ISSN: 2472-3703 DOI: 10.6911/WSRJ.202310_9(10).0012

Simulation Analysis of The Construction Process of Large-span Multi-layer Orthogonal Steel Truss

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Abstract

The construction method of in-situ assembly and segmented lifting is generally used for large-span orthogonal steel trusses, which is difficult to construct and quality control is also a challenge. Taking actual engineering as the background, a finite element software was used to simulate and analyze the entire construction process of the steel structure in the podium I area of a certain museum. The construction process of the podium I area was divided into 24 steps. The finite element results showed that the displacement and stress changes of the steel truss during the construction process met the requirements, and the steel truss installation construction plan was safe and feasible, providing reference for similar engineering construction.

Keywords

Orthogonal steel truss; Stress analysis; Displacement analysis; Finite element simulation.

1. INTRODUCTION

With the development of the times, the forms of building structures have become increasingly diverse and complex. Steel structures are widely used in large space and span buildings, and the forms of steel structures have also become diverse. Large span orthogonal steel trusses are one of them. The large usage space brought by the large-span orthogonal steel truss structure also greatly increases the difficulty of engineering construction, and quality control during the construction process is also a challenge. Taking actual construction as the background, finite element simulation software is used to simulate the construction process of the orthogonal steel truss. Based on the results of finite element simulation analysis, the feasibility of the construction plan and the areas that need to be focused on during the construction process are studied.

2. PROJECT OVERVIEW

The construction project is a large-scale museum, consisting of a main building and a podium. The main building has a height of 70m and the podium has a height of 35m. The museum podium has four, six, and eight floors, with three floors arranged using trusses. The height of the single-story truss is 2.15m. The distribution area of the orthogonal truss is mainly on the south and north sides of the podium, with the truss arranged in both directions and a maximum span of about 30m. The steel structure of the podium is divided into four construction areas: Zone I, Zone II, Zone III, and Zone IV. The following text mainly analyzes the construction process of the large-span orthogonal steel truss in Zone I.

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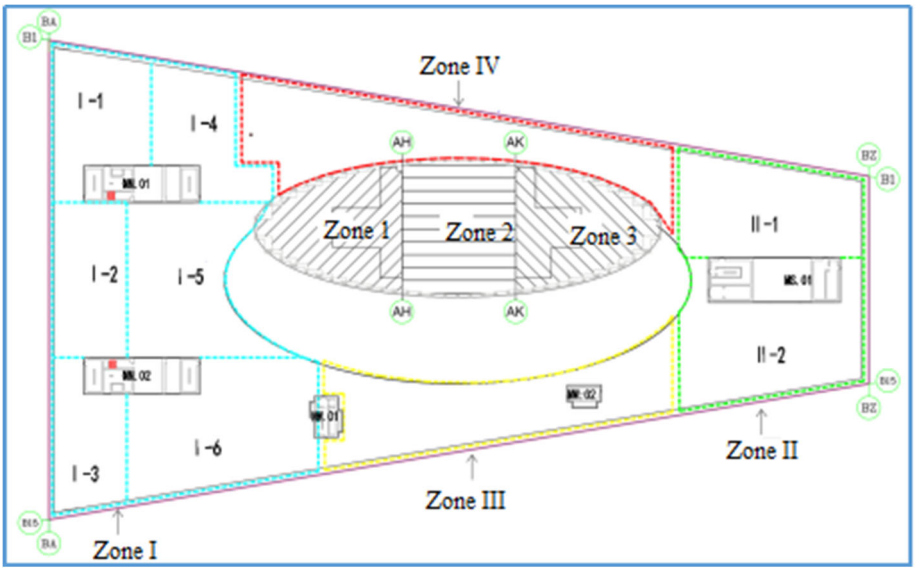

