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Study on passive housing considering the influence of climate type and geographical difference

Xingwu Sun

School of Architecture and Civil Engineering, North China University of Science and Technology, Tangshan 063000, China

lu1871460054@163.com

Abstract

At present, the global fossil fuel reserves are decreasing year by year, because the sharp reduction of energy has restricted the economic development of some regions, but also shows the importance of getting rid of the excessive dependence on energy. Therefore, the construction industry has put forward the concept of passive housing, which upgrades the traditional residential buildings relying on fossil fuel heating to residential buildings that don，t need any external energy and can satisfy daily life only by relying on their own functions. German passive housing development is in the forefront of the world. It has reached the era of passive housing 3.0. By using the technology of electricity storage or heat storage for renewable energy, besides solving the energy consumption of heating and refrigeration, German passive housing has begun to solve the energy consumption of hot water, lighting and cooking, which makes the housing develop towards zero energy consumption in an all-round way. If passive buildings are industrialized in China, it will be of great significance for China's overall energy conversion, abandoning fossil energy as soon as possible and responding to global climate change. This paper briefly describes five climate types in China, the development status of passive buildings in the world and in China, and the concept of developing passive buildings according to local conditions by combining these five climate types with six key technologies of passive buildings.

Keywords

Passive housing, key technologies, local conditions.

1. Introduction

China's terrain is diverse and vast, with a longitude of 73 33 to 135 05, latitude of 3 51 to 53 33 in the north and latitude. The long span between North and South also makes China have a variety of climate types. It mainly includes five climatic types: temperate monsoon climate, subtropical monsoon climate, tropical monsoon climate, temperate continental climate and plateau mountain climate. 1. Temperate monsoon climate: North China and Northeast China are all in this climate type. Its attributes are cold and dry in winter, warm and rainy in summer, distinct seasons, changeable weather, hot and rainy in the same season, and with the increase of latitude, the range of annual temperature change increases accordingly. 2. Subtropical monsoon climate: subtropical monsoon climate. The climate mainly distributes in the south of Huaihe River in Qinling Mountains in eastern China. It is not cold in winter, hot in summer, and the wind direction in winter and summer has obvious change. This kind of climate is most typical in southeastern China. 3. Tropical monsoon climate: mainly distributes in southern Taiwan Peninsula, Leizhou Peninsula, Hainan Island, and Central and South Peninsula, with high temperature and temperature change all year round. the annual average

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temperature is above 20 degrees Celsius, the tropical monsoon is developed, and there is a clear dry and wet season. 4. Temperate continental climate: most of the inland areas north of 30 degrees Celsius north latitude in China are temperate continental climate. It is characterized by dryness and less rain, the diurnal and annual difference of temperature is larger; 5. Alpine climate of the plateau: Qinghai-Tibet plateau in China belongs to this type of climate. The sun radiates strongly and the sun shines abundantly.

Passive house initially means that in cold climate conditions, building does not need heating equipment, only through the thermal insulation of enclosure structure can achieve a more comfortable indoor environment [1]. It is also said that passive housing is based on very low building heating and refrigeration needs, to achieve the optimization of comfort. No matter what climate conditions, passive housing has a unified definition [2]: that is, on the basis of reducing heating and refrigeration load to less than 10W/m^ 2, passive measures can meet the thermal comfort requirements of ISO 7730. In terms of energy consumption, the heating and refrigeration load of passive buildings is about 1/10 of that of traditional buildings, which can be neglected. Therefore, passive buildings are sometimes referred to as "buildings with near zero energy consumption".

