

# Construction Technology and Application of Ultra Long ALC Boards in Large Exhibition Halls

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## Abstract

Through the study of the construction process of large-scale and large-sized ALC strip partition walls in a large exhibition, a comprehensive explanation is provided on the operational process, main detailed structures, and special or critical node methods for on-site installation. Especially the introduction of ultra wide openings and ultra-high strip plate nodes on the exterior wall can provide reference for other projects.

## Keywords

ALC strip board; Large size; Construction nodes.

## 1. INTRODUCTION

ALC (Autoclaved Lightweight Aerated Concrete) wall panels are lightweight wall materials made mainly of cement, lime, fly ash, sand, and water under steam and high-pressure curing conditions. They have the advantages of lightweight, high strength, insulation, fire resistance, green and energy-saving. In recent years, with the continuous innovation of wall material technology and the increasing environmental protection efforts in China, ALC wall panels (and blocks) have gradually replaced sintered clay bricks as one of the main wall filling materials, and are widely used in non load-bearing walls of civil and industrial buildings.

For building partitions with excessively long openings and high walls, if the construction method is incorrect and the quality control is not strict, it is easy to cause wall deformation, which not only affects the appearance of the building, but also affects its performance, and even poses a threat to the safety and durability of the building.

## 2. PROJECT OVERVIEW

The construction object is a large-scale steel structure exhibition. The project has a construction area of 64.32 square meters, and most of the above ground building interior walls are made of ALC panels. The total usage of the project is 53000 cubic meters. The size of the ALC board used is 200mm × 600mm × 6000mm; The strength is 3.5MPa, 5.0MPa; Volume density ≤ 800Kg/m<sup>3</sup>.

Part of this project has a clear height, and when installing on super high walls (with a height exceeding 6m), it needs to be installed in sections; There is also an extra wide opening on the exterior wall, with a size of 18000mm × 1500mm, reinforced with a square steel frame.

At the same time as installing the ALC panel wall, the project conducts research on the key nodes of the construction of large volume and large-sized ALC walls.

### 3. ALC PANEL WALL CONSTRUCTION TECHNOLOGY AND KEY NODES

#### 3.1. Construction process flow

Grassroots cleaning → Measurement and laying out → Embedded parts construction → Keel installation → Plate installation → Inspection and correction → Upper and lower joint filling → Repair and caulking → Acceptance

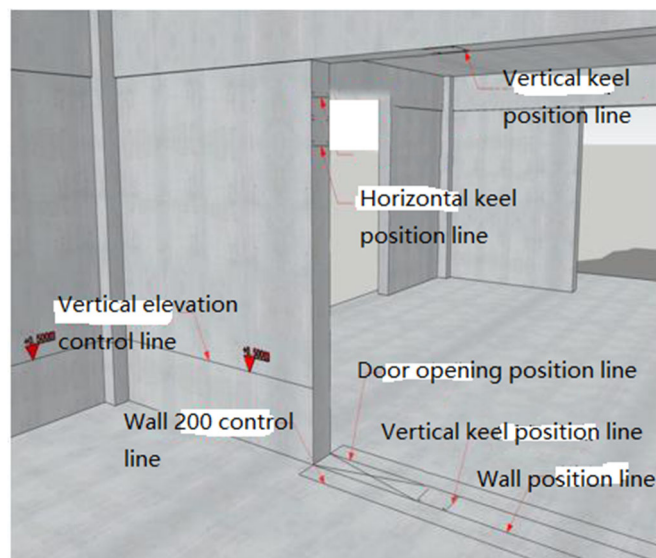
#### 3.2. operation point

Grassroots cleaning:

Use a chisel or steel wire brush to remove the floating slurry, ground ash, etc. that are stuck on the structural base layer, and then use a broom to clean the floating soil.

Measurement and laying out:

According to the wall positioning in the construction drawings, mark the installation position control line, door opening position line, vertical keel position line, etc. at the top of the structure or floor where the wall panel is installed. Mark the verticality control line, horizontal elevation control line, and horizontal keel position line on the structural columns or walls on both sides to control the verticality and flatness of the entire wall, as well as the installation position and elevation of door and window openings.



**Figure 1.** Surveying and setting out

Embedded parts construction:

According to the layout plan of the embedded parts, the embedded parts should be buried and fixed before concrete pouring. During the concrete pouring process, follow up and pay attention to whether the position and elevation of the embedded parts are offset, and adjust them in a timely manner. The installation of embedded parts can be divided into two forms: one is pre embedded, which is installed synchronously with the structural construction; Form 2 is post planting, where the embedded parts are fixed with expansion bolts on the constructed structural floor slab.

