

Research and Application of Prefabricated Steel Structure Inner Partition Connection Technology

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Abstract: Based on an example of a steel structure residential building project in Yinzhou District, Ningbo, this paper focuses on innovative methods for new connection nodes between steel beams, columns, and ALC internal partitions in steel structure buildings, standardized new installation process steps and key points for attention, and analyzes the technical points of key node connections.

Keywords: ALC wall panel, Node connection, Construction quality.

1. Introduction

Autoclaved aerated concrete blocks (also known as ALC wall panels) are porous inorganic environmentally friendly wall materials made from calcium and silicon as raw materials, aluminum powder as an aerating agent, gypsum as a regulator, and high-pressure steam curing.

ALC wall panels have a history of decades of application in Europe and Japan. With the development of the domestic construction industry, green and environmentally friendly wall materials have been vigorously promoted, and lightweight wall panel product technology has been widely introduced and rapidly developed. ALC wall panels are currently a widely promoted lightweight environmentally friendly material that can be sawn, grooved, and sized according to actual on-site conditions. They can be customized in advance according to the model in the factory and are mainly used for internal partitions in residential and public buildings, as well as external wall panels and internal partitions in steel structure buildings. Its main advantage lies in the insulation and heat preservation of partitions, which has a high cost-effectiveness. During construction, dry construction can be used, with little pollution and no need for secondary structures such as structural columns and lintels. It can reduce plastering processes and other advantages, making it suitable for non load-bearing interior partitions in buildings.

2. Project Overview

The 5th building of this project is a steel frame structure residential building, with a building height of 50.5 meters. The steel frame structure of Building 5 mainly consists of steel tube concrete columns, steel tube columns, H-shaped steel beams, etc. The floor slab adopts a vertical pole support system for cast-in-place slabs. The outer partition adopts UAAC splicing large panels, while the inner partition adopts ALC autoclaved aerated concrete wall panels.

3. Old Construction Process Issues

For the construction of ALC inner wall panels, the upper part is welded and fixed with U-shaped clamps and steel beams, while the lower part is fixed and connected with floor panels using pipe clamps. The pipe clamp method is convenient and fast in construction, but it needs to be knocked

into the board, and there may be deviation and unstable fixation when used for lower connection; Although U-shaped cards can be fixed firmly, the construction speed is relatively slow. To take advantage of both advantages, a new construction process is proposed in a relatively novel way.

4. Innovation in Construction Technology

In order to accelerate the construction speed, facilitate the construction of construction personnel, and ensure that the ALC panel wall can achieve a firm effect, we boldly propose the construction process of L-shaped card fixation. Two L-shaped cards are used at both ends of the ALC board to limit displacement and fix it, as shown in the following figure.

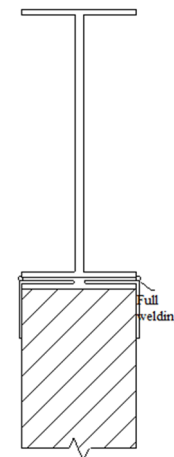


Figure 1. Connection between ALC inner partition wall and steel beam

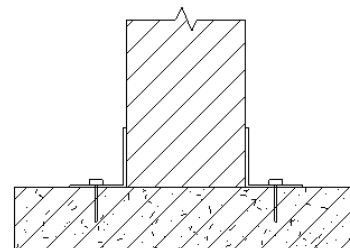


Figure 2. ALC internal partition wall connected to concrete floor slab

Due to the use of L-shaped clamps for fixing the lower connection of the ALC inner partition wall, it is best to install the board from the long side of the board. The advantage of using L-shaped card components over pipe and U-shaped cards lies in the ability to construct the L-shaped card components on one side in advance, providing positioning for the ALC board and preventing the board from being misaligned; Compared with fixing the lower part of the pipe clamp, the installation of the ALC plate is more secure, and there is no need to insert the components into the ALC plate, ensuring the integrity of the plate; Compared to U-shaped cards, construction speed is faster and more convenient.

5. Construction Technology

The innovative construction process of ALC inner partition wall includes deepening design, factory production and processing, and transportation of panels to the site, measurement and setting out, fixing and positioning of half L-shaped cards, horizontal and vertical verification of L-shaped cards, plastering waterproof mortar at the bottom, installation of ALC wall panels, fixing of the other half L-shaped cards, grouting, pointing, etc. The process is shown in Figure 3.

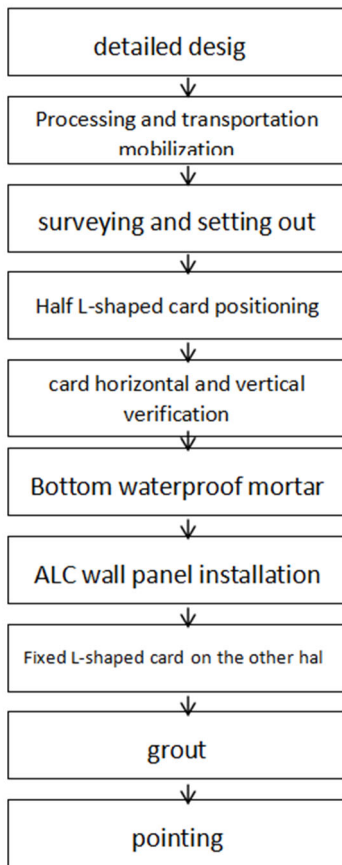


Figure 3. Process Flow Diagram

5.1. Detailed design

(1) Layout deepening: Use CAD to deepen the layout of panel walls, taking into account the gaps between panels and the total length of internal partitions, to avoid cutting the wall panels in the later stage.

