A Brief Analysis on the Redesign of Traditional Cave Dwellings

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Abstract. Cave dwelling, the treasure of ancient architecture, is the unique product of Chinese Loess Plateau. However, recently due to the continuous development of social economy and industrial civilization, traditional cave dwelling in our country has represented the backwardness and poverty of the country, and it had been gradually abandoned in the history. In order to effectively avoid this phenomenon and protect the traditional cave dwelling to the greatest extent. This paper makes relevant introduction about traditional cave dwelling, and meanwhile, the redesign of traditional cave dwelling houses has also been studied in detail.

1. Introduction
Since the intensification of urbanization, the traditional "old house" in our country has begun to be slowly forgotten by the public, and their living residence has also turned into high residential buildings while the traditional residential buildings are disappearing constantly. Traditional cave dwelling is the treasure of architecture in our country, especially its unique architectural style and ecological value with local cultural characteristics have always drawn attention by experts and scholars in various countries. In the 1960s, there has been relevant researches about it. But, from development process of urbanization nowadays, the decline and rebirth of traditional cave dwelling have become the key problems. The decline of traditional cave dwelling is the disappearance of the outstanding architectural culture in our country, and if we aim to protect the culture of traditional cave dwelling better, we need to carry out redesign research about it and give full attention to its green architectural concept existed for more valuable design, thus effectively promoting the sustainable development of traditional cave dwelling in our country.

2. Related overview of traditional cave dwellings
2.1. Natural conditions of cave dwellings
Cave dwellings are the products created by our people in the process of practical life and are the unique architectural symbols in local area. The Loess Plateau area in our country is special, an area which is mostly covered by loess, so its soil has suffered the watering erosion for a long time, which results in the special and fragmented landform in this area is, and all of these are natural conditions that generate cave dwellings[1]. In addition, the Loess Plateau crosses six provinces in total and there exists difference of climatic environment in different regions. Under this environment, the soil has remarkable changes, and what’s more, the altitude of Loess Plateau is very high, and the air
temperature will decrease along with the increase in altitude, which also causes serious soil desiccation and sand erosion in the area. Under this kind of natural conditions, cave dwellings emerge.

2.2. The history of cave dwellings development
Traditional cave dwellings have a long history which can be traced back to ancient times. Because in the early phase in which apes transform into people, our dwelling form also constantly changes, which gradually changes into today’s artificial caves from original ones, and the unique resource of loess also cause people easily make holes for dwelling. After that, when Xia-Shang-Zhou period started, new tools were made, and people began to build houses through artificial means, and cave dwellings became living places. In the Sui and Tang dynasties, the economy of our country developed gradually, and the technological level of architecture has significantly improved, which derived grottoes and so forth. In short, cave dwellings are the product generated in the process of people’s continuous practice and living experiences. There exists rich historical culture, which has very prominent value for us to research the culture of historical architecture.

2.3. Distribution and types of cave dwellings
Cave dwellings are mainly distributed in Shaanxi, Shanxi, Gansu and west part of Henan. While in Ningxia, Inner Mongolia, Hebei and other regions, there are also a few distributions[2]. Its types are relatively diversified, which can be divided into independent type, along the cliff type and sunken type according to the forms, and among the three types, we can also call sunken type as “type of pit”, which mostly appears in Henan, Shanxi and Shaanxi. Under general conditions, in the process of construction, it needs to vertically dig a pit on the flat ground and then crosswise dig up cave dwellings all around. It usually has the forms of two holes and three holes, and one of the holes will cut the slope, which is the main channel that connects with the outside world. Along the cliff type is built on the edge of groove surface and cliff surface. People will cut the palisades into vertical form and then dig cave dwellings crosswise. Because this way of excavation relays on the mountain shape, it will build backwards several meters when constructing upwards, making load-bearing part of cave dwellings not on the arch of next layer. This type of cave dwelling is mainly in Jinzhong, Shanxi and North of Shaanxi. For example, the dormitory of Yan’an University adopts this form[2]. Finally, we also call the independent type as “hoop cave dwelling”, which are earth kiln and brick kiln. This type of cave dwelling mainly is soil-covered arched architecture like the coalition of square and cave dwelling, which are mostly applied to the area where there is no suitable places to excavate.

3. The necessity of redesigning traditional cave dwellings

3.1. Able to construct a space environment with regional characteristics
Traditional cave dwellings itself contain a kind of unique regional culture and is a highlight in the garden of vernacular architecture in our country. But along with the rapid development of our country’s social economy, natural environment in Loess Plateau has been damaged to some degree and local unique cultural features also bear the pressure brought by industrial civilization, like this is shown in Fig.1. Traditional cave dwelling is a kind of unique symbol of residential buildings in our country and is a sign of memory and feelings accepted by local people. Only this architecture can bring them sense of identity and belonging. The redesign of traditional cave dwelling is an approach of protection of Chinese traditional architecture and regional characteristics, thus making it sustainable for ecology and human settlement of Loess Plateau obtain which effectively protects this land with rich culture and structures a space environment with local cultural characteristics.
3.2. Able to create a sustainable green ecological environment
Traditional cave dwelling is a kind of green buildings and adheres to the plain and naturally artificial spirit of natural ecology to create an ecological value for China's sustainable development. Because cave dwelling is a kind of living places built by local people accord with local conditions, it exists a relatively historical culture as well as unique construction method and architectural art. Its construction idea reflects the interaction and harmonious and unified symbiosis among human, architecture and nature. During the construction, whether the site selection of region or architectural technology, both can show the wisdom of local people in the aspect of using local materials and adjusting measures to local conditions, so it also exists these characteristics like warm in winter and cool in summer, energy conservation and environment protection, sound and thermal insulation as well as ecological harmony[3]. Thus, the redesign of traditional cave dwelling can create greener and more ecological environment.