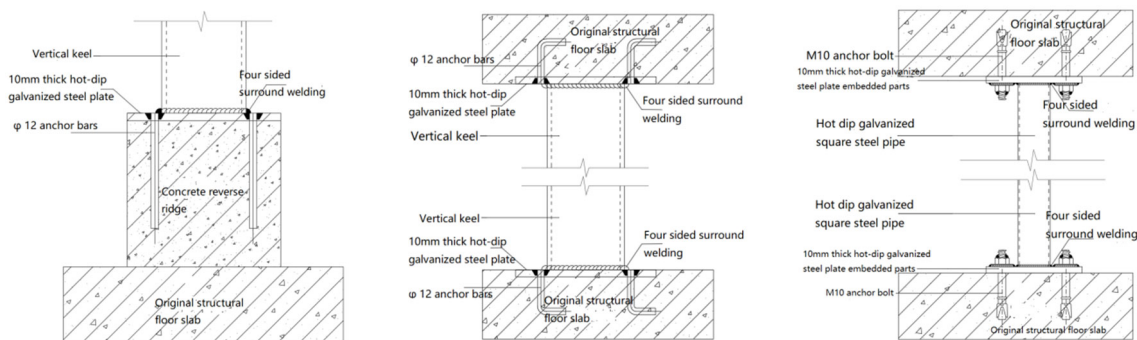


Figure 2. Pre embedded location map

Keel installation:

ALC board, with a maximum length of 6 meters, needs to be equipped with vertical and horizontal keels to meet installation requirements when the wall height exceeds 6 meters. The principle of keel setting: At the upper middle position of the wall (meeting the layout requirements of the board, generally set at a 6m position), a 200 \* 100 \* 6 rectangular steel square is set as the horizontal keel, with a width direction of 200 consistent with the thickness direction of the wall. When the wall length is  $\leq 6$  meters, the horizontal keel is connected to the original structure on both sides of the wall end; When the wall length is greater than 6, 200 \* 200 \* 6 vertical keels are set every 6 meters to connect the horizontal keels.

According to the layout plan of the keel, the vertical keel of the strip wall is welded, with the lower part fixed on the embedded part and the upper part fixed on the steel beam or embedded part (when there is no steel beam on the upper part); The height of the horizontal keel is determined according to the design drawings and welded to the vertical keel.

When installing the keel, a gourd is used to cooperate with the installation. After the keel is in place, one end is temporarily fixed by welding, adjusted and corrected, and then welded firmly on all four sides.

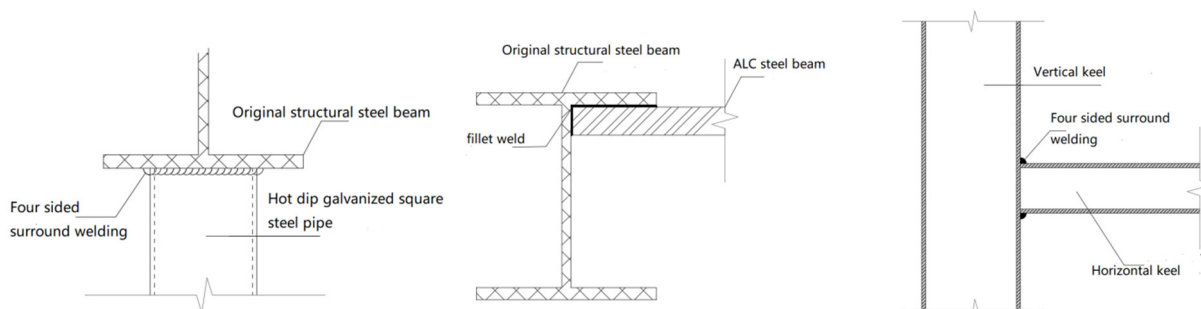


Figure 3. Schematic diagram of each connection

Board installation:

(1) Strictly follow the detailed layout diagram, and pre process the strip boards into corresponding lengths and widths using specialized cutting tools in the corresponding stacking yard on the corresponding floor for future use; The minimum width of the ALC strip after secondary processing shall not be less than 200mm.

(2) Before installation, install pipe clamps connected to the floor slab at the bottom of the strip board, and use a flatbed handcart to transport the strip board to the installation site.

