Academic Journal of Architecture and Geotechnical Engineering
ISSN 2663-1563 Vol. 2, Issue 1: 1-6, DOI: 10.25236/AJAGE.020101

Research on Energy Saving Renovation of Old Housing

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ABSTRACT. *With the rapid development of national economy and continuous innovation of construction technology, the old housing are subject to the age of construction, its construction concept, construction technology, building materials selected is relatively backward, especially the energy saving effect is poor, which increased the energy consumption. The article mainly studies the wall structure, roof, Doors and windows insulation, Heating and ventilation of the old housing, systematically analyzes the main reason for the excessive energy consumption of old housing and puts forward the countermeasures for the reconstruction of buildings on the basis of analysis above.*

KEYWORDS: *the old housing, energy saving reconstruction, countermeasures and suggestions*

1. Introduction

It is of great significance to carry out energy-saving renovation of old housing. With the development of economy, building-energy- consumption is increasing rapidly. As of 2018,the energy consumption of China's construction industry accounted for nearly 35% of total social energy consumption, the existing construction area had exceeded 46 billion square meters, but the proportion of energy-saving buildings shall not exceed 10% [1-2]. Energy-saving renovation of old housing is not only an important measure to thoroughly implement nation resource conservation but also an inevitable choice to respond to energy conservation and emission reduction [3-4], it is yet a concrete embodiment of the concept of sustainable development. In order to ensure the compatibility and sustainable utilization of buildings, it is necessary to use accurate force and aim at specific targets [5].

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2. Analysis of Excessive Energy Consumption in Old Housing

At present, the old housing mainly has the following problems. First, the building had built for a long time and its energy-saving level was relatively low due to the development level of building technology at that time. Second, the building structure was mainly a masonry structure, one part was built with “brick column, brick wall and precast slab” while the other part was built with “reinforced concrete column, brick wall and cast-in-situ reinforced concrete slab”, and the architectural style was old. Third, some of the energy-saving functions of old housing had been weakened or disappeared as more renovation and expansion were carried out in the process of living. Next, the article will analyze the wall structure, roof insulation, door and windows insolation, HVAC, indoor ventilation.

2.1 Analysis of Wall Structure

The wall insulation and heat preservation performance of old houses are poor, resulting in unobvious indoor and outdoor temperature difference and heat loss, affecting the living quality. Compared with modern architecture, the heat transfer coefficient of outer walls of old buildings is 4 to 5 times higher, and as the outermost layer of the whole house, the wall plays an important role in dividing the indoor and outdoor environment and medium conduction. Once the medium conduction is lost, the disadvantages of the primary heat transfer mode will be exposed. Therefore, in the process of internal and external heat transfer of the old housing walls, the heat convection and the heat radiation are too high to effectively block the heat from entering and exiting, thus increasing the building energy consumption.

2.2 Analysis of Roof

The roof is located at the top of the house, dividing the upper and lower spaces, directly blocking the heat exchange between the interior of the house and the natural environment such as wind and rain erosion, solar radiation, etc. It needs to have the characteristic of corrosion resistance, high temperature resistance, etc. Compared with modern housing, the roof heat transfer coefficient of old housing is 2.5 to 4.5 times higher, and its resistance to heat conduction is relatively weak, which can neither block the entry of external heat nor block the loss of the loss of internal heat, thus increasing the building energy consumption. For an example, the heat radiation of the sun during the day will cause the temperature outside the roof to rise, resulting in positive heat change and room temperature rise, at night, the solar radiation weakens, and reverse heat exchange occurs, resulting in a drop in room temperature.

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2.3 Analysis of Window Insulation

A considerable part of indoor and outdoor heat exchange is carried out through window gaps. Compared with other houses, the window-wall ratio of old housing is higher, its air permeability is 3 to 6 times higher than that of modern housing, resulting in increased cooling load of air conditioner, frequent heat exchange and affecting energy-saving effect. Radiation convection heat transfer is another important way of heat transfer for doors and windows, which mainly depends on the type, composition and installation form of door and window glass, so it is also important to reduce the heat transfer of glass. At the same time, sliding windows are mostly used in old houses, and after long-term using, the air tightness and cold air permeability of sliding windows will decrease, increasing the power consumption of air conditioners.

2.4 Analysis of HVAC

There is a great waste of electricity in the use of HVAC in old housing, the main reasons include the following. First, there are regional differences in central heating, many residential buildings use split air conditioners for heating, with different models and power, and do not use air conditioners with energy-saving signs. Second, the maintenance of the line is not timely enough, and the regularly inspection system for air conditioning units has not been well implement. Third, all kinds of facilities, equipment and lines are seriously aged, their operation and energy consumption also do not conform to the standard quota or even far exceed it. At the same time, heating methods and technical means have not kept pace with the development of social productivity and production technology, resulting in disconnection.