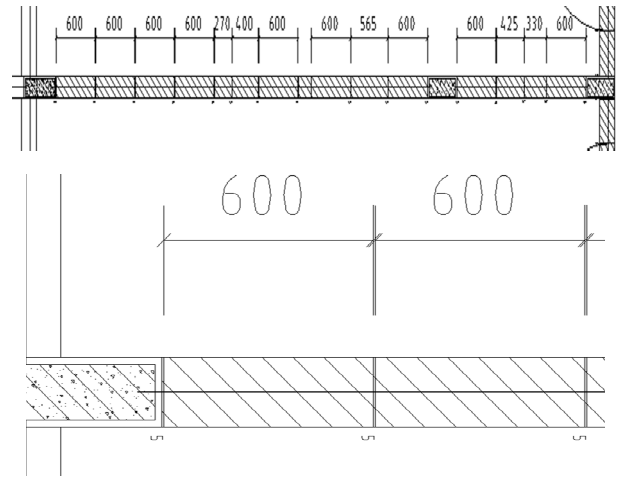


Figure 4. ALC layout diagram

(2) Deepening of hole reservation: For mechanical and electrical pipelines that are complex, with varying sizes and elevations of through-wall openings, and with a large workload of later opening, it is easy to cause significant damage to the ALC wall. By using BIM technology, a comprehensive model of electromechanical pipelines can be constructed to determine the location and size of through-wall voids, and to reserve holes in advance, ensuring the coordination and collaboration between the main structure construction unit and the electromechanical unit.

5.2. Factory production and processing, as well as plate transportation entering the site

(1) Factory production and processing: According to the ALC panel wall layout and deepening diagram, a cutting order will be made. After review and confirmation, it will be sent to the manufacturer for production. Considering the long steaming time of the ALC panel, the deepening time should be prepared in advance. Perform deep processing on the ALC board, and centrally process and number non specimens, wire slots, reserved openings, etc. in the material processing area to ensure that the corresponding wall panels match the detailed drawings to avoid damage caused by chiseling on the wall.

(2) Transportation of panels to the site: Necessary isolation and protection measures should be taken for ALC panels during transportation. The panel yard should be separated by wooden blocks with a spacing of 600mm, and the fixed parts should be padded with flexible materials such as rubber. During transportation in rainy days, waterproof cloth should be covered to prevent rain. After entering the site, the boards should be classified and stacked according to different specifications. The stacking site should undergo hardening treatment, and the stacking height should not exceed 1.5m. There are also requirements for the stacking site, ensuring that the site is hard and flat, and there is no accumulated water. The boards should be isolated from the ground to avoid direct stacking. They should be close to the project site and avoid secondary handling problems due to distance during use.

5.3. surveying and setting out

According to the deepening drawing of the ALC inner partition wall, determine the axis position of the ALC wall and snap the line according to standard specifications. Use the control line as the reference to set out the center line of the door opening, adjust the size of the completed surface of the inner and outer walls of the door pocket, and set out the

positioning. Recheck the position of the wall axis to ensure that the deviation of the wall axis does not exceed 3mm. At the same time, setting out is also used for positioning the installation of the L-shaped card on the ground side.

5.4. Installation of half L-shaped card

(1) Installation of fixing parts: The ALC plate fixing parts are made of Q235 galvanized steel. Each ALC board is equipped with fixed parts at both ends. During installation, the fixed parts are placed on the lower control line position and the bottom edge of the L-shaped card is fixed on the concrete structural surface with a nail; The upper fixed part is connected to the steel beam through full welding.

(2) L-shaped card horizontal and vertical verification: Before installing the ALC wall panel, the installation position of the L-shaped card must also be checked horizontally and vertically to ensure that the wall does not deviate or tilt under the L-shaped card limit.

5.5. ALC wall panel installation

Before installing the ALC wall panel, waterproof mortar should be applied first. Then, the ALC wall panel should be placed in the direction of the long edge of the panel, and the panel should be erected so that the upper part of the ALC wall panel is tightly attached to the L-shaped fixed part after installation. The lower fixed part on the other side should be fixed to the concrete floor with a nail to limit the bottom of the ALC wall panel. Then, the upper L-shaped fixed part should be installed to weld and connect it to the steel beam.