(3) Use a flatbed handcart to push up the wall panel to be installed, and use a dedicated pry bar to pry from the side of the panel end to avoid damaging the panel surface when prying from the front. Adjust the verticality and installation position of the wall panel while pushing and prying it with both hands in coordination. When installing the edge wall, a scissor climbing car should be used on the edge side to cooperate with the installation.

(4) After the installation position of the wall panel is calibrated to be qualified, use a wooden tenon to support the wall panel at the lower end, then align the pipe clamp at the top and fix it to the upper structure. When the wall top is a steel structure beam, weld the pipe clamp to the steel structure beam; When the top of the wall is a composite floor slab, use shooting nails or anchor bolts to fix the pipe clamp at the bottom of the structural slab.

Check and correct:

Each board is checked for verticality and flatness using a suspension wire and a 2m ruler. If there is any deviation, a dedicated pry bar is used to adjust it to meet the requirements before fixing or welding can be carried out.

Upper and lower seam filling:

After the wall installation is completed and the quality meets the requirements, the joints between the lower part and the structure are filled with 1:2.5 cement mortar. After reaching a certain strength, the lower wooden wedge is pulled out and the holes in the wooden wedge are filled tightly with mortar; The joint between the top and the structure is filled with specialized sealant and foaming agent.

Repair of caulking:

After the installation of the wall panel is completed, special repair powder is used to repair the missing edges and corners. The gaps between the wall panels and the structure, as well as the gaps between the wall panels, are filled with alkali resistant mesh cloth and crack resistant mortar for surface finishing. The repair of high-altitude areas is carried out using a curved arm high-altitude vehicle.

Acceptance:

After the installation of the strip board is completed, the project department conducts self inspection, and after passing the inspection, it is submitted to the supervision party, the construction party, and the construction party to jointly organize acceptance. According to the technical specifications for the application of autoclaved lightweight aerated concrete wall panels in Zhejiang Province DB33T1232-2021, the on-site construction quality of the panels should comply with the following regulations:

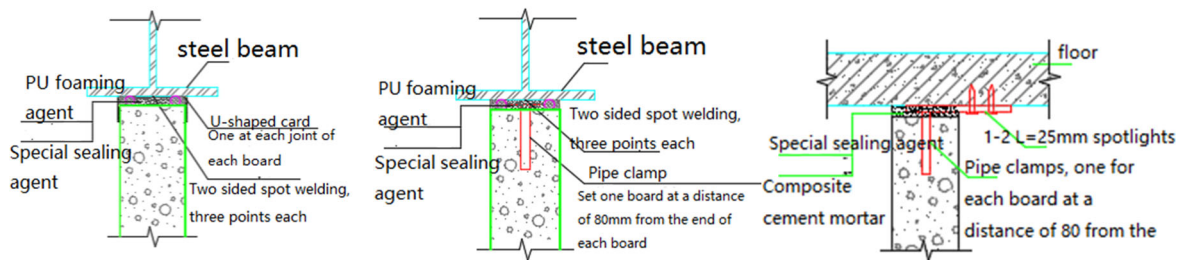
(1) The connection method between the board and the main structure should meet the design requirements, and the connection with the main structure must be firm.

(2) The treatment of board joints, construction of nodes, and joint filling methods should meet the design requirements.

(3) The joints of the exterior wall panels shall not leak.

### 3.3. Main detailed structure

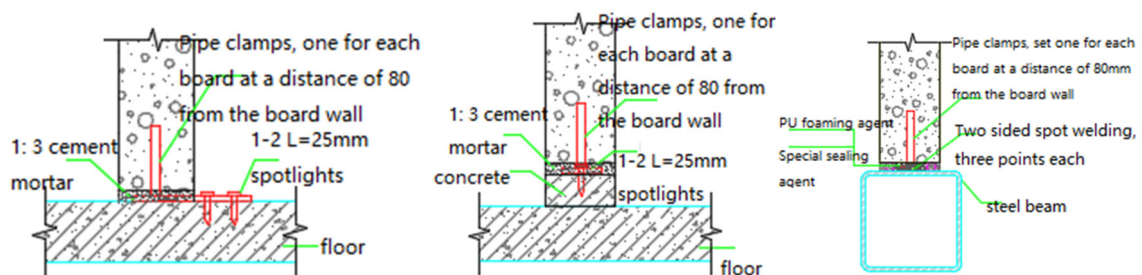
Connection nodes between the top of the strip and the structure:



**Figure 4.** Schematic diagram of various methods for connecting the top of the slab to the steel beam or main body

ALC strip root and structural connection node:

