Research on the design of the integrated wall panel of the prefabricated building in substations

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Abstract: In order to meet the needs of the modular construction and prefabricated construction of the State Grid Corporation of China, higher performance requirements are put forward for the wall panels of the building. Integrated wall panels have the advantages of high integration, high assembly, short construction period and good construction quality, which can effectively reduce on-site wet work and have significant economic and social benefits. This article combines the actual engineering and existing construction technology to explore the technical application of the integrated wall panel design for assembly buildings in substations, which provides a reference for the future development of assembly buildings.

1. Introduction

The State Grid Corporation of China is promoting the modular construction in an all-round way, requiring buildings in substations to be prefabricated structures, putting forward higher requirements for standardization and rapid construction of the engineering construction. In order to meet the needs of the modular construction and prefabricated construction, higher performance requirements are put forward for the wall panels of the building [1]. At present, the most commonly used external wallboards in substations are cement fiberboard and metal sandwich panels and the internal wallboard is gypsum board. However, there are still processes such as on-site assembly, pipeline layout and decorative surface layer. The construction period is long and the assembly rate is not high. In this paper, a common size external wall panel of prefabricated buildings is used as an example to carry out technical research on the design of integrated wall panels of prefabricated buildings in substations, which provides a reference for the future development of prefabricated buildings.

2. The situation of research on the integrated wall panel

Based on the research and development of low-rise modular buildings and combined with the Zhongtian steel structure industrialized villa demonstration project, Lv Huaxin and others summarized the process flow and construction points of the steel frame-lightweight sandwich panel integrated wall system. Practice has shown that the integrated wallboard system has the advantages of high integration, high assembly, short construction period and good construction quality. It can effectively reduce wet work on site and has significant economic and social benefits[2].

Wang Xinxiang and others reviewed the development status of domestic and foreign wall panels, compared the performance of current fabricated exterior wall panels and pointed out that energy-saving decoration integrated exterior wall panels have the advantages of fast construction
speed, thermal insulation, environmental protection and low overall cost. It is in line with the current development trend of housing industrialization and building industrialization and is in line with the national industrial policy of green buildings and building energy efficiency[3].

Based on specific engineering design examples, Wang Xiaowen analyzed the applicable conditions for the use of metal wall panels as the external wall enclosure structure in the design of the main building of the thermal power plant and discussed new technologies and new materials suitable for the main building construction when the unit capacity is different and when different building structures are used[4].

Qian Ping and others explained the performance characteristics of bamboo-wood fiber integrated wallboard, including the advantages, disadvantages and the testing requirements of its products, especially the key performance advantages indicators, which provides a reliable reference for the development of this building material [5].

It can be seen that integrated wall panels have been used in civil buildings and it is feasible to use integrated wall panels in substations in terms of safety and technology.

3. Design of the integrated wall panel
The size of prefabricated buildings in substations is relatively solid and there are few types of column nets and story heights, which are easy to modularize. In this paper, the commonly used column network and story height (3m×3.6m) are used as examples to carry out technical research on the design of integrated wall panels for prefabricated buildings.

3.1 Definition
The integrated wallboard is an integrated product prefabricated in the factory by wall skeletons, wallboards, sandwich materials, water and electricity buried pipes and decorative projects, which has a high degree of integration. The wall panel is installed on site, thereby greatly reducing the on-site installation period, improving construction efficiency and reducing the total construction period.

3.2 The wall material
At present, the wall materials of fabricated buildings in substations include cement fiberboard, metal profiled steel plate, gypsum board and aluminum-magnesium-manganese alloy board. Based on the consideration of the full life cycle of the substation, the structural requirements and material durability of integrated wall panels are combined and aluminum-magnesium-manganese alloy panels that meet the requirements are selected.

3.3 The structural design
The integrated wall panel consists of a 2mm thick aluminum-magnesium-manganese alloy outer panel, a waterproof and breathable membrane, a 150mm thick wall frame (the steel keel wears a Φ50 buried pipe and a 150mm thick fireproof rock wool), a vapor barrier and a 1mm thick aluminum-magnesium-manganese alloy inner panel, as shown in Figure 1.
Figure 1. Wall panel structure diagram

Take the commonly used column network and story height (3m×3.6m) as an example, 3.0m×3.6m integrated wall panels are customized. Other sizes of wall panels can be designed as reference. The specific keel layout diagram and buried pipe diagram are shown in Figure 2 and Figure 3 respectively. The two sides of the wall panel are connected with the structural column by channel steel and the 150mm wide square steel tube in the integrated unit curtain wall panel can be used as the buried pipe perforation space and play a fixed role. When prefabricating and assembling wall panels in the factory, PVC pipes are arranged in the wall panels according to the process requirements and the prefabricated buried pipes are laid as cables for power, lighting, fire alarm, image monitoring, plumbing and electricity and other equipment. The board has holes for easy cable penetration later. The openings required for large boxes such as switches, power boxes, lighting boxes, and grounding terminal boxes, as well as reserved openings for doors and windows are reserved during prefabrication in the factory.
Figure 2. Keel layout

Figure 3. Buried pipe layout
3.4 Processing and installation of wall panels

Processing of integrated wall panels: The entire wall panel processing and production are all completed in the factory. First, according to the keel layout drawing, complete the keel production, splicing and buried pipe laying. And the channel steel and the keel are welded. Secondly, complete the installation of the aluminum-magnesium-manganese alloy board on the outside of the wall panel and the inner core fireproof and thermal insulation rock wool and reserve holes for doors and windows, terminal boxes and pipe openings. Finally, install the aluminum-magnesium-manganese alloy plate on the inner side of the wall panel for sealing work and reserve cable holes at the corresponding positions.

Installation of integrated wall panels: First, connect the wall panel connectors to the structural columns through bolts and handle the joints between the wall panels and the wall panels. Secondly, install doors and windows and related equipment boxes. Finally, pass the cables through the reserved holes in the inner wall panel and the buried pipes in the keel to complete the electrical wiring.

4. Conclusions

The application of integrated wall panels of prefabricated buildings in substations reflects the concept of modular construction of the State Grid Corporation of China and has the following advantages in terms of quality, efficiency, technology and economic benefits:

1) The integrated wall panels are fully assembled and installed on site with short construction period and high degree of assembly.
2) On-site construction rarely requires welding operations and the construction quality is guaranteed.
3) Insulation material filling and hydropower buried pipe laying are converted from traditional facade construction to plane construction, which can improve laying efficiency and quality.
4) As a large number of on-site operations are moved to the factory for completion, construction conditions are optimized, labor efficiency is improved and labor costs can be saved.
5) Compared with the traditional on-site construction technology, it is simpler and easier to operate and the quality is easier to control, which has greatly promoted the development of assembly buildings.

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