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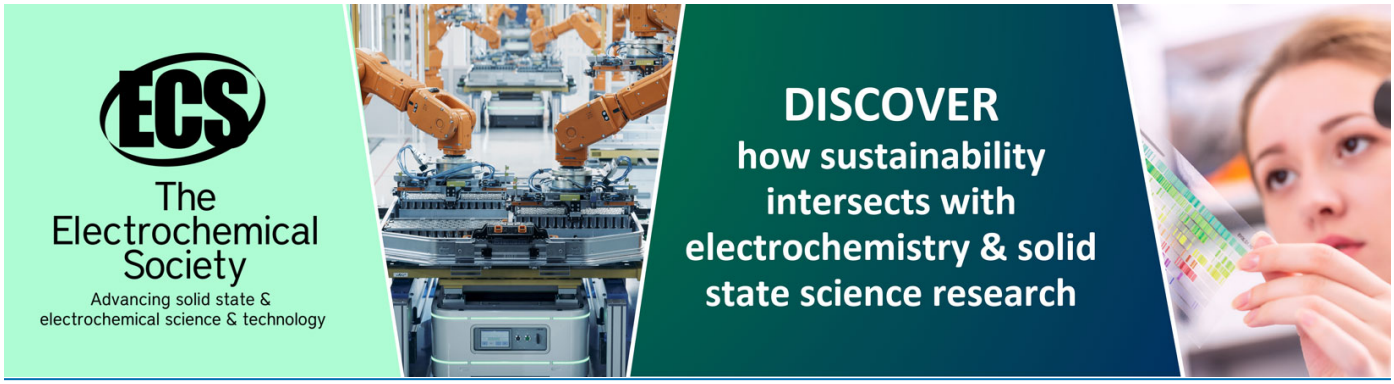

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Application and development of construction technology of raw soil materials

Yuewen Hu[1,*]

[1]Xi'an Academy of Fine Arts, Xi'an 710065, Shaanxi, China

*Corresponding author Email:3810172@qq.com

Abstract: by recognizing the cultural origin and environmental components of regional raw soil materials, the interaction between the building development elements in traditional culture of living environment and its natural environment, and the cultural extension characteristics in a given area are witnessed. Strengthening the observation and analysis of the texture characteristics of regional raw soil materials and the practical application and development of ramming technology of raw soil materials are helpful to the cultural control of local and modern construction, and the research on the human situation of relevant materials and technologies.

Keywords: region; raw soil; traditional building materials; mechanism

1. Introduction

The traditional building material is the mechanism extension and continuation of human early multiple settlement living forms, and is the visual characteristic carrier of ancient architectural culture with a long history. Due to geographical, ethnic, economic, cultural and other factors, the regional architectural forms of various regions are independent and mutually influenced. The texture of building basic materials and its unique cultural mechanism create the type diversity of traditional architecture, and reflect the unique natural and cultural form, highlighting the cultural character and spiritual realm of "harmony but difference, beauty and common". The construction method based on soil has become one of the traditional technical construction methods. Raw soil is widely used not only in China but also all over the world. In traditional architecture, "soil, wood, brick, tile, stone" is the first, which shows the importance of its occupation. In China's traditional dwellings, a large number of different types of regional buildings are distributed in the Loess Plateau, South China, Southwest China, Qinghai Tibet Plateau and Xinjiang.

2. Cultural and Environmental Elements of Regional Raw Materials

Through data collation, it is recognized that the application of clay is not a native soil technology in the mainland. Mr. Ge Chengyong pointed out that from the history of human architecture, the ancient kingdom of Egypt, the Assyrian Empire, the Persian Empire, Central Asia and Xinjiang, China, Adobe

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buildings were used earlier than those in the Han culture in the Yellow River Basin, and the technology was more refined. It has not changed after thousands of years.In the spring and Autumn period and the Warring States period, rammed earth technology has been quite mature, "Kao Gong Ji" records: "the wall height is equal to the base width, the top width is two-thirds of the base width, and the door wall scale is based on" plate ".[1] Since the Han and Tang Dynasties, the technology of building blocks, which has occupied an important position in the history of ancient Chinese architecture, actually came from the ancient western regions.[2] It is also pointed out that "the earliest adobe wall in China[3] was not exactly seen in the late Shang and early Zhou dynasties, and pointed out that the production and use of adobe in the Shang and Zhou Dynasties was not widespread, but occasionally appeared in palace buildings. In the Shang and Zhou dynasties, most of the buildings were built with plates, [4]the walls were much faster than the adobe, flattened and dried in the sun, and the soil layers were more closely connected. Therefore, the rammed earth was widely used. The technology of rammed earth plate building and wall building in Song Dynasty has made great progress than before. The ratio of height to thickness of rammed earth wall has changed from 1:1 in the early stage to 3:1, which means that rammed earth wall is widely used in civil residential buildings. [5]Since the Ming Dynasty, rammed earth buildings began to decrease due to the development of brick firing technology, but the ordinary folk houses are still in use, and the ramming technology has changed, and a large number of adobe construction is used. As a matter of fact, "Adobe" is also known as "Hu" in China. Due to different local accents, there are many kinds of changing names, commonly known as "Huji", "Huqi" and "Huqi". Volume 47 of the Yinyi of all sutras explains that "Bo" is a kind of thing that is square like a billet made by pressing the earth. It is not fired in the kiln, but used as the material for building the city fortress. Shuo Wen: Li, lingshiye, is called unburned. [6]Note: to make the right is to make the year. Bi is brick, and Bi is unburned brick.

In the world, the technology of making Adobe in ancient China was relatively late than that in ancient Egypt, West Asia and Central Asia. In 4000 BC, the ancient Middle East and West Asia began to use soil as materials. The construction tradition of raw soil was relatively independent, originated from the main ancient civilization countries and spread as the main carrier. After conquering ancient Egypt and Western Asia in the 6th century B.C., the Persian Empire absorbed the method of building palaces and houses with adobe, and its masonry technology was very exquisite. After the 4th century B.C., the Macedonian Empire marched eastward to the edge of Central Asia. Under its influence, most areas of Central Asia immediately spread. From the ruins of adobe houses in the ancient city of Jericho, 11000 years ago, the remains of adobe arched houses in the temple of Ramses in ancient Egypt, about 3000 B.C., the village of niye in northern Iran, is now in use The rammed earth high-rise buildings in the old city of shebam, Yemen, 300 years ago, [7]and adobe buildings of the 2nd century BC have been found in Xinjiang, China.

From the historical point of view of cultural exchange between China and foreign countries, long before Zhang Qian opened up the western regions in Han Dynasty, the nomadic people in Central Asia shuttled between the East and the West. Along the ancient "Silk Road", the technology of adobe production in West Asia and Central Asia naturally came to the Central Plains together with the immigrants. Among them, Ge Chengyong also believed that craftsmen in the Central Plains imitated the western regions to make large adobe in order to distinguish the inland similar mud brick "Tu Liao", so he called it "Hu He", which revealed the origin of earth embryo technology. In fact, archaeological examples have proved that the size of "Huli" in Central Asia is generally larger than that in Han Dynasty. Therefore, the etymological name of "Hu He" has the historical background of the silk road. It is the product of the exchange of Chinese and foreign architectural culture and the historical witness of the Han people's acceptance of Hu culture.

3. Mechanism Characteristics of Regional Raw Soil Materials

Taking soil as the research object, its unique material mechanism characteristics are the physical core elements of its quality. The "soil" in the construction of raw soil is composed of soil particles of different sizes. The finer the particles are, the stronger the adsorption capacity is, the smaller the pores

between particles are, and the more water absorption is Figure 1.

Figure 1.microstructure of soil clay(craterre ensag)

The worse the corresponding water permeability is, the water holding capacity, moisture swelling property, plasticity, cohesiveness and adhesion will be significantly enhanced. When the particle size is less than 0.01mm, the physical properties of water change suddenly, especially when the particle size is less than 0.001mm. According to the international classification standard generally adopted by the international construction industry, the particle size composition of soil includes gravel with particle size greater than 20 mm, sand particle between 2 mm and 0.02 mm, silt with 0.02 mm and clay with particle size less than 0.002 mm. We can see that the proportion of particle size composition of different soils is quite different. Gravel and gravel play the role of aggregate in raw soil materials. Even the coarsest coarse sand soil or the finest clay will contain different proportions of sand, silt and clay. According to the content of clay particles, the soil texture can be divided into four categories: sandy soil, loam, clay loam and clay, with a limit of 15% respectively 、25%、45%、65%。 "Soil" also contains at least 5% clay particles, so the clay is the smallest part of the soil, with plasticity, compressibility, adhesiveness and adhesiveness. It is widely used in residential buildings as the most widely used raw soil material. According to the application mechanism of clay composition in raw soil materials, and the characteristics of climate, landform, resources and customs in different regions, there are various application forms in the construction methods of different regions. According to the research and statistics of the International Center for raw earth building (craterre ensag), the application of raw soil materials can be summarized into 12 kinds of processing methods, such as ramming, masonry, extrusion, molding, filling, pressing, cutting, covering and filling, and the application forms of 18 kinds of raw soil materials, such as adobe, rammed earth, pressed earth brick, grass mud ball and bamboo bone mud wall, and the living styles of different regions can be changed In the development process of traditional raw soil construction, raw soil construction materials are explored.

In the application of raw soil technology materials, the most important thing is the soil moisture. The water migration through the clay composite wall will cause ponding, and the ponding in the modern raw soil processing module will lead to mechanical or thermal disorders. The study of water migration is currently an agreed research topic within the framework of the climate and energy. engineering project of the National Institute of Applied Sciences in Strasbourg. The focus of the study is to determine the thermal and water characteristics of rammed earth, simulate its behavior in the face of water

migration Table 1

Table 1. sample characterization of rammed earth used by critt materials Alsace Laboratory simulate the water content of interior walls, insulation and exterior walls, as well as condensation

Parameter	Unit	Valuation Measurement (First Method)	Sample Test Value
Dry Apparent Density	[Kg.m-³]	1860	1740
Porosity	[%]	29	34
Thermal Conductivity	[w.m-¹.k-¹]	0,93	0.9
Specific Heat	[j.Kg-¹.k-¹]	830	980
Water Resistance Value	[-]	10	11

in the thickness of the insulation. At present, it is concluded that rammed earth is a kind of porous material with little water content (2% after several years). When it is frozen, due to the porosity (34%) of the material, the liquid water compensated by voids is converted into ice. The porous characteristics of rammed earth make it a heavy material with relatively balanced heat insulation and heat storage performance. Under the joint action of moisture exchange, the thermal storage performance of rammed earth is far better than that of most conventional materials Figure 2.

