Application of Green Building Technology in Cold Region Cities

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Abstract. After half a century of development, green buildings have gradually formed a relatively sophisticated system. Based on the development status of green buildings and the climatic characteristics of cold region cities, the paper analyses the key technologies applicable to cold region cities in combination with actual projects, and provides a theoretical and applied basis for promoting the sustainable development of green buildings in severe cold regions.

1 Introduction

With the popularization of environmental protection concepts, the recognition of green buildings has gradually increased. China has substantial climate differences; at the same time, the application of green building technology has closely related to climatic conditions. This paper lists the primary classification of green building technology and focuses on the use of green building technology in cold region cities.

1.1. Overview of the development of green buildings in the world

In 1969, American architect Ian McHarg wrote "Design and Nature", marking the official birth of ecological architecture. In 1990, the world's first green building standard was released in the UK, in 1993, the United States established the Green Building Association and in 2000, introduced the LEED green building standard, and the green building evaluation system was further improved.

1.2. Overview of the development of green buildings in China

As early as 1996, Hong Kong, China, has introduced green building standards. In 1999, Taiwan, China, introduced green building standards. In mainland China has introduced the concept of green building in the 1990s. In 2006, China released the first green building evaluation standard. In 2018, China made the third revision; finally formed a relatively complete green building system and evaluation criteria.

2 Green building technology introduction and application

2.1 Solar technology

The solar energy utilization methods mainly include solar water heating systems, solar photovoltaic power generation systems, and solar heat pump heating systems. Besides, solar technology often works with low-energy and zero-energy building technologies to further reduce the consumption of non-renewable energy in building production and life.

2.2 Water-saving technology

Water-saving technologies in green buildings could divide into alternative water source technologies and efficient water systems. Alternative water sources include the use of rainwater, intermediate water, and condensate, which could apply in agricultural irrigation, urban miscellaneous, industrial production, and landscape water use.

Efficient water use system refers to the use of water-saving appliances to reduce unnecessary water waste at the same time to improve water use efficiency. Water-saving appliances could divide into diverting water-saving appliances and inductive water-saving appliances. Diverting water-saving devices, such as dual-pipe systems, enhances the utilization efficiency of different water resources while reducing the clogging of sewage by distinguishing the use of domestic water. Inductive water-saving appliances like the self-closing faucets could effectively improve water use efficiency.
2.3 Assembled prefabricated component technology

The precast component technology can significantly reduce the carbon emission content during the construction process. The industrially produced of prefabricated building components could minimize noise pollution and the material waste during the construction. Prefabricated components lead a flexible building construction, reduce the labor use, and promote the construction cost control.

2.4 Low-energy consumption and zero-energy building technology

The low-energy and zero-energy technologies in green buildings are mainly used to reduce the use of heating and air-conditioning systems through more thoughtful planning and layout, more moderate façade opening, and higher performance insulation materials. Lower energy consumption ensures the regular operation of indoor. The key to zero-energy buildings is to achieve “self-sufficient” building types through current energy-saving technologies such as solar photovoltaic panels, wind power technology, and rainwater recycling.

3 The critical technology of green construction for cold region cities in China

The application of green building technology is closely related to regional climate characteristics. The cold region cities always focus on heating, and green buildings also have specific key technologies that are suitable for cold region cities.

3.1 Climate characteristics of cold region cities

Cold region cities refer to areas with long winters and low average temperatures. Typical examples of cold region cities in China are Harbin, Hohhot, Changchun, and Shenyang. This paper takes Changchun as an example to analyze the climate characteristics of cold region cities.

3.1.1 Climatic conditions.

As is shown in figure 1, there are five months that the annual average temperature lower than -18°C: in January, the minimum temperature close to -30°C; In August, the maximum temperature close to 36°C. Annual daily temperature difference is 10°C.

3.1.2 Water resources.

As shown in Figure 2, the rain in Changchun is unevenly distributing. The annual rainfall is 51.47% concentrated in the summer, 33.49% in the autumn, 9.3% in the spring, and 5.74% in the winter. To be equipped with alternative sources of water diversion systems and water-saving technology to make up for the winter and spring of water collapse of Pan problem.
3.1.3 Solar energy resources.

The total yearly solar radiation of Changchun City just reached 5137.19 MJ/m², the annual average sunshine time is about 4.8h, and the actual yearly sunshine time is about 2643 hours. Apparently, from the figure, Changchun’s sunshine time is fluctuating. The average daily total radiation is too little, so solar energy could not be right energy supplements.

3.2 Application of critical technologies of green building in cold region cities

Compared with other regions, cold region cities have the characteristics of lower temperatures, more extended cold weather, and uneven distribution of solar energy resources and precipitation. Therefore, low-energy and zero-energy technologies and water-saving technologies in green building technologies are directly related to critical technologies for cold region cities. In cold region cities, passive buildings generally focus on using both to solve the energy consumption and water use problems. Assist with solar energy technology to achieve an excellent energy-saving effect. The 2# in Jilin Research and Institute of Building Science, for example, the project by strengthening the insulation properties and airtightness of the envelope, adopted by high fresh air heat recovery and utilization of renewable energy technologies implemented in low power consumption Provide a suitable indoor environment under the conditions.
Table 1. Indoor environmental parameter indicator of 2# in Jilin Research and Institute of Building Science

| Indoor environmental parameters | Indicator requirements | Indicator of 2# |
|--------------------------------|------------------------|-----------------|
| Temperature (°C)               | Summer 17~26.1, winter 15.6~23.3 | Summer ≥ 20, winter ≤ 26 |
| Temperature non-guarantee rate (%) | 30~80 in summer and 30~80 in winter | Summer ≤ 10, winter ≤ 10 |
| Relative humidity (%)          | ≤700                   | ≤1000           |
| Carbon dioxide concentration (ppm) | ≥30                   | ≥30             |
| Fresh air volume (m³/h·person) | ≤50 at morning, ≤40 at night | ≤40 at morning; night ≤30 |

It could see from Table 1 that the project reduces the heat transfer coefficient and air tightness to a lower level through the above-mentioned vital technologies. Under a lower energy consumption, the 2# could conform to the index requires of the internal temperature, relative humidity, and fresh air volume. The noise control is quite well; however, the carbon dioxide concentration is higher than the index requirement of ASHRAE. In general, the project basically meets the needs of healthy indoor living.

4 Conclusions

This paper summarizes the sustainable technologies commonly used in green buildings, and analyses several key technologies suitable for urban construction in cold regions. Based on the selected cases, the paper further analyses these sustainable technologies suit for cold regions. The specific application in the city promotes the sustainable development of urban buildings.

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