Analysis of Construction Technology of Hospital Sloping Roof Engineering

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Abstract. In order to improve the building level, this paper analyzes the concrete construction methods of hospital sloping roof engineering, and summarizes the problems in the construction process. In order to ensure the normal operation of Hospital A and improve the overall waterproof and drainage function of the roof, a sloping roof structure is added on the basis of the original roof. During the construction period, it is difficult to organize the building materials resources, and the construction period of the roofing project is extremely short. By integrating design and bidding, the fastener-type steel pipe scaffold and color steel tile structure are selected, and the construction technology is simple and efficient, which greatly improves the construction efficiency. The pipeline system of the roof is complex, so the modular arrangement of vertical steel pipes increases the wind resistance measures of the roof to ensure the safety of the roof structure. At the same time, optimize the detail node practice, ensure the construction quality, and completely eliminate the leakage hidden trouble of Hospital A.

Keywords: Hospital · Double slope roof · Waterproof · Design · Construction technique

1 Instructions

In recent years, with the continuous development of housing construction, different styles of buildings are constantly developing, and the original flat roof is mostly replaced by sloping roof, which makes the function of housing more colorful [1]. At the same time, it should not be ignored that the rise of sloping roofs has also brought certain influences and hidden dangers to the quality of roofing construction, especially the leakage of sloping roofs has occurred from time to time, which has caused an unavoidable influence on the application and development of this architectural form. Therefore, it is imperative to strengthen the control measures for the construction technology and quality of sloping roofs [2].

S. H. B. D. M. Zailani et al. (Eds.): ICMSEM 2023, 259, pp. 309–316, 2024.
https://doi.org/10.2991/978-94-6463-256-9_33

Table 1. Roof frame data.

Pole setting	Roof purlin square pipe	Purlin spacing	Roof tile	Roof tile and square pipe connection	Wind rope spacing
3 m × 3 m	40 mm × 2 mm	1.0 m	Thickness: 1.0 m Width 840 mm	The horizontal spacing is 250 mm and the horizontal spacing is 1.0 m	3 m

2 Methods

2.1 Project Overview

A hospital adopts double-slope roof with a slope of 5%, and the roof consists of fastener-type steel pipe scaffold + square steel purlin + color steel tile [3]. The roof is made of steel pipe, combined with the design module of container, and the vertical poles are arranged according to 3 m × 3 m; Roof purlin square pipe specification is 40 mm × 2 mm, purlin spacing is 1.0 m [4]; 0.7 mm thick color steel tile is used for the roof, and the width is 840 mm; Roofing and square pipes are connected by dovetail nails, with a horizontal spacing of 250 mm, and the horizontal spacing is the same as that of purlin. Set the roof gutter rainwater hopper and downspout; Cable wind rope is set on the outside of the steel pipe frame, which is fixed with the ground and the bottom of the container, and the distance between the cable wind ropes is 3 m [5]. As shown in Table 1.

2.2 Roof day Lighting Roof Construction Process

See Fig. 1 for the construction technology of daylighting roof of large-span sloping roof.

Detailed design of glass and aluminum specifications and steel structure: according to the vertical and horizontal spans of concrete frame columns, reasonably determine the basic division of glass plates, and the size of glass divisions should be moderate, with 2000 mm ~ 3000 mm being appropriate, which not only reflects the atmospheric and beautiful decorative effect of daylighting roof, but also meets the requirements of steel structure and glass strength, rigidity and bearing capacity, and then designs the specifications of glass according to the size of glass divisions [6]. Glass TP10(Lowe) + 12A + TP8 + 1.52PVB + TP8 hollow tempered laminated Lowe glass is adopted, and its specification can meet the safety requirements of strength and rigidity, as well as the functional requirements of lighting, energy saving and heat preservation. In addition to the basic requirements such as strength and rigidity, the key to the deepening design of the aluminum specification is to consider the deepening design of the steel structure of the anti-leakage internal drainage system as the daylighting roof. The anchor bolts are embedded in the concrete frame columns, and connected with the horizontal load-bearing steel members of the daylighting roof through φ 300 round steel tube short columns