2.5 Analysis of Indoor Ventilation

Indoor ventilation is mainly divided into air conditioning ventilation and natural ventilation. In the process of air conditioning and ventilation, the installation of air conditioning unit is not reasonable enough, the facade structure is not appropriate, once the air inlet and exhaust pipes of the air conditioning compressor are obstructed, it is not conductive to the heat discharge of the compressor, resulting in poor air flow, decreased equipment efficiency and air conditioning energy efficiency. In the process of natural ventilation, the inappropriate size and location of ventilation holes, coupled with the lack of comprehensive consideration of regional climate conditions and surrounding building layout in the construction process, will also directly affect the indoor ventilation effect. It should be realized the open-window ventilation is not only more comfortable than air conditioning in enclosed spaces, but also more energy-saving. Not only is it beneficial to improve air quality and comfort, but also it can prolong the service life of air conditioner.

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3. Contermeasures for Energy-saving Renovation of Old Housing

3.1 Energy-saving Reconstruction of Wall Structure

First, add or repair external wall thermal insulation layer. Adding thermal insulation materials with small heat transfer coefficient on the wall can reduce the comprehensive heat transfer coefficient of the wall. In the summer, air-conditioning consumption can be reduced, in winter, combined with heating equipment, indoor heat loss can be reduced to ensure a relatively constant room temperature.

Second, it is to use light-colored exterior wall paint for painting. Light-colored exterior walls can reflect more sunlight, effectively reduce solar radiation absorption rate, thus reducing heat transfer from outside to inside, controlling the temperature rise rate of the wall and indirectly controlling the indoor temperature.

3.2 Energy-saving Reconstruction of Roof

First, transforming the roof into an inverted thermal insulation roof can play a role in heat insulation and cooling. Its principle is to lay a layer of insulating layer on the outer side of waterproof layer to prevent the surface temperature of the waterproof layer from rising sharply due to direct solar radiation, thus delaying the aging of waterproof layer and prolonging its service life.

Second, it is to do flat-to-sloping roof conversion. A ventilation cavity is additionally arranged on the sloping roof, so that the whole roof becomes a ventilated roof, and the outer surface of the ventilated roof can shield and reflect solar radiation to prevent direct sunlight. In addition, wind pressure and hot pressing can also be utilized, and the steering flow can take away the heat flow stranded under the roof, thus reducing the heat transfer in the top room and lowering the room temperature.

3.3 Energy-saving Reconstruction of Doors and Windows

First, the traditional single-layer aluminum alloy windows and steel windows should be replaced with energy-saving windows with small heat transfer coefficient, small shading coefficient and great air tightness to meet the primary objective of heat insulation. Windows frame materials can be broken bridge aluminum alloy or PVC materials with good quality. When selecting window glass materials, the heat insulation performance of the glass is mainly considered, and materials such as hollow double-layer and LOW-E glass can be selected.

Second, heat insulation materials can be pasted on the outer window glass, it can block some rays in sola radiation and reduce indoor light pollution degree. Experiments show that after the heat insulation material is pasted on the common glass, part of infrared rays and ultraviolet rays will be filtered out, the effective heat

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insulation rate can reach 83%, the visible light penetration rate can reach 78%, and the performance is greatly improved.

3.4 Energy-saving Reconstruction of HVAC

It is necessary to carry out energy-saving renovation of central heating. The first step is to quantitatively manage the water heating equipment and improve the management level of the heating system. The second step is to implement electric control operation management, the electric control automatic system is applied to the boiler equipment to improve the working environment, the heating guarantee efficiency and reduce the input of human resources. The third step is to digitally transform the heating system, set up monitoring nodes at the heating terminal, adjust the boiler parameters according to the feedback temperature and carry out real-time monitoring.

At the same time, to carry out passive heating energy-saving transformation. It is necessary to comprehensively consider the location and orientation of the housing, select safe and reliable phase change materials, and realize the goals of storing energy during the day and releasing at night without manual intervention. The energy-saving renovation process can be divided into two categories. The first kind of categories is direct benefit category, sunlight enters the room directly through windows or pre-opened holes and heats the room through thermal radiation. The second kind of categories is indirect benefit category, solar energy does not pass through windows or pre-opened holes, but collects solar energy through an outdoor heat collector, and provide heat for indoor in a heat conduction and air passive circulation mode, thus realizing the purpose of indirect heating.

3.5 Energy-saving Reconstruction of Ventilation Conditions

The first is to increase the indoor air intake by increasing the window-wall ratio, this is conductive to the formation of cross ventilation. The second is to introduce fresh air conditioning system, timely installation is required to reduce subsequent energy consumption.

At the beginning of the design, we should actively communicate with the construction unit and designers to determine the energy-saving benefits of the fresh air conditioning system. When technology permits, the inlet and outlet positions of the system shall be optimized and adjusted, and the air supply outlet shall be of jet type to ensure that the system can deliver cold and hot air to all areas.

4. Conclusion

To sum up, there is still great potential for energy-saving renovation of old housing, and there are still many places to be renovated. Through the research on the internal structure of old housing, the main breakthrough point for energy-saving

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renovation was found, and several reasons for excessive energy consumption were analyzed. The existing energy-saving technologies and energy-saving concepts were applied to realize the purpose of renovation of old housing and promote the heathy development of building energy-saving and environmental protection undertakings.

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