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Analysis of Fatigue Fracture Accidents of Welded I-beam Bridges, Key Technology and Demolition Method in Australia

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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Short Communication

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ABSTRACT

When Germany built Bendorf Bridge over the Rhine River, the cantilever pouring construction method was adopted, and the cantilever pouring method and cantilever assembly construction method were adopted. The continuous improvement, innovation and perfection of the method make this method widely used. At present, our country has made rapid progress in science and technology. New changes have been made in the prestressed design of concrete Bridges, as well as in the analysis and testing of structures, as well as in materials and processes. Great progress has been made in the design and construction of prestressed concrete Bridges.

In the construction of continuous steel Bridges, the width and weight of block 0 are changed with the size of the bridge span, for example, the higher the pier of the bridge built over the river valley, the more difficult the construction. When the two are put together, it will become the most important part of the construction, so the construction personnel should be extremely concerned about it. For the construction of No. 0 block, the following two construction processes are generally adopted, one

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is the support method. The second is the bracket method. Among them, the support method is divided into two kinds, respectively: full support and steel pipe pile support.
The bracket method involves a little more variety, the most important of which are: welded ox legs, embedded Beret pieces and counterthreading I beam method. In these construction methods, the I-beam method has been widely used, and its main advantages are that its bracket steel is tough, fast construction and wide range of application. Based on this, this paper studies the fatigue fracture accidents of welded I-beam Bridges in Australia for reference.

Keywords: Australian welding; I-shaped steel beam bridge; fatigue fracture accident.

1. INTRODUCTION

I-beam is a type of steel with a "I-shaped" cross-section, which has been widely used in construction projects. When constructing I-beam bridges, welding is required to fix it. However, if the welding process level is not up to standard, fatigue fracture accidents may occur. Therefore, it is proposed to analyze the I-beam bridge.

1.1 Welding Method and Inspection of Welds

There are also certain requirements for the welding environment. Firstly, during the welding process, it is affected by wind speed, and protective barriers and insulation measures need to be used to protect it. The humidity of the environment can also affect welding. When the temperature is below 5 degrees Celsius, it can also affect welding. Changes in weather can also have an impact on welding.

After the installation of the steel beam, it is necessary to weld it, but before welding, it is necessary to do a good inspection work. Firstly, all impurities must be effectively removed, such as oil stains stuck on it or areas with rust on it. When welding the fusion position and the railing positions on both sides of the Cao Cao, it is necessary to set the arc plate and extinguishing arc plate at both ends of the welding. During this process, there are also certain requirements for the material, style, and size of the groove. It is necessary to select the manual arc welding arc plate and extinguishing arc plate according to the requirements, in order to ensure that the grinding effect is consistent with the main material, You need to use an air cutting machine to remove it and keep the welding scars [1-2].

When baking and insulating welding rods and consumables, they must be strictly operated in accordance with the corresponding specifications. During the specific welding process, it is necessary to always keep the battery pack area connected at all times in order to facilitate its use at any time and to close the battery pack cover. Moreover, it needs to be re fixed every four hours.

The indirect head distance of the multi-layer welding layer must be greater than 30 millimeters, and it must be continuously welded. When it is interrupted due to a malfunction, it is necessary to weld it again, and the impurities on it must be cleaned before welding. For welds that require preheating, heating work must be done in advance.

After the welding task is completed, it is necessary to remove the welding slag and cracked impurities on top.

1.2 Welding Inspection

For the appearance of the weld seam, it is necessary to conduct a thorough inspection and record the data. If there are cracks, lack of solvents, welding slag and other issues on the surface, they must be promptly changed, and when operating them, they must strictly follow the instructions on the drawing [3].

Only after the appearance inspection of the weld seam is qualified can non-destructive testing be carried out. And this content also has time requirements, and non-destructive testing work must be completed within 24 hours after welding.

2. BRIDGE OVERVIEW

One of the most important bridges in Melbourne is the King Street Bridge, which belongs to the construction of a multi-span simply supported I-shaped steel bridge. Each section of the bridge has a span of 30.5 meters, with a width and height of 9.5 meters and 1.5 meters respectively. In order to support the 24 centimeter thick concrete, four welded I-shaped steel beams need to be welded and combined with force reducing keys to form a composite beam.

Fig. 1. Fatigue destruction accidents

3. COLLAPSE PROCESS

As early as 1962, a major bridge in Melbourne had a collapse accident. At that time, a 45 ton truck passed over it, causing the I-beam to suddenly break. Fortunately, the fracture did not completely collapse, otherwise it would cause harm to both personnel and vehicles. Based on this incident, researchers conducted an investigation and found that the reason for this condition was that they did not pay attention to the weld details at the cover plate, and cracks had already appeared in seven places at the weld toe, with brown primer left on top. This is enough to prove that cracks had already occurred when it was painted, but they were not visible at that time. For this reason, we have adopted non-destructive testing technology to inspect this broken bridge again and found that not only is there a crack at the welding toe of the cover plate end, but there are also cracks in other places. Moreover, the crack depth is around 1.6 millimeters to 16 millimeters, and some have already penetrated the floor. Therefore, in order to avoid such incidents, we should no longer rely on visual observation when inspecting the bridge structure, but choose specialized damage detection equipment to detect it, effectively reducing the occurrence of accidents [4-5].

