Academic Journal of Science and Technology
ISSN: 2771-3032 | Vol. 1, No. 3, 2022

Construction Technology and Key Points of Vertical Transportation in Shaft of Office Building

Bo Gao[1, *]

[1] Xigaze border management detachment, Xigaze, Tibet, 857099, China

[*] **Corresponding author**: Bo Gao (Email: 174449028@qq.com)

Abstract: Combined with a project, this paper compares the shaft type construction elevator with the traditional construction elevator, studies the construction technology of the shaft type in the installation, operation and use of the high-rise elevator, and focuses on its process flow, parameter performance and key points for attention. After the verification of the project, the construction elevator in the shaft operates safely, reliably and efficiently, saving costs for the project and ensuring the construction period. The construction experience summarized can be used for reference for similar projects.

Keywords: Shaft type construction elevator; Installation process; Key points for attention; Safety.

1. Introduction

With the development of the national modernization process, the design style of high-rise office buildings gradually pursues the concept of "people-oriented", and pursues transformation and upgrading in independent innovation ability, resource utilization efficiency, industrial structure level, informatization degree, quality and benefit, etc. Starting from the image of the building, by using the block design of the whole structure, rotation in different directions and staggered platform of the interlayer structure, the building appearance can be beautified and the space utilization rate can be improved. However, it poses a problem for the vertical transportation in the construction process [1,2].

By rotating and staggering the floors of high-rise office buildings to achieve the effect of space utilization, the difficulty of traditional vertical transportation is often greatly increased [3,4]. Based on the actual construction project, this paper studies the vertical transportation of this kind of structure from three aspects: construction technology, safety measures and advantages comparison.

2. Project Overview

The project is located in Jiaxing City, Zhejiang Province. The project consists of a single building with 2 floors underground and 17 floors above the ground. Two elevators are arranged in the core tube of the main building during the construction. This paper studies the construction feasibility, safety and reliability of the new elevator through the installation and use of the upper shaft construction elevator. Through the comparison between the shaft type construction elevator and the traditional construction elevator in terms of safety indicators, service performance and transportation efficiency, the advantages of the shaft type construction elevator are analyzed.

3. Key Points of Construction Operation

3.1. Selection of Construction Elevator and Initial Installation Floor

Determine the lift car model in combination with the project drawings and the elevator car size provided by the installation unit, and determine the jacking times according to the project building height (number of floors). The size of the two hoistway construction hoists in the project is 2200mm × 2200mm, ssd1.6t hoistway construction elevator is selected, which is installed in the elevator hoistway, with high speed, low energy consumption and high safety.

3.2. Installation of Lifting Beam, Ceiling Beam and Control Cabinet

Installation process: install the lifting beam → lift the overhead beam → fix the overhead beam → install the control cabinet and speed governor → connect the control cabinet and traction machine line

(1) Installation of lifting beam: install a 20\i-steel lifting beam for lifting at the lifting point layer according to the dimensions of the layout plan. The I-steel is lifted to the top layer by a tower crane and manually transported to the installation layer. The lower flange of the end of the I-steel is perforated and fixed with the floor of the elevator door opening with 4 12mm expansion screws after correction. The other side is plugged with a wooden wedge at the opening. Two electric hoists are installed on the I-steel according to the position shown in the figure, The first electric hoist is set 1500mm away from the elevator door opening, and the second electric hoist is set 2000mm away from the door opening.

(2) Installation of roof beam control cabinet: the roof beam is composed of two I-beams, one end of which is fixed to the wall and the other end is fixed to the ground, bearing the weight of the machine room platform, hanging cage and counterweight. Transport the ceiling beam and control cabinet to the 1F elevator shaft door with a flat hydraulic car, confirm that the expansion beam is inserted into the main beam cavity, hang two hoisting wire ropes of the same length on the two balance lifting lugs on the left and right sides of the ceiling beam respectively, and hoist the main machine to the installation floor through an electric hoist. The installation floor is equipped with a reserved opening, the bottom of which is horizontal to the door opening ground, and the reserved opening is arranged along the horizontal direction. The ceiling beam extends 50mm out of the shear wall opening,

The other end extends 400mm out of the elevator door opening; After the ceiling beam is hoisted to the installation floor, remove the fixed bolts of the expansion beam, pull the expansion beam towards the elevator door opening to the fixed position, and then fix it with the fixed bolts. Align the ceiling beam with the reserved hole, horizontally push the reserved hole, release the hook after it is in place, and place the ceiling beam flat on the floor. After accurate positioning according to the plane positioning drawing (the positioning is attached according to the elevator installation plane detail drawing), 3 pieces (100mm+300mm) are used × 600mm × 5mm L-shaped steel plate fixes the roof beam on the main structure.