When the root of the slab is a concrete floor slab or a concrete retaining wall, use shooting nails to fix the pipe clamp to the concrete structure; When the root of the strip is a steel beam, weld the pipe clamp to the steel beam. The connection nodes are shown in the following figure:

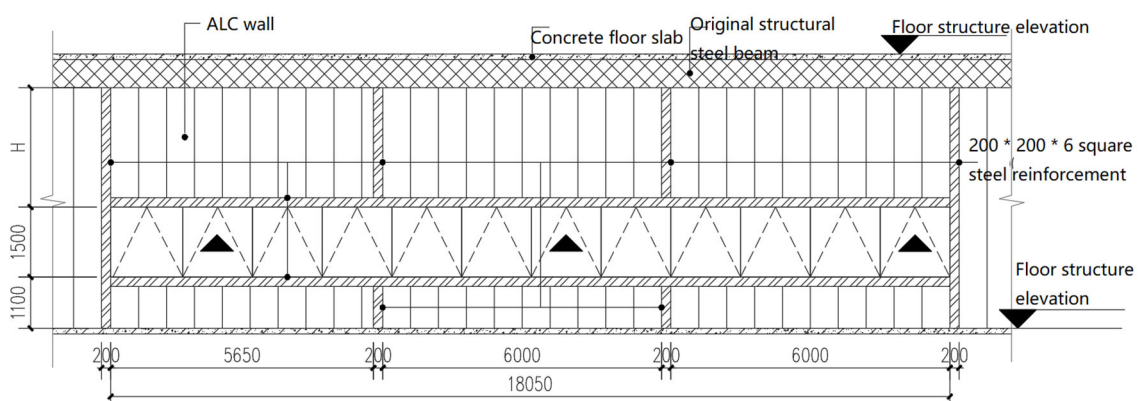


**Figure 5.** Schematic diagram of the connection between the bottom of the board and various positions

### 3.4. Method of node construction for special or critical parts

External wall ultra wide opening nodes:

This project has an ultra wide and full-length fire rescue window opening with a size of 18000 \* 1500. Both sides of the opening are reinforced with 200 \* 200 \* 6 steel square tubes as columns, and short columns with a spacing of no more than 6m are set in the middle to support the upper and lower connecting steel beams of the window opening. Both the short columns and the connecting steel beams use 200 \* 200 \* 6 steel square tubes.

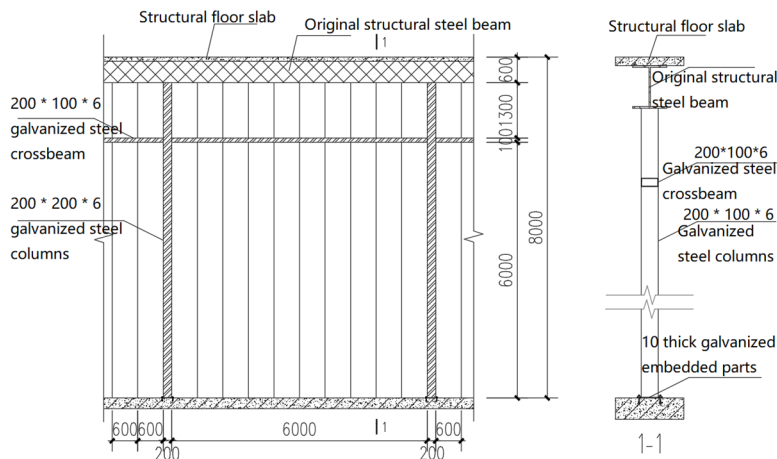


**Figure 6.** Construction of Extra Large Window Openings on External Walls



Node of ultra-high strip board:

When installing on ultra-high walls (with a height exceeding 6m), segmented installation is required; First install the lower panel of the horizontal keel, and after the lower panel is fixed, install the upper panel. The installation process is the same as that of ordinary wall panels.



**Figure 7.** Construction of Extra Large Window Openings on External Walls

Due to the installation of the horizontal keel above the ultra-high wall, both sides are suspended and the weight of the board is relatively heavy. One side needs to be lifted to the installation position with a car crane, while the other side requires construction personnel to use a scissor climbing car to straighten and fix the board.

If the installation space of the upper wall panel is too small to be installed with a car crane, a self-made gantry crane or hoist should be used to lift the panel to the installation site, and a scissor cart should be used to install and fix it in place.