2. Development status at home and abroad

2.1 Development Status of International Passive Architecture

Since the early 1990s, Professor Feist, as the father of passive housing in the world, built the world's first passive housing in Germany, passive low-energy buildings have developed rapidly in various countries and regions, including Germany, Austria, France, Britain, the United States, Italy and so on. The following mainly introduces the development status of passive housing in the above countries and regions

Germany: The development of passive housing in Germany is becoming more and more popular with the implementation of high energy-saving standards. In 2002, the German government promulgated the first edition of Building Energy Conservation Regulation (En EV 2002), which stipulates that the present value of heating energy consumption of new and existing buildings should reach 75 kWh/m^2 a. Later, after drafting, the German Passive Housing Standard was officially issued in 2015. This edition integrates the provisions previously used in passive housing, non-residential passive housing and EnerPHit renovation into one clause, and produces new PHI low-energy building standard clauses, which realizes the transformation of passive housing type into all buildings. Type. Britain: Britain is an early industrial country with huge energy consumption. Facing the current situation of energy shortage, it is also trying to explore low-energy buildings. In the early 1990s, BRE, the British government organization, formulated the world's first building green assessment standard BREEM. Since the beginning of the 21st century, Britain has proposed zero-carbon buildings. It proposes that the proportion of renewable energy use in electricity is 38.6%, heating and refrigeration 15.5% in 2020. From the first Center for Energy Efficient Design (CEED) school building to Carrowbreck Meadow's latest large-scale passive residential building, the number of passive houses in Britain has risen year by year, and has been in the forefront of the world. France: The first passive house in France belongs to the integrated house. The main body of the house is prefabricated plank timber structure. It is certified by European PHI and Passive House Research Institute. In 2008, the French architectural design company karawitz architecture designed a passive energy-saving house with a total floor area of 161 square meters in the town of Bassancourt. USA: Passive housing is developing rapidly in American states: The first passive house in Commonwealth of Pennsylvania, Onion Flats Stable, is located in George Street, Philadelphia. The energy consumption of the house is all borne by a 4.23 kilowatt photovoltaic panel; the first passive house in Illinois is constructed by Toms Bass. Design by TomBassett-Dilley and construction by Weise, located at 1430 Jackson Street, the project passed passive house certification; Solar Harvest, a passive house in Colorado, adopted passive solar energy utilization design, high-performance envelope structure, high-performance windows and other measures. Passive housing is also available in other states, which will not be repeated here. Austria:

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In 2008, Austria established the building energy efficiency certification system, which divides buildings into several levels according to their leisure needs, namely A+, A+, A to G. Among them, A+ is equivalent to the standard of passive houses. Heating demand is 15kWh/(m^2 a), A++ is the best level. That is, heating energy consumption and total energy consumption are the lowest [1]. At the same time, the Austrian government has formulated a policy of energy recycling economy, and is expected to achieve the two major goals of getting rid of dependence on fossil energy and zero carbon dioxide emissions by 2040, and make every effort to develop passive housing construction.

2.2 Development Status of Passive Architecture in China

Compared with the western countries in Europe, the domestic passive housing started late, and there is no systematic and perfect passive housing standard system at present. However, with the further strengthening of China's environmental protection policy and the introduction of foreign technology, it is believed that the development of passive low-energy buildings in China will come to the fore. In recent years, our governments at all levels have promulgated some relevant norms and regulations on low-energy passive buildings, which can be summarized as follows: Qinghai Province promulgated technical guidelines for passive low-energy buildings in Qinghai Province (residential buildings) in 2018, and abolished Technical Regulations for BS Modified Fire-proof Insulation Panel External Wall Insulation System. It specifies the construction requirements of the non-thermal bridge, including the insulation methods of the exterior wall and roof, the installation methods of the exterior doors and windows, and the treatment methods of the connecting parts with the wall, etc. In 2017, Shandong Province implemented the management measures for the demonstration project of passive ultra-low energy consumption green building in Shandong Province, and stipulated special management rules for the whole process of passive housing construction. In 2013, Hubei Province approved the implementation of the Energy-saving Design Standards for Low Energy Consumption Residential Buildings, adding the following items: 1. Increasing the layout and architectural design; 2. Increasing the energy-saving design of water supply and drainage and power supply and distribution systems; 3. Adopting the method of meeting the required thermal performance indicators for building envelope structure, and not adopting the thermal performance of envelope structure for comprehensive judgement of energy; 4. Simplified selection of heat transfer coefficient of doors and windows, etc. Qingdao Energy Saving Design Guidelines for Passive Low Energy Consumption Buildings (Trial Implementation) was issued in 2017. The Guidelines draw lessons from the experience of Germany and Sweden in the development of passive housing, and combine with the current relevant standards and norms in China, in order to promote the further development of passive housing construction in the local area.

