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Green Insulation Integrated Assembly Composite Wall Panel Development Review

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Abstract

Composite wall panel is one of the main forms of assembled building structure. Composite wall panels play an important role in load-bearing, heat insulation and energy saving of the structure, etc. Extensive scientific research on composite wall panels has been conducted at home and abroad in recent years. In a systematic summary of the relevant research on composite wall panels at home and abroad, introduce the development status and latest achievements of domestic assembled composite wall panels, and finally put forward the prospect of assembled composite floor panels.

Keywords

Composite Wall Panels; Thermal Insulation; Latest Achievement.

1. Introduction

In the past thirty years, China's infrastructure awareness has flourished, and the construction industry has flourished in order to promote socialist construction. However, its construction is relatively backward, there are still shortcomings in the development of the industry, the loss of a large number of resources, while also facing the difficulties of pollution of the environment.Therefore, in order to meet the new situation and new policies to adapt to the green and healthy development of the construction industry, according to the Ministry of Housing and Construction "fourteen five" building energy saving and green building development plan" proposed that by 2025, the proportion of assembled buildings accounted for thirty percent of the new urban buildings[1].The construction industry was explicitly promoted to actively carry out energy-saving renovation of existing residential buildings, improve the energy efficiency of buildings and raise the energy-saving level of new buildings. In 2020, the Ministry of Housing and Construction and other departments issued the "Green Building Creation Action Plan", proposing to promote assembly construction methods, vigorously develop steel structures and other assembly-type buildings, and adopt steel structures in principle for new public buildings. With the promotion of many advantages and policies in China, the assembled steel structure building industry will usher in a vigorous situation[2].

2. Foreign Development Trend of Assembled Wall Panels

Europe and the United States is the origin of assembly building, after the Second World War, many European countries, especially Finland and other vigorously promote assembly building, the 1960s, assembly building popular to the United States and Japan and other developed countries. The United States in the type of assembled housing to concrete assembly and steel assembly type, wall panels mostly gypsum board; Japan mainly to GRC composite panels, etc[3].As foreign construction industry development awareness before China, like Finland Pce company, Finland X-Tec company, Germany Mack, Germany Siempelkamp company early into the development of the assembly building industry[4].In the development of composite wall panels, countries attach equal importance

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to the use of wall materials, such as the United States, Denmark, Sweden and so on for the use of insulation materials, high-efficiency insulation accounted for up to 70%[5].

3. Domestic Development Trend of Assembled Wall Panels

3.1 Steel Structure Field

China's low degree of mechanization, late start, there is still a lack in the development of composite wall panels, the industry is lagging behind, the technology content is low, through the research and study of the domestic assembly composite wall panels, the type and comprehensive performance of the assembly composite exterior wall panels developed so far is analyzed and compared as follows. Steel construction is also the trend, and the technical development in China's construction industry is more mature. However, for steel buildings, there are not many facade types for them to choose[6].The biggest difference between the walls of steel buildings and those of ordinary buildings is the exterior walls[7].Because steel is light and strong, its exterior walls mainly play the role of enclosure. Wall panels of light steel structures are usually prefabricated, and Chongzhi Li[8]proposed a new type of pumice lightweight concrete composite wall panel made of pumice lightweight aggregate concrete in the applicable steel structure residential assembly, which has been effectively improved in some problems out of the dimensional stability of the insulation panels, and the vulnerability of the external insulation system to cracking during construction, so severe that it even falls off. The surface density of this new type of composite wall panel is not more than 150kg/m^2, and the heat transfer coefficient of the main section of the exterior wall panel is not more than 0.45W/(m^2K). The thermal insulation performance is more obvious when compared with general exterior wall panels, and the apparent density of 1830kg/m^3 is also lower than that of ordinary concrete. Fang Ji[9]optimized the sandwich layer on the basis of existing composite wall panels, and made a lightweight composite exterior wall panel with non-asbestos fiber cement board as the surface layer, glass bead modified foam concrete as the sandwich layer, and welded steel mesh as the reinforcement layer, and by setting expansion and contraction joints, the slab joints were treated by using sealant, and the problems of inconsistent deformation of the structure and exterior wall panels caused by thermal expansion and contraction were effectively solved, which also satisfied the prevention of rainwater leakage and ensured the mechanical properties of the wall. On the other hand, autoclaved aerated concrete wall panels are also more prevalent in steel structures, but their drawbacks are numerous, especially the thermal performance of this type of wall panels in alpine regions is not as good[10]. Jianjun Hu[11] studied aerated concrete exterior wall panels, which are made of cement, silica sand, etc. as the main raw materials and additive to make a lightweight porous green and environmentally friendly building material exterior wall panels, which are cost-effective, easy to construct, good sound and heat insulation, and also can be used as an ideal substitute for aerated blocks, but they do not get satisfactory results in terms of heat insulation. Yao Qianfeng [12]prefabricated a new energy-saving composite wall panel, using reinforced concrete with small cross-section and reinforcement as rib lattice embedded with industrial wastes such as slag and fly ash with aerated silicate blocks, the blocks, rib lattice and outer frame of this wall panel can play an important role under the action of small, medium and large earthquakes in turn, which is outstanding in seismic performance but not experimentally verified, and the wall insulation is also used for partial insulation and overall insulation by inlaying insulation panels so as to achieve the insulation effect, and the construction process is complicated. Miao Jikui[13]made a new composite exterior wall panel with structural integration of heat insulation by compounding organic insulation board and 35 mm thick A-grade insulation slurry on the construction of the original aerated panel and compared with the autoclaved aerated concrete exterior wall panel of the same thickness it seems that the heat transfer coefficient of the new composite insulation exterior wall panel is reduced by 39.6%~56.7%, and the self-weight of the wall panel is reduced by 17.9%~36.7%. The thermal insulation performance of the new composite wall panel is significantly improved, thus improving the defect that it cannot be used as an assembled exterior wall panel under the extreme weather of severe cold. In order to study the seismic performance of GRC composite insulation wall panels in steel frame structures, Chen Jianghua