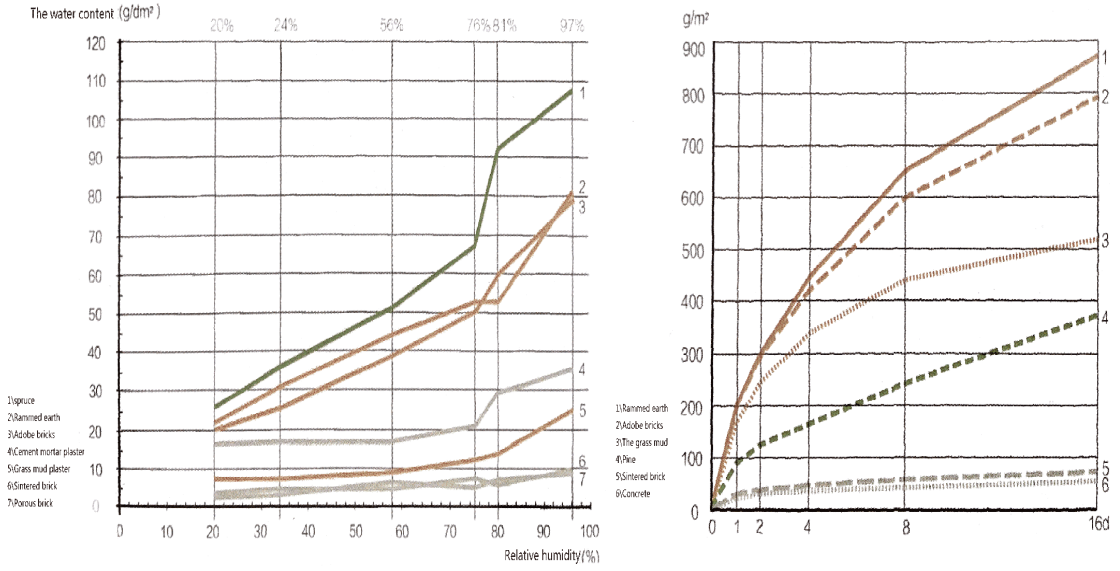

Figure 2. Comparison of equilibrium water content between raw soil and conventional wall materials (left) comparison of hygroscopicity of raw soil and conventional wall materials of other materials (right)

In view of this performance, the wall can play a role similar to the battery, achieving the effect of heat absorption in the daytime and heat dissipation at night, so that the indoor temperature difference

is relatively stable and comfortable Figure 3.

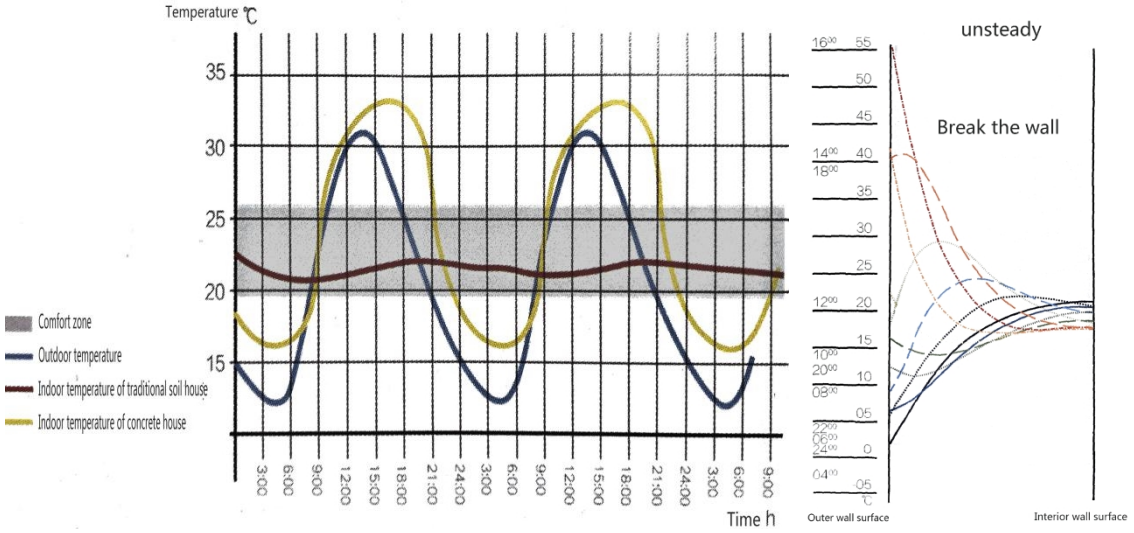

Figure 3. Comparison of indoor air temperature of raw soil concrete house (left) temperature variation of raw soil wall under fluctuation of diurnal temperature difference ((right)

