International Journal of Technical Research and Applications e-ISSN: 2320-8163,
www.ijtra.com Volume 3, Issue 4 (July-August 2015), PP. 200-204

THE STRESS STATE CALCULATION AND ANALYSIS FOR LONG-SPAN CONTINUOUS RIGID FRAME BRIDGE WHEN CLOSURE ORDER ADJUSTED

Yupeng Cao[1] Hui Liu[1]
[1](School of civil engineering and architecture, Chongqing Jiaotong University, China
Email: pengfullofenergy@163.com)

***Abstract*— The closure is an important part of the continuous rigid frame bridge during construction stage. The stress state of girders will change when the closure order adjusted. Therefore, reasonable closure scheme is crucial for whether the stress state to meet the design ideal state. In the actual construction, due to the terrain conditions, construction progress and the limitation of the final closure temperature, it need to adjust the order of the final closure scheme for long span continuous rigid frame. In this paper, we took a long-span continuous rigid frame bridge in Yunnan province as example. The closure plan changes and we do calculation and analysis for two kinds of closure scheme-first side span than middle, first middle span than side span. We got the bridge stress state and construction phase stress state. We analysed the differences between the two kinds of closure scheme. We chosen some stress weak position, those position should be monitored and in real construction should be strengthened monitoring. *Index Terms*—Component, formatting, style, styling, insert.** *(key words)*

I. INTRODUCTION

1. Long-span continuous often use segmented cantilever pouring construction scheme. Each segment of the construction state is to guarantee bridge structure to meet the requirements of design and usage. In this type of bridge construction control, stress control is a major task of construction control. Through the study of the stress in each node construction monitoring, we check whether bridge internal stress state in the process of construction and design value. If you find that the stress state of bridge actual stress state with theoretical predictions difference exceeds a certain limit, it must stop construction and find the cause of the stress state overrun. So in a timely manner to control differential allowed range, this can ensure the safety of the bridge construction and the stand or fall of stress control don't like the deformation control that easy to find. If the stress control is not good is likely to cause harm to bridge structure, Bridge construction in the history of the world there are many examples of structural instability caused by accident. So the stability of the bridge structure for safety of the bridge structure is very important. In some cases it is even more important than the strength of the bridge. In the high pier and long span continuous rigid frame bridge construction, It has to go through the process of structure system transformation. Along with the advancement of construction stage, the structure form of bridge, supporting constraint conditions and load mode are constantly changing. So it's finally dead load state is closely related to the construction of internal forces closure order[1]. In the process of system transformation, under the different closure order, due to the different initial internal force of dead load, caused by shrinkage and creep of the internal force redistribution is different also. In this article, through comparison analysis for the closure order of two common states of stress in different stages, elaborated the weak position of the stress monitoring under the two closure order construction, in order to achieve the purpose of construction safety[2].

II. TWO COMMON CLOSURE SCHEMES

Currently closure order of long span continuous steel bridge often used as first side span than middle, while using first middle span than side span of the closure order in exceptional circumstances [3]. Two kinds of closure program in figure 1 and figure 2.

A. Scheme I: first side span than middle

This scheme is a closure order of long span continuous steel bridge most commonly used. After hanging basket cantilever pouring stage is completed, the first construction side span cast segments, and side span closure section, the final closure of the cross-section of construction, before the closure box beam T-frame are all statically indeterminate structure, at a temperature change deformation without stress. In this case after the closure side span is completed, the bridge will form one statically indeterminate structure. It is subject to shrinkage and creep effects and temperature affect less affected [4].

B. Scheme II: first middle span than side span

This closure order in cross closure is completed, its middle span form a TT type multiple statically indeterminate structure, