

1. Analysis of the historical background and current situation of caves in northern Shanxi

1.1. Historical background

Historical documents show that the history of people in northern Shaanxi living in caves can be traced back to Neolithic Age. At that time there were the semi-caves, and in the late Neolithic Age there were the horizontal caves along the cliffs.

The choice of cave location usually obeys the following rules: leeward towards the sun, easy accessibility, good safety, near drinkable water sources, and beautiful environment. People often choose and follow what is best by taking village conditions, family economic situation or "Fengshui" into consideration. Some people choose to build caves on high ground, because it is sunshiny, dry, and wide, easy for mountain labor; the others choose to build caves on lower ground, because it is near springs and the access to the cave is flat. In the past, people choose hard soil, parallel slopes as the location of a cave while avoiding vertical or inclined soil vein. People focus on whether the soil is uniform as foundation and if the soil veins are parallel when choosing locations to build brick caves and stone caves. The roof of various soil caves is basically a round arch. The arches are of different sizes, depending on if it is a long deep cave or a short cave. Different caves are connected to each other or kept in line. In recent years, there is improvement on the traditional model of caves. People put a higher value on practicality and aesthetics of the caves. Caves can be used widely not only as living room, but also as storage room. They can also be used as offices, conference rooms, and classrooms. According to local conditions, caves can be multi-functional (Hou and Wang, 1999).

1.2. The classification of caves

Caves in northern Shaanxi are affected by the natural environment, landscape features and local customs. In terms of the architectural layout, caves can be divided into three basic types:

Cave on the cliff (Cliff cave): Mainly at the foot of the hill, the slope of the hill or the edge of the Loess Plateau region. These caves are built against the cliff. They

have spacious open ground outside. Caves are built along the contour lines or along the river, which develop into a strip village. The village is surrounded by mountain and water, and is in harmony with the nature. This model is the main living patterns of urban villages in the Loess Plateau.

Sinking-cave (in Kiln): evolved from the underground cave dwellings, commonly known as the underground caves. Hill side and gully are unavailable in the arid Loess Plateau region. The clever residents take advantage of a special type of loess (stability of the vertical slope). They dig a square hole to form an underground courtyard, and then dig caves towards the four directions to contact with the ground through slopes.

Independent cave (Cave House): Structurally, the essence of an independent cave is an arched building that is covered with soil. The building is first based on a brick wall. It is then built into a brick arch, and then finally covered with soil. The layout of caves of this kind is rather flexible. It can be in triangles, quadrangles form or a mixed cave compound. Because of its flexibility, this type of cave is widely used for new residential districts in northern Shaanxi.

2. The status quo of the caves

2.1. The advantages of a traditional residential cave

Traditional caves are in harmony with the nature. Its construction embodies the principles of sustainable development and addresses the concerns of contemporary architecture. Therefore the benefits are land conservation, energy conservation, low cost, low technology and less pollution.

In northern Shaanxi, most caves are built against the hill. They occupied less land with low cost. They are sound-proof and heat-proof. This region has been called the "fairyland" as the first choice of homes for local people (Fig. 1). The building is made of soil with good physical properties. The process of building is simple and convenient. It can be built in various forms and materials can be recycled in construction. Moreover, a lot of bricks will be saved by developing soil structure, which not only is energy-efficient, but also benefits the ecological balance.

Traditional caves have the following advantages: ①