Top Push Construction of Steel-Box Girder Bridge Across Existing Transportation Lines

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ABSTRACT: The fifth connection of the main line bridge of the New JiuZhong Road in Chongqing is a continuous steel box girder bridge with a span diameter of (40+49+40)m, which is divided into left and right frames with a total weight of 1535.8t. The steel box girder bridge adopts a single-box single-chamber cross-section form, with a roof width of 9m, a bottom plate width of 5m, a beam height of 2m, a steel box girder roof thickness of 20mm, a bottom plate thickness of 24mm, and a web plate thickness of 24mm. Each frame is divided into 19 steel box girder sections. Because the fifth connection of the main line bridge of the New JiuZhong Road crosses the second line of Chongqing Rail Transit, it intersects vertically. It crosses the viaduct section of Chen Tuo Road on the expressway and intersects vertically. There are existing traffic lines on the upper nine neutral intersections. Therefore, it is designed as a steel box girder and adopts the construction technology of steel box girder top push. In the jacking construction, temporary structures such as assembly temporary piers, jacking temporary piers, steel guide beams, etc. are set up; multi-point synchronous continuous jacking technology is carried out using 650t intelligent stepping equipment; steel box girder jacking technology and steel box girder herringbone slope adjustment technology are used to complete the bridge steel box girder jacking construction. The results show that the push process is stable, and the structural strength of the steel box girder and guide beam meets the requirements of the specification.

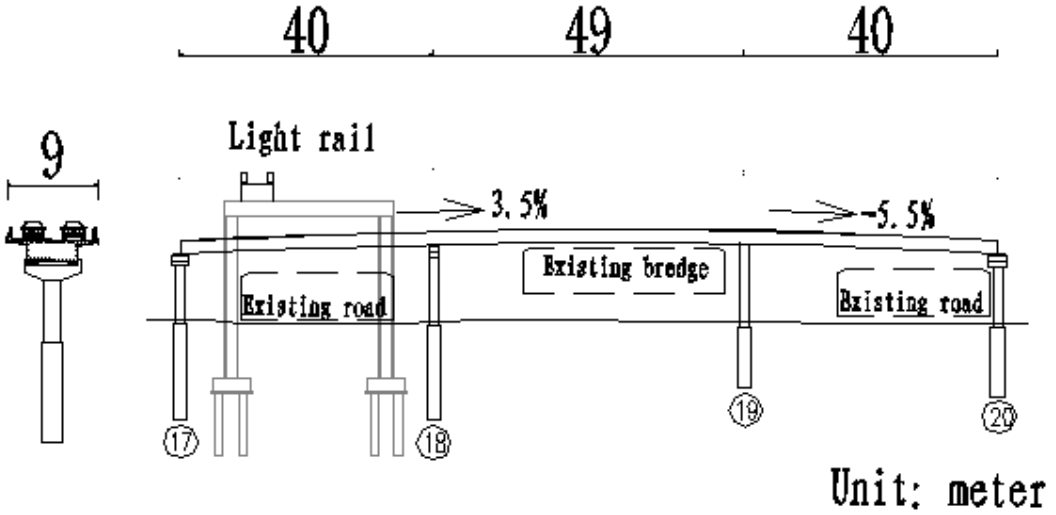
1. Introduction

With the steady development of China's social economy and the continuous improvement of science and technology, bridge construction has sprung up like mushrooms. In the process of bridge construction, steel box girder bridges are widely used because of their large leapfrogging capacity, convenient industrial manufacturing, fast transportation and installation speed, and ability to adapt to various site restrictions [1].

The commonly used construction methods in the construction of steel box girder bridges include hoisting method, top push method, etc [2-4]. Among them, the top push method has obvious advantages in crossing rivers and canyons and crossing existing traffic lines. The construction technology is mature and has been widely used in many bridge constructions at home and abroad [5-7].

