Universe Scientific Publishing

ORIGINAL ARTICLE

Study on temporary support of continuous girder bridge in construction

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Abstract: The reasonable design of the temporary support of the continuous girder bridge is a safe guarantee for the smooth closing. According to the characteristics of temporary support of the closed section, the corresponding calculation method is put forward, and then several kinds of temporary support locking devices colmmonly used in engineering practice are discussed. Based on the engineering example, the paper discusses the selection and design of the temporary support form of the construction of the continuous girder bridge. The results show that the transition of the structural system has great influence on the temporary supporting force, and it is feasible to use the external rigid support when the long - span continuous girder bridge decouples the temporary fixed bearing restraint.

Key words: Closure; temporary support; external rigid support; continuous girder bridge

Introduction

It is a key step in cantilever construction of long span continuous girder bridge, which is an important link in the structural system transition of continuous girder bridge, which has important influence on the girder line shape and structural internal force after completion. Closed section of the new pouring of concrete to reach the design strength before the closing side of the cantilever end of the mouth with the temperature will shrink, the temperature rises and elongation, concrete hardening process will produce contraction, closed section of the construction control is not good, the main girder is easy to crack and affecting the quality of the project. Therefore, it is necessary to design reasonable temporary support to ensure that the new section of the closure of the concrete pouring to meet the design strength before the cantilever to meet the deformation and do not bear the additional axial force. Temporary support in a variety of ways, should be based on the actual situation of the project selected to ensure the construction safety and construction quality.

1. Calculation method

1.1 Stress Analysis at Both Ends

When the force is fixed at both ends of the closure of the closure of the pier on both sides of the temporary consolidation of the pier is not removed, temporary support is mainly affected by temperature control design, the

doi: 10.18686/wcj.v6i1.80

Figure1 Schematic Calculation of Temporary Support

calculation shown in Figure 1.

To simplify, it is assumed that the piers on both sides of the span are consolidated. The deformation of temperature is calculated by the linear expansion or shortening of the temperature. The stage of the box girder is calculated by the average section of the section. Temperature Action Control Design.

Girder heating △t the amount of elongation of the girder L△t，which is:

$$L\triangle t = \alpha s \cdot \triangle t \cdot Ls + 2\alpha c \cdot \triangle t \cdot Lc$$

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Both ends of the constraint reaction N, The resulting girder is shortened to L△N，then:

$$L_{\Delta N} = \frac{NL_s}{E_s A_s} + 2\sum_{i=0}^{n} \frac{NL_i}{E_c A_i}$$

According to the structural deformation coordination principle,

There are:

$$L_{\Delta t} = L_{\Delta N}$$

Therefore, can conclude:

$$N = \frac{\alpha_s \bullet \Delta t \bullet L_s + 2\alpha_c \bullet \Delta t \bullet L_c}{\frac{L_s}{E_s A_s} + 2\sum_{i=0}^{n} \frac{L_i}{E_c A_i}}$$

Where: αs, αc respectively, for the temporary expansion of concrete and linear expansion coefficient; Lc, Ls are cantilever casting section length of the main girder, closing the mouth of the temporary support length; N for the temporary support of the mouth of the axial force received; Es, Ec respectively, the elastic modulus of temporary support and the elastic modulus of concrete; As for the temporary support of the cross-sectional area; Ai、Li respectively, the average cross-sectional area and length of the i-th section of the box girder.

1.2 Mechanical Analysis of Sliding at One End

When the two sides of the pier are closed, the axial force caused by temperature is very large. It is necessary to temporarily release the temporary consolidation constraint to close the one-way pier after the temporary support of the closure section. Vertical free to slide. At this point, closing mouth temporary support of the internal force analysis is as follows:

Heating Time:

$$N = Ny + f \bullet Q$$

Cooling Time:

$$N = Ny - f \bullet Q$$

Wherein: Q For the closure of one end of the vertical sliding bearing support reaction; f is the friction coefficient of the sliding bearing; Ny pre-stress provided for tensioning temporary pre-stressed steel strands，If only rigid support is set, the value is zero.

