A Brief Talk on Overseas T-Beam Erection Technology in Conditions of Steep Slope with Segment Customized Assembled Bridging Machine

Yan-Qiang GAO\textsuperscript{a,*}, Peng ZHAO\textsuperscript{b} and Hai-Nan WANG\textsuperscript{c}

No. 2 Engineering Company Ltd. of China Communications Construction Company First Harbor Engineering Company Ltd, Qingdao Fuzhou South Road No.16,266071,China
\textsuperscript{a}15853267498@163.com, \textsuperscript{b}1095010440@qq.com, \textsuperscript{c}124858678@qq.com

\*Corresponding author

Keywords: T-Beam erection, Bridging machine, Segment customized, Assembling type, Steep slope.

Abstract. Combining with construction practice of Kupius bridge in Jamaica, Comprehensive consideration the particularity of overseas projects and construction site restrictions, This paper summarizes the T-beam erection technology in conditions of steep slope with segment customized assembled bridging machine.

Introduction

In recent years, with the development of highway and railway construction in China, the bridge construction has made great progress, and the construction technology of prestressed concrete T-beam in China is relatively mature\cite{1-2}. But the construction conditions for some project under-construction of China in Caribbean region are always hard to achieve internal level. Therefore, the corresponding construction technology is more difficult than the domestic\cite{3-4}. For example, the bridging machine has a vast market in China, and the same type of bridging machine is relatively lacking in Caribbean region\cite{3-6}. How to solve the bridging machine hoisting, container transport and on-site assembly and many other conditions, it is a problem need to face for overseas projects.

The Kupius Bridge lies in the parish of Clarendon along the Class B road from Danks to Mears Bridge just north of Chapelton. The span of Kupius Bridge is 2x31m. Seven T beams are used for each span. The width of the bridge is 13.1m. Based on the construction practice of Kupius bridge, this paper summarizes the method of realizing the container transportation through segment customized, and the T-beam erection technology in conditions of steep slope.

Bridging Machine Transport, On Site Consolidation and Lifting Process

Transportation Scheme

The type of YQ100/31 bridging machine is a large-scale assembly of construction machinery, and the main beam, the saddle type in the support, the counterattack and other large structural parts of bridging machine in the packaging and transportation process need to consider the impact of many factors. As the main beam acts as the main bearing member of the bridging machine, so for its transport need to pay more attention. The original design of the single main beam is 12.5 meters long, exceeding the container size of 0.5 meters. Taking into account the lifting, container transport and on-site assembly and other restrictions, the original design is optimized that adjust the single main beam size to 11 m.
On Site Consolidation and Lifting Process

To overcome the narrow field backside of abutment, when all the segment of bridging machine clearance transported to the site, Each segment will be directly assembled on abutment and pier head. The assembly steps are as follows:

1. Assemble the front supports on the river bed of first span, and then lift the assembled front supports to the pier head with 100T crane. And fixed with 18# wire rope and six 5T hand chain hoist.
2. Place the traverse track for middle supports on the top of the abutment, and assemble the middle supports as a whole according to the needs of the slope of the bridge.
3. Each main beam segments sequentially emissions next to the first span, and then Assemble 2 sets of 33 meters long main beam with crane.
4. Place the main beam above the front supports and middle supports with 100T crane and fixed lock.
5. Install the cross beam and lifting trolley with crane.
6. Add a section of the main beam of 11m in the back of the two groups of the main beam.
7. Finally, connect the power supply circuit of bridging machine.
8. After assembling, supervision and inspection by the LAM POWERPLANT SERVICES LTD.

T-Beam Lifting and Erection Construction Scheme

Scheme Brief Description

T beams are prefabricated in the precast beam field, The T beam prefabricate field be located backside of abutment from K0+200~K0+270, and full length 70.0m, total width 24.8m. The T beam prefabricate field consists of 2 rows of pedestal, each row of 7, a total of 14 pedestals. The layout of the T-beam prefabricate field as Fig1:

Figure 1. The T-beam prefabricate field.

Due to the elevation difference between the top of the abutment and T-beam prefabricated site, The T-beam lifting and erection cannot be carried out by conventional way. The T-beam lifting and erection construction scheme as follows: Through the co-operation of bridging machine and crane to enhance the ground to achieve the first span T-beams lifting and erection. The schematic diagram for the first span T-beams lifting and erection as Fig2.
After the T-beam erection of the first span is completed, backfilling the rear of abutment with gravel, and the T-beam in the prefabricate field was lifted up to the beam carrying trolley by the two 100T crane. The T-beam will be transported directly from the prefabricate field to the tail of the bridging machine. The schematic diagram for the second span T-beams lifting and erection as Fig3.

