

Analysis on Construction Technology and Quality Control of Large Span Space Steel Structure

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Abstract: In construction engineering, the construction technology of long-span spatial steel structure is widely used and has achieved good results. However, there are still some problems in its practical application, which have a great impact on the engineering quality. Based on the theoretical exposition of the on-site construction of long-span space steel structure, this paper explains how to ensure the safety and stability of permanent structure and temporary support structure in the construction process. Ensure that the state of the structure in the construction process is in a controllable range, and finally reach the design requirements of the complete structural state.

1. Introduction

With the change of architectural concept, many new types of buildings have emerged at present, especially the roof structure system of large public buildings such as airport buildings, stadiums, exhibition centers and so on all adopt large-span complex spatial steel structures. However, in the actual design and application process, the large span brings new adjustments to the construction quality control personnel due to its high requirements on steel strength, good prestress control effect and large welding quantity. On-site construction of large-span spatial steel structures refers to the process of assembling scattered steel members into umbrella structures that meet the design requirements and have the use function after the steel members are processed, manufactured and transported to the site by different construction technologies and methods [2]. The new type of steel has the advantages of high strength, light weight, high precision of finished products, stable quality, reusability, batch prefabrication in factories, simple assembly in construction sites, etc. Therefore, the design scope of the spatial structure is wider, the structural performance is better, and the industrial production is more favorable [3]. The construction technology of long-span space steel structure is favored in application due to its various forms, strong appreciation and good economy. At present, large-span spatial structures are applied in some roof structures such as airport buildings and exhibition centers.

2. Construction of Large Span Space Steel Door

This paper mainly takes a base project as an example to analyze the construction quality control measures of long-span spatial steel structure.

2.1 General Situation of Gate Project

The gate of the project is arc-shaped with an arc top height of 10.103m m. The tower is constructed with reinforced concrete structure in the middle. The steel skeleton of the arc-shaped gate is connected to both sides of the tower and presents symmetry. The arc width is 17.55m m. The arc-shaped steel beams are all H-shaped steel. The choice of each construction scheme has its technical pertinence and is closely related to the management of safety, progress, quality, cost and other aspects of the project. From a mechanical point of view, the structural mechanical analysis in the construction stage is different from that of the operation structure. The construction process is a process of changing structure, load and boundary. Therefore, tragedies will be avoided. Whether from the perspective of safe construction or the perspective of construction quality, it is particularly

important to control the construction process of long-span spatial structures.

2.2 Construction Plan

The quality of all fittings of this project should be checked in time before leaving the factory. Only by ensuring the quality of components can the construction quality be guaranteed. In addition, during the pre-assembly of steel beams, the staff should control the quality of the steel beams in a timely manner. If deformation and cracks are found in the components, they should be corrected and repaired in a timely manner. Full framing scaffold installation is a method of erecting full framing scaffold according to structural form characteristics and site characteristics and assembling structural components in the air, which is mostly used for structures with low height and small span [4]. In the middle of the construction process, it is necessary to specify the linear shape and internal force state of the incomplete structure. Otherwise, the structure cannot meet the design requirements when it is completed [5]. Specifically, the larger the span of engineering construction, the greater the load the cantilever will bear, which requires that the strength of steel must meet the design requirements. Staff should count the quantity and specifications of each component in time to ensure that the quantity and specifications of accessories meet the actual construction requirements. It is suitable for space structures with high installation height, large span and large component size and weight. Lattice supporting structure has the advantages of good bearing capacity and flexible arrangement, and can also ensure construction safety compared with full scaffold method [6].

2.3 Construction Technology

Before the installation of steel structure, the number and specifications of components must be checked. The supervisory staff should also check the construction certificate and other documents in time. If quality problems are found, records should be made in time and corrections should be supervised. According to the actual situation of the structure, the appropriate assembly sequence should be selected to facilitate control accuracy and reduce accumulated errors. During the assembly process, the elevation and axis position should be well controlled to ensure that all relevant assembly indexes of the structure meet the relevant specification requirements after the completion of the overall assembly [7]. For example, the size and location of construction load, the assumption of structural performance (elastic modulus, density, cross-sectional characteristics), the connection form of components (rigid connection or hinged connection), the constraint form of supports, etc. These differences determine the preparation for understanding the intermediate structure state during the construction phase. Reuse old materials when the structure allows, reduce the emission of pollutants and minimize the impact on the surrounding environment. Therefore, it is extremely difficult for the construction unit to set out. Moreover, for some bent and twisted components, special experimental research must be carried out before they can be completed.

2.4 Installation Method of Steel Structure

In the actual construction, the staff added five curved steel beams on each side of the gate tower according to the actual situation of the construction site. Before the construction of steel beam crane, the staff need to build full scaffolding, the main purpose is to provide operating platform for the staff. A smaller triangular lattice is formed by secondary beams in a large triangular lattice formed by primary steel beams, and the triangular elements of the primary and secondary beams jointly form a thin shell whole. Predict the structural shape of the subsequent construction process, put forward the technical measures to be taken in the subsequent construction process, and adjust the necessary footwork technology and technical scheme so as to effectively control the position, deformation and internal force of the completed structure. Span projects are all national key projects, requiring relatively high project quality. Only by improving the machining accuracy of components can the requirements of engineering quality be met. In addition, the requirements for welding seams and the like reach the first level, thus bringing great difficulty to the construction. In the aspect of prestress, the tension structure and cable dome, which are important manifestations, can greatly enhance the service strength of steel. The symmetry of the tower needs to be ensured when installing on both sides. Usually, the left curved steel beam is installed first, then the right curved

steel beam is installed, and finally the connecting beam between the two curved steel beams is installed. Ten steel frames are installed according to this construction method. An additional crawler crane shall be installed with high-altitude assembly method. During installation, there shall be an installation support frame and an installation operation platform. The installation sequence shall be from bottom to top, from inside to outside.

3. Construction and Quality Control of Large Width Steel Structure in Workshop

3.1 Construction Plan

The quality of all fittings of this project should be checked in time before leaving the factory. Only by ensuring the quality of components can the construction quality be guaranteed. In addition, during the pre-assembly of steel beams, the staff should control the quality of the steel beams in a timely manner. If deformation and cracks are found in the components, they should be corrected and repaired in a timely manner. At the same time, roof components, electromechanical equipment and the like can be installed in place on the ground before jacking, and the roof components and the electromechanical equipment can be jacked to the design elevation together, thus saving installation cost and time. The location of monitoring points must be comprehensive so as to grasp the overall state of the structure. According to the principle of comprehensiveness of monitoring sites, the more sites, the better. However, too many measuring points will increase the workload and difficulty of on-site monitoring. Too many lines often affect on-site construction, and the operability is poor. During the construction, the staff should prepare auxiliary materials for the construction in time, such as welding rods, pads, etc., and also show certificates and lists of various components. For the connecting plates of two welded steels, the method of welding and fixing shall be adopted, or the direction of connecting pieces shall be set along the shearing force of steel members, so as to prevent the leakage of plates [8].

3.2 Component Processing and Assembly

Because there are many kinds of components to be processed in this project, the article mainly analyzes the fabrication and assembly of H-beam and crane beam. After the fabrication of H-section steel is completed, it should be corrected to ensure the quality of the components. Before assembly, the staff should inspect the flange plate, web plate and other parts in time, and ensure the straightness is less than 1/1000 tolerance before entering the next construction link. The corresponding structure shall be constructed after hoisting is completed, and no running water can be inserted, which will have certain influence on the construction period of the overall structure, and requires the use of lifting equipment with relatively high performance and heavy lifting weight. Then the secondary steel truss between the two main steel trusses is hoisted, and other steel trusses are hoisted in this order to ensure the hoisting stability of the whole steel structure. The unloading process in the construction stage is often a complicated process of mechanical transformation, and it is also a stage of frequent construction accidents. This stage is the focus of monitoring. In addition to monitoring the stress and deformation of permanent structures, it is very necessary to arrange stress measuring points on temporary support structures.

During the crane beam assembly process, the staff should open the groove of the contact part of the web plate and flange plate according to the requirements, and then adjust the gap and wrong edge. After completion, the welding can be started. It should be noted that the anti-deformation value should be fully considered in time during the assembly. It is applicable to the construction of space steel structures with corresponding structural support points and insufficient assembly site. The integral lifting is similar to the integral lifting, and the lifted structure is also integrally assembled at a lower height. The main steel truss is large in span and high in height, so it is hoisted in three times. The steel truss near the two sides of the concrete column is hoisted by single crane. Because the middle section is too far away from the outside of the building, considering the hoisting height and hoisting range, double cranes are required to be hoisted, and the full cooperation of two cranes is needed in the hoisting process. According to the principle of monitoring, the overall

monitoring time should be from the beginning of the structure construction to the end of the construction. In terms of specific time, it is generally necessary to monitor various contents before and after the change of construction conditions to collect the change value and compare it with the theoretical analysis result. Due to the characteristics of large span and new structure, in order to ensure safety and economy, advanced technology must be adopted in the construction to ensure smooth completion.

4. Steel Column Hoisting

4.1 Preparation Before Hoisting and Installation

Before hoisting and installation, staff should build temporary ladder climbing columns according to actual conditions to prevent safety accidents. Generally speaking, the ladder is made of $\Phi 12$ round steel in the process of making, the width should be controlled at 300 ~ 350 mm, and the distance between the rungs should be 300 mm. Taking six reinforced concrete core tubes in the main structure as lifting bearing points, the overall weight of the main truss is about 10,500 tons. After all trusses of steel structure and main steel beams and other main components are assembled on the ground, hydraulic lifting equipment is used for overall lifting. After being in place, two cable wind ropes shall be set up on both sides of the roof for temporary fixing, and the verticality shall be corrected by cable wind ropes. After that, the roof truss shall be temporarily fixed and corrected by wood and wire ropes.

The acceptance of sub-projects is the final check on the quality of some completed sub-projects and is a key link in quality control. The quality and technical management objective of this project is to reach the national excellent engineering level on the basis of meeting the requirements of standard acceptance and qualified engineering. The process of assembly in place can be divided into the following management aspects: quality control of raw materials, technical quality control of processing process, technical quality control of various sub-projects during installation, temporary support and unloading control (Figure 1).

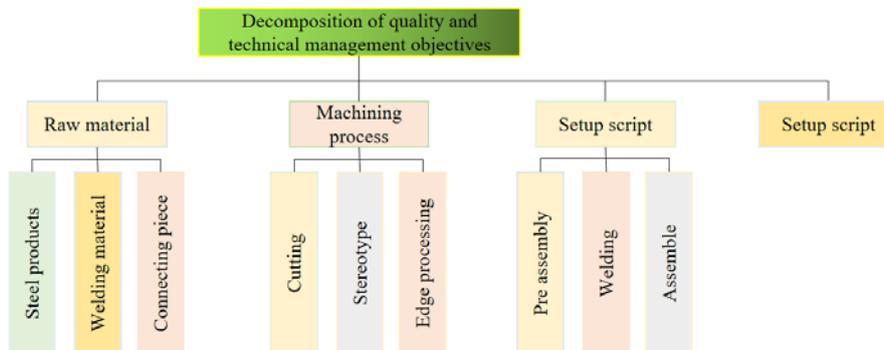


Fig.1 Breakdown Diagram of Quality and Technical Management Objectives

For the stadium with large steel structure, the spectator stands are relatively high and concentrated, so the steel structure is usually hoisted in sections. In the process of sectional hoisting, the main technologies include: the position and selection of hoisting machine, the selection of section and center of gravity of large steel structure, the selection of steel wire rope and the treatment of point position, etc. No welding points can be found on the longitudinal and longitudinal uprights of the ladder. the top of the steel ladder should be simmered into hooks, and the ladder should be made in sections, with each section 4 ~ 8m in length and 2.5m in interval tied with No.8 iron wire and steel columns.