2. Temporary support design

Before the large-span continuous girder bridge is closed, it is generally necessary to observe the deformation of girder section and the actual temperature continuously for 24 hours, draw the curve of elongation of girder section and temperature with time, and then determine the closing temperature temporary support differences after locking and the amount of girder stretching. Under normal circumstances, try to select a day with low temperature and a constant night to support temporary and lock the closing section immediately after the concrete pouring. Due to the very short duration of the temporary support locking to the strength of the cast-insitu concrete, the creep of the concrete during this period is generally not taken into account and only the influence of the temperature variation of the girder is taken into account to determine the temporary support form.

Large-span continuous girder construction of the common section of temporary support locking device are as below: -

2.1 External rigid support and internal rigid support

This kind of temporary support locking device is the top plate of cantilever casting section on both sides of the closing mouth. The top plate of the bottom plate is embedded with steel plate with shearing nail. The steel is used as outer rigid support, welded or bolted to the embedded steel plate. At the same time in the closing section and the cantilever sections of both sides of the concrete frame set up within the framework of rigid support. External rigid support and internal rigid support together to bear the external force when the role of closure (see Figure 2).

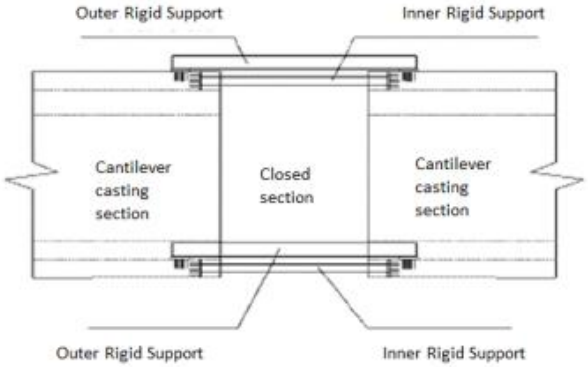

Figure 2 Outer and Inner Rigid Supports

2.2 External (Internal) rigid support and tension temporary steel girder

In addition to the use of external rigid support and internal rigid support for locking, but also can be part of the permanent or temporary use of temporary tension of steel to provide pressure reserves (see Figure 3).

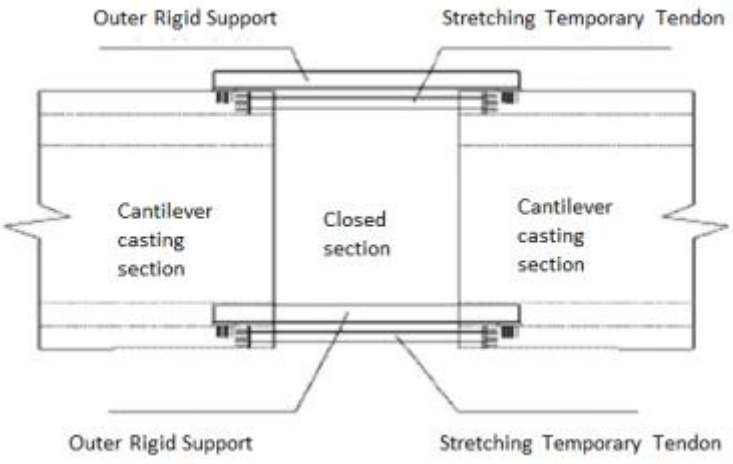

Figure 3 Outer Rigid Support and Stretching Temporary Tendons

2.3 Outside the rigid support

Since the internal rigid support only to provide compression and inconvenience for construction due to the amount of steel bar, the actual construction always set the external rigid support during the lowest temperature in the day when pouring the concrete section (see Figure 4) .

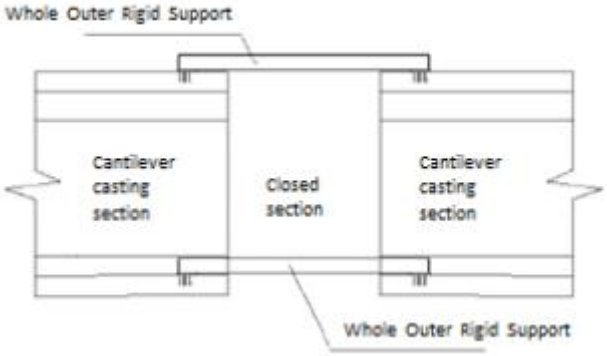

Figure 4 Whole Outer Rigid Supports

3. Project example

3.1 Project Overview

Wangyuhe Railway Bridge is a 70 m + 125 m + 70 m long-span variable height continuous girder bridge, the cross-section in the form of single-box single-chamber (see Figure 5). The bridge is constructed by symmetrical cantilever casting method. The single cantilever is divided into 13 segments.