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[14]found that both have good seismic performance by using external GRC composite insulation panels and internal GRC composite insulation panels, but the connection between the wall panels and the steel frame is reliable in the external method, while the connection between the top of the wall panels and the frame is easy to be pulled off or pulled off in the internal method.

3.2 Material Field

In the building insulation materials, the insulation effect of rock wool is better than the general insulation of traditional insulation materials. According to access, 1 ton of rock wool used as insulation, the savings effect is equivalent to saving about 1 ton of oil, the use of 10 tons of rock wool materials in the building, about 1 million less bricks can be used, greatly reducing the problem of destruction of land[15].Tu Zhongyuan [16]researched a thin-walled concrete rock wool composite exterior wall panel, which was developed for the first time in China as a new composite thermal insulation wall panel with light weight, energy saving and versatility, and also participated in the construction of a two-story 340m^2 experimental building. Rice husk is an agricultural by-product, usually used as fuel or waste disposal, polluting the environment, for this reason, Wang Ying[17]compounded rice husk mortar on both sides of common rock wool composite wall panels to make a new rice husk mortar lightweight composite wall panel, with thermal conductivity of 0. 434W/(m^2K) and surface density of 85kg/m^2, which has good thermal insulation performance and lightweight characteristics. Construction gypsum is one of the more common green cementitious materials in construction materials and is often widely used in wall panels in buildings, and is collectively known with cement and lime as the three most popular cementitious materials today[18].Gypsum is relatively common and stored in large quantities around the world, so it can be made from small amounts of cement, water, gypsum, certain additives, and fibers to make quick-fiber gypsum wallboard, which and its system were first developed and popularized in Australia as a new green wallboard[19].Because the type of plate vertical concrete dark column in the horizontal direction of the respective most are in an independent state, in the seismic code of construction requirements are still lacking, but also not insulation, to the actual promotion of the plate in China has brought difficulties. Shao-Chun Ma[20]made a new type of gypsum composite interior wall panel by increasing the bi-directional porous cavity of the cross beam and on the basis of this, a gypsum composite exterior wall panel considering the insulation system was proposed. By improving the force characteristics of the previous gypsum cavity composite wall panel in vertical direction only, it has better load bearing capacity and seismic performance, and the thermal insulation performance is effectively improved by setting the thermal insulation layer with gypsum board outside. As a new green insulation material, foam concrete has the characteristics of sound insulation and light weight, heat insulation and fire resistance. Based on these characteristics, it has been widely studied and applied in the research and production of some high-performance insulation composite wall panels in recent years[26]. Ma Jianlock[27]proposed a core-column prefabricated plain-foam concrete composite insulated exterior wall panel by means of a core-column steel skeleton and horizontal reinforcement built into the plain-foam concrete composite panel, thus improving the shortcomings of the previous load-bearing capacity and increasing the ductility of the wall panel and the seismic performance of the panel. Li-Lian Xu[28]simulated the glass bead recycled concrete composite wall panels and PC composite wall panels and obtained that ordinary concrete played only 3.2% of the role in the insulation effect of PC composite wall panels, which was almost the role played by polystyrene insulation panels. And the glass bead concrete insulation effect is about 20% of the composite wall panel, and the deformation of the two types of composite wall panels is not much different. Wang Jingfeng[29]combined glass beads with foam concrete to develop reinforced mesh glass beads foam concrete sandwich composite exterior wall panel (SVMFC sandwich composite exterior wall panel), and the SVMFC sandwich composite exterior wall panel meets good flexural load bearing capacity and can meet the requirements of relevant codes through lateral load bending experiments, which provides a reference for practical construction and design.