## 4. QUALITY CONTROL OF ALC WALL CONSTRUCTION

Based on on-site and multiple project construction experience, the main quality common problems in ALC construction can be divided into three categories: quality problems at the joints of the board, appearance quality problems of the board, and installation deviation problems. The quality problem at the joint of the board is the main common quality problem.

### 4.1. Quality issues with board joints

The quality issues of inter panel joints mainly involve lax splicing between panel joints, cracks around wire frame openings, surface flatness, vertical angle errors, inadequate sealing of strip joints, cracks at connections with main components such as columns, walls, and columns, as well as other welding quality issues. Based on on-site investigation and construction experience, the main causes of quality issues with board joints are non-standard wall slotting and inadequate handling of board joint nodes.

### 4.2. Improper wall slotting

Before installing the panels, specialized personnel should be arranged to use CAD software and prepare layout diagrams for the internal partition walls required for this project. Through the arrangement of the layout diagrams, the slotting positions and installation plans for water and electricity construction and wire box installation should be determined. The use of the pre layout diagrams can better carry out construction planning. Vertical grooves should be chosen as much as possible for wall slotting, but horizontal grooves should be avoided as much as

possible. If there are special requirements, the diameter should not exceed 300mm, and inclined grooves should not be opened. The length of the wall groove should be the outer diameter of the pipe+5mm, and the depth should be the outer diameter of the pipe+15mm. During construction, the line should be marked according to the distance, and a cutter should be used to cut the seam at the required depth. Finally, manual grooving or chiseling should be used to remove the scratches, and the edge line should be flat and straight, with a flat bottom surface. Lay pipes in the trench and fasten them with pipe nails every 300mm. Clean the grooves with a small brush, and finally repair them in two parts with high polymer or cement mortar. After each filling, flatten them to a distance of 7-8mm from the surface. After drying, fill them again until the surface is flat. To increase wear resistance, a 100-200mm wide alkali resistant fiberglass mesh cloth should be pasted at the groove before applying putty to the wall surface for decoration.

#### **4.3. Prevention and control of quality issues in sheet metal**

(1) Low strength, easy to damage during transportation and handling. ALC suppliers are subject to contract constraints and on-site acceptance control measures. A specific material acceptance zone is set up in the project, and boards that do not meet quality requirements and are damaged are removed from the site. A corresponding exit record ledger is established to ensure quality and cost control.

(2) When lifting, nylon slings (not steel wire ropes) should be used to bind the two ends of the board at 600mm. Each hanging weight should not exceed 2 tons, and a wooden block must be placed on each end of the board at 600mm after landing. Personnel should guide the lifting work, and the binding length of the slings on both ends of the board must also be the same, and the slings must be vertical to ensure that both ends of the solid board are off the ground and falling at the same time. In order to facilitate the transportation of solid wooden boards, the number of stacked layers after unloading should not exceed 2, and single layer stacking is allowed if conditions permit.

(3) Waterproof protection measures: Waterproof protection measures should be taken according to the material and construction site requirements to avoid moisture. ALC boards should be stacked indoors, and if stacked outdoors, the site should be hardened. The stacking site should be close to the construction site to avoid multiple transfers of boards. The floor should be hard, flat, and free of standing water. The lower part of the board should be equipped with padding and should not come into direct contact with the ground. The boards should be stacked according to specifications and sizes, with a stacking height not exceeding 3 meters. The padding should be arranged in layers, with each layer not exceeding 1 meter in height. The upper and lower padding should be on a vertical line. The board should be covered to prevent moisture in rainy and snowy weather.

## **5. CONCLUSION**

The use of ALC wall panels not only reduces costs, but also improves the construction environment and reduces labor demand. As a product of building industrialization, ALC has accelerated the advancement of building industrialization and industrial construction. It is a new, green, and high-quality wall material that is worthy of our strong promotion and application.

This project analyzes the installation process, key nodes, and quality control of the ALC strip board, summarizes the installation experience, and has a good reference value for future construction of other projects.

## ACKNOWLEDGMENTS

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## REFERENCES

- [1] Junlong Ren . Research on Application Technology of New Wall Construction (ALC) Anhui Architecture, Issue 7, 2023
- [2] ALC construction drawings for Hangzhou Grand Exhibition Center
- [3] Bao, Y., Wang, H., Su, L., Geng, D., Yang, L., Shao, P., ... & Du, N. (2022). Comprehensive analysis using multiple-integrated techniques on the failure mechanism and dynamic process of a long run-out landslide: Jichang landslide case. *Natural Hazards*, 112(3), 2197-2215.