Research of green architecture—take Chinese traditional cave dwellings as an example

To cite this article: Wenting Li and Hongbao Li 2019 IOP Conf. Ser.: Earth Environ. Sci. 310 022054

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Research of green architecture------take Chinese traditional cave dwellings as an example

Wenting Li¹, Hongbao Li¹*

¹Design Cience, University of Science and Technology Liaoning, Anshan, Liaoning Province, 114051, China

²Environment Design, University of Science and Technology Liaoning, Anshan, Liaoning Province, 114051, China

*Corresponding author’s e-mail: 976097866@qq.com

Abstract. Most of people on the Loess Plateau live in cave dwellings. Cave dwelling, as a traditional residential building in China, demonstrates the wisdom of traditional Chinese residents. Cave dwelling, which is mainly made of earth, is gradually built by the people of the Loess Plateau by integrating natural environment and their unique natural resources. To a certain extent, cave dwelling also embodies the philosophy of sustainable development, coexisting harmoniously with nature, conforming to nature and cultivating nature. The research on the design of traditional Chinese cave dwellings has played a certain role in the exploration of green architecture in the future. In this paper studies the traditional Chinese dwellings – cave dwellings comprehensively, describes from many perspectives like the historical background, practical role and long-term impact, which is of great practical significance.

1. Introduction:
With the development of our society and the progress of human civilization, Chinese architecture is constantly evolving and developing according to people's demands. At present, China's construction industry is no longer just to meet people's needs of finding an accommodation, many people put forward higher requirements for the government, society and residents to create a harmonious coexisting satus between architecture and nature. It requires that people, nature and architecture should coexist harmoniously and achieve sustainable development, the essence is to realize the concept of sustainable development. Therefore, we can refer to the design concept of traditional residential buildings in Chinese history, and draw lessons from it to develop the current dwellings.

2. Green architecture philosophy
The current requirements for designing buildings are no longer only to meet people’s needs of finding an accommodation, but to build architectures based on the idea that people and buildings and natural environment can coexist in harmony. Since the end of the Industrial Revolution, human beings have cultivated more and more resources from the environment and nature. Our environment has been destroyed irreversibly. People’s unrestrained demands will inevitably lead to retaliation from the nature in the future. So we put forward the concept of green building to make the building develop sustainably, namely, gradually change the original architectural design to a resource-saving, environment-friendly green design. The emergency of green building brings new challenges and opportunities to the construction industry. This is a transitional period, in which the transformation of
construction industry happens, so as to make green buildings achieve saving resources, protecting the environment, and coexisting with the environment when they are being built. This is also consistent with the call of President Xi: "We want not only great economies, but also green mountains and clean waters ", so as to adapt to local conditions, using local materials, try their best to save energy and protect the environment. Therefore, green building is a vivid statement, which means building that can achieve sustainable development, and they are also environmentally friendly buildings.

3. Research of the background of cave dwellings
Cave dwellings have a long history. It is a landmark building on the Loess Plateau. It originated from cave buildings in Chinese history and is one of the primitive architectures. Besides the background of primitive society, the formation of cave dwellings in the Loess Plateau is closely related to the unique natural environment. The Loess Plateau is bleak and barren, it is extremely short of water resources, it is just some yellow earth looking from a distance. The depth of loess can reach more than 100 meters. In addition, the wind and sand are strong, and it is located on the plateau. Therefore, it is difficult for buildings to be built here, and even if there are buildings, they have to be highly qualified.

Cave buildings are distributed in Shanxi, Henan and Gansu provinces, but among them, the most representative is the cave in Shanxi Province, which is also the most well-known to the public. Cave dwellings are constructed by utilizing local topographic characteristics and abundant "loess" resources. Cave dwellings has a very good function as "air conditioner" , it can ensure that it is warm in winter and cool in summer, and it is also resistant to big wind with sand, earthquake, but also has the advantages of saving resources, energy, using local materials, costing less and so on. Cave building can also stand the test of the environment, and has been integrated with the natural environment, it takes full advantages of resources, and protects the environment, from this perspective, the cave dwellings are also a kind of green building which can achieve sustainable development.

This "pure nature" architecture provides a new idea for the construction industry in China, and its design concept has also been adopted by contemporary architecture. Today, with the continuous development of science and technology, people gradually realize the importance of green building, and constantly improve the design and construction of green building. Based on the original technique, we should make the best use of resources, make the buildings be adaptable to the environment, coexist with the environment harmoniously and promote the development of each other.

4. Green architectural thought of cave dwellings
4.1. Cave dwellings should be adapted to local conditions
Cave dwellings on the Loess Plateau have the characteristics of being built according to local conditions. Most of cave dwellings are built on "loess", which avoids the use of many polluting materials and saves a lot of resources, this also avoids the cumbersome construction process and makes use of the most abundant "earth" resources in local areas in construction. Cave building not only has the characteristic of the region and time, but also has cultural characteristics, showing the "earth" culture of the Loess Plateau. Cave can be said to be a beautiful treasure of traditional Chinese architecture. This kind of architectural design, which integrates architecture with environment, nature and culture, greatly embodies the concept of sustainable development, which is urgently needed in architecture, and also shows the harmony between man and nature and the firm belief of harmonious coexistence.

