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Analysis of the Suitability of Green Renovation Technology for the Envelope of Existing Public Buildings

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Abstract

In order to cope with the new development stage of building green renovation, the green renovation of existing public buildings has also put forward new requirements accordingly. The envelope structure is an important part of the building resistance to the external environment, and its green performance directly affects the building use performance and to some extent the building use experience. The higher the comprehensive green performance of the envelope of existing public buildings, the lower the energy consumption and the stronger the greenness of the building as a whole, so the envelope is a key research object in the green renovation of existing buildings. This paper mainly discusses the common envelope insulation system and technology in the green renovation of existing public buildings and analyzes its suitability, in order to provide some technical reference for the actual green renovation of existing public buildings.

Keywords

Public Buildings; Envelope Structure; Retrofitting Technology Suitability.

1. Introduction

The green performance of the envelope structure, as an important structure for the building to resist the influence of external adverse environment, plays the role of separating indoor and outdoor, and its green performance will directly affect people's experience, and its thermal insulation effect is extremely green to a large extent affects the green performance of the whole building. At present, there are various kinds of transformation technologies applied to the envelope structure, lacking comprehensive analysis and comparison of its applicable climate, environment and benefits brought, and there is still a gap with the real green transformation, and the technology selection does not only stay at the level of choosing newer materials and more high-tech technologies, but fully consider the actual situation of buildings in each region, and select the green transformation that is more in line with the needs of local people according to local conditions. In order to better promote the green transformation process of existing public buildings in China, [1]it is urgent to conduct a comprehensive suitability analysis of specific technologies in the selection of technologies.

2. Research Background

In the general environment of promoting the construction of high-quality buildings in harmony with human beings and strengthening the construction of ecological civilization, "green building" has developed rapidly in recent years, but the problems of large stock of existing public buildings and high energy consumption still exist in China, and as of early 2019, according to statistics, the total stock of existing floor space in China is about 60.1 billion m^2, including 12.8 billion m^2 of urban public building area, but the proportion of energy-efficient buildings in cities and towns among all existing building areas in the country is only about 30%. According to statistics, the total energy consumption of public buildings accounted for about 38% of the overall energy consumption of

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buildings nationwide in 2018, which shows that the energy-saving situation of public buildings is still very serious. [2] In addition, the energy consumption per unit area of public buildings is greater than that required for residential buildings in China, and the energy consumption intensity (including heating) of public buildings in China is about 230 KWh/(m2·a), and there is still a trend of continuous improvement. [3] Therefore, the energy-saving renovation of existing public buildings still needs to be further intensified, and also has great energy-saving potential and renovation space.

Based on the latest "China Building Energy Consumption Research Report 2020" released by the China Building Energy Conservation Association, the total energy consumption of the whole building process in 2018 was 2.147 billion tons ce, of which the energy consumption of the building operation stage was second only to the building materials production stage, accounting for 21.7% of the total energy consumption of the whole building process nationwide.

As shown in the figure 1 below, public building operation energy consumption is an important part of building operation energy consumption, and the output energy consumption of existing public buildings was 380 million tons ce in 2018, which is an important part of building operation phase energy consumption, with a proportion of 38%. Compared to its energy consumption share of 38%, while the proportion of public buildings to total building area is only 20%, it can be seen that the amount of energy consumption per unit area of public buildings is still higher compared to other types of buildings.

Table 1. Distribution of Energy consumption in the whole building process

Energy consumption in the whole building process	Building materials production stage	11	Steel	4.97
			Aluminum	2.78
			Cement	2.33
			Other	0.83
	Operation phase	10	Urban residential buildings	3.83
			Public buildings	3.8
			Rural buildings	2.38
	Construction phase	0.47		

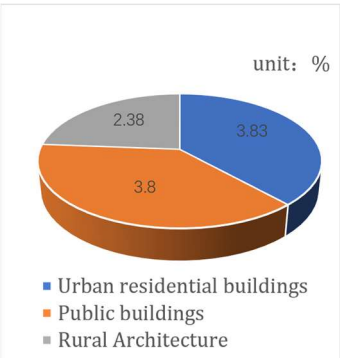

Figure 1. Two or more reference

3. Necessity of Green Transformation of Envelope Structure

From the analysis of the structure level of the building, the envelope structure forms the peripheral structure of the building, is an important part of the whole building, and is the basis for the building to meet the function of separating indoor and outdoor space. The envelope structure maintains the indoor temperature of colleagues to isolate the influence of external temperature on the interior, and

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whether it has the performance of fireproofing, waterproofing and durability all fundamentally affects the indoor thermal environment of the building, thus serving as a barrier affecting the indoor comfortable environment and resisting the outdoor climate change. At the same time, it affects the heating and air conditioning energy consumption that accounts for the main body of building energy consumption for the purpose of improving the indoor thermal environment, so the green transformation of the envelope plays a very important role in the greenness of the whole building. Nowadays, the concept of "four sections and one environmental protection" for the green transformation of existing buildings is not only considering the greenness of the building itself, but also putting forward higher requirements for "people-oriented", and putting forward new requirements for the safety and durability, health and comfort, and environmental livability of the building. The concept of "people-oriented" has put forward new requirements for the safety and durability, health and comfort, and environmental livability of buildings, which all rely on a green envelope to achieve.

4. Green Renovation Technology Strategy of Existing Public Building Envelope

The green transformation of the existing building envelope is mainly to replace the materials and choose the appropriate green technology for the three major types of structures, namely, exterior walls, exterior windows and roofs [4], and due to the important special characteristics of the envelope, the green transformation of the envelope is a more common way of building transformation and the main way of embodying the green energy-saving transformation of buildings.