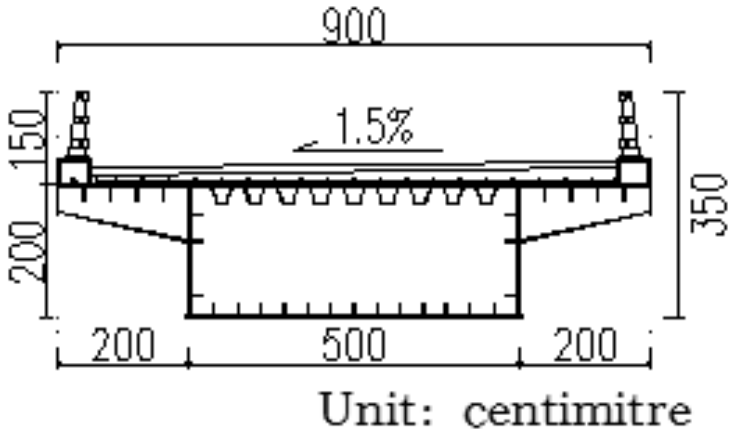
The main line bridge of the New JiuZhong Road in Chongqing is divided into two frames, each with a total of 6 pairs. Among them, the left and right fifth bridges are designed as steel box girders and adopts steel box girders due to the existing transportation lines under Chongqing Rail Transit Line 2, the viaduct section of Chen Tuo Road on the upper-span Expressway, and the upper-nine neutral intersection wheel. The length, linearity, elevation, etc. of the left and right fifth steel box girders are the same, the span diameter is (40+49+40)m, the equal-section continuous steel box girder bridge, the left and right steel box girder are 258m long, and the total weight reaches 1535.8t.

Figure 1 is the ecade diagram of steel box



girder.

Fig. 1 Ecade diagram of steel box girderSingle box single room and other cross-section forms, roof width 9m, bottom plate width 5m, beam height 2m. The horizontal bridge is arranged as a 0.5m wide anti-collision guardrail + 8m roadway + 0.5m anti-collision guardrail.Figure 2 is the cross-section diagram of standard section of steel box girder



bridge.

Fig. 2 Cross-section diagram of standard section of steel box girder bridgeConsidering that the segmentation position of steel box girder segments should be as close to the 1/4 span position as possible, avoid the span neutralization pier position, and combined with the construction technology, transportation and on-site lifting ability of steel box girder, a single steel box girder is divided into 19 construction sections and 5 segment types, of which the standard section length is 14.55m, the longest is 14.75m, the shortest segment is 9m, the single heaviest section 43.7t, and the lightest section is 27.2t.

2. Methodology

Because the left and right fifth main line bridge of Chongqing the New JiuZhong Road crosses Chongqing Rail Transit Line II, the viaduct section of Chen Tuo Road on the upper expressway, and the upper span of the nine neutral turntable have existing transportation lines, and there is no place for cast-in-place box girder with full support, so it is designed as a steel box girder. Because there is no steel box girder, the traffic is busy and the traffic flow is large. In order to minimize the impact on the existing traffic lines, after comprehensive comparison, the left and right sides of the fifth steel box girder of the main line bridge of the New JiuZhong Road in Chongqing adopt the top push construction technology.Figure 3 is the top push construction layout drawing

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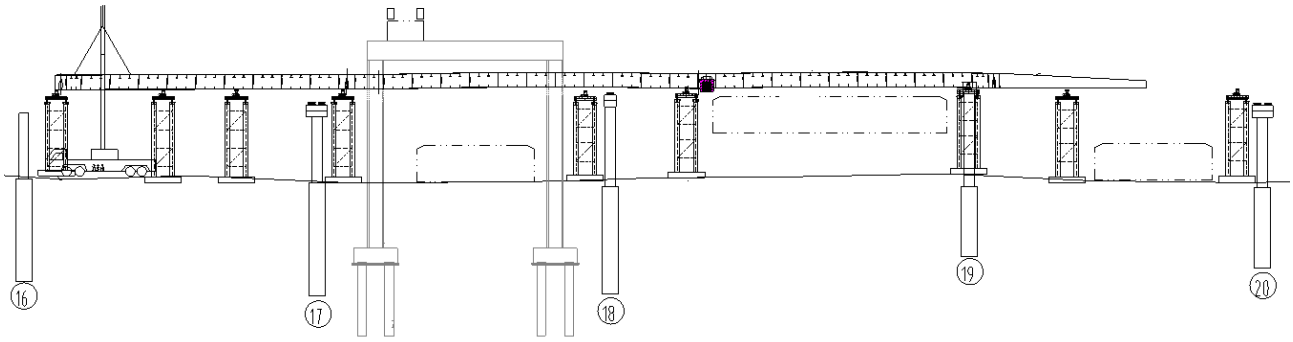

