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On the Construction Technology of Passive House

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Abstract: In the context of "carbon neutrality", the passive house, as a green and low-carbon building construction technology, has attracted more attention. Under construction based on the sino-german ecology garden residential construction projects, from the passive room efficient external insulation, passive doors and Windows, no heat bridge design, air tightness, fresh air system and so on five aspects introduces the passive room design ideas, briefly introduces the green low carbon construction technology in the application of the project, at the same time the passive room construction process control points are introduced.

Keywords: passive house; construction; green; low carbon

Introduction

According to statistics, about 90% of one's life is spent in the house[1]. Affected by the environment, materials, construction technology, and many other factors, has built houses often feel poor temperature and humidity, sound insulation performance, and the existence of passive room can well solve the above problems, and provide people with a comfortable office, living environment, so the passive room construction increasingly favored by everyone.

Passive room technology originated in Germany, the construction form was first proposed in 1988, in decades of development abroad, the introduction of domestic time relatively late, passive room construction experience in China is still in the development stage, to better development of passive room construction technology, the State Council on February 6,2016 issued the management on further strengthening the construction of several opinions, first explicitly put forward to promote energy-saving urban construction, promote building energy saving technology, development of passive housing green energy-saving buildings.

1. Project overview

The residential construction project of Sino-German Ecological Park is located in "Sino-German • Green Tianyuan Zero Carbon Community" in Qingdao city, Shandong Province. It is divided into four plots with a total construction area of about 156,325 square meters. It is planned to build multi-storey and small high-rise residential buildings, with the highest unit of 11 floors and the lowest of 2 floors, all of which are passive house design, fine decoration and delivery. In order to better adapt to the development trend of green and low-carbon development of the construction industry and seize the commanding heights of the passive housing construction market, this project actively

explores the practical experience of passive housing construction technology with advanced nature, low energy consumption, economy and extension[2], The project is committed to the construction of advanced passive house community, innovative application of photovoltaic thermal, high performance external doors and Windows, air source heat pump, fresh air heat recovery system and other energy saving technologies, so that the room temperature is maintained at 18-26°C, humidity control at 30% -65%, the overall energy saving rate of more than 20% than the conventional housing.

2. The main difference between passive house and traditional architecture

Compared with the traditional architectural form, the changes brought about by the passive house architectural form are multi-dimensional:

(1) The insulation of the facade of the passive building adopts vacuum insulation board, graphite polystyrene board and other materials for double insulation. Compared with the traditional building heat transfer coefficient of the external wall is 0.35-0.45, and the heat transfer coefficient of the external wall of the passive building is only 0.15.

(2) Passive building Windows use multi-layer insulating glass, with breathable film outside the window and breathable film inside the window to ensure the air tightness of the building, which can greatly reduce the loss of indoor energy. Compared with the traditional building doors, the heat transfer coefficient of doors and Windows is 1.5-2.0, and the heat transfer coefficient of passive building doors and Windows is only 0.8.

(3) The passive building is equipped with a fresh air system with heat recovery. The actual replacement device, the filtration efficiency is not less than 90%, can effectively filter the moisture, dust, PM2.5 and other pollutants in the environment, and effectively ensure the air quality.

3. Design practices related to passive houses in this project

Passive house refers to a building that adapts to climate characteristics and natural conditions, adopts the envelope structure with higher thermal insulation performance and air tightness performance, adopts efficient fresh air heat recovery technology to minimize the building heating and cooling demand, and make full use of renewable energy to provide a comfortable indoor environment with less energy consumption.

The five elements of passive room: excellent insulation system, passive air tight doors and Windows with good performance, design and structure without heat bridge, maintenance structure with good air tightness, efficient heat recovery fresh air system.

(1) Thermal insulation system design

The external wall of this project adopts double-layer graphite polystyrene insulation board, 250mm insulation thickness; the external wall of the basement passive area adopts extruded polystyrene board, 200mm insulation thickness; the slope roof adopts 300mmB1 hard foam polyurethane insulation board; the floor flat roof adopts 50mm thick extruded polystyrene insulation board and 60mm thick STP insulation board; U value of heat transfer coefficient is 0.15W / m^2.k.

(2) passive air-tight doors and Windows design

Passive window is P120SP aluminum clad passive window: window frame is made of aluminum clad wood, window frame thickness is 120mm; passive glass structure is three glass two chamber hollow (or vacuum) glass, set Low-E film layer and filled with inert gas; outer window and curtain wall installation is external, and embedded in external wall insulation layer; U value of whole window heat transfer coefficient 0.8W / m²K;

The outer door of the passive room area of the project (including heating and non-heating) of the thermal envelope shall be passive air tight door. No specific model or material has been determined yet, but the U value of heat transfer coefficient shall be controlled at about 1.0W / m²K;

(3) No-thermal bridge design and construction

Open balcony adopts the form of broken plate; air conditioning panels and equipment platform; the necessary fixed components (such as door and window fixings) use high performance heat insulation gasers and anchor bolts to block the heat bridge, and plastic, stainless steel or high heat resistance materials are selected as far as possible; the drainage risers shall be added (indoor and roof) or the airtight valve at the top.