Figure 1. Partition diagram for steel structure construction of podium building

3. CONSTRUCTION PROCESS OF LARGE-SPAN ORTHOGONAL STEEL TRUSS

The construction of steel structures in Zone I includes the construction of round steel columns, jump floor trusses, core tube cantilever trusses, and orthogonal steel trusses. The specific construction steps are as follows: Construction step 1: Install the structural columns and core tubes; Construction step 2: Install the cantilever truss and temporary support below the transition truss; Construction step 3: Install the core tube cantilever truss, temporary support for the 4th to 8th floors of the cantilever truss, and the transition truss; Construction step 4: Install the temporary support for the lower part of the first floor main truss, remove all temporary supports for the cantilever and jump floor truss; Construction step 5: Install 4 main trusses and 4-6 temporary supports; Construction step 6: Install the main truss on the 6th floor, temporary support on the 6th to 8th floors, and remove the temporary support on the first floor; Construction step 7: Install the main truss on the 8th floor and remove the temporary support on the 4th to 6th floors; Construction step 8: Install the trusses of I-1, I-5, and I-6 on the 4th to 8th floors, as well as the tire racks of the first floor of I-1, I-5, and I-6; Construction step 9: Install the truss and temporary support of I-1, I-5, and I-6 sections on the fourth floor; Construction step 10: Install the truss and temporary support of I-1, I-5, and I-6 sections on the 6th floor, and dismantle the temporary support on the first floor; Construction step 11: Install the truss of I-1, I-5, and I-6 sections on the 8th floor, and the first layer of I-4, I-5, and I-6 sections; Construction step 12: Install the truss and temporary support of I-4, I-5, and I-6 sections on the fourth floor; Construction step 13: Install the truss and temporary support of I-4, I-5, and I-6 sections on the 6th floor, and dismantle the temporary support on the first floor; Construction step 14: Install trusses and temporary supports for I-4, I-5, and I-6 sections on the 8th floor, and temporary supports for the first floor of I-4, I-2, and I-3 sections; Construction step 15: Install the truss and temporary support of I-4, I-2, and I-3 sections on the fourth floor; Construction step 16: Install truss sections I-4, I-2, and I-3 on the 6th floor, and dismantle temporary supports on the first floor; Construction step 17: Install the truss of section I-4, I-2, and I-3 on the 8th floor, and install temporary support for section I-6 on the first floor; Construction step 18: Install 4-layer cantilever components, I-6 truss, and temporary support; Construction step 19: Install the 6-story cantilever components, I-6 section truss, and temporary support, and remove the first floor temporary support; Construction step 20: Install 8-story cantilever components, I-6 section truss, and I-6 section first floor temporary support; Construction step 21: Install the I-6 truss and temporary support on the fourth floor; Construction step 22: Install the I-6 truss

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and temporary support on the 6th floor, and dismantle the temporary support on the first floor; Construction step 23: Install the 8-story I-6 truss; Construction step 24: Dismantle the temporary support of I-6 on the 8th floor.

4. CONSTRUCTION PROCESS SIMULATION ANALYSIS

During the installation process of the steel structure of the Canal Museum, the structural stress situation is different from that of the original design in the one-time forming state. Therefore, in order to ensure the safe implementation of the engineering construction plan, finite element analysis software is used to simulate and analyze the structural construction process.

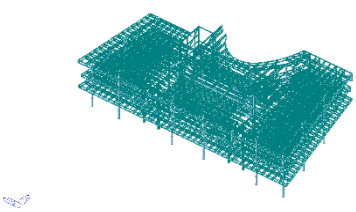

Figure 2. Finite element analysis model

4.1. Displacement analysis during construction process

As shown in Figure 3, the vertical displacement change during the construction process of the steel truss structure (unit: mm) (select the displacement diagram of construction steps 1, 4, 8, 14, 18, and 24). From the beginning of construction to the stable stage of the truss after completion. The cumulative deformation during the truss installation process gradually increases with the construction process, with a maximum installation deformation of 30mm and a final deformation of 16mm, meeting the requirements of the specifications.