3. Evaluation Criteria for Passive Housing

From the definition of passive housing, we know that it depends on a very low energy supply to meet the daily living standards, and to achieve a high level of comfort. Therefore, the evaluation criteria of passive housing should be energy consumption and indoor environmental value. According to Hebei Provincial Energy-saving Design Standard for Passive Low Energy Consumption Residential Buildings [3], Hebei Provincial Standard stipulates the indoor environment as follows:

1) The indoor temperature ranges from 20 to 26 degrees Celsius.

2) The overtemperature frequency is less than 10%.

3) indoor carbon dioxide concentration < 1000 ppm;

4) The temperature difference of the inner surface of the opaque part of the enclosure is not more than 3 degrees Celsius, and the temperature of the inner surface of the enclosure is not less than 3 degrees Celsius .

5) There is no condensation on the indoor side of doors and windows.

6) The indoor relative humidity should be 35%-65% throughout the year.

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7) The sound transmitted through the pipeline network and auxiliary channels should be in accordance with the requirements of <35dB in the computer room, <30dB in the functional room, <30dB in the living room and <30dB in the bedroom.

The requirements for energy consumption in Hebei Standard are as follows:

1) Annual heating demand Qh of housing unit area is less than 15 kWh/(m ^ 2 * a);

2) Heating load qh< 10 W/m^2 per unit area of a house

3) Annual refrigeration demand per unit area, Qc< 15 kWh/(m ^ 2 * a);

4) The cooling load qc， max of house refrigeration is less than 20 W/m^2.

4. Six Key Technologies of Passive Housing

The key technologies of passive ultra-low energy consumption buildings are mainly embodied in the following six aspects [4]: first, efficient thermal insulation system, second, high-performance door and window system, third, no-heat bridge structure design, fourth, good air tightness, fifth, efficient fresh air heat recovery system. References will use renewable energy to assist cooling and heating as the sixth key technology. This paper argues that renewable energy to assist cooling and heating does not belong to the key technology category. The reasons are as follows: First, passive housing itself is an ultra-low energy-consuming building, which can satisfy people's living without much energy consumption. The requirement of comfort is that if these few energy sources are supplied again, the supplement itself will be of little significance. Secondly, renewable energy has developed into a mature technology field. Wind energy, solar energy and biomass energy have all reached the stage of efficient utilization, and the application of renewable energy will become more and more mature in the future. It is no longer an obstacle to the development of passive housing. In conclusion, this paper argues that the auxiliary cooling and heating of renewable energy will not be the key technology for passive housing construction. Therefore, the sixth key technology is introduced, which pays more attention to the influence of shape coefficient and spatial layout on building energy saving. The reasons are as follows: 1. Shape coefficient and spatial layout are very important to the energy balance of buildings, and effectively improve the feasibility of passive buildings. Taking the water side project of Qinhuangdao as an example, as the first passive building with Sino-German cooperation, the shape coefficient of the building is small, and its layout breaks through the tradition. It adopts the pattern of three bedroom living room facing south. This housing structure is more conducive to the heating and cooling of the building. At the same time, the non-north-south permeability pattern also effectively improves the cost. The harmfulness of regional monsoon to human body meets the requirement of higher comfort pursued by passive housing. Secondly, due to the different environment of different countries, the passive housing development in different countries is slightly different. Germany is sparsely populated, and its passive houses are mostly low-rise or high-rise buildings. However, although China occupies the third largest territory in the world, its population base is large and its buildings are high-rise. Therefore, the size coefficient of buildings in China is much larger than that in Germany, which also brings about structural problems. To sum up, two points are the reason why the figure coefficient and spatial layout are regarded as the sixth key technology in this paper.