5.6. Grouting and pointing

The mortar between adjacent board joints is a thin layer masonry mortar (also known as adhesive, produced and provided by professional manufacturers), with a coating thickness of 3mm~5mm. The adhesive mortar joint should be full and uniform, and the fullness should be greater than 80%. The gap between the lower end of the board and the floor slab is filled with 1:3 cement mortar, and the surface of the gap between the upper end of the board and the floor slab is also filled and smoothed with 1:3 cement mortar. The surface of the joint between adjacent boards should be filled and smoothed with special sealing agent; After the grouting material in the gap solidifies, the joint should be pointed using a specialized V-shaped joint pointing device for finished products. The joint application force should be uniform, and the gap should be flat and straight.

5.7. Stick anti crack and alkali resistant mesh cloth

After the installation of the board, alkali resistant glass fiber mesh cloth should be pasted on the joints of the board. Press the mesh cloth into the polymer mortar. The tensile breaking strength of alkali resistant glass fiber mesh cloth shall not be less than 1250N/50mm, the retention rate of alkali resistant tensile breaking strength shall not be less than 90%, and the weight per square meter shall not be less than 160g.

6. Detail Quality Control

6.1. installation precision control

The installation accuracy of ALC wall panels is mainly reflected in the position of the axis, the position and levelness of L-shaped fasteners, verticality, wall verticality, wall flatness, joint width, internal and external angles, and hole

displacement.

6.2. Axis position control

When installing L-shaped fasteners, it is necessary to recheck the position of the wall axis to ensure that the deviation of the wall axis does not exceed 3mm. After the wall panel is in place, another review of the position, levelness, and verticality of the wall panel can be conducted to ensure that there is no deviation.

6.3. Control of seam width and splicing treatment of different materials

When splicing wall panels, the seam width of the panels should not exceed 5mm. During installation, the squeezing method should be used to ensure that the seam is full of grout. A 20mm gap should be reserved at the connection between the wall edge and the top and the main body of steel structures such as columns, beams, and plates. Elastic materials should be used to fill the gap. If there are fire protection requirements, fire-resistant materials should be used to fill the gap. 20mm should be reserved at the connection between the upper and lower parts of the wall panel. After the installation of the lower part is completed, grouting is required, and the upper part needs to be filled with cement mortar. After the mortar has completely dried and shrunk, an alkaline fiberglass mesh cloth with a width of 100mm should be pasted at the junction.

6.4. Material moisture content control

Plates with high moisture content are prone to cracking due to inconsistent shrinkage. During the storage process, it is also necessary to consider the placement requirements. A dry indoor environment should be selected. If conditions are limited, suitable areas should be selected for outdoor storage, and cover measures should be taken to avoid interference from rainwater or other factors; In addition, it is also necessary to ensure that the site is hard and flat, and to isolate the boards from the ground to avoid direct stacking. After being soaked in rain, the board cannot be used directly. It must be dried and tested for moisture content, and can only be used after reaching the standard.

6.5. Full mortar

Before installing the next wall panel, the installed board or structural end should be moistened with mortar roller brush, and the mortise and groove of the board to be installed should be evenly plastered with mortar. After installation, use a grouting gun to inject the special bonding mortar between the board joints to ensure that the mortar is full. Before the filling mortar inside the board joint is completely hardened, the board must not be subjected to harmful vibration and impact.

6.6. L-shaped card horizontal verticality accuracy

As the first half of the L-shaped fixing piece also plays a positioning role, a review of the levelness and verticality of the L-shaped fixing piece is also necessary to avoid the ALC wall being tilted and not meeting the installation requirements.

7. Conclusion

(1) Compared to traditional partition panels, ALC panels have the characteristics of small bulk density, good insulation and insulation performance, strong non flammability, good sound absorption performance, strong seismic resistance, and good

crack resistance, making them a new type of energy-saving and environmentally friendly building material.

(2) Compared to the traditional pipe clamp method for fixation, the L-shaped clamp can more stably and firmly fix the ALC board, while also not causing local damage to the board, ensuring the integrity of the board; Compared to the U-shaped card method for fixation, it is more convenient and faster to construct than the U-shaped card method.

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References

- [1] Qiguang Cao , Yonghui Zhang . Construction Technology of a Prefabricated Steel Structure Residential Project [J]. Construction Technology, 2017 (18): 8-10.
- [2] Lanning Yin , Wangyang Yu , Kun Yue. Construction technology of prefabricated steel structure residential wall panel connection nodes [J]. Steel Structure, 2015,30 (12): 75-79.
- [3] Zhang D, Cheng Z, Geng D, et al. Experimental and numerical analysis on mesoscale mechanical behavior of coarse aggregates in the asphalt mixture during gyratory compaction [J]. Processes, 2022, 10(1): 47.
- [4] Geng D, Dai N, Guo P, et al. Implicit numerical integration of highly nonlinear plasticity models [J]. Computers and Geotechnics, 2021, 132: 103961.
- [5] Zhao X, Geng D, Cheng Z, et al. Study on the Performance of Active Embedded Steel Wire Knot Form in Silicone Graphene Composite Thermal Insulation Structure Integrated System[J]. Buildings, 2023, 13(3): 705.
- [6] Yonglong Shi . Application Prospects of UAAC Board Replacing Wall Masonry [J]. Engineering Technology, 2017, 27: 297.