4. Development and Application of Raw Soil Compaction Technology Protection Practice

For thousands of years, rammed earth technology has been widely used in different types of buildings all over the world, from ordinary residential settlements to palaces and temples. For a long time, rammed earth technology in China has been stagnated in the traditional technology construction, lacking systematic cognition of materials and construction technology, and no guiding special research on quantitative indicators. In recent years, a large number of experimental cases have been carried out on rammed earth technology at home and abroad, which has changed our cognition of rammed earth building in the past. The facade of rammed earth building is single, plane layout and ventilation Because of the characteristics of rammed earth, daylighting remained in the use of soil materials in the early low-rise and monotonous building mode. It seems that it is difficult to escape the form of dark, humid and simple folk settlements. In fact, the traditional Rammed Earth Dwellings and their culture, which have been formed for thousands of years, are facing the variation and extinction. From the side, it also reflects the shortcomings of the advantages and characteristics of rammed earth materials. In the survival of the fittest economy, this kind of materials will naturally fade out of the way of people's optimization. Under this kind of collision, only further material improvement and optimization of raw soil construction technology can be carried out It is necessary to improve and reduce the inherent defects of raw earth materials, non-standard building materials, poor mechanical properties of materials, only suitable for labor-intensive construction mode, and poor water resistance, moth proof and moisture-proof of traditional raw soil materials, so that the high-quality characteristics of traditional dwellings in terms of region, ecology, appropriate technology and local materials can adapt to the advantages of today's urban and rural development, and it is possible to guide people to maintain them The traditional construction and application of this material.

5. The advantages of rammed earth building are as follows:

① Structure: low moisture content coexists with civil engineering. The strength of rammed earth material can reach 4-5mpa after improvement;

② Thermal stability: it has great heat storage, cohesiveness, warm in winter and cool in summer;

③ Comfort: hygroscopicity can adjust indoor temperature, soil trace elements can regulate human body function;

④ Environmental friendliness: no dewing, low pollution, low energy consumption, degradable, no

construction waste;

⑤ Technical conditions: simple construction, manual, mechanical and other ways;

⑥ Renewability: it can be recycled and returned to the original soil, which is conducive to the regeneration and recycling of natural resources;

⑦ Economy: low cost, local materials, economic convenience, strong plasticity. At present, the international community is focusing on tradition

At present, the optimization and promotion path of raw soil materials in developed countries in Europe and America can be summarized as "physical modification" and "chemical modification". Physical modification refers to the physical effect produced by mixing and pressing organic materials such as straw, hemp wool, animal hair or inorganic materials such as sand, stone and volcanic stone into raw soil raw materials. It can effectively maintain the advantages of traditional raw soil materials such as heat storage, moisture absorption, energy consumption and degradation. The first choice of technical improvement is the ratio modification of soil, sand and stone. The chemical properties of raw soil materials refer to the method of adding additives into the soil materials to improve the properties of raw soil materials through chemical reactions. For example, biological gelling agents such as brown sugar, glutinous rice water, tung oil, rosin, animal blood and feces, and mineral raw materials such as hydrated lime are commonly used additives in raw soil construction to effectively improve the mechanical and durability of raw soil materials.

6. Conclusions

In recent years, the scientific research on the properties of raw soil materials and its modern engineering application research have gradually become a hot spot in the construction industry of European and American countries. The United States, Mexico, Australia, Switzerland, Germany, New Zealand, Brazil, Mexico and a series of countries have carried out research on rammed earth technology at different levels, and the development level of each country is slightly different. However, the research has a certain scale, formed a certain industrial standard, and has the basis of industry standard operation. The overall situation of the raw soil construction industry chain has been initially formed in France, and the Research Institute of raw soil materials has been set up in Colleges and universities (craterre of ensag, France) is the pioneer and authoritative institution in this field. (founded in 1979)[8]focuses on sustainable building materials in the case of excessive consumption of resources and energy. As a cost-effective ecological building technology, ramming technology is organically combined with various modern architectural design systems such as residential buildings and public buildings to improve the comprehensive efficiency of the building environment.

The research and development of raw soil compaction technology in China is also on the way. At present, more standardized industry rules and practical application and promotion of raw soil compaction technology are needed, which will help local and modern constructive culture control the research on human situation of relevant materials and technology implementation, develop knowledge system about building materials and traditional and modern diversified materials, and better geography To understand the cultural and environmental components of these materials, in order to produce the contemporary architecture of "environmental" economic and ecological housing, and promote the promotion and development of local society; through the research of this theme, it is also helpful to the protection and practical development and the enhancement of architectural heritage.

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