5. Combining Six Key Technologies with Climate Types

Compared with the single climate type in Germany, the typical climate can，t be used as the basis for building passive houses in China. The bamboo buildings of Dai nationality in Yunnan, caves in northern Shaanxi, and fire Kang in northern China are all gradually formed according to the local climate type. Therefore, we should base on our country's complex and diverse climate types, combine core technology, and develop passive architecture according to local conditions. 1) For temperate monsoon climate, in order to cope with its cold and dry winter and hot and rainy summer, we should have more core technology in efficient thermal insulation system and high-performance door and window system so as to minimize the energy exchange between indoor and outdoor. 2) Subtropical

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monsoon climate is characterized by cold winter and hot summer. The type should take measures in refrigeration. The space layout mentioned in this paper can be applied to this condition, and use reasonable layout to resist high temperature, such as indoor balcony, building shelter, etc. 3) As a tropical monsoon climate area with obvious dry and wet season, it pays attention to the problem of mildew in summer and dew in winter, especially. The problem of mildew in buildings should be improved; 4) Temperature continental climate, inland areas are mostly this type of climate, which is dry and rainless. The requirements of passive building indoor environment include constant temperature, constant humidity and constant oxygen. Therefore, more attention should be paid to indoor humidity in this area, and new high-performance technologies should be applied. Wind system; 5) Qinghai-Tibet Plateau is a plateau mountainous climate, which mainly includes Qinghai and Tibet provinces. It is estimated that it is the most difficult area to construct passive housing. The climate is abnormal, the elevation is high, and the geological conditions are complex, but the advantages are obvious, and it has sufficient sunshine intensity. Therefore, it is possible to develop energy conversion and storage using photovoltaic panels as the main energy medium to maintain the indoor environment of constant temperature, humidity and oxygen.

6. Conclusion

At present, passive architecture is developing vigorously all the world, including China and Germany, Sweden, Norway, Denmark, Austria and Korea. At the same time, countries have put forward higher requirements for building energy efficiency, such as Passive House in Germany, Nearly Zero Energy Building in Switzerland, Climate House in Italy and Zero Energy Building[5]. The rise of zero-energy buildings in the world is focused on the future. This paper argues that the development direction of zero-energy buildings is as follows:

1) Combination of passive housing and assembly type

Assembled and passive construction are the two major directions of future architecture. Assembled construction can increase labor productivity by more than 10 times, and passive construction can increase energy efficiency by more than 10 times. Assembled passive housing is the only way to realize the 10-fold factor theory in the construction industry[6].

2) Integrating Passive Elements into the Reinforcement and Reconstruction of Existing Buildings

China is located between the Pacific Rim Seismic Zone and Eurasian Seismic Zone, and is a country with frequent earthquakes. For buildings damaged by earthquakes, we often adopt the reinforcement method, because it is extremely difficult to build a city in the ruins. In addition, with the passage of time, buildings at the end of the 20th century have entered the stage of renovation and reinforcement. We should take this opportunity to transform the former high-energy buildings into low-energy buildings.

3) Pursuing "Zero" Energy Consumption Building Complex

At present, the passive buildings built in China are: Hamburg House in Germany, Longshibrook Hotel, Halodome in Foshan, Guangdong, Happy Fort complex in Xinjiang, Xinhua Curtain Wall Office Building in Hebei, Sino-German Eco-Park in Qingdao and Qinhuangdao on the water side. A. Robert et al. argued that zero-energy buildings depend heavily on weather, and it is difficult to get the conclusion that buildings can achieve zero-energy consumption only by using typical climate. It is suggested to simulate the past data of meteorological for years, and then reduce the impact of climate parameters on building zero-energy consumption [7]. At present, it is difficult to achieve the goal of building zero energy consumption, and even if it is achieved, its construction cost is higher. However, no matter zero energy consumption or near zero energy consumption, the ultimate development trend of buildings is to meet the living and office needs with very low energy consumption. In order to reduce costs, we should not confine ourselves to one or several projects, but build passive buildings with sufficient scale to realize industrialization and industrialization. In order to recover the cost as soon as possible.

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4) Allow the existence and long-term existence of non-passive housing

In our country, there are a large number of historical and artistic monuments and buildings, such as the Forbidden City, the Potala Palace, Qufu Sankong, the Stele Forest Museum and so on. The precondition for us to promote passive buildings is not to affect or even destroy the existing ancient buildings in our country. We should not sacrifice cultural heritage for the development of passive houses alone. Therefore, we should allow the existence of non-passive houses.

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