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STRESS AND STRAIN CONTROL TECHNOLOGY FOR STEEL STRUCTURE WELDING

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Abstract: Stress and strain will inevitably occur during the welding process of steel structures. If not effectively controlled, it will have a significant impact on the quality, performance and safety of steel structures. This paper explores the stress and strain control technology of steel structure welding, and elaborates on the factors affecting welding and various control technical measures. This paper explores the application and effect of these technologies in practical engineering, and looks forward to future development trends. It aims to provide a comprehensive technical reference for the field of steel structure welding and promote the continuous development and progress of this field.
Keywords: Steel structure; Welding; Stress and strain control

INTRODUCTION

Steel structures are widely used in many fields such as construction, bridges and machinery due to their high strength, excellent mechanical properties and relatively low cost. Welding, as the main connection method of steel structures, will produce complex thermal processes during the welding process, resulting in stress and strain in the welded joint area. If these stresses and strains cannot be effectively controlled, they may cause problems such as welding cracks, deformation and fatigue performance degradation, seriously affecting the quality and safety of steel structures. Therefore, in-depth research on stress and strain control technology for steel structure welding has important theoretical and practical significance.

1 PROJECT OVERVIEW

The China Grand Canal Museum Project is located in Hangzhou Canal New City. This project has two underground floors with an elevation range of -2.000-13.100 m. The basement steel structure is mainly composed of core tube rigid steel columns and podium outer frame circular tube columns. The tower structure has 15 floors above ground and the podium structure has 8 floors. The tower steel components mainly include: steel columns + steel beams + lap columns + folded beams + steel plate walls + split-level trusses + cantilever trusses + cantilever walls + large-section ring beams. The podium steel structure includes orthogonal trusses, one-way trusses, core tube built-in rigid structures, split-level trusses, cantilever trusses and outer frame steel pipe columns.Project effect can be seen in Figure 1.

Figure 1 Project Effect

2 KEY FACTORS AFFECTING WELDING STRESS AND STRAIN

Welding process parameters: welding current, voltage, welding speed and other process parameters directly affect welding heat input and cooling speed, and thus affect the size and distribution of welding stress and strain; welding process also has a key impact on the installation accuracy of steel structure components. Specifically, there are 4

common impacts:
(1) Welding preparation. The weld preparation before welding is extremely critical to welding quality and installation accuracy. The weld preparation covers cleaning the welding surface, angle, size, etc., which plays a significant role in ensuring the matching accuracy of the welded joint.
(2) Welding sequence. The welding sequence during the welding process will also affect the installation accuracy. Selecting a reasonable welding sequence can reduce the accumulation of welding stress and the occurrence of deformation.
(3) Welding temperature. Temperature control during the welding process is also very important for the installation accuracy. Too high welding temperature will cause the weld joint to deform and the heat affected zone to expand, while too low welding temperature may affect the quality of the weld.
(4) Welding speed. The welding speed will also affect the installation accuracy. Too fast or too slow welding speed may affect the quality and deformation of the weld joint.

3 WELDING STRESS AND STRAIN CONTROL TECHNOLOGY

Welding is a commonly used steel structure connection method, but welding stress and strain will inevitably be generated during the welding process; welding stress refers to the stress in the weldment during and after the welding process. These stresses may cause deformation, cracking, fatigue performance degradation of the weldment, etc.; welding strain is the change in size and shape of the weldment under the action of welding stress; the purpose of welding stress and strain control technology is to take a series of measures to reduce, adjust or eliminate these adverse effects to ensure the quality and performance of the welded structure.
Among them, preheating and post-heat treatment refer to the fact that preheating can reduce the cooling rate of the welding area, reduce the temperature gradient, and thus reduce the welding stress. Post-heat treatment helps to eliminate welding residual stress and improve the performance of the welded joint. Choose a suitable welding method, such as arc welding, gas shielded welding, etc., according to the characteristics and requirements of the steel structure. Welding preheating treatment can be seen in Figure 2.

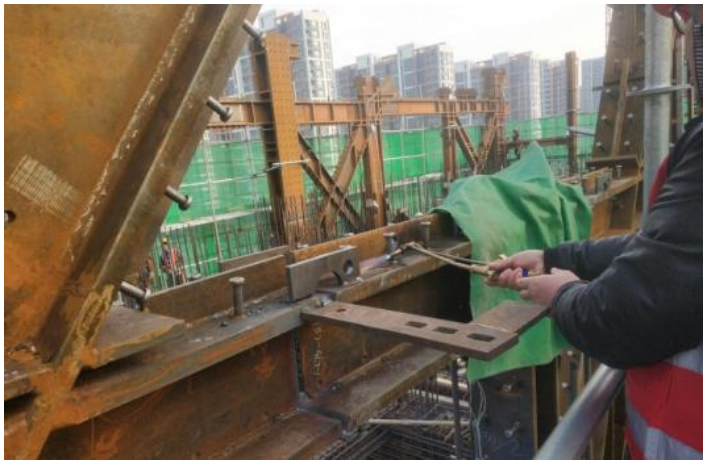

Figure 2 Welding Preheating Treatment

Just like Figure 3, design a reasonable groove form. The design of the groove affects the welding heat input and welding deformation. Use appropriate welding materials to select welding materials that match the parent material to reduce welding stress and strain.

Figure 3 Groove Design

Just like Figure 4, control welding heat input, control welding heat input by adjusting welding process parameters, and reduce welding stress and strain.
Constraint control technology: Rationally design the constraint structure and consider the influence of constraints on welding deformation and stress in the design stage. Use temporary restraint measures and use temporary clamps and other measures to limit deformation during welding.

Figure 4 Constraint control

Welding deformation correction technology, mechanical correction method: use mechanical force to correct the deformed part.
Flame correction method: correct welding deformation by local heating and cooling.

4 CONCLUSION

Steel structure welding stress and strain control technology is a key link to ensure the quality and safety of steel structures. Through an in-depth understanding of the formation mechanism and influencing factors of welding stress and strain, and the comprehensive application of various control technical measures, welding stress and strain can be effectively reduced. With the continuous advancement of science and technology and the continuous growth of engineering needs, welding stress and strain control technology will continue to develop and innovate. In future research and practice, it is necessary to further strengthen multidisciplinary cooperation and exchanges, promote welding technology to a higher level, and provide more reliable guarantees for the wide application of steel structures in various fields.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] Zhang Xudong. Influence of residual stress and strain in engineering structures. Engineering Thermophysics, 2005, 26(1): 75-78.
[2] Wang Mingli. Residual stress and strain in mechanical structure welding process. Welding, 2007, 26(4): 1-5.
[3] Li Hongzhi. Common problems and prevention of steel structure welding technology. Steel Structure, 2011, 42(1): 42-46.
[4] Li Dongyu. Residual stress measurement under the influence of pin connection decompression strategy based on characteristic function method. Light Roof Truss, 2018, 39(1): 33-38.
[5] Yang Jun. Technical points in the welding production engineering of building steel structures. Today's Manufacturing and Upgrading, 2023, (05): 64-67.
[6] Zhang Qianhua. Precautions for steel structure welding engineering technology and measures to achieve quality control. China Metal Bulletin, 2023, (05): 222-224.
[7] Li Pei, Xu Dawei. Analysis of steel structure technology in civil engineering construction. Bulk Cement, 2023, (02): 139-141.