Fig. 3 Top push construction layout drawingFrom the perspective of safe construction, site restrictions and economic feasibility, 3 temporary assembled piers are set up between piers 16 and 17 piers. A single steel box girder is hoisted 4 times and pushed up 4 times, namely 4, 3, 6 and 6 pieces respectively. There are 6 top push temporary piers between the 17th and 20th piers, with a maximum distance of 35m. They are the viaduct section of Chen Tuo Road on the upper span expressway. The steel guide beam has a maximum span of 60% and 21m. Considering that the weight of a single steel box girder is 767.9t and the weight of the steel guide beam is 22.5t, and the7 temporary piers are pushed up at the same time when bearing the maximum weight, two step-by jacks rated 650t are set up on the top of each temporary pier, which can theoretically meet the top push requirements of the steel box girder.

The construction steps of the steel box girder of the bridge are as follows: 1. The steel box girder is manufactured in sections in the processing factory, assembled as a whole after molding, and transported to the lifting site after passing the pre-assemble; 2. The lifting steel box girder is lifted by 160t automobile to the temporary pier of the steel box girder assembly, and welded with the guide beam after the plane position and elevation are adjusted to the design line shape. ; 3 Use a multi-point step-by-step push-up push system to slide the steel box girder forward segment by step and circulate until all steel box girder reach the design position; 4 After the steel box girder is pushed in place, cut the temporary welds of the steel box girder at 2 folded wires, adjust them to the design line step by section before welding. 5 Use step-by-step jacks and temporary cushion blocks to convert to each other and gradually drop the beam to the design elevation; 6 Build the structural layer of the bridge deck to complete the bridge construction.

3. Results and Discussion

3.1 Large Temporary Structure

From the perspective of safe construction, site restrictions and economic feasibility, 3 temporary assembled piers are set up between piers 16 and 17 piers, which are connected to the expanded foundation in the form of steel pipe columns, and I-beam distribution beams are arranged at the top. The assembly, welding and push-up construction of steel box girder sections are carried out on the assembly of temporary piers.

Between the 17th and 20th piers, 6 push temporary piers are set up. Each temporary pier is equipped with two step-by-step jacks rated at 650t as steel box girder top push equipment. The structural form is the same as the assembly of temporary piers, and the expansion bracket is at the No. 19 consolidation pier.

The maximum span of the temporary pier is 35m, which is the viaduct section of Chen Tuo Road on the upper span expressway. The length of the steel guide beam is 0.6L=21m (L is the maximum span of the temporary pier). The steel guide beam adopts the form of variable-section I-beam, and a steel guide beam is set at the front end of the top-push steel box girder. The length of the steel guide beam is 21 meters, which is divided into three sections. The first section is 10 meters, and the front end is set in the shape of an eagle's mouth, which is convenient for the steel guide beam to build temporary piers; the second section is 10 meters, which is the middle section; the third section is 1

meter, which is the guide beam and the main Connection section of the beam. The cross-section form of steel guide beam adopts I-shaped cross-section. The two guide beams are connected by steel pipes and channel steel, and a total of 4 sets of connection systems are set up.Figure 4 is the structure diagram of steel guide beam.

