

Exploration Of Structural Design Principle and Construction Technology Application for Super High-Rise Buildings

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Abstract. With the rapid development of super-high-rise buildings, the popularity rate becomes higher and higher. People's requirements for the stability and practicability of their buildings are also increasing. At the same time, the design principle of super-high rise building structure is constantly improved and developed. The various construction methods of super-high rise building make the structure of high-rise building more stable. It can meet more construction needs and further improve the appearance of the building. At the same time, the construction process is improved. The application of construction technology and construction optimization are laying a foundation for the development of super high-rise buildings. This paper focuses on the summary of structural design principles of super-high-rise buildings and the introduction of construction technology and optimization. At the same time, it discusses the construction process of the main structure of the building, as well as the different processes and different theoretical schemes before and during the construction. In this way, the super-high rise building structure is systematically improved and summarized, which will lay a foundation for future research and development.

Keywords: Construction process; Structural Design Principles; Application of Construction Technology; Construction optimization.

1. Introduction

The completion of the Manhattan Life Insurance Building in New York City in 1894 marked the development of high-rise buildings into the super tall building stage. The large influx of people into cities during urbanization has increased the shortage of land for construction. Therefore, the development of high-rise and super-high-rise buildings was an irreplaceable choice at the beginning of high-rise phenomenon. After the end of the World War II, with the recovery and gradual prosperity of economy, the development of super-high-rise buildings has entered a new stage. Modernist super high-rise buildings characterized by simplicity, practicality and freedom from traditional architectural firms have become the mainstream of development. High rise buildings can bring obvious social and economic benefits. Firstly, population concentration can shorten the distance between departments by using the vertical and horizontal traffic inside the building, thus improving efficiency. Secondly, the use of super-high-rise buildings is diversified and comprehensive, generally used for office, living, apartment and hotel. This has contributed to the diversification and economic development of today's cities. In addition, super-high-rise buildings can make the land for large buildings significantly smaller, and the various construction methods make the structure of high-rise buildings more stable. High-rise buildings can save urban land and shorten the development cycle of public facilities, thus reducing municipal investment and accelerating urban construction.

The construction departments of large cities in various countries are constantly carrying out comprehensive research on various problems that have arisen and taking improvement measures. The lateral resistance system of super-high-rise engineering building structure is an important basis for judging whether the super-high-rise engineering building structure can be reasonable and stable. As the construction quality of the project is improving day by day, the quality requirements for the structural anti-side force system are getting higher and higher. So people need to innovate the structural system. The integrated construction mode, the breakthrough of high-altitude technology and the fire evacuation have also led to the development from a single supertall building to a conjoined structure of "sky city" formed by several supertall building towers. This study analyzes the

construction process, design principles, construction techniques, and construction optimization of super-high-rise buildings from different perspectives and explores the structure of super-high-rise buildings.

2. Construction process and design principle of main structure, optimization and measures of construction and management

2.1. Construction process of main structural engineering of buildings

For the construction of houses, engineers usually adopt the flow casting method to form a whole construction operation process from bottom to top in order to achieve better building quality and construction efficiency. First, the pre-data need to be checked before the building foundation construction project is carried out. The installation of structural reinforcement bars and the bundling of columns are carried out after the construction site is determined. Secondly, during the construction, first set the foundation construction template, then implement the construction of structural reinforced concrete pouring [1]. Then vibrate and extrude the structural reinforcement, remove the reinforced concrete of the foundation strut synchronously at the end, and maintain the foundation frame. Thirdly, after the reinforcement construction of the building beam slab, the pre-stressed reinforcement of the component in the construction is added simultaneously, and then the reinforced concrete is used to complete the floor structure of the building and the excavation of the reinforced concrete. Fourth, placing cement on the foundation frame, stretching the reinforcement and removing the reinforcement of the foundation frame. In the construction of the main structure of buildings, masonry technology of building reinforcement, template and concrete material occupies a key proportion in the construction of the main structure of buildings. In the construction of the main structure of buildings, the masonry technology of building reinforcement, template and concrete material is also very critical.

2.2. Exploration of Structural Design Principles of Super High-rise Buildings

1. It is necessary to increase the intensity sensing of seismic fortification. Buildings over one hundred meters with different seismic fortification intensities are of different heights [2]. Complex high-rise buildings and super-high-rise buildings are more suitable for construction in areas with seismic fortification intensity of magnitude six. In general, taking seismic fortification intensity into account in this area is the precondition for the construction of such related super high-rise buildings. By doing so, we can avoid technical errors and prevent unnecessary losses to people's lives and property. At the same time, great attention should be paid to seismic technology to improve the quality of high-rise buildings, including the economy and safety of buildings.

2. Structure scheme and type. The issue of structural plans and types of buildings is an important foundation. The design organization should have structural expertise and participate in the design. The selection of the type of high-rise structure not only considers the geotechnical engineering geological conditions of the scheme location but also the seismic requirements of the location. In addition, in order to better save construction costs, the problems of project cost and construction rationality should also be fully considered. Under the same conditions, a lower-cost solution is generally adopted.