3.3. Able to save land resources
As the urbanization is gradually intensifying, per capita land area is also reducing and land resources in our country also become more and more scarce. Under this environment, architectural forms also should have appropriate changes to achieving the goal of saving land resources, which cave dwelling can make. In the construction process of traditional cave dwelling, if we have a reasonable redesign towards cave dwelling along the cliff, it can effectively realize the goal of saving land resources and reserving architectural features of traditional and regional culture and building area will achieve more significant development and progress.

3.4. Able to protect historical and cultural heritage
Traditional cave dwelling is the product of material culture created by people during constant production and practice experience of life in an area. Its natural and geographic conditions and historical human environment also endow the traditional housing with relatively unique cultural characteristics. A series of factors make cave dwellings become a treasure in traditional culture and the
4. Relevant Suggestions on Redesign of Traditional Cave Dwellings

4.1. Material design
When redesigning cave dwellings, its design style should combine with current people’s demands for appropriate changes, and design style depends on building materials, thus designers should combine with existing space form to choose suitable building materials in the design process. When choosing materials, make sure that the materials can satisfy usage functions and people’s aesthetic demands. Meanwhile it needs to reflect regionalism and historic significance of cave dwelling. For example, when redesigning the interior of cave welling, designers can create a kind of plain and natural style with the fabric, wood and straw. As for the selection of coating, they can choose some economic and beautiful coatings. On the doors and windows, they can choose transparent glass which has stronger performance in heat insulation. In terms of external wall of cave dwelling, there are a lot of choices in materials, just like stone paint, stone curtain wall as well as tiles, they all can serve as the materials of redesign, because these materials show a natural and plain style, and the wood itself belongs to renewable resources which creates a welcoming feeling when being applied into redesign.

4.2. Space design
In the progress of redesigning cave dwellings, its interior space design is also an important part, and in terms of arch of interior space of cave dwellings, it is a classic representative. In order to ensure the rationality of redesign of cave dwellings, designers need to pay attention to the following points in the design process: first of all, they must ensure that it has basic usage functions, so they need to abandon traditional layout of cave dwelling except Kang; second, in the design process, they need to have a reasonable division about public and private area in interior area and combine with modern living habits for targeted design, and concretely speaking, they can divide the space into bedroom, living room, kitchen and toilet, which can better meet the demand of residents on the use of living environment space. The interior of cave dwellings is mostly narrow and vertical space, so they can increase the daylighting area when designing, which have the improvement effect in moist[4].

4.3. Energy conservation design
In the process of modern architectural design, the concept of energy conservation, green, and environment protection is the most important design concept, thus, when redesigning traditional cave dwellings, it also should pay attention to this point: energy conservation design. To be more specific, when carrying out daylighting design, we not only can use artificial light for daylighting and illumination design, but also can use natural light for daylighting and energy conservation design and make use of shadow changes of sunlight to maximize the use of natural light, which can produce the effect of reducing energy consumption and utilizing resources and realize the energy conservation in design. For example, during the process of design, the designer can install wooden windows in the internal hole of doors and windows which leads in sunlight, and in this way, it can produce the certain effect on light regulation and at the same time, it also produces certain regulating effect on indoor temperature; along with rhythm generated by sunlight angle, the shadow passing the texture of pane is also different, and in this way, it can increase flexibility of space to a certain degree. In a word, when redesigning traditional cave dwelling, we must combine with the actual situation for energy conservation design. Taking an American designer as an example, when he designs soil-covered farmhouse, he designs a kind of solar soil-covered farmhouse with glass dome. The bottom of round house is covered by raw soil and solar heat storage device and ventilation device are installed on the ground, making the heat energy of sunlight circulate in the interior[5], like this is shown in Fig.2.
5. Conclusion
To sum up, traditional cave dwellings are the treasure of traditional Chinese regional culture, and have great value for the innovation and sustainable development of architecture. At present, our country is in the stage where economic development accelerates and social problems like decrease in available land, lack of material resources and increased environment pollution still exist, thus, it is extremely urgent to pay attention to inherit and protect regional culture and redesign traditional cave dwellings. We should effectively combine modern design method of energy conservation and environment protection with construction concept of traditional cave dwelling and through redesigning, creating a kind of cave dwelling form with a greener and more ecological concept, which not only can protect traditional culture, but also can improve sustainable construction value towards modern architecture, and at the same time, it profoundly inherits harmonious and ecological concept which exists in cave dwelling itself and ecological view – the union of human and nature.

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