China Academyof Art
Image source: blog.sina.com.cn

Recycling of Wastes. On one hand, the recycling of building materials refers to the "reclamation" of wastes in material viewpoint to realize the renewal of the "life" of buildings and reduce the pressure on environment. On the other hand, it refers to the "rebuilding"in both mental and emotional viewpoints, which means to establish the reconstruction of spirit and memory and to evoke emotional resonance through the locality and sense of history represented by materials. Low technology strategy is the update of traditional technology more than inheritance of traditional technology. Wastes can be adaptable to the environment through recombination and transformation.

"Recycled Brick Materials". In recent years, more and more architects are devoting themselves to design theory, technology and practice of green buildings built with construction wastes. Speaking of green buildings, Jiakun Liu, the so-called "vernacular architect" and his recycled brick plan must be mentioned. "Recycled bricks" are made from the broken bricks and tiles, which are used as aggregates, cut straws that are working as fibers and concrete by the local brick factory in the disaster area for the reconstruction of the Wenchuan. The recycled materials of low technology and low cost are not only the regeneration of construction wastes, but also the hope and eagerness of the victims for home rebuilding.

Many buildings designed by Jiakun Liu are built with these environmental friendly materials. The external wall of Shuijingfang Relics Museum are built with recycled bricks and antiseptic bamboo materials, and thus shows a visual effect that it is built with traditional materials. In this old block surrounding by high-rise buildings, this building community built in modern architectural language while conveys plain charm creates a thought-provoking memory.

"Agglomerated stone materials". Just as now, we put more emphasis on the concept of green and environmental friendly materials, while material suppliers are pursuing technology innovation of materials and construction, and as a result, "agglomerated stones" are developed. The emergence of agglomerated stones realizes conversion of wastes to raw materials. With respect to materials, natural gravels and stone powers are used as the aggregates, which make the agglomerated stones equipped with environmental friendly functions that other materials cannot compare with; moreover, agglomerated stones have rich colors and textures, making the adaptability of the originality of architects improved significantly.

The design of Hua Zhang for National Geology Museum in Ji County (Fig.3) is inspired by stones; and therefore the architectural form of the museum is in curves. In general, there are always joints between building materials. Concrete is too grey in color and lacks of textures, so it is not a good choice to fill joints. However, the emergence of agglomerated stones solves all problems about joints, and building built with agglomerated stones can also demonstrate the original ecology of a

region.

Fig.3 National Geology Museum in Ji County

Image source: www.archreport.com.cn

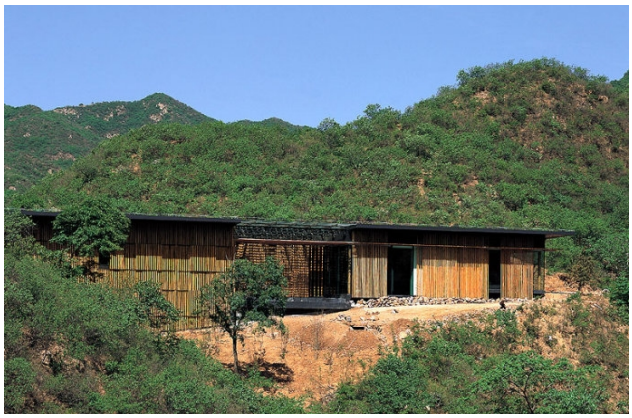

Fig. 4 Bamboo House

Image source: blog.sina.com.cn

Unearth the Potential of Natural Materials for Construction. In the modern construction history of human beings, many building materials with high potential are ignored by us, for example, bamboos, wood and paper, etc. Being sensitive to regional climate conditions, architects are exploring the construction potentials of traditional building materials as they attach importance to ecological and environmental friendly building materials and pay attention to the material demands of poor ordinary people.

The design style of “weak architecture” and the philosophy of “mingling architecture and environment harmoniously” of Japanese architect Kengo Kuma can strike a popular chord. In the design of bamboo houses of “Commune by the Great Wall” (Fig. 4), he utilizes bamboos as building material to realize the improvement of indoor lighting and ventilation conditions through the gaps of bamboo mattresses. In addition, for the purpose of make up the deficiency in load bearing, Kengo Kuma cut joints open and filled in reinforced concrete to realize the perfect combination of traditional bamboo materials and modern architecture.

The famous Japanese architect Shigeru Ban, who has been focusing on studying “paper tube architecture” is treated with respect by the architectural design world for his special paper architecture and humanitarian concern conveyed by his designs. Papers used by Shigeru Ban are environmental friendly fax paper cores, which are very suitable for building small-sized and light-weighted temporary buildings. The temporary classrooms of Chengdu Hualin Primary School is the first paper building reconstructed in the disaster area during Sichuan earthquake.

Conclusions

Nowadays, the attention paid to ecological environment by architects is fully embodied by their exploration of building materials and construction methods. After the 3D printing technology emerges, architects should be more eager to find out the accord point between industrialization and low technology strategy along with the rapid development of fabricated buildings, in order to resolve the conflict between modernized construction and regional connotation. In the view of low technology, the discussion of material aesthetics and construction methods is not only the response to green architectural concept, but also the interpretation and inheritance of regional culture. In the future, low technology will develop into a complete technology system based on its own advantages and features gradually, and an indispensable part for ecological technology system.

References

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