Two L-shaped steel plates in the hoistway are fixed with two 16mm bolts and three 12mm expansion screws with the main structure; The L-shaped steel plate at the end of the ceiling beam at the elevator door opening is fixed with 4 16mm bolts and 2 12mm expansion screws with the main structure. The ceiling beam is installed. The control cabinet is installed outside the shaft and fixed on the wall at the door of the floor where the roof beam is located with two 12mm expansion screws. The lower end is about 800mm above the ground.

(3) The Governor shall be installed on the inner side of the shaft according to the size requirements of the drawing, and two 12mm expansion screws shall be used to fix the inner wall.

3.3. DIN-Rail Mounting

Installation process: setting out and positioning → installing the bottom guide rail bracket → installing the guide rail → correcting the guide rail → installing the second guide rail bracket → installing the second guide rail connecting plate → installing the second guide rail → installing the three guide rail brackets

(1) Six 0.5mm steel wires shall be placed on the installation layer of the roof beam as the reference line for calibrating the guide rail according to the requirements of the drawing. Six steel wires shall be fixed at the bottom of the hoistway. The main and auxiliary guide rails shall be lifted into the hoistway in turn and placed in the pit. The bottom shall be leveled with wood plates to avoid damage to the guide rail joints.

(2) The guide rail shall be hoisted with electric lifting tools. Firstly, the guide rail bracket shall be fixed on the shaft wall with two 12mm expansion screws, and the guide rail shall be installed on the guide rail bracket and fixed with pressure guide plate. The spacing between each two guide rail brackets shall not be greater than 2.5m. The pressure guide plate screws of each support shall not be tightened too tightly. The screws of each access plate are in a loose state. After the guide rail is aligned once, the guide rail connecting plate shall be connected for secondary alignment, The distance between the setting out of the guide rail and the top surface of the guide rail is 50mm.

(3) The steel wire shall be accurately positioned. The rail calibrator shall accurately position the spacing of the guide rail. The guide rail joint shall be on the same plane to avoid bending and deformation of the guide rail due to insufficient support strength during the action of the safety gear. The guide rail shall be aligned from bottom to top, starting from the second support of the pit. The car track shall be installed first, and then the counterweight track.

(4) The lift car and counterweight shall be based on one of the tracks. First, use a steel ruler to roughly measure the approximate dimension from the top surface of the track to the setting out of the guide rail. If the distance is 50mm, the installation dimension of the support can be adjusted. The rail calibrator corrects the perpendicularity of the guide rail by measuring the horizontal distance between the guide rail and the steel wire. In case of out of tolerance, it shall be corrected through the guide rail bracket. Then use the rail calibrator to correct whether the side of the guide rail is twisted. The rail calibration ruler used must be a qualified product after calibration, and it is not allowed to collide with other objects or the ground or wall during the use process, so as not to affect the accuracy of the calibration guide rail. After the installation of the second floor, the rail gauge shall be calibrated again to see if the gauge is shifted. Measure whether the guide rail is folded on one side or both sides with a rail calibrator. After the final correction, it is appropriate to control the gauge error within 5 mm. Before use, the rail calibration ruler must be fixed with bolts after it is determined according to the size shown in the drawing to prevent the size from moving. After the subsequent guide rail is installed in the car, the installation personnel shall construct on the car roof. The car top during installation is shown in Figure 1.

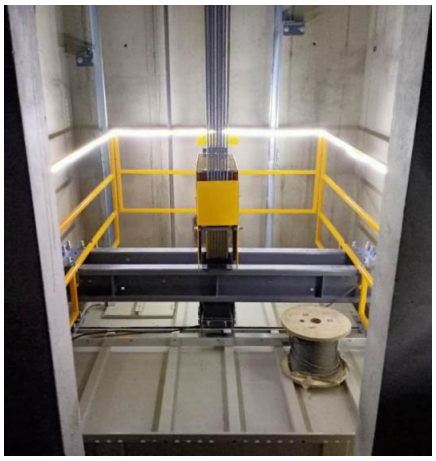

Figure 1. Schematic diagram of lift car top

3.4. Installation of Shock Absorber and Car

(1) Before installation, use the above electric hoist to hoist all accessories to the bottom floor. After installing 5m guide rail in the hoistway, fix the two shock absorbers of the lift car at the bottom of the hoistway with 8 12mm expansion screws according to the size requirements. (control the distance between the top surface of the shock absorber and the contact surface of the car bottom to be 150mm)

(2) Install the lower cross beam of the car between the guide rails and clamp it onto the buffer base with guide shoes. Install and connect the vertical beam of the car to both sides of the lower beam with 16 16mm screws. After the installation of the vertical beam, install the upper beam. Use the hoistway operating frame construction personnel to construct on the frame. Connect the upper beam with the vertical beam with 12 16mm screws. After the installation, install the upper guide shoes to the upper beam and clamp it onto the guide rail. The car frame installation is completed. Remove the hoistway operation frame. Install the car bottom plate. The bottom plate is connected with the lower crossbeam with 6 16mm screws. The four corners are connected to the vertical beam with diagonal pull rods to keep the car balanced. After the car wall plate and the car wall plate are spliced with 6mm screws, install the three sides of the bottom plate and the front door

side wall plate. Finally, install the car top plate and connect it with the upper end of the car wall plate with 8mm screws. Thus, the car installation is completed.

