Research on Rust Removal and Rust Prevention Method of Super-High-Rise Steel Structure

Yong Yin*, Hong Zeng and Xinjie Deng
Prefabricated Construction Applied Technology Promotion Center of Chongqing Higher Vocational Colleges, Chongqing Jianzhu college, 857 Lihua Avenue, Nan'an District, Chongqing, China
Email: 103237256@qq.com

Abstract. The super high-rise steel structure is exposed to the natural environment for a long time, due to the long construction period of super high-rise buildings and the great impact of natural and social environment. If the steel structure is not properly protected, it will cause structural quality problems. Super high-rise steel structure has large volume and high height, so its rust prevention and rust removal methods are quite different from ordinary steel structure. This paper combines the actual engineering projects and briefly describes the ultra-high-rise steel structure rust removal, rust prevention construction and quality, safety assurance measures. Through the comprehensive application of this project, the feasibility of relevant countermeasures is confirmed, with a view to the follow-up similar projects can be useful and helpful.

Keywords. Steel structure, rust removal, rust prevention, construction platform.

1. Introduction
An ultra-high-rise steel structure needs to be shut down for two years because it has been ordered by the owner. During the two-year shutdown period, the tower steel plate shear wall, the inner wall of the outer frame column and the outer frame beams and other inevitable long-term exposed in the air. Due to the lack of protection of the alkaline environment of concrete, these open-air steel structures are bound to have rust problems due to long-term exposed. In order to ensure the performance of these steel structures after the resumption of work, these steel structures need to be treated with rust prevention.

2. Selection of Construction Method and Analysis of Key and Difficult Points
2.1. Analysis of Rust Removal And Rust Prevention
According to the structural characteristics of the tower, the outside of the steel plate shear wall is the outer frame pressure steel plate, the inner bottom is mostly the core cylinder elevator shaft, and there is no horizontal working surface on both sides of the steel plate shear wall. To do this, there are two rust removal and rust prevention methods to choose from [1].

Scenario 1: Re-establish the core barrel elevator shaft operating platform for the construction of the main structure in the early stage, and provide sufficient operating surface for the construction of rust removal and rust prevention of the steel wall.

Scenario 2: Use the "hanging basket” construction method, the safety rope is suspended from the top of the steel wall, and then the safety rope is used to provide the operator with a skateboard.
The safety of scenario 1 is high, the operator's operating surface is large, but it is required to re-set up the core elevator shaft scaffolding, a large one-time input, while the installation and removal takes a long time [2]. Scenario 2 is simple to operate, the construction progress is fast, and in the case of safety rope equipped with sufficient safety is also very good protection.

In order to ensure that the owner requires the duration node, while considering the safety and economy of construction work, choose scenario 2 for rust removal and rust prevention construction.

2.2. Rust Prevention Material Selection

At present, the construction industry for steel structure exposed rust prevention treatment mainly has the following.

Scenario 1: The finished epoxy coating is used for painting, which has the problem of high processing requirements and higher cost increase.

Scenario 2: Pour with C15 fine stone concrete. The practice is simple to operate, rust prevention effect is good, but the late chisel work is large.

Scenario 3: Rust prevention treatment with manual brushing and mechanical spraying of waterproof and anti-cracking slurry. The method has low cost, fast duration, green energy saving and environmental protection [3].

From a safety and economic point of view, steel wall and steel beams are mechanically sprayed with waterproof anti-cracking cement slurry and manually painted, and the inner wall of steel pipe column is manually painted to the top of the column by waterproof anti-cracking cement slurry, and the steel pipe column is closed.

2.3. Analysis of Major and Difficult Points

According to the characteristics of the tower structure, analyze the important and difficult points of steel structure rust prevention as showing in table 1.

Table 1. The important and difficult points of steel structure rust prevention.

| Serial Number | Important and difficult points | Responses |
|---------------|--------------------------------|-----------|
| 1             | The bottom of the steel plate wall is the opening of the elevator shaft, and the operator has no "foothold" | Lay I-beam and bamboo scaffolding at the entrance of the elevator shaft to provide horizontal working surface for the operators |
|               | The steel plate wall spans 3 floors and has a height of 18m, which is a high safety risk during vertical operation | The safety main rope is combined with the skateboard and hanging plate to provide vertical support for the operator, and the safety auxiliary rope is configured to ensure safety |
| 2             | The outer steel plate wall and the inner connecting beams and concealed columns have a heavy workload of rust removal and rust prevention, and the work efficiency is low | Configure enough operators and mechanical equipment to ensure that the construction tasks are completed at the designated nodes of the owner |
| 3             | There are two independent steel columns on the north and south sides, which makes the construction difficult | First, fix the safety rope to the top of the column through a light steel ladder, and then use the safety rope for construction |
| 4             | The outer frame steel beam has a small cross-section size and a very narrow working surface | Use a long safety rope to fix on the top of the steel plate wall, and then use the safety rope for operation and construction |
3. Construction Platform Erection

3.1. Steel Pipe Column Construction Platform
The operating platform for rust removal and rust prevention is the same as the operating platform for the construction of outer frame columns, which shows as figure 1.

![Frame column operation platform](image1)

**Figure 1.** Frame column operation platform.

3.2. Inner Construction Platform of Steel Plate Shear Wall
The operating platform for rust removal and rust prevention on the inside of the steel plate shear wall can use the core tube elevator shaft operating frame erected during the construction of the steel plate shear wall. Figure 2 is the construction drawing of the operating platform.

![Steel plate shear wall operating platform](image2)

**Figure 2.** Steel plate shear wall operating platform
4. Construction Method

4.1. Rust Removal Method

By hand with mechanical rust removal method: steel structure rust components are mainly steel plate walls and the corrosion situation varies from region to region. For areas with less severe rust conditions, take a manual wire brush and sandpaper rust removal. Let's first use a small hammer to loosen the rust on the wall of the rust-free steel plate, then use a blade to remove the rust from top to bottom, then brush the rust from top to bottom with a wire brush, brush the rust root by root from side to side, and finally polish it with sanding paper in the same order, until the rebar reveals its metal color, and immediately wipe it clean with a dry towel [4]. Upon completion of the rust removal, report to the full-time quality inspector and Party A, supervision for acceptance, acceptance of qualified before entering the next construction process. For severe rust conditions, rust removal is carried out with a polishing machine.

4.2. Rust Prevention Method

4.2.1. Steel Wall Rust Prevention. After the steel wall rust removal is completed and passed the acceptance, the sprayer is used to spray the steel wall, and then the steel wall is painted manually, and the best rust prevention effect has been achieved.

1) Waterproof anti-crack cement slurry configuration: first cast cement, then take half the water, stir, then add the remaining water to the water-resistant anti-crack cement slurry being stirred, continue stirring, and the two stirring time is 2.5 min-4 min. The uniformity and working performance of the waterproof and crack-resistant cement slurry are maintained before the slurry is sprayed on the steel plate wall [5].

2) Brush waterproof anti-crack cement slurry: for the configuration of waterproof anti-crack cement slurry, use a sprayer to carry out a spray treatment, and then use wool brush for brushing, brushing uniform. After the first spray, the interval is 4 to 6 hours, and you can the next brush construction. The total brush waterproof anti-crack cement slurry thickness is 10 mm.

3) Brushing operation surface: in the 5F to 8F steel wall waterproof anti-crack cement slurry brushing, in order to provide operators with an operating surface, the use of skateboards, suspension plate process rust prevention construction.

4) Layered splint painting: because the structural layer height is high, the maximum is about 6m, so each layer of steel plate wall vertical needs to be carried out three times [6].

This method can effectively protect the steel plate wall from rust spots or surface floating embroidery, avoid the danger of corrosion of steel plate wall, save the cost, duration and cost of rust removal, green energy saving and environmental protection. Due to the long downtime of the owner, the rust prevention effect should be checked and evaluated on a regular basis, and if the rust prevention effect is found to be not achievable, report to the owner and take certain measures in accordance with the owner's instructions.