(4) Air tightness design

Good air layer can effectively reduce the external environment of the building environment, compared

with the traditional building doors and Windows node air tightness, winter cold wind often from the weak links into the indoor environment, good air tightness buildings can effectively reduce the heating load and dehumidification load demand, and reduce the outdoor environment factors on indoor environment, improve the quality of indoor living life. Passive room, passive room requires the ventilation times of the building under 50Pa pressure difference N50<0.6/h, while traditional energy-saving buildings have no requirement of building air tightness. Therefore, passive room can greatly reduce the cooling consumption and heat consumption brought by the outdoor infiltration wind of the building, and can reduce the building load by about 15%.

The passive room adopts the indoor plastering layer as the air-dense layer. After the construction of the passive air tightness nodes form the whole air tightness, the blast door test method is used to detect the integrity of the passive air tightness. In order to ensure the integrity of the air tightness, the following attention should be paid to the key parts in the construction process:

① Air tightness of pipelines, pipelines and other facilities passing through the wall. For example, the external wall casing must be poured at one time, no secondary opening; all kinds of wall pipelines such as exhaust pipe, air conditioning pipe, wire, etc. are blocked with polyurethane, and paste air tight film.

② Doors and Windows, holes, and air tightness. The embedded parts for the installation of the external window and the gap of the entrance are pasted with air tight film.

③ Air tightness of the main structure. The holes of the concrete wall of the main structure are made with foaming agent, and polymer mortar is used on both sides.

(5) Fresh air system

The air conditioning system scheme of this project is as follows: small fan coil for cold and heat source (summer) + floor radiation (winter) + fresh air heat exchanger system, and the unit air power consumption of the heat recovery unit shall not be greater than 0.45W / (m^3 • h).

4. The effect of the passive house building

(1) The annual primary energy demand of 120kWh per square meter of available residential area in the passive house (including household energy, electricity for refrigeration, heating, lighting and hot water);

(2) The annual heating of the passive room shall not exceed 1.5 kg of diesel oil or 1.5m^3 of natural gas (15kWh) per square meter, saving 90% of the energy consumption compared with the traditional buildings;

(3) The annual indoor temperature that is lower than 18 degrees and more than 25 degrees shall not exceed 10%;

(4) After the delivery of the passive room, reach constant temperature, constant humidity, constant oxygen, constant static, constant net (five constant).

5. Passive house site construction assurance measures

At the present stage, the project is in the construction stage of main structure, secondary structure, passive window installation and insulation model, which mainly involves passive construction requirements: installation of air conditioning plate, external wall screw hole plugging, passive window installation and external wall insulation construction.

(1) Installation of the broken heat bridge components of the air conditioning board

According to the design requirements of the drawing, the air conditioning panel adopts the finished component of broken heat bridge. The purpose of the design is to greatly disconnect the outer part of the air conditioning panel through the structure to reduce energy loss. The secondary in-depth design of the finished components conducted by the manufacturer according to the original structural drawings shall be reviewed and confirmed by the original design institute. The processing and acceptance of the broken heat bridge components shall be carried out according to the design drawings, and the site installation work shall ensure that the components installation meet the requirements of the specifications and drawings.

(2) External wall screw hole plugging

The sealing quality of the external wall screw hole is not only related to the integrity of the passive house air tightness, but also affects the construction of high-quality housing. If the plugging quality of the screw hole is not good, it will often lead to external wall leakage, and rust points and watermark will appear after delivery, leading to negative effects such as poor household experience. Therefore, the plugging of the

screw hole must be regarded as a key work to grasp, and all processes should be strictly checked and in place step by step. The treatment method is basically higher than the conventional treatment method. First of all, all the casing is required to be removed, and the residual mortar around the hole is cleaned with a brush. To screw hole with cement mortar plugging, deep screw hole is not less than 3cm, after mortar reach strength, the hose into the bottom of the foam foam, foam depth from metope, the excess foam agent with shovel knife after cleaning, with expanding cement mortar sealing remaining holes, with φ 10 steel, and cement mortar with metope, to prevent leakage brush, three different color polyurethane times brush: the first time for white, the second with red brush, the third with black brush, the total thickness of not less than 1.2mm.

(3) Passive window installation

Passive window is a key element of the construction of passive room, early according to the installation requirements of passive room, in the window frame circle 200mm wide concrete frame column, exterior wall plastering according to the window line, determine the position of the window installation bracket, using embedded installation on the window hole concrete column, metal material and the main structure of the junction set insulation bridge bridge treatment according to the design requirements.