3. To focus on comfort and construction. (1) Horizontal vibration comfort of high-rise buildings. the structures of complex high-rise buildings and super-high-rise buildings are relatively soft. Therefore, in the design, in addition to ensuring structural integrity, more people need to satisfy the building comfort requirements [3]. Comfort analysis is the main task of analysis of complex high-rise buildings. For concrete structures, the damping ratio is better at 0.02; For steel structures and hybrid structures, the damping ratio can be taken from 0.01 to 0.02 according to the actual situation. Limits of horizontal vibration index are also very different between public buildings and apartments. The main reason is the different functions. (2) The feasibility of the construction process should be considered in the design. It is necessary for the designer to pay attention to the transmission condition

of the steel, the reliability of reinforcement in complex joints and the practicability of construction in time. Complex high-rise buildings employ other special techniques in their construction. Concrete construction is a procedure for preparing cement materials, such as concrete additives, proportioning design, raw material calculation, formwork manufacturing, concrete transportation, laying materials, conveyor pipes, vibrating, placing and concrete inspection. At the same time, do not place the water pipe directly on the building. The water pipe must not absorb air during transportation, otherwise, it is easy to cause cement backflow blockage. In addition, the tank should be replaced regularly, and the pump line should be checked regularly for smoothness. A reasonable pouring method is selected by the construction method which can improve the quality of cement. Concrete is poured once to the top, with slope stratification, continuous step-by-step, and with a natural flow gradient [4]. However, we must pay attention to the fact that while the concrete is being transported, the problems of quality and management must be correctly solved. As water hardness is one of the most important characteristics of concrete, it needs to be maintained later to prevent excessive and rapid water loss of the concrete surface layer, leading to cracks.

2.3. Application of Construction Technology for Super High-rise Buildings

1. Main technical application of construction inspection. Before each building project of super-high-rise engineering building starts, the main axis, vertical and elevation lines of the building with the whole structure must be checked first [5]. The inspection of the main shaft requires each inspector to check the results of axle measurement accurately and mark the control points of the embedded working steel plate correctly. Testing must also be carried out strictly following actual construction specifications and regulations of main engineering projects of super-high-rise buildings. Laser theodolite must be used in specific operations. Vertical detection, and correct positioning must be made, and the positioning of edge and corner columns of the overall structure should be double-checked by using the weighting hammer and laser instrument in the whole detection process, to ensure that the vertical of the main structures of super-high-rise engineering buildings reach a reasonable range [6]. For elevation line calculation, all building designs reserved holes above 4, and the standard axis size has been carefully controlled and precisely positioned. In reviewing, reference must also be made to the standards of other buildings and operation must be carried out by leveling gauges.

2. A method of formwork construction. Formwork construction requires the timely selection of molds and the design of the construction process according to the current situation on-site. The selection of molds shall be based on the dimensions of super-high-rise buildings and the characteristics of their current construction site. Usually, the floor structure used needs to be made according to the size of the clear water component, and the plug seam needs to be treated with foam adhesive tape for template jointing or directly sealed with adhesive paper. After the beginning of the board construction, the template control circuit needs to be prepared and the elevation control axis needs to be completed. Concrete mortar is the traffic foundation, so it is necessary to look for a flat floor, find the form joint at the bottom of the wall and holes in the doors and windows, and level the thickness according to the elevation of the floor. The sample design should point out that the upper and lower inspection, reasonable door and window opening, and leakage should be avoided. To verify the quality of the board binding, you must first control the template specifications and standards on the axes when binding the board. For template removal, the removal procedure shall be formulated to meet the corresponding standard specifications.

2.4. Construction optimization for super high-rise building processes

Calculate the elevation line, all the reserved holes in the building design are above four, and the standard axis dimensions are carefully controlled and precisely located. In reviewing, reference must also be made to the standards of other buildings and operation must be carried out by leveling gauges. Ultra-high-rise construction is different from common multistoried or high-rise buildings. The technical level and conditions of building construction have their own special needs. To improve the technical level of construction, technical optimization must be carried out in the following aspects.

First, adjust the center of gravity of the building. Due to the long construction period and a large investment in super high-rise projects, it is necessary to plan in the early stage of building construction, take the main building as the center of gravity of the main building, and comprehensively adjust the conditions of other parts of the building, to achieve the desired architectural effect. Second, the adjustment of the main building line [7]. Because the foundation of a super high-rise building is deeply buried and the structural construction conditions are complex, the Contractor must adjust the main line of construction technology to the construction technology of the foundation and structure and must make reasonable allocation and optimization of building construction technology, which is conducive to effective control of the whole project construction situation. Third, actively implement management. The construction working surface of a super high-rise building is relatively small, so the whole building construction process becomes more stable. The key is to shorten the delay time, which requires harmonious and orderly construction management. Fourth, improve construction efficiency. Increasing the proportion of mechanized construction to give full play to the advantages of vertical construction technology, so as to improve the overall construction efficiency, is also a must in super high-rise construction [8].