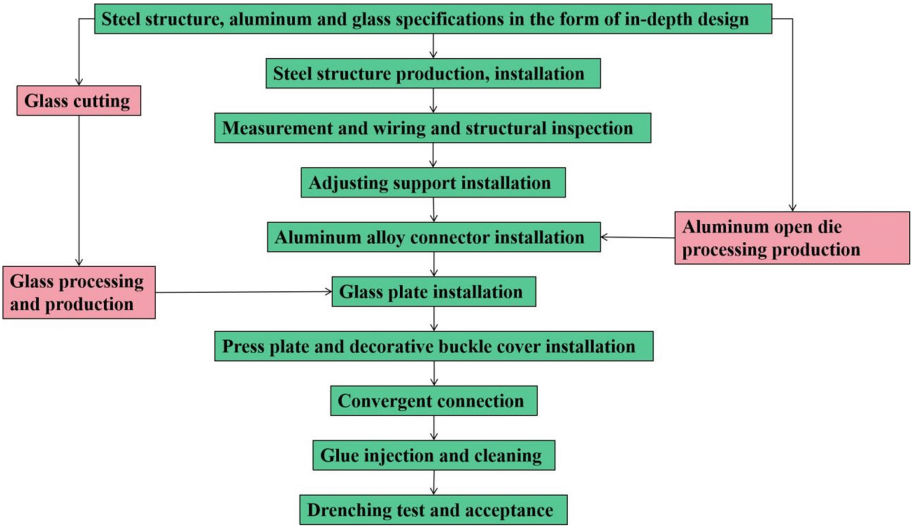

Fig. 1. Process flow chart of roof lighting roof construction

with steel plate bases: the design of the horizontal members adopts the combined steel structure of square tube truss and square tube purlin, which can realize the long span of the daylighting roof unit without being bulky and beautiful [7].

Material: TPI0(Lowe) + 12A + TP8 + 1.52PVB + TP8 toughened laminated glass is selected as the glass. Aluminum material 6063-T5 is selected, and the specifications and forms of aluminum materials are all customized in the aluminum factory according to the requirements of the drawings [8]. High-quality 3 mm thick fluorocarbon spraying board is selected for the edge-closed aluminum veneer, and the coating thickness is not less than 40 μm. Domestic high-quality carbon steel is used for steel, austenitic stainless steel A270 for stainless steel bolts, austenitic stainless steel 304 for indoor part and austenitic stainless steel 316 for outdoor part for decorative materials such as stainless steel plates. Exposed steel is treated by fluorocarbon spraying. See Table 2 for equipment [9].

2.3 Roofing Construction Difficulties

Due to the severe situation of public health events, the organization of building materials and resources is difficult, and the construction period of Hospital A is extremely short, so it is necessary to choose an appropriate roof system to improve the construction speed. The conventional building waterproof roof adopts profiled steel sheet metal roof, which takes a long period of material procurement, processing, transportation and construction, so it is difficult to meet the construction delivery requirements. Through deep integration of design and mining, the principle of using whatever materials are available is adopted, and considering the abundant steel pipe resources and convenient transportation, the fastener-type steel pipe scaffold + color steel tile structure is selected, which has simple construction technology, controllable quality and high construction efficiency [10].

Table 2. List of main machines and equipment.