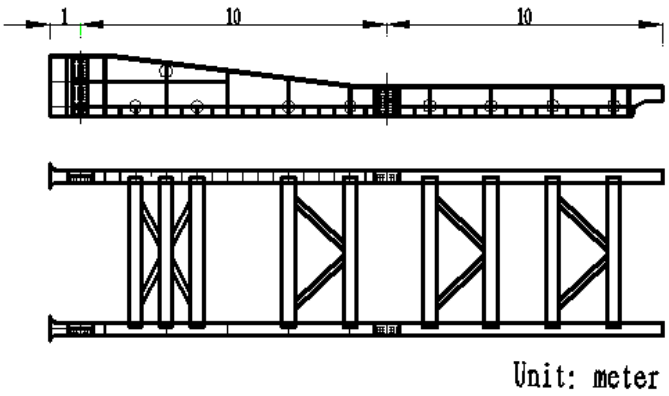

Fig.4 Structure Diagram of Steel Guide Beam

3.2 Multi-Point Synchronous Continuous Push Construction Technology

The single steel box girder is divided into 19 sections, which are divided into 4 liftings and 4 pushes, which are 4, 3, 6 and 6 respectively. The construction is carried out with step-by-step push-up equipment, which mainly includes push-up equipment, hydraulic system and intelligent control system. The jacking equipment adopts 650t intelligent stepping jack for the lifting, translation, falling and reset construction of steel box beams. The hydraulic system provides driving for the jack, combines the action, and feedbacks the information to the control system. The control system makes dynamic adjustments by analyzing the jack stroke information and the dynamic information of the hydraulic system, and drives the intelligent push. Ensure that the bottom of the steel box girder has good contact with the jacking equipment, the jack is evenly subjected to force, and the jacking direction is correct.

The vertical lifting force of a single 650t step jack is 650t and the lifting stroke is 200mm; the jack force of the horizontal correction jack is 80t and the stroke is 150mm; the vertical thrust is 80t and the stroke is 600mm.

The left and right steel box girders are pushed by banners respectively, and 2 intelligent walking jacks are arranged on each temporary pier, each with a total of 9 temporary piers, and a total of 18 sets of intelligent stepping jacking equipment are arranged. During the push-up process, all hydraulic equipment are dynamically controlled in real time through the control system to achieve the process of step-by-step jack synchronous action, thus realizing multi-point synchronous continuous push-push. Using multi-point synchronous continuous push technology, the synchronization accuracy between temporary piers can be controlled within 5mm, and the two sides of the same pier can be controlled within 1mm, which meets the required allowable deviation of 10mm.Figure 2 is the structure diagram of steel guide beam.

3.3 Steel Box Girder Herringbone Slope Adjustment Technology

In order to ensure that the main bridge of the New JiuZhong Road maintains a safe distance from the clearance of the rail girder of Chongqing Rail Transit Line II, piers 17 to 19 are uphill and the longitudinal slope is 3.5%; the viaduct section of Chen Tuo Road on the upper span expressway leaves a safe clearance distance, and piers 19 to 20 are downhill and the longitudinal slope is -5.5%. If the longitudinal slope of the steel box girder bridge is too large, the conventional step-by-step push slope needs to be controlled within 2%, and more than 2% is easy to slip during the push-up process, causing the steel box girder to fall off from the temporary bracket, resulting in safety accidents. In addition, temporary piers need to be added for the joint top push of 129 meters of steel box girder to ensure that the longitudinal slope meets the design requirements. Due to the limited operating space and the large number of underground pipeline networks, the temporary pier layout

position is limited and cannot be implemented.Figure 5 is the construction site of steel box girder top push

Fig.5 Construction Site of Steel Box Girder Top Push

Therefore, the herringbone slope adjustment technology of the steel box girder is adopted. In the process of steel beam assembly, the steel beam is divided into three sections and the overall leveling is made, so that the steel box girder is at the same height in the top push process, the bending reduces the elevation height difference at the bottom of the beam, and the three sections of the steel beam are temporarily welded. After pushing the jack in place, cut the temporary welds of the steel box girder at 2 folded wires, adjust them to the design line type one by section, and then reweld them. Finally, the beam falls to the design elevation.

4. Conclusion

The top push construction of the fifth steel box girder of the main line bridge of the New JiuZhong Road in Chongqing has the characteristics of wearing multiple existing traffic lines, limited operating space, complex construction environment, large top push span, and large longitudinal slope. Through the reasonable layout and design of temporary piers, accurate control in the top push process and effective preventive measures, the smooth progress of construction is guaranteed. In November 2021, the steel box girder of the main line bridge on the New JiuZhong Road in Chongqing successfully completed the top push construction. The successful application of steel box girder top push construction technology under the bridge shows that the construction technology is safe, reliable, economical and reasonable, energy-saving and environmentally friendly.

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