2.5. Measures for Strengthening the Supervision and Management of the Construction Quality of Super High-rise Buildings

It is very necessary to strengthen safety management. In order to make the construction go smoothly, the safety staff must be reasonably set up to carry out inspection and patrol operations, and the staff must be properly trained. At the same time, the illegal construction problems among construction workers should be corrected in time, and their operation behavior should be gradually standardized to avoid major safety accidents. The formwork control line and elevation axis shall be well prepared. In addition, the support points choose concrete foundation, find the plane and wall bottom formwork, and at the same time avoid the leakage of slurry. The quality of tying of plates is strictly checked. When tying the plates, first of all, the specifications of the formwork and the standard of the center axis should be controlled. For formwork dismantling, the dismantling procedure should be made so that it meets the corresponding standards and specifications.

2.6. Application of construction technology in building and main structure engineering

The main structure project and construction method of the construction project are applied to the construction field. First of all, the implementation of the main structure of the building project in a city is taken as an example. The main structure project of the building adopts the frame-type shear wall structure, and the actual application of the main structure project of the building to the building technology mainly involves the following aspects.

2.6.1 Pre-stressing construction of the main body of the building.

The steel is divided into steel bars and steel wires according to different lengths of steel. The steel bars are often coiled into coils [9]. The length of thick reinforcement is more than 22mm, the length of medium thick reinforcement is 12~22mm, and the length of fine reinforcement is 6~12mm. The processing of ordinary steel bars is completed in the company and has gone through many technological processes, such as cold drawing, connecting steel bars, cutting, etc. When adjusting the joints of binding load-bearing bars, they should be staggered and should not be more than 30 times the diameter of the original load-bearing bars. When adjusting the section width of the load-bearing bars in the binding joints and the section length of the load-bearing bars, the proportion of the section width of the load-bearing bars should be adjusted. The adjusted load-bearing area should be less than 50% and the adjusted tensile area should be less than 25%. During on-site binding and assembly, formwork construction must be combined. When making the column frame, the binding work must be completed before the column frame assembly. When binding a dyed frame, usually after the column frame is assembled, it is tied up immediately above the template and then placed inside the template. If the frame is very high, one side die should be retained and not placed until the dimensions

of the frame are tied up in the template, then placed in the template and fixed through the side die. When bundling floor reinforcement, it is usually done after assembly of floor reinforcement and then bundling. In concrete, the certain protective film is produced reinforced concrete. Therefore, concrete mortar blocks are usually prepared in advance for construction between reinforced concrete and sample plates to adjust the thickness and thickness of the protective film. During the construction of reinforced concrete, the diameter of some surface layers of reinforced concrete cannot be reduced to prevent engineering quality problems. The normal construction of steel bar diameter should not be exposed. Before concrete construction, it is necessary to check the diameter of the steel bar and installation of embedded parts and make relevant records.

2.6.2 Methods of construction and placement of concrete for the main structure of building.

The corresponding construction techniques and essentials must be mastered during the concrete construction process to make the structural load-bearing capacity of the building composite members greater and to cover more dimensions. During the construction of the walls and columns, the mixing time of the concrete should be adjusted. Adjust the thickness of concrete to about 40 cm and strictly control the construction of concrete to prevent the formation of honeycomb on the surface of concrete. During the construction of the bridge elements, ensure the reasonable adjustment of the level of the girders to facilitate the later construction and avoid prolonging the construction time. In addition, the whole process of cement construction cannot be interrupted [10]. Due to the extensive use of modules to ensure the quality of concrete placement, the concrete setting effect has changed accordingly. In the process of setting concrete or placing some modules, bamboo and wooden formwork should be used as building materials for manufacturing columns to rationalize the use of building materials. It is more recommended to use high steel materials as building materials for interior wall columns and bamboo glue boards for columns and roof structures.

2.6.3 Formwork construction and disassembly.

When the module is set up or supported, the uniformity and smoothness of the upper and lower parts are ensured to prevent concrete from slipping. The dismantling of modules should be done according to various construction specifications specifying the concrete strength. If the concrete strength is above 1.05 of the design strength, most of the module disassembly can be completed. If the concrete strength is within the range specified in the specifications, the integrity of the concrete edges, corners, etc. must be ensured before the modules can be completely dismantled. In addition, the template removal work should be carried out concurrently with the concrete construction work to delay the removal time of the building parts. scientific and technical personnel are required to complete various technical delivery work as well as project quality supervision and inspection in strict accordance with the construction specification requirements.

3. Summary

This paper focuses on the summary of structural design principles and the application of construction techniques for super tall buildings. These studies in this paper include the analysis of construction process: the methods and steps of using steel and concrete during construction, the summary of design principles: including the increased induction of seismic intensity, the pre-design of structural solutions and types, and the development application and optimization of construction techniques. The results of this paper show that the design principles of supertall buildings are still in the process of improvement and refinement, and the existing design principles need to be summarized and generalized. It is also necessary to optimize the construction process and technology so as to ensure the smooth implementation of construction. As for different construction quality management measures, it can ensure the smooth completion of super high-rise buildings. And this paper is a good reference for the construction of any supertall building. On the basis of this paper, various aspects such as design principles, construction techniques and optimization, and improvement of construction process are added. All these researches will play a good role in promoting the development of super

tall buildings in the future and now. In the future, the development of supertall buildings will still be mainstream.

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