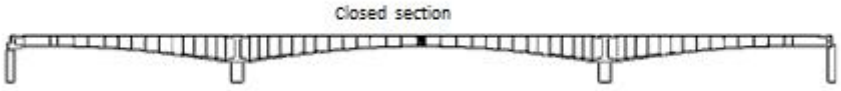

Figure 5 Structural Arrangement of Jiahai Highway Bridge

3.2 Support force calculation

The temporary tension steel can reduce the temporary deformation of concrete and reduce the possibility of tension cracks in the concrete. However, when the temperature rises, the pre-tension of the tensioned temporary steel girder acts

on the concrete of the closing section, which makes it premature to participate in the force, adversely affecting the setting and hardening of the concrete and the strength development. In fact, the temporary support of the lock selection in the lower temperature of the day as full external rigid support whereby the stiffness is large enough. When the cooling deformation is very small, it is not enough to cause the closure of concrete cracks in the cracks. Practical experience also shows that as long as the temporary support locking and closure of concrete pouring at the right time, then the selection of the appropriate use of external rigid support construction scheme is entirely feasible.

Wangyuhe Railway Bridge in the temporary closure of the use of external rigid support if the closure of the temporary support at both ends of the fixed situation. Temporary support of the lock selection at low temperature at night, according to theWangyuhe Railway Bridge before the closure of 1 to 3 days before the continuous observation of the temperature data, the temporary support of the force by heating 15 ℃, cooling 5 ℃ considered.

Suppose the temporary support using 10 units of 25 # b channel, the temporary support suffered axial force :

$$N = \frac{\alpha_s \bullet \Delta t \bullet L_s + 2\alpha_c \bullet \Delta t \bullet L_c}{\frac{L_s}{E_s A_s} + 2\sum_{i=0}^{n} \frac{L_i}{E_c A_i}} = 28241kN$$

It can be seen that the axial force generated by temperature is very large when the piers on both sides of the joint are all consolidated. Therefore,Wangyuhe Railway Brige in the interim closure of temporary support before the closure, the release of one end of the temporary consolidation of the bearing so that it can slide in the vertical, the lock after the support of internal force to offset the temperature changes caused by bearing friction. The bridge is close to both sides of the top of the pier bearing are used ball bearing, friction coefficient of 0. 05.

The bearing capacity of the sliding bearing is the weight of the cantilever girder, the dead weight of the 1/2 closing girder, the mechanical load of the bridge, and the load of the hanging basket, etc., calculated by 48 000 kN. At this point, the temporary support needs to bear the level of force:

$$N = f \bullet Q = 0.0499 \times 48000 = 2395kN$$

Temporary support using external rigid support, the roof set 3, the floor set 2, the safety factor of 2.0, the axial force required for each rigid support is 959 kN.

According to the actual situation on the scene, the temporary external rigid support is using double-limbed plate. Two units of 25 # b channel steel, both sides using 200mmx200mmx20 mm thick at the spacing of 550 mm steel plate as a decorative plate

After confirming the form of temporary support, the strength and stability of the double-limbed plate should be checked, and the welding connection of the embedded shear plate and the steel plate of the double-limb plate should be checked accordingly for security.

Conclusion and suggestion

Through the discussion of the design of temporary support of the closure section of Wangyuhe Railway Bridge, the following conclusions and suggestions are as below:

When large-span continuous girder is used to consolidate the span across the two ends, due to the large axial force caused by the temperature change, it is necessary to adopt the rigid and large temporary supporting facilities.

Large span continuous girder bridge structural system transformation has great influence on the selection and design of

temporary support. It is suggested that the temporary consolidation restraint of the bearing is released before the construction of the large span continuous girder bridge is closed so that it can slide longitudinally freely and then lock the temporary support of the closing section at the lowest temperature.

Outside the rigid support should first complete the same end of the weld when the temperature dropped to a day when the lowest. Then all the other welding the end of the lock. Welding a number of temporary rigid support at the same time to ensure that all rigid support and force by force at the same time.

If the temporary tensioning steel girder is set, the pre-stressing tension should be carried out immediately after the rigid support is locked and the tensioning sequence is symmetrical according to the bottom plate of the first roof.

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