Journal of Trends in Applied Science and Advanced Technologies
ISSN: 3007-6889
DOI: 10.61784/asat3001

UNITIZED AND EFFICIENT INSTALLATION CONSTRUCTION TECHNOLOGY FOR LARGE-AREA CURVED HONEYCOMB ALUMINUM CEILING

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Abstract: This paper proposes the "pre-assembly on the ground, unitized installation" construction technology to solve the ceiling construction problems of the first phase of the Hangzhou Convention and Exhibition Center project. It aims to improve construction efficiency and accuracy. By forming a professional surveying and mapping team to monitor the construction process throughout, we implemented structural optimization and precise control, effectively reducing the on-site labor demand by more than 40%, and reducing material loss and construction waste by more than 20%. This series of innovative measures not only ensures the project's construction period and quality goals, but also provides reliable technical references and experience references for the ceiling construction of large-scale exhibition buildings.
Keywords: Ceiling construction; Pre-assembly on the ground; Unitized installation

1 PROJECT BACKGROUND

In Figure 1, the first phase of the Hangzhou Convention and Exhibition Center project is located in Nanyang Street, Xiaoshan District, Hangzhou City, Zhejiang Province. The design concept is inspired by the urban culture of Hangzhou and the Qiantang River culture, integrating Chinese elements and Song style, showing the characteristics of an international convention and exhibition center that blends mountains, rivers and trends [1-2]. The total construction area of the project is 225,000 square meters, of which the aluminum ceiling area of the banquet hall of Hall 1 is 7,000 square meters. Since the ceiling in this area contains a large number of single and double curved panels and variable cross-section designs, and the specifications and sizes are different, the potential accumulation of installation errors has increased significantly, and the construction difficulty has increased. In order to meet the above challenges, this study proposes the construction technology of "pre-assembly on the ground, unitized installation, and overall jacking", and is equipped with a professional surveying and mapping team to monitor the construction process throughout the process. It aims to reduce labor and material waste, while ensuring high-precision positioning and installation of the ceiling, and provide technical reference for the ceiling construction of large-scale exhibition buildings.

Figure 1 Hangzhou Convention and Exhibition Center Phase I Project Rendering

2 OVERALL SURFACE CEILING BASE CONSTRUCTION

The overall surface ceiling base construction process includes several key steps. First, mark the control points on the walls (columns) in the room according to the elevation control line, and pop up the ceiling elevation control line along the wall. Next, pop up the main keel position line and the embedded equipment dimension line on the top plate, and arrange the main keel spacing according to the design requirements. Subsequently, determine the elevation of the lower end of the hanger after the line is calibrated, and install the hanger according to the main keel position and hanging spacing. When installing the main keel, connect the assembled hanging parts with the main keel, ensure that the hanging parts are inserted into the corresponding hanging bolts, and assemble the connectors at the main keel joints to adjust the elevation, arching and straightness. After that, according to the secondary keel spacing specified in the design, fix the secondary keel to the main keel with the hanging parts. Finally, before installing the gypsum board, the pipelines in the ceiling need to be inspected and accepted, and the gypsum board can only be installed after passing the pressure test.

3 TOP ALUMINUM PLATE CONSTRUCTION

In order to deal with the problems of a large number of single and double curved panels and complex sections during the construction of the suspended ceiling, the project team set up a professional surveying and mapping team throughout the entire project cycle to provide necessary surveying and mapping data support. This team is responsible for providing favorable conditions before placing an order and conducting technical review for on-site installation. After the on-site structure is closed, the team quickly completes the three-dimensional scanning re-measurement, and through verification with the surface model, ensures the accuracy of various data, and places an order as a whole after confirmation. At the same time, the installation process of the base keel is tracked and re-measured in real time to ensure its applicability and stability. In order to further improve the construction accuracy, the project team dispatched management personnel to key material manufacturers to not only ensure that the material processing sequence matches the on-site work surface, but also to supervise the production progress and quality control. Before the material leaves the factory, a quality inspection is carried out on the special-shaped plate, and by comparing with the model drawing, it is verified whether the size of the key parts meets the arc and curvature required by the design. Ordering and Processing of single and double-curved materials can be seen in Figure 2.

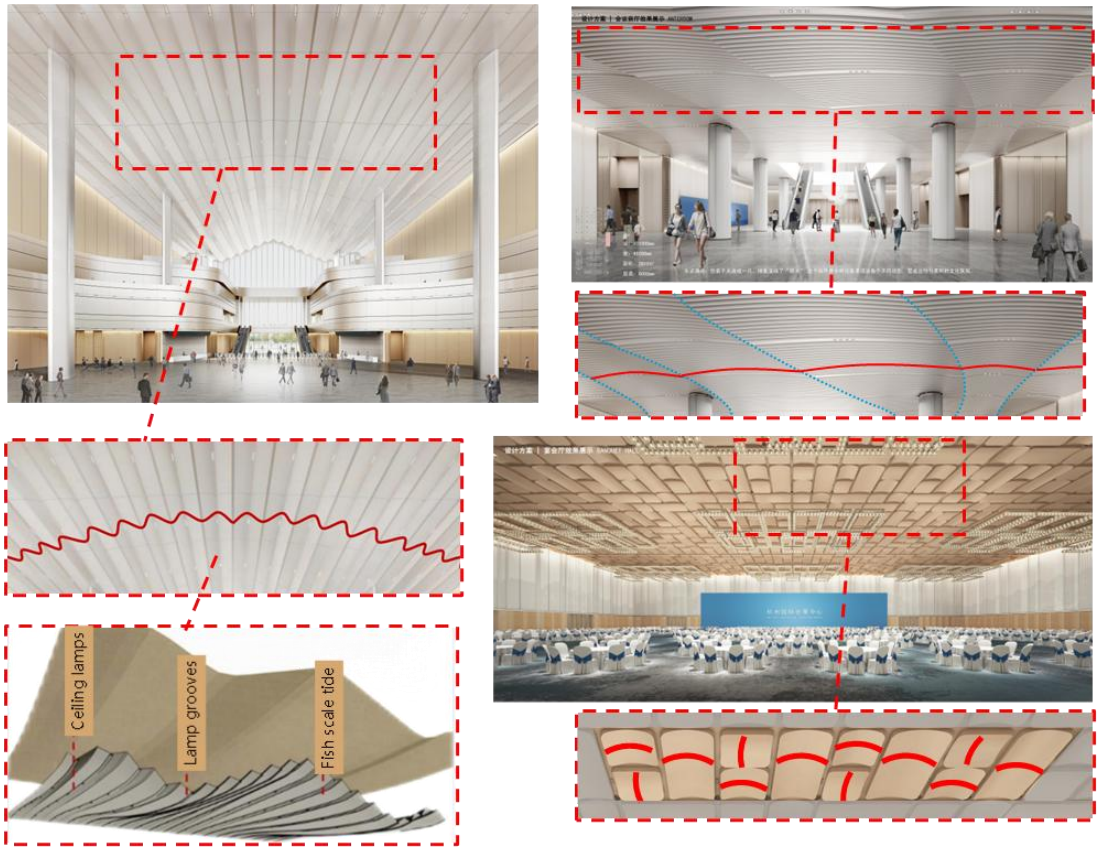

Figure 2 Ordering and Processing of Single and Double-Curved Materials

In terms of precise control of the installation of single and double-curved materials, the project team used a professional surveying and mapping team to conduct spatial coordinate briefings, provide accurate positioning for the installation of on-site panels, and review the completed surface layer to ensure the stable construction process of the labor team. Combining precision measurement with traditional positioning methods, the construction efficiency and quality are effectively improved through the method of total station dotting, reference surface positioning and review. In addition, the material layout diagram is promptly issued to project management personnel and labor teams for special briefings on surface layer installation to clarify the numbering rules and precautions, reduce the risk of material confusion, and

ensure the standardization and efficiency of the construction process. The specific detailed process of the top aluminum plate construction is as follows.

3.1 Hoop Installation

In Figure 3 and 4, based on the total station measurement data and the positioning requirements of the construction drawings, the position of the lower chord node is first determined. The construction personnel complete the calibration of the total station on site to ensure the measurement accuracy, and check the drawing markings and the actual situation on site to avoid errors. After confirmation, the hoop is accurately installed at the lower chord node to ensure the firmness of the connection and the stability of the structure.

Figure 3 Installation of clamp

Figure 4 Installation of transfer layer hanger

3.2 Installation of Transfer Layer Hanger

According to the actual situation of the steel structure on site, measure the connection position between the transfer layer and the clamp to ensure the accuracy of the size and fit. The construction personnel use appropriate measuring tools to confirm the length of the connector, which meets the design specifications and safety standards. During installation, carefully check the position to ensure that the connector matches the transfer layer and the clamp, and follow the corresponding construction specifications to ensure the connection strength. Finally, perform appearance inspection and schematic marking to verify the load-bearing and safety performance of the structural system.

3.3 Installation of Horizontal Keel of Transfer Layer

Just like Figure 5 and 6, according to the height of the finished surface of the aluminum plate, accurately adjust the ceiling height of the transfer layer to ensure the accuracy of the welding construction. Monitor the ceiling height in real time during the welding process to avoid affecting the final position and appearance of the aluminum plate due to errors. At the same time, ensure that all welding points can meet the design strength and stability requirements, thereby providing a solid foundation support.

Figure 5 Installation of Horizontal Keel of Transfer Layer

Figure 6 Installation of Hanger Bar

3.4 Installation of Hanger Bar

According to the design elevation, accurately determine the height of the lower end of the hanger to ensure that its position is consistent with the predetermined construction standards. On this basis, according to the configuration and layout of the main keel, the hangers are accurately installed to ensure that their spacing meets the design requirements. Appropriate measurement and adjustment measures should be taken during installation to ensure the uniform distribution of all hangers and effective connection with the main keel.

3.5 Keel Installation

In Figure 7 and 8, the pre-assembled hanging parts are connected to the main keel. According to the pre-established dividing line position, ensure that the hanging parts are correctly inserted into the corresponding hanging bolts to achieve a stable connection. For the joints of the main keels, install suitable connectors to ensure the continuity and overall strength of the structure. Subsequently, the elevation, arch and horizontal direction are precisely adjusted using

the wire positioning technology to ensure the vertical and horizontal consistency of the main keel.

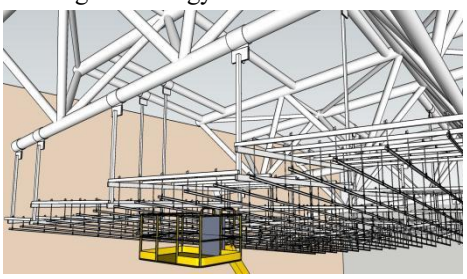

Figure 7 Keel Installation

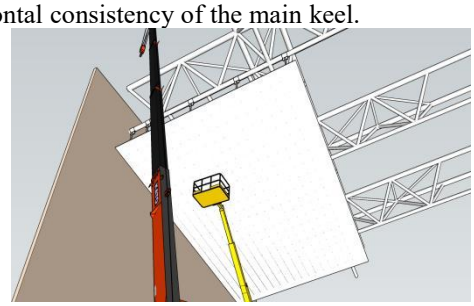

Figure 8 Aluminum Plate Installation

3.6 Aluminum Plate Installation

The aluminum plate is hoisted to the designated installation position by combining precision measurement with traditional positioning. The plate is installed by the method of total station marking → reference surface positioning → total station verification to ensure its matching with the main keel and other additional structures. The aluminum plate is then firmly installed using appropriate fixings to ensure its safety and stability during construction. After the installation is completed, it is necessary to use a total station to re-measure to verify the height, flatness and position error of the aluminum plate to ensure that it meets the design standards. If no problems are found in the re-measurement results, the installation of the next aluminum plate can be continued. Finally, the material layout diagram is promptly issued to project management personnel and labor personnel for special instructions on surface installation, clarifying the numbering rules and other precautions to avoid the possibility of material confusion. In this process, the importance of accurate measurement should be emphasized to achieve the consistency and overall visual effect of aluminum plate installation, while ensuring the structural safety in long-term use.

4 CONSTRUCTION BENEFITS

The construction technology process adopted in this project has significantly improved efficiency and resource utilization benefits. Overall, the on-site labor demand has been reduced by more than 40%, effectively reducing labor costs. At the same time, material loss and construction waste have been reduced by more than 20%, contributing positively to environmental protection and reducing the pressure of subsequent waste disposal. In addition, precise construction control has created good conditions for subsequent ground construction, ensuring the smooth progress of construction and the stability of quality, and achieving the established construction period and quality goals. Rendering of unitized installation of curved honeycomb aluminum ceiling can be seen in Figure 9.

Figure 9 Rendering of Unitized Installation of Curved Honeycomb Aluminum Ceiling

5 CONCLUSION

This study aimed at the difficulties in ceiling construction of the first phase of the Hangzhou Convention and Exhibition Center project, and proposed a new construction technology of "pre-assembly on the ground, unitized installation, and overall lifting", supplemented by full monitoring by a professional surveying and mapping team, which significantly improved the construction efficiency and accuracy. Through precise planning and implementation, the project successfully reduced the on-site labor demand by more than 40%, and reduced material loss and construction waste by more than 20%. The above results not only set a technical benchmark for the ceiling construction of large-scale exhibition buildings, but also provided experience and reference for subsequent similar projects.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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