(3) Install the door motor and car door, adjust the tension of the door wire rope and the door lifting bolt, manually open and close the car door several times, and confirm that the door opening and closing are flexible and reliable.

3.5. Counterweight Installation

Install 4 auxiliary rail guide shoes on the counterweight frame. First install 15 counterweights (45kg/ block), which are suitable for light load operation. After the lift car is installed and the length of the steel wire is adjusted, the remaining 20 counterweights are installed to meet the conditions for formal operation.

3.6. Installation of Traction Wire Rope

(1) Determination of rope length: if the civil dimensions of the actual hoistway are consistent with the drawings, or if it is a standard hoistway, it can be directly calculated according to the sum of hoistway height above ± 0 + basement height +15m in the civil drawing (the manufacturer shall ship the hoistway according to the 110m high standard. If there is any discrepancy, it shall be proposed before delivery). The installation of steel wire rope is very important. The steel wire rope must be handled carefully on site to prevent damage by water, cement, sand, etc. do not twist or kink the steel wire rope. The kinked steel wire rope cannot be used.

(2) Lift the counterweight with a hoist to about 3.8m from the top of the counterweight to the bottom of the roof beam (the specific value shall be determined according to the design of the building), and fix the counterweight at this position with a lifting wire rope.

3.7. Wires, Cables and Safety Circuits

It mainly includes the installation of main cables and control cables from the control box to the traction machine, as well as control lines, i.e. traveling cables, as well as the installation of safety circuit limit switches, limit switches, deceleration switches, speed governor switches, safety gear switches, landing door switches, cage door switches, safety window switches, emergency stop switches, etc.

3.8. Commissioning Operation

Carry out the trial operation of layer by layer and docking according to the operation requirements, and install the deceleration and docking positioning magnetic strips at the same time. This is also the learning process of the computer main control board. After reciprocating operation, it reaches the standard of automatic deceleration and accurate leveling parking. Automatic operation can be realized after successful self-learning.

So far, the installation work has been completed. The project shall follow up the progress of installation and timely follow up the installation of shaft protective door. Ensure that there is no hole protection hole during the installation of the lift.

After all installation work is completed, the acceptance self inspection procedure can be entered. The standard is: the lift car is firmly installed, square and beautiful; The car guide rail and counterweight guide rail are installed accurately and firmly (the deviation is not greater than 1/1000), and the car runs smoothly without collision. Each safety limit is sensitive and reliable, each interlocking device is complete, sensitive and effective, and the floor stop is stable and accurate without impact.

4. Safety Measures

(1) The rated load of the hoistway construction elevator shall be placed in an eye-catching position in the elevator, and the hoistway construction elevator shall be used when the rated load is exceeded.

(2) Obvious safety warning signs shall be set within the operation range of shaft type construction elevator, and safety protection shall be done in the centralized operation area.

(3) The user unit shall set up corresponding equipment management organization or allocate full-time equipment management personnel at the site, and designate full-time equipment management personnel and full-time safety production management personnel for supervision and inspection.

(4) When a situation is found during the operation of the hoistway type construction elevator, it shall be shut down immediately until the fault is eliminated.

(5) The hoistway construction elevator needs a full-time driver to use it in strict accordance with the regulations, and to open and close the door for the users.

(6) The operators must pass the physical examination and have no diseases and physiological defects that hinder the operation. After obtaining the operation certificate through professional training and examination, and after the safety technical disclosure, they can work with the certificate.

(7) Operators and users must wear safety helmets and insulating gloves for live operation.

(8) No one is allowed to stay below when working above the ground. It is strictly prohibited to throw tools and materials up and down during the work.

(9) Coordinate multiple transportation when the goods are overloaded; After manual work, the door shall be closed and locked, and the key shall be managed by a specially assigned person.

(10) The electrical equipment used for construction must be well insulated. All exposed live electrical equipment and hazardous areas prone to electric shock shall be provided with fences, protective nets, boxes, gates and other facilities.

(11) The engineering and domestic electricity at the construction site shall be unified and standardized, the layout shall be reasonable, and the grounding device shall be reliable, so as to achieve "three-level control" and "two-level protection".