4. ANALYSIS OF COLLAPSE CAUSES

4.1 Welding Process

Due to the incorrect sequence of welding the cover plate and floor, in the actual welding process, the longitudinal welding corners are welded first, followed by the transverse welding seams at the ends. This will greatly limit the deformation and prevent it from being released, resulting in stress generation. Moreover, during the cooling process of the weld seam, cracks are generated during the deformation process due to the influence of surrounding steel. After the welding is completed, phosphoric acid is also used to clean the weld seam. Therefore, when phosphoric acid penetrates through the cracks, a large amount of hydrogen gas is generated inside, which can affect the steel beam and cause it to crack.

4.2 Fatigue Life Analysis

The main reason for fatigue fracture is that the length of the crack has changed, causing the initial length to expand to the critical length. A length greater than or equal to 69.6 millimeters is the critical length. At this time, the stress generated by the rear section did not reach the allowable stress of 155 MPa, leading to the

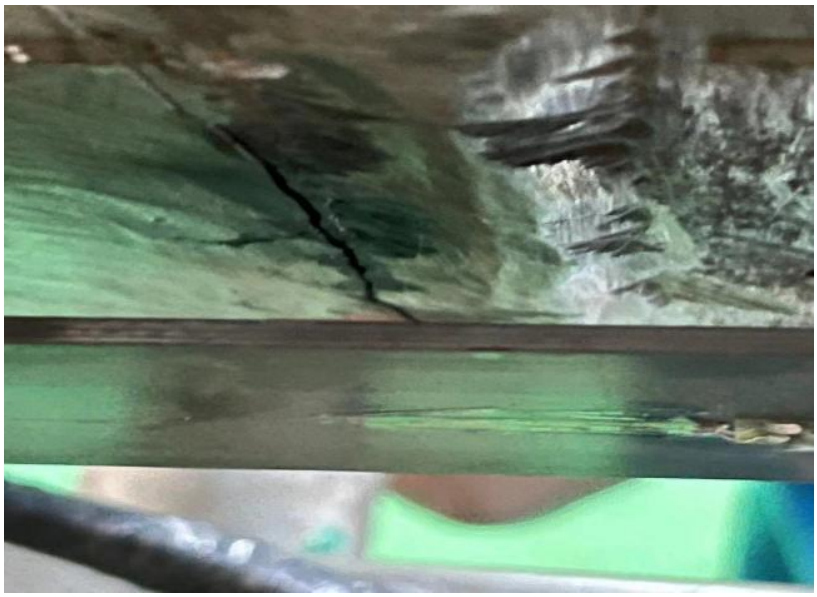

Fig. 2. Structure failure

occurrence of fatigue fracture. Moreover, if exposed to corrosive environments for a long time, it will increase the crack propagation speed and reduce the service life of steel beams.

5. COMPARISON AND SELECTION OF CONSTRACTION PLANS

The height, navigation, and required dimensions for the main pier must be analyzed based on the actual terrain characteristics of the site. Although the steel pipe pile support method has good adaptability and high rigidity, it is still very stable. However, this method still has certain drawbacks, that is, it is difficult to control the straightness, so it is not feasible to use it in pier construction, and it is not suitable to control the pile position of the steel pipe. Therefore, this method is not suitable for the construction of the main pier. Although the full nail construction method is not only convenient but also fast, it has certain operational difficulties and high requirements for the foundation, and is prone to accidents during the construction process. Therefore, it is not recommended to use this method. The main characteristics of the welding bracket method are: strong rigidity and good performance. But it also has its drawbacks, which are the need to bury a lot of steel, which affects the appearance of the pier body.

The process of later processing is relatively cumbersome, not only difficult to control the engineering quality, but also poor economic performance, especially for tasks during rush times. So this method can also be adopted. The characteristic of the I-beam bracket method is that it has strong rigidity, good performance, and clear stress, which not only facilitates construction but also effectively reduces costs. However, when using this method again, it is necessary to adjust the distance of the pier column reinforcement. When dismantling this method, only the pier body and appearance need to be treated. This article also provides corresponding analysis for the unsuitable support method. In order to jointly develop technology, economy, and safety, the pouring process is divided into two stages [6-7].

6. STEEL BEAM PRODUCTION PROCESS

Firstly, CNC should be used to cut the parts, making the resulting parts more accurate. The web plate can only be bent after the anti groove opening, and the modification will be bundled and tied to the wing plate on a dedicated flat tire bracket. Secondly, the next step is deployment work. Firstly, draw the positioning line on the wing plate, so that when creating the web plate, it can be aligned with the positioning line. Finally, fix it and firmly weld the wing plate and web plate. Before reassembly, it is necessary to check the quantity, size, material, and number of the web plates. Thirdly, do a good job in positioning the T-shaped plate.