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3.3 Insulation Board Field

In China, in order to make efforts in heat insulation and energy saving green, most of the walls are made of organic polymers as the main raw material, and polystyrene particle composite wall panels are widely accepted in the market and even recognized by some codes and standards because of their light weight and heat insulation[21]. However, this type of composite panel does not serve as a load-bearing structure, but only plays the role of an enclosure in the market. Calcium silicate board is harmless to people and is made of recyclable wood pulp and other substances, which can reduce pollution to some extent, and Ishikawa[22]poured foam concrete with high quality properties between boards with calcium silicate board as the face material to make heat-insulating and fireproof composite wall panels, which have excellent properties such as light weight, heat insulation and heat preservation. However, because of the difference in bubble stability of foam concrete itself, foam concrete fluidity or different infusion methods can indirectly affect the compactness of composite wall panels, resulting in very little real production of foam concrete composite wall panels and few actual cases. Whether the process used in the manufacture of calcium silicate panels is in any way to meet the green development also needs to be verified[23].Li Ya Mo[24]found that the tensile side of the calcium silicate fiber board is a key factor in the damage and deformation of the wall panel, and the temperature and humidity of the calcium silicate fiber board will directly affect the bending resistance of the wall panel, so improving the tensile strength of the calcium silicate board is of great significance to improve the bending resistance of the polystyrene particle composite wall panel. In order to overcome the basic requirements and conditions of XPS composite wall panel as an exterior wall panel for hanging and bending resistance due to the softer texture of the panel, Tan Yanke [25]proposed an improved composite exterior wall panel based on XPS, i.e., SP-X composite wall panel and its system, and the overall thermal performance of SP-X composite exterior wall panel was studied experimentally through the protective thermal chamber method, and it was found that the heat transfer coefficient of SP-X composite wall panel was 0.367W/(m^2K), which is about 40% lower than the traditional ALC composite wall panel with a heat transfer coefficient of 0.605W/(m^2K).In addition, Hou and Tao[30]et al. studied vitrified reinforced concrete composite wall panels and bamboo reinforced vitrified concrete composite wall panels, and found that the performance of using diagonal inserted bamboo reinforcement will be more stable than that of straight inserted bamboo reinforcement, and the composite wall panels have good seismic performance, but this way does not have a great impact on their seismic performance. As the ceramic concrete has the advantages of small weight, good heat insulation, so that the composite wall panel not only reduces the self-weight, but also achieves the effect of heat insulation.

4. Latest Achievements and Prospects of Assembled Composite Wall Panels

In the study of assembled composite wall panels, at first as a load-bearing structure in the building, but construction difficulties at the same time does not have insulation, not conducive to assembly. And then the pursuit of light weight at the same time gradually lost the characteristics of its composite panels of high strength, while the ceramic concrete in reducing the self-weight of composite wall panels at the same time can maintain its high strength characteristics. Foam concrete also has the characteristics of sound insulation and light weight, heat preservation and fire resistance, etc. Combining ceramic granules with foam concrete, a new type of ceramic granule foam concrete composite wall panel is developed, which can achieve the goal of light weight and high strength with heat preservation and heat insulation integrated composite wall panel.

5. Conclusion

Assembled composite wall panels are generally composed of inner and outer wall pages, insulation sandwich layer, connectors, etc. Relevant research is constantly conducted to achieve green insulation integration, and efforts are made to achieve the goal of protecting resources and the environment and achieving sustainable development. China's assembly structure in the construction industry started late, but in the industrialization of the general environment and policy encouragement and support,

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assembly composite wall panels have a huge market prospect, gradually from lightweight, green energy-saving composite wall panels to the structure of lightweight and green insulation integration of composite wall panels transformation step, assembly composite wall panels have great potential, I believe that scientific researchers will overcome the difficulties and serve the construction of the motherland.

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