Passive window inside, waterproof steam film paste is an important measure to ensure air tightness and prevent leakage, the part of the construction is the most critical:

First will have installed in place of the passive window window outside frame and near metope area clean, ensure, combining surface, clean without dust, clean finished, the steam film with colloidal side paste in, passive window frame, on the other side with the special, adhesive, adhesive through steam film should bond, no breakpoint, ensure water tightness and air performance. Fixation parts and window four corners, need to two paste processing. The permeable film should be 5cm from the door and window components. Secondly, clean the passive window frame around the window with a brush, close the side of the inner vapor film to the window hole, and reserve enough corner allowance in the corner[3], The superposition length of the vapor film should not be less than 5cm, the vapor film should extend 5cm from the door and window components to ensure good passive window air tightness,

(4) External wall thermal insulation construction

The external wall insulation system reflects the excellent insulation system of the passive building. The key process before the construction of external wall insulation is the handover of the working face. Before the construction of external wall insulation, the installation of passive Windows and waterproof vapor film paste, the installation of electric curtain box is completed, and the plugging of the air conditioning fresh air system is completed.

After the completion of the handover exterior wall insulation construction, material for graphite polystyrene board insulation, double insulation thickness of 250mm, need wrong seam paste, the first layer and the second layer plate wrong seam width is not less than 20cm, the Angle should be wrong seam, the gap between the insulation board is not more than 2mm, otherwise need to use the same insulation material cut filling gap, double insulation board are full sticky, passive room external wall insulation fixed need broken heat bridge anchor parts, the number of 8-10 / m^2. 24 hours after pasting the insulation board, install the anchor parts. After the installation of anchor parts, 5mm thick polymer waterproof and crack-resistant mortar should be divided into three layers, and a layer of alkali-resistant mesh cloth should be pressed between each two layer of crack-resistant mortar. The thickness of the first layer of mortar should be 1.5 mm (vertical 4 flat four).

6. Combine the application of green construction technology of passive house project

(1)Passive house, ultra-low energy consumption building construction technology

Passive room refers to, can well adapt to the climate characteristics and site conditions, the application of high performance external doors and Windows, good air tightness, no heat bridge structure, efficient ventilation system, and solar energy utilization and shelter passive energy saving technology, greatly reduce the energy demand of building ontology, and by optimizing the energy supply scheme, improve energy efficiency, at the same time meet the requirements of indoor environment thermal comfort and building

energy efficiency.

The additional benefit of the passive house building is to reduce the building carbon emissions due to the reduced energy consumption of cooling and heating. For ordinary energy-saving buildings, the total power consumption of air conditioning in summer is 4.32 million kW • h. The heating energy consumption of passive house buildings in winter is 50% lower than that of ordinary buildings. If the power consumption is still the calculation unit, the annual heating and cooling power consumption of ordinary buildings is 7.485 million kW • h. Therefore, the passive house building can save 5,362,500 kW • h per year. The carbon emission factor of electricity is 0.58kgCO_2/ kW• h, so for the passive house complex of 150,000 square meters, the annual carbon emission can be reduced by 3110 tCO_2, The low-carbon performance of ultra-low energy consumption construction technology is very significant.

(2) Run pump agent

Run pump agent is a new product construction market in recent years, compared with conventional using the accessory carry half square ready-mixed mortar to pump tube run tube way, run tube agent has the characteristics of low economic input, good effect, single run tube only 3 run pump agent can achieve the purpose of the tube, a use cost less than 15 yuan, not only greatly reduce the cost of pipe, avoid plugging pump slowdown phenomenon, put an end to the ready-mixed mortar run pipe prone to local loose quality problems, also can reduce carbon emissions, realize the purpose of the construction market low carbon environmental protection development.

7. Conclusion

Passive house is a high-efficiency and energy-saving building, but also a highly comfortable building, which can meet people's growing demand for a more healthy, more comfortable indoor environment. Passive ultra-low energy consumption building technology has received widespread attention. From the government to the practitioners in the construction market are all committed to the industrialization and localization of passive housing technology. Thanks to a series of industrial guidance policies, In this respect, Shandong province is in the forefront, In November 2022, Shandong Provincial Department of Housing and Urban-Rural Development and Shandong Provincial Market Supervision Administration revised and issued the Energy Saving Design Standards for Residential Buildings, The energy saving rate of residential buildings in Shandong should reach more than 83%, Have higher requirements for building energy efficiency, According to the current building energy saving standards, The energy saving rate of passive house is as high as 90%, While achieving the goals of energy conservation and environmental protection, Achievalized constant temperature, constant humidity, Body feel more comfortable, more suitable air living dream, Passive house technology will surely be more used in other buildings, The future market of passive housing projects is very broad.

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