4.1 Section Headings

Different types and thickness of insulation materials all affect the insulation effect to a certain extent, so no matter for external walls, external windows or roofs, the most suitable materials should be selected for green renovation by analyzing the performance of different materials. According to the composition elements of insulation materials in green renovation are divided into organic materials and inorganic materials. Organic insulation materials are mainly expanded polystyrene board (EPS board), extruded polystyrene board (XPS board), etc.; inorganic insulation board includes commonly used rock wool board, glass bead inorganic insulation board, silica vacuum insulation insulation board, composite phenolic insulation board, etc. [5].

Relative to organic insulation materials, inorganic insulation materials, flame retardant relatively better, the performance is more stable, such as the burning performance of EPS board for B1 level and inorganic materials, most of the burning performance of A level, improve the shortcomings of organic insulation materials, but most of the inorganic materials thermal conductivity than organic materials, thermal insulation is relatively poor, especially inorganic light aggregate insulation mortar, the material due to the thermal conductivity of large can not be used in China's northern region of the external wall use. But a comprehensive analysis of the above inorganic external insulation system has its own characteristics, such as the best comprehensive performance of foam glass, but the price is high; rock wool board and glass wool board insulation performance is good, but the quality of domestic production is poor, easy to fall off, peel; inorganic light aggregate insulation mortar has a large thermal conductivity drawbacks, but its price is low, convenient construction. Besides, physical performance indexes such as radioactivity, frost resistance, apparent density, thermal storage coefficient, correction coefficient, compressive strength and flexural strength of materials should be considered comprehensively.

4.2 Technology Selection

The green transformation of the external wall mainly considers two aspects, on the one hand, by improving the thermal insulation performance of its materials, on the other hand, to enhance the greenness of various construction technology methods, usually according to the construction position of the insulation material is divided into three categories of insulation forms: external insulation, internal insulation and self-insulation. External wall insulation green transformation is generally

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divided into thin plaster external insulation, curtain wall, etc.; external wall of the internal insulation transformation is mainly placed inside the wall such as polystyrene board; self-insulation transformation is mainly applied to the frame structure of the filling external wall, this transformation compared to the first two has its limitations, but because of its small density, good effect of heat insulation, fire resistance, and in the current environment construction is convenient, construction technology It is mature and meets the current requirements of green development.

5. Analysis of the Suitability of Green Renovation Technology of Existing Public Building Envelope

This paper is dedicated to adopting and implementing the latest national "Green Building Evaluation Standard" GB/T 50378-2019 regulations, analyzing the technical suitability of the green transformation of the envelope of existing public buildings from the levels of safety and durability, health and comfort, resource saving and environmental livability, and proposing measures that are conducive to improving the technical greenness of the envelope of existing public buildings. On the premise that the three types of structures, such as exterior walls, exterior windows, and roofs, are selected to meet the comprehensive green performance in terms of safety and durability, health and comfort, resource saving, and environmental livability, [5]proposed the following technical measures on the appropriate green transformation of envelope structures for exterior walls, exterior windows, and roofs, respectively.

Table 2. Performance and Technical Requirements of the Envelope suitable for Green transformations

	Exterior Walls	Exterior Windows	Roofing
Safe and durable	Set up moisture-proof layer and adopt durable materials	Wind pressure resistance, watertight performance in line with regulations; installation of glass with protection,anti-clip function; good protection measures for accidental loss of exterior window glass	Installation of moisture-proof layer and use of durable materials
Health and comfort	Whether the sound insulation performance meets the regulations; whether condensation and condensation; orientation; the use of light-colored exterior wall finishes, the use of vertical wall greening; the two surfaces between the air layer and the wall parallel to do paint heat-reflective coating or paste heat-reflective film, aluminum foil.	Sound insulation, solar heat gain coefficient and sun shading coe fficient are in accordance with t he regulations; fixed shading is used for external windows; glazi ng systems with sun shading eff ect are used, such as insulating glass, heat reflective insulating g lass, etc.	Light-colored roofing fi nishes; ventilation and passive evaporation roof ing; air interlayer insula tion roofing with heat-r eflective materials; wate r storage roofing or pla nting roofing
Resource saving	Thermal performance improved by 5%-15%	thermal performance shall be improved by 5%-15% compared with the current national and regional energy-saving design standards; openable area ratio ≥35%; air tightness in accordance with the energy-saving design standards	Thermal performance should be improved by 5%-15% compared to the national and regional current energy-saving design standards
Livable environment	Greenery is reasonably set on the wall in all directions, and the control greenery rate reaches 10%.	Visible light reflection ratio conforms to regulations	Roof greening

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6. Conclusion

This paper firstly puts forward the research background and explains the necessity of envelope transformation, then sorts out and analyzes the technical strategies for green transformation of the envelope of existing public buildings from two aspects of material selection and technical selection respectively, and finally proposes technical measures suitable for green transformation of the envelope according to the Green Building Evaluation Standards.

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References

[1] Li J, Pan YH: Evaluation of energy-saving retrofitting effect of existing public buildings based on cloud model - an example in Chongqing, Journal of Engineering Management, vol. 35 (2021), p.1-6.

[2] Li Mingyang, Yin Shuai, Ding Hongtao: Current situation and future prospect of energy efficiency improvement in public buildings in China, Construction Technology, vol. 16 (2020), p.7-12.

[3] Xing Meng: Research on green renovation technology of existing public building envelope structure, Building materials and decoration, vol. 21 (2018), p.103.

[4] Zhu Xiaojiao,Song Bo,Liu Jing: Study on the Technical suitability of green retrofitting of existing Buildings in public Institutions, Building Energy Efficiency, vol. 45 (2017), p.118-123.

[5] GB/T 50378-2019, Green building evaluation standard [S].