Firstly, use a leveling machine to level it before cutting, and also use a multi head machine and a

shelling machine to cut multiple plates. This can reduce the occurrence of side bending after cutting the parts. Fourthly, for technical standards, it is necessary to inspect the H-type components before welding the hit and inch. Not only that, it is also necessary to control the current, voltage, and welding speed well. It is necessary to conduct it defect detection within 24 hours. Fifthly, after all inspections are qualified, the reinforcement plate and shear nails should be installed on top and their contours checked for normality.

7. DEMOLITION TECNOLOGY OF LARGE-SPAN I-BEAM LDADBEARING BRAKET

When dismantling the I-shaped steel bracket, preparations must be made. As the road is very busy during the dismantling of the bracket, it is necessary to use the corresponding technology reasonably to dismantle it. Firstly, first remove the upper bracket and corresponding formwork on the support bracket, and only retain the beam steel on the bracket for removal. Secondly, after removing the heavy support, it is necessary to promptly dispose of the on-site support to quickly repair the road. Thirdly, when demolishing vehicles, it is necessary to communicate with the traffic management department in advance and develop corresponding handling strategies based on the actual traffic situation. Warning signs should be set up on the roads of the construction section to prohibit vehicles and pedestrians from passing. By setting up roadblocks, warning work should be done for driving. In order to facilitate passage, only one passage can be set up. Fourthly, after some traffic control is completed, it is necessary to install a crane with a capacity of over 25 tons not far from the separation strip, which can facilitate the transportation of steel and steel pipe piles.

In addition, the dismantled components can be transported to a place outside the high-speed guardrail for temporary storage. Thus achieving effective management of components. Fifthly, when removing the reinforcement on the assembly of the U-shaped beam and cutting the connection between the reinforcement and the beam, oxygen welding process is required to cut it. After selecting the reinforcement, support needs to be installed on the beam of the loader. After the installation of the support is completed, the reinforcement needs to be slowly pulled out of the bottom of the box beam and lifted by ice. After everything is completed, it needs to be slowly taken to the roadside with a truck crane and stored.

Moreover, when dismantling the support, it can not be rushed, it must be segmented before it can be dismantled, and the speed of demolition must be consistent with the load schedule before it can be dismantled, and the I-shaped steel column is supported.When the frame is dismantled, because the pillars used are a whole, it should be dismantled in the following way: First, a pillar is set every two meters. Second, the welding ring on the embedded steel plate is removed. Third, a truck crane weighing about 25 tons is used to place the parts.

8. CONCLUSION

When designing the bottom plate of a steel box girder, if a thicker plate is used (such as steel with a thickness of 16 minutes and 30 millimeters), the plate will crack at the joint. From the perspective of overall strength, it is possible to expand the base plate or use thinner steel plates to facilitate welding and improve structural durability. The grid is connected by a box type grid, which is not as reliable as steel grid from both strength and installation perspectives. Therefore, it is recommended to use steel grid instead of box type grid.

From the actual situation of construction, it is difficult to control the construction, and it is difficult to shorten the horizontal bridge by 10 centimeters to four supports at the same time, and shorten the vertical bridge to two intermediate points. It is recommended to adjust the position of the neutral axis of the section near the branch point to improve the stress on the top and bottom plates of the section at the branch point. Shear force is an important component of group beams. Although the calculation results can meet the force requirements, its state must also be verified through relevant experiments.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Yihai, Xiao Minwei, Zhang Han, Luo Yijie. Traditional cantilevered I-beam Research on embedded form optimization technology in shear wall [J]. Real Estate World. 2020; 21:80-82.
2. Zuo Jiawang. Large span I-beam load-bearing bracket in cast-in-situ box on span

high-speed bridge Construction application in beam [J]. Transportation World. 2020; 30:40-41.
3. Jiang Hong. I-beam-concrete composite beam in the reconstruction of dangerous bridges Engineering Construction and Design. 2020;16:134-136+148.
4. Zhang Qing, Yu Liang, LI Buhui. Steel pipe rod "new I-beam-steel pipe" T Research on Joint Node Analysis [J]. Journal of Wuhan University (Engineering Edition). 2020; 54(S2):124-129.
5. Feng Guangyou. Long-span I-beam bearing in cast-in-situ box girder project of span high-speed bridge Green Building Materials. 2020;01:91-92.
6. Lu Wucheng, Du Yubiao, He Kun, Li Yan, He Shengquan. Ultra-high altitude independent beam Construction of double-pinned I-beam [J]. Jushe. 2020;01:87-88.
7. Wu Zhifei, Zhang Wenqiang, Sun Wenduo. I-beam-concrete composite beam Industrial quality control technology [J]. Public Road. 2020;65(06):65-69.

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