Adapting to local conditions and taking local materials is one of the purposes of contemporary architectural design and construction. At present, there are many kinds of garbage produced in our country, and the quantity is astonishing, which is the killer of the natural environment because it can destroy the original ecological chain. Among them, construction waste is one of the most serious types of pollution and cause severe natural destruction. The annual consumption of building materials, the waste of chemical raw materials and the pollution of decoration materials in our country all impose a heavy burden on nature and our earth. According to incomplete statistics, China's current construction
waste have reached more than 400 million tons, and the main waste is some cement products, steel materials and so on, which are highly polluting. Therefore, it is an inevitable requirement to learn from the characteristics of building cave dwellings according to local conditions.

4.2. Cave dwellings can save lands
Cave buildings use the topographic characteristics of the Loess Plateau. Faced with the uneven topographic characteristics of the plateau, the local people built a cave on the plateau, to meet the local people's living requirements. The most important thing is that the Loess Plateau is wide but has a small population. Most of the land is loess and can’t be cultivated at all. Therefore, the only cultivated land is the "golden land" of the local people, which can be used to let the local residents make a living. Therefore, it is impossible to construct buildings on this cultivated land. People in the Loess Plateau are b residential land with the idea of saving land and protecting the environment, which is also one of the causes of caves. In modern architecture, we should also adhere to this philosophy and find out reasonable and scientific construction strategies according to the local conditions, so as to ensure not to use cultivated land, and farmers can plant crops normally and that the cultivated land area of our country can be guaranteed not to be destroyed. We should never only copy exactly cave dwelling when refer to it, but we should learn the essence of cave building including the accommodation needs of the public, which is suitable for both living and current environmental resources.

4.3. Air conditioning in cave dwellings
The most amazing point of cave dwellings is that it can naturally adjust the internal environment of cave according to the external environment, achieve the function of maintaining warm in winter and cool in summer, it fully plays the role of air conditioning, saves energy, reduces pollution caused by air conditioner. There is a certain scientific basis for the air-conditioner function of cave dwellings. Because the temperature of the underground is slower than that on the ground, there is a certain time difference, so when the weather becomes cold, the cave is still at a comparatively higher temperature, and when the weather is hot, the cave is still in a comparatively low temperature, showing that it has the function of keeping warm and insulating heat. In the design and construction of modern buildings, people should also try their best to use environmental protection and thermal insulation materials, which can well isolate the influence from the outside world. The use of such materials can greatly reduce pollution caused by air-conditioner and save energy.

5. Summary
According to above analysis and elaboration of green buildings and green development philosophy of caves, we can see that green building has become the purpose of current architectural design and construction, we need to learn from the relevant philosophies in our history and apply them to our daily life, and build green buildings that are sustainable combining modern design technology and relevant philosophies. By analyzing traditional cave dwellings, we can see that the design idea of cave dwellings can still be used today, and can even be used in the future. This is the crystallization of the wisdom of the people of our country. And they adopted the idea of coexisting with the nature, society harmoniously. It has special significance which surpasses the times. We should have an open and tolerant attitude towards traditional cave buildings. We should learn its advantages while ddo away with disadvantages, combine its status quo, take the natural environment into consideration in the construction, integrate traditional and advanced architectural philosophies with the times, science and technology, so that the construction industry will continue to develop towards the direction of green building.

Acknowledgments
Here I would like to thank my instructor, professor Li, she gives me many valuable opinions from the beginning to the end. It is her many instructions and revisions that makes my paper be concluded smoothly. Thank you for your conscientious and responsible attitude and guidance, which makes my
paper gradually optimized. Thank you for all the scholars I referred to in this paper. This paper quotes the research literature of several scholars. Without the help and inspiration of the research results of these scholars, it would be very difficult for me to complete this paper.

**Reference:**

[1] Liu Danfeng. Analysis of Green Architecture in Chinese Traditional Cave Dwellings [J]. Intelligence, 2013 (16): 180.

[2] Shen Lu. Decline and revival of traditional cave dwellings [D]. Suzhou University, 2015.

[3] Ma Chengjun. Inheritance research and renovation practice of sinking cave dwellings [D]. Xi'an University of Architectural Science and Technology, 2009.

[4] Gao Xinxi. Characteristics of cave dwellings and modern interior environment design [J]. Shanxi Architecture, 2001, 27 (3): 1-2.

[5] Huang Xianming. Research on the Eco-Economic Optimization of Green Building[D].Tsinghua university, 2006. (in Chinese)

[6] Ru Jiping. Green architecture and sustainable development of settlements[J].Architecture and construction, 1999,(10):31-32.(in Chinese)

[7] William G Reed. and Elliot B Gordon. Integrated design and building process: what research and methodologies are needed?[J].Building Research & Information, 2000, 28 (5/6):325 -337.

[8] Gu Zhonghua. Discussion on the development of green architecture[J].Shanxi architecture,2001.

[9] Ding Xiaoling. Ecological construction of sustainable development[J].Public commerce:The second half,2009.