100T Crane Lift Beam Condition

Crane Lift Beam Parameters. The lifting-point position is set at 0.8m from the beam end. When crane lifts the beam, the roundabout radius ≤5m, the arm length ≤10m. When the roundabout radius is 5m, the arm length is 10m, its maximum lifting is 58T. The weight of the 31m T beam is 62t, so the two 100t crane can meet the lifting requirements.

Wire Rope Selection. Calculation of wire rope tension:

\[ P=31.07T. \quad (1) \]

\[ S_1=(31.07/2)/\sin 60^\circ \sim \sin 45^\circ =17.94 \sim 21.97T. \quad (2) \]

Wire rope selection: The wire rope selected as 6 × 37 (a) steel wire rope that the tensile strength is 170kg / mm2, and diameter is 52mm. The safety load factor of the wire rope is 6.0. The minimum breaking force of the wire rope is:

\[ P=(1705.0/9.8)1.321=229.83T. \quad (3) \]

The safety bearing capacity of wire rope:

\[ 229.83/6=38.304(T)>21.97(T). \quad (4) \]

So the wire rope meets the lifting requirements.
Calculation of Bearing Capacity of Foundation. The weight of crane is 90T, and the weight of T-beam is 62T; The crane bracket paving steel plate area:

\[ 2m \times 2m \times 4 = 16m^2. \]  
\[ 152t/16m^2 \times 1.5 = 146.25 \text{Kpa} < f_{ak}. \]  

The foundation bearing capacity meets the requirements for lifting.

Oblique Analysis and Control for Drag Lifting Beam

Oblique Analysis for Drag Lifting Beam of the First Span. As the elevation difference between the top of the abutment and T-beam prefabricated site, and the maximum oblique is 16.5% during drag lifting beam of the first span T-beam. The forced diagram during drag lifting beam of the first span as Fig4:

The sliding friction coefficient between wire rope and T-beam: \( \mu_1 = 0.6 \).

The sliding friction during drag lifting beam:

\[ f = \mu_1 T \cos \alpha = 0.6 \times 62 \times 0.986 = 36.7T \]  
\[ F = T \sin \alpha = 62 \times 0.167 = 10.35T < f \]  

Control Points for Drag Lifting Beam of the First Span. The trailing beam is one end of the T-beam lifted by the bridging machine and the other end supported by beam carrying trolley. The schematic diagram for drag lifting beam of the first span as Fig5.
In the process of feeding beam, the front lifting trolley of bridging machine as the active body and the beam carrying trolley as the passive body. In the trailer mode, the operator only needs to determine the start time of the trailer, the speed of the trailer, and the end time of the trailer. When the beam carrying trolley reaches the limit position, the drag action will automatically stop, and then the rear lifting trolley of bridging machine lifts the second lifting point. At this point, the front and rear lifting trolley of bridging machine move forward at the same time.

**Design and Stability Calculation of T-beam Transport Track**

**Parameter Design.** During the T-beam erection of second span, the T beam transported is the key link. The design of the transport track is as follows: The transport track length is 45m, overcome the height difference of 2.1 meters, and the average slope is 4.7%. That meets the requirements of the 5% design slope limit of beam carrying trolley. The track gauge is 2.0 meters, and the track laying gauge error ± 2mm. The adjacent rail joint height difference is ± 1mm.

**Stability Computation of T-beam Carrying Trolley.** In the traction, the beam and the body of carrying trolley contact with each other by the pad wood. The friction coefficient between objects as follows:

- The sliding friction coefficient between pad wood and T-beam $u_1 = 0.6$;
- The sliding friction coefficient between pad wood and carrying trolley $u_2 = 0.4$;
- The rolling friction coefficient of wheel shaft sleeve $u_3 = 0.05$;

Concrete beams and pad wood, pad wood and carrying trolley to produce a relative slip of its horizontal force at least greater than the friction = $31 \times 0.4 = 12.4T$, but the carrying traction is only $31 \times 0.05 = 1.55T$, so it is impossible to slip in the traction. The schematic diagram for T-beam carrying trolley of the second span as Fig.6.
Summary
It is a good way to solve the bridging machine hoisting, container transport and on-site assembly and many other conditions by segment customized. By using transshipment T-beam with large-tonnage crane and drag lifting beam to solve the problems of narrow field backside of abutment II and elevation difference between the top of the abutment and T-beam prefabricated site. It can provide reference for similar overseas projects.

References