4.2.2. Steel Pipe Column Rust Prevention. When the steel column concrete is poured to 5F (29.4 m), the concrete surface is still a reserved space from the top of the steel pipe column to facilitate subsequent welding of the steel column, which is about 700 mm in height. The inner wall of the steel pipe column is brushed with waterproof anti-cracking cement slurry to ensure that the inner wall of the steel pipe column does not come into contact with air. When the waterproof and crack-resistant cement slurry is brushed, cover the top cover of the steel pipe column and spray foam glue between the top cover and the gap between the steel pipe columns to completely close. The construction schematic is shown as figure 3.
4.2.3. Steel Beam Rust Prevention. Except for the top surface of the "I-shaped" steel beam (the studs will be welded during the subsequent construction of the profiled steel plate), the rust prevention paint has not been applied to the other external surfaces [7]. Therefore, the top surface of the steel beam needs to be painted with waterproof and anti-crack cement slurry, and the construction process is the same as that of the steel plate wall with waterproof and anti-crack cement slurry.

When the waterproof and anti-cracking cement slurry is applied, two steel ropes are erected on both sides of the steel beam, and the operator must fasten the safety belt before construction.

5. Recovery Method

5.1. Recovery of Steel Plate Walls and Steel Beams
In order to prevent the water-proof and crack-resistant cement slurry from adversely affecting the integrity of the bonding between steel components and concrete, the water- and crack-resistant cement slurry must be cleaned up when resuming work. The manual cleaning method is adopted: first hit the steel component to be cleaned with a small hammer [8]. The impact force is beneficial to destroy the bonding force of the waterproof and crack-resistant cement slurry and the steel component. Then use a wire brush to remove the waterproof and anti-cracking cement grout from top to bottom, from side to side, and finally wash the removed steel components with pressure water until the steel bars are exposed to the metal color.

5.2. Steel Column Recovery
When work is resumed, the water-proof and anti-cracking cement slurry in the steel pipe column shall be cut out and transported out of the column before the next section of the steel pipe column can be hoisted.

6. Quality Assurance Measures
(1) Do a good job in the optimization of the construction scenario, and prepare for the construction according to the construction organization design [9].
(2) Do a good job in safety and technical disclosure.
(3) Operate the construction strictly in accordance with the construction process, report any problems in time, and ask relevant personnel to study and deal with them.
(4) Rust removal is not suitable for rainy and wet weather.
Due to the long suspension of construction time, in order to ensure the optimal effect of rust prevention, it is necessary to send personnel to observe the steel structure members regularly. If it is found that the above-mentioned rust prevention treatment method loses the protective effect, it should immediately report to the owner, and take certain measures according to the owner’s instruction [10].

7. Conclusion
The project is applied and verified in the project by consulting relevant information at home and abroad. This project solves the key technologies of rust removal and rust of steel plate shear wall, steel pipe column and steel beam, and puts forward the corresponding quality and safety assurance measures, which have certain reference value for similar engineering projects.

References
[1] Huang Z M and Chen X J 2020 Talking about the rust removal Scenario of rebar in the port terminal under construction *Pearl River Water Transport* 19 51-52.
[2] Sun Q B 2020 Exploration of on-site construction detection methods for rust removal treatment of steel bridge deck paving steel plates *Henan Science and Technology* 39(25) 63-66.
[3] Song X J, Zhang P K, Zhang Z and Pei W C 2020 Research on the uniformity of rust removal on the inner wall of mechanical elbows *Machine Design and Manufacturing* 07 142-145.
[4] Zhang R, Cheng X L, Pan L and Li Y X 2020 Comparative study on rust removal efficiency and corrosiveness of rust removal reagents commonly used in iron cultural relics *Science of Cultural Relics Conservation and Archaeology* 32(03) 17-27.
[5] Li Z P 2020 Research and application of permanent magnet track of ship rust removal cleaning wall-climbing robot *Guangdong Shipbuilding* 39(02) 47-50.
[6] Hu H 2020 Anticorrosive construction technology of Linhai Wharf steel structure *Building Construction* 42(03) 431-434.
[7] Wang J P 2020 Thinking about the manufacturing technology of building steel structure *Building Materials and Decoration* 08 4-5.
[8] Liu Z X 2020 Research on construction technology of super high-rise building steel structure *Science and Technology Innovation and Application* 33 149-150.
[9] Bai X H, Luo S X, Tian Y J and Tang X J 2020 Design and research of temporary supports for the construction of the outer-tilted "Pull-out" outer cover steel structure of the stadium *Proceedings of the 2020 Industrial Building Academic Exchange Conference* 1.
[10] Xu X P 2020 Discussion on safety management of steel structure workshop construction site *Green Building Materials* 09 129-130.