4.2 Steel Column Hoisting Process

When lifting the column, due to its large length and heavy weight, extra care should be taken when lifting. The staff shall check the lifting point, lifting appliance, lifting rope and other equipment in time, and at the same time tie the dragging rope well, and ensure the integrity of the

foundation. In order to eliminate the influence of roof truss side bending on verticality, the hanging line clip can be used to extend a certain distance from one side of the lower chord of roof truss to pull the wire, and the same distance hanging line hammer can be used to check the upper chord. The main unit components of the installation method are assembled at the lower part, and the safety is high; By checking the assembly quality, the docking error during hoisting can be reduced and the quality can be controlled. Compared with full scaffolding, it reduces the usage and saves the construction cost. Environmental sanitation cleaning shall be carried out on the construction site, special personnel shall be arranged for cleaning, and waste materials and construction wastes shall be stored and disposed of in a classified manner. Then mark the inside of the cup mouth, and apply C35 fine stone concrete to smooth the cup bottom. Centerlines should be installed on three sides of the column body to improve the safety of hoisting. The length of the column is 34.6m, which can be divided into two parts for hoisting. The first part itself weighs 30t and is installed to a height of 25.3m m. The invention is suitable for a system in which the segmented strip-shaped or block-shaped units have enough rigidity, have self-stability or can ensure self-stable structures through temporary inch reinforcement measures, and a support frame installation platform still needs to be built at the splicing position after the separation units.

5. Roof Beam Installation

5.1 Construction Technology

The construction process flow is shown in Figure 2.

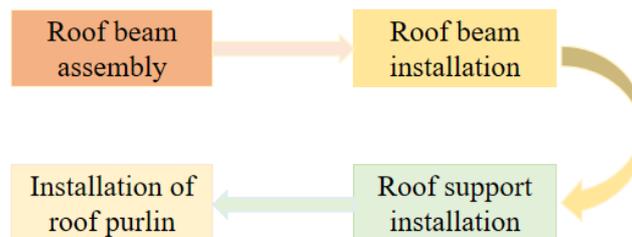


Fig.2 Construction Process

5.2 Construction Method

Before the roof beam hoisting construction, the staff should install temporary railings on the roof beam, etc., and also ensure that the roof beam is hoisted in place synchronously. When installing the roof system, the construction shall be carried out according to the unit, and if necessary, the adjustment shall also be carried out according to the unit. Two 250t crawler cranes are selected for hoisting. After the steel ring beams are hoisted in place on both sides of the site in sections, the whole assembly is adjusted, welded and formed. The main truss adopts the construction method of setting up a lattice type installation platform at the connection point and hoisting the main truss in sections and splicing it at high altitude. Each node is provided with a limiting plate, and the stability is strengthened by a space triangular truss. In order to ensure sufficient strength, rigidity and stability of temporary piers in steel frame installation and construction, and ensure construction safety, the heaviest steel frame with the most unfavorable stress is used. For the 36m-span roof beam of the B-E axis, the overall hoisting shall be carried out after the assembling of the ground jig frame is completed, and the 27m-span roof beam of the side span shall also be hoisted after the assembling is completed. During the roof beam hoisting construction, punching nails are used to locate the beam and column connecting bolts, and then bolts are threaded. After all bolts are threaded, adjustment and initial tightening are carried out. Before pouring the slab or installing the prefabricated slab, recheck the connection between the beam and the column directly to ensure that there are no welding leaks, loose bolts and qualified installation gaps of components to ensure the safety of the construction process and the later use [9].

6. Conclusion

To sum up, the construction technology of span space steel structure is of great significance in construction engineering, which can not only improve the appreciation of buildings, but also ensure good economic benefits of construction engineering. With the continuous improvement of the domestic economic level, people's desire for large railway stations and gymnasiums is also increasing. At present, large span steel structures with different structures are emerging in the market. According to the characteristics of the engineering installation process, the quality control objectives are decomposed, and the quality management of multi-curved space steel structure is decomposed into the quality management of various sub-projects and the quality management of temporary projects such as support and unloading. Construction enterprises should carry out fine management of the whole construction project to ensure the rational use of resources and energy and to prevent extravagance and waste. Save construction cost and improve social and economic benefits.

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