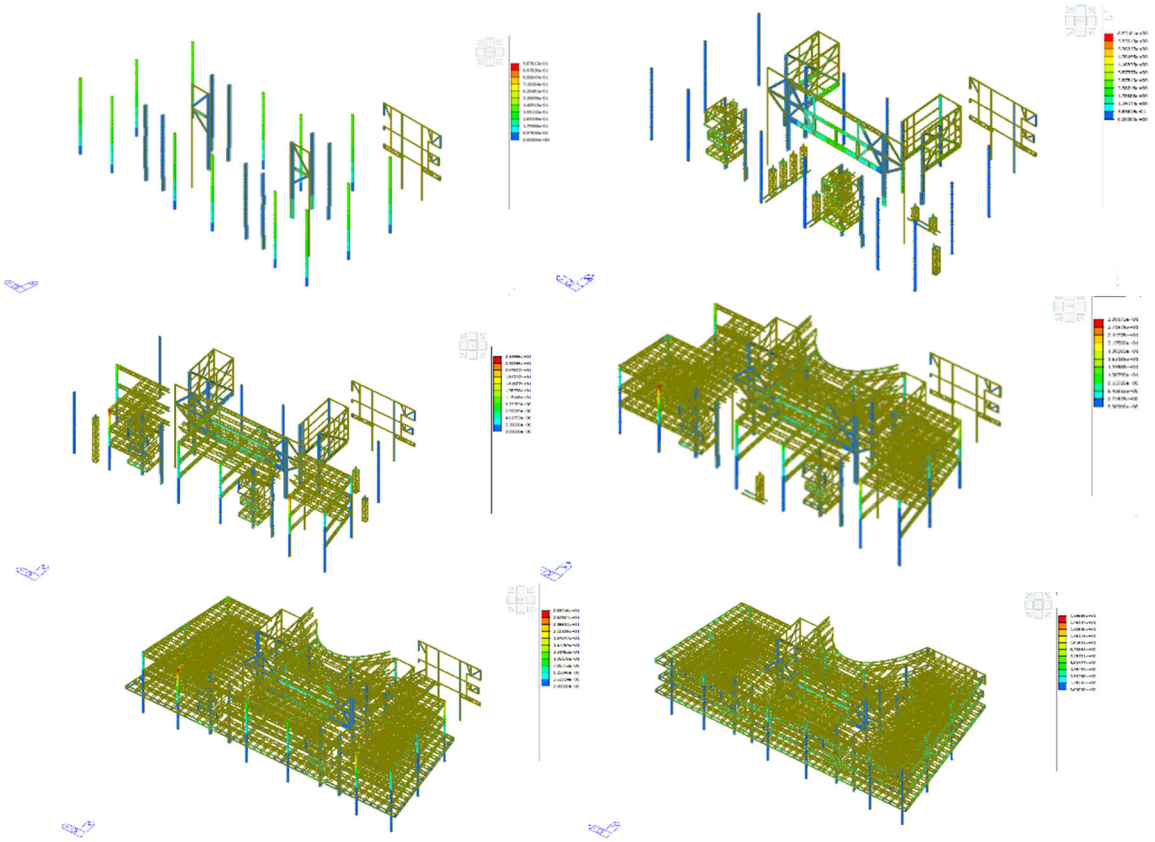

Figure 3. Displacement variation diagram during construction process

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4.2. Stress analysis during construction process

As shown in Figure 4, the cloud diagram of unit stress changes during the construction process of the steel truss structure (selecting the displacement diagrams of construction steps 1, 4, 8, 14, 18, and 24). From the beginning of construction to the stable stage of the truss after completion. During the construction process, the stress of the truss gradually increases and stabilizes within the range of 100. The strength stress ratio is at a low value, meeting the unit stress requirements.

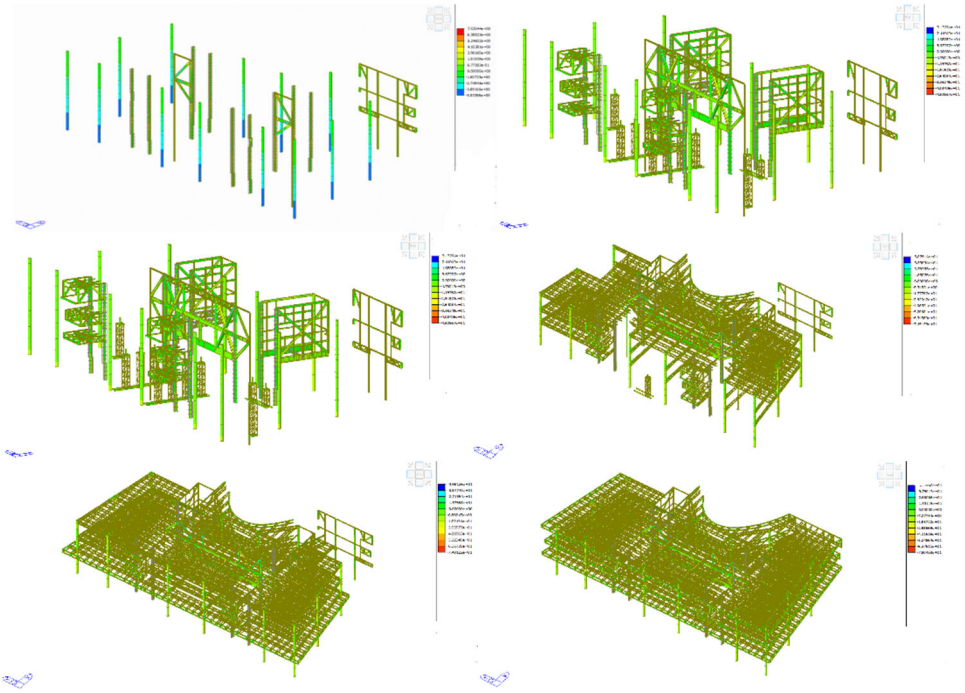

Figure 4. Stress cloud map during construction process

5. CONCLUSION

The large-span orthogonal steel truss of the museum podium adopts the installation concept of in-situ assembly and segmented lifting. The finite element software is used to simulate and analyze the entire construction process of the steel structure. The displacement and stress changes of the steel truss during the construction process meet the requirements, and the installation and construction plan of the steel truss is safe and feasible. In the future, areas with significant displacement and stress changes can be monitored to ensure the safety and controllability of the construction process.

ACKNOWLEDGEMENTS

Thank you for the research on key technologies of large-span orthogonal steel truss system and the project support of CSCEC4B-2023-KTB-15.

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ISSN: 2472-3703 DOI: 10.6911/WSRJ.202310_9(10).0012

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