(12) The machinery must be correctly operated and reasonably used according to the technical performance, bearing capacity and service conditions specified in the site instructions. Overload, overspeed operation or arbitrary expansion of the scope of application are strictly prohibited.

5. Advantages of Hoistway Construction Elevator

At the edge of the structure, the single point transportation distance is far, and the elevator shaft position is not effectively utilized. The hoistway construction elevator proposed in this paper effectively uses the elevator hoistway as the carrier of vertical transportation, which will greatly improve the current construction organization mode of high-rise buildings and improve the construction production efficiency.

In combination with the actual characteristics of the project and in consideration of the requirements of Jiashan County

for building a civilized city, there are many factors such as limited site. Through comparative analysis, the hoistway construction elevator has the following obvious advantages.

(1) Sustainable operation during dust control. According to the fact that the indoor hoistway construction elevator is adopted, it has the advantages of low energy consumption, stable operation, no noise, and is completely enclosed in the structure without dust, which can ensure the normal operation of the construction during the dust control period.

(2) High security. At present, SC series elevators are used in the traditional dual-purpose construction elevators. Its structure is that a single cage or two cages are hung on both sides of the standard section, which will produce a overturning moment. When the elevator exceeds the last wall frame or the bolts of the standard section are not fastened, the overturning moment may break the standard section under this state, so that the cage will overturn and fall, resulting in a major accident. However, there is no overturning moment in the hoistway construction elevator, which completely avoids the occurrence of this problem and thus avoids the occurrence of this link accident. Because the traditional elevator is anchored on the external wall, it is also called external elevator. There is a certain distance between the elevator cage and the building. It is often necessary to build a frame, a springboard, etc. as a channel, and add protective nets and guardrails on both sides. Workers are easy to fall from the gangplank if they are slightly negligent during construction, while indoor construction elevators do not need additional protective nets. When the elevator stops at a certain floor, personnel or materials can be moved directly from the lift car to the floor. There is no gangplank in the middle, avoiding the danger of falling when workers walk on the gangplank.

(3) From the elevator to the basement, the material site can be set in the basement. The traditional external hanging construction elevator can not reach the basement through the column cap of the beamless floor, or needs to leave a hole in the basement roof to operate to the basement, which is difficult and difficult to achieve. A large number of aboveground secondary structural materials and decoration materials are piled up outdoors, resulting in the delay in the construction of the basement roof waterproof and roof backfill after the main structure is capped, resulting in the delay of the overall construction period of the basement roof outdoor construction. Moreover, a large number of materials are stacked on the top plate of the basement in disorder, resulting in poor site appearance, which is not conducive to civilized construction management. The application of shaft type construction elevator completely solves the above problems. From the elevator to the basement, set up a material site in the basement to ensure that there is a good civilized construction standard on the ground and it is conducive to the early backfilling of the underground reservoir.

(5) There is no external elevator, which can ensure that the facade construction can be completed in advance. In the construction of exterior wall insulation or curtain wall, the zipper opening needs to be reserved in the area occupied by the traditional external construction elevator, and the facade insulation and curtain wall construction can be continued only after the external construction elevator is removed, resulting in the overall delay of the facade construction period. The facade construction is a key process of completion and delivery, which will lead to the delay of the overall completion and delivery time, and the shaft type construction elevator is used, Will not affect the external wall insulation and completion delivery time.

6. Conclusion

This paper focuses on the installation process, operation key points, safety control and parameters of shaft type construction elevator, and introduces a kind of elevator equipment suitable for special-shaped high-rise buildings. The research results show that

(1) The reasonable overall arrangement of shaft type construction elevators can ensure the construction progress requirements.

(2) The shaft construction elevator can effectively use the elevator shaft as the carrier of vertical transportation, which will greatly improve the current construction organization mode of high-rise buildings and improve the construction production efficiency.

References

[1] Perttula, P., Korhonen, P., Lehtelä, J., Rasa, P. L., Kitinoja, J. P., Mäkimattila, S., & Leskinen, T, "Improving the safety and efficiency of materials transfer at a construction site by using an elevator," Journal of construction engineering and management, vol. 132, pp. 836-843, Aug. 2006

[2] Wei, C. Q., & Gao, X. Q, "Design of control system of construction elevator based on PLC," Applied Mechanics and Materials, vol. 380, pp. 337-341, Aug. 2013

[3] Wang, Y., Chong, H. Y., Liao, P. C., & Ren, H, "Interactive mechanism of working environments and construction behaviors with cognitive work analysis: an elevator installation case study," International Journal of Occupational Safety and Ergonomics, vol. 25, pp. 362-376, Mar. 2019

[4] Quine, B. M., Seth, R. K., & Zhu, Z. H, "A free-standing space elevator structure: a practical alternative to the space tether," Acta Astronautica, vol. 65, pp. 365-375, Apr. 2009.