Serial number	Name of machinery or equipment	Model specification	Quantity	Rated power	Production capacity
1	AC welding machine	BX3- 500	2	38 kW	φ 2.5–6 φ 6
2	DC welding machine	ZX5- 400-1	2	25 kVA	φ 2.6–6 φ 6
3	Tower crane	QTZ5615	1	38 kW	80t.m
4	Material hoist	SMZ150	2	12 kW	/
5	Abrasive wheel cutting machine	φ 400	4	2 kW	
6	Bench drill	φ φ 12	2	370 w	
7	Electric hammer	φ 6–20	5	750W	
8	Electric hand drill	φ 1–32 mm	5	0.4 kW	
9	Air compressor	WY-12/9	2	88.2 W	12m3/min
10	Semi-automatic cutter	CG1–30	6	24 W	Good
11	Airless spray paint machine	PS22	2	1 kW	Good

Adding a sloping roof structure on the basis of the original roof, the pipeline system of the roof is complex, and the reasonable arrangement of steel pipes and ensuring the safety of the roof structure are important and difficult points.

Considering the stress characteristics of the supporting box structure at the lower part of the roof, combined with the design module of the container and the layout of the roof pipelines, the vertical poles are arranged according to the principle of 3 m $\times$ 3 m, and at the same time, the wind resistance measures of roof joints are added to ensure the safety of the whole structure. Roof truss system involves a variety of materials fixed connection, should ensure that the connection is firm.

The key points are to ensure the waterproof and drainage function of the roof and the waterproof construction quality of the roof details. The hospital adopts double-slope roof, and eaves gutter and drainage pipe are arranged at the junction of ward building and corridor to ensure the drainage of sloping roof. Combined with the actual situation of the site, the waterproof detail nodes are optimized, and meanwhile, the construction quality of detail nodes is strictly controlled to reduce the leakage hidden danger.

2.4 Top Force Calculation

During the jacking period, it is necessary to consider the friction resistance between the box culvert and the soil layer. In order to reduce the friction resistance and overcome the influence of the resistance on the blade corners on both sides of the box culvert, the resistance in the construction is collectively referred to as the jacking force of the box culvert. After estimate jacking force value, the appropriate jacking equipment should be selected. The maximum jacking force is calculated according to the Design Code for Railway Bridge and Culverts (TB 10002--2017). The specific calculation formula is as follows:

$$P_{\max} = K\left[N_1 f_1 + (N_1 + N_2) + 2Ef_2 + RA\right] \tag{1}$$

where $P_{\max}$ is the maximum jacking force value; K is the coefficient; N_1 is the top load weight of the box culvert (including the weight of line reinforcement material); N_2 is the weight of the box culvert; f_1 is the friction resistance coefficient between the top surface and top load of the box culvert; E is the soil pressure on both sides of the box culvert; f_2 is the friction coefficient between the box culvert bottom and base soil; R is the positive resistance at the steel blade angle; A is the positive area of the steel blade angle.

3 Roofing Construction Technology

According to the design scheme and the actual situation of the site, combined with the characteristics of each working procedure, the roof construction process is as follows: basic treatment → setting out, determining the plane position of vertical poles → placing vertical poles → setting up sweeping poles → repairing waterproofing membrane → fixing the bottom of vertical poles → setting up inclined roof crossbars → setting up splayed braces → welding purlin square steel → installing roof color steel plate → installing roof gutter and rain water bucket → fastening and fixing the whole with wire rope → installing side wall louver and closed treatment upper louver.

3.1 Vertical Pole Plane Positioning Layout

Combined with the design module of the container, the vertical poles are arranged according to the principle of 3 m × 3 m. The vertical and horizontal distance of the steel pole of the scaffold is 3000 mm, and the minimum height is 1200 mm, and the maximum height is 1800 mm. Both ends of the steel pipe are cantilevered by 500 mm, and the color steel tile is cantilevered by 800 mm; In case of air duct position, the steel pipe overhangs 1250 mm, and the color steel tile overhangs 1500 mm. Plane positioning of the vertical pole needs to find out the position of the container steel beam and the hoisting hole, and the vertical pole arrangement and erection shall be accurately placed in strict accordance with the design drawing, avoiding the air duct, fan, oxygen pipeline and other pipelines. The frame body shall be built strictly according to the plan to avoid damaging the original waterproof layer of the container roof and reduce the leakage risk.

The roof pipeline system of the hospital is complex, especially the welding process should not be used near the oxygen pipeline. After optimization, the original welding connection of the middle pole is changed into wire binding, and the purlin and steel pipe are welded into fastener + binding connection. The steel pipe pole is designed as standard specifications to avoid on-site cutting and reduce fire safety risks.

1) External pole roof The peripheral pole is firmly welded with the container. The peripheral vertical pole is connected to the container as shown in Fig. 2.
2) The middle pole of the roof and the outer pole that cannot be welded shall be connected with the container with iron wire. The column foot and container lifting hole are used no. 8 double strands 2 (4 in total) X-shaped binding with iron wire (see Fig. 3).
3) The roof purlin adopts no. 12 wire for two double strands (a total of 4) X binding, and the purlin and steel pipe (two lower and one upper).

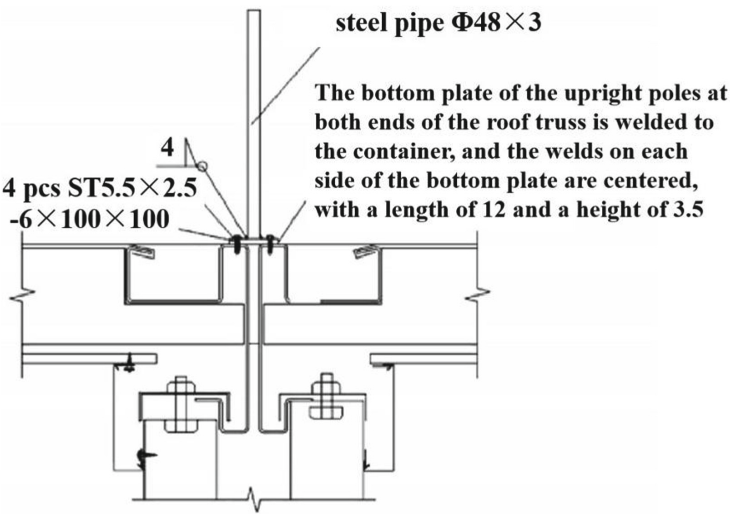

Fig. 2. Connecting node between peripheral pole and container

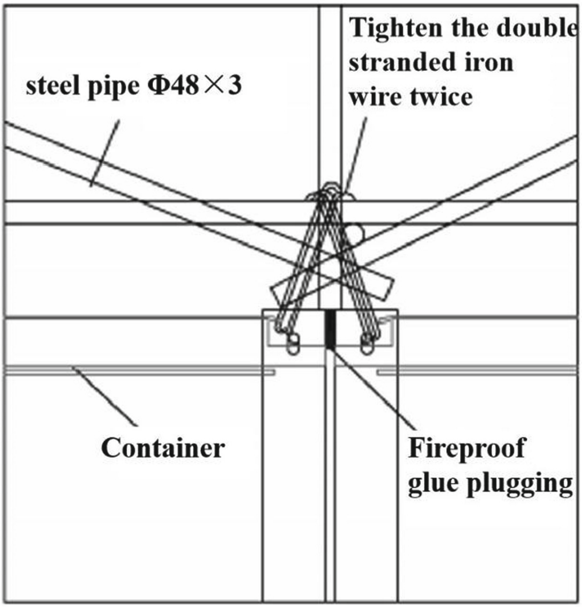

Fig. 3. The middle vertical pole is connected with the container lifting hole

4 Conclusion

A Hospital took 10 days from design to put into use, including 7 days from design to put into use of information data room. According to the traditional hospital construction method, it can be completed in at least 3–4 months. Through the above analysis, it can be seen that in the construction of information data room in emergency hospitals, the traditional information data room technology is no longer applicable because of the long construction period, complicated installation and debugging, and the need for professional personnel to be on duty for maintenance. The modular technology effectively solves the disadvantages of the traditional information and data computer room in design and construction. With the increasingly mature modular computer room, it can be widely used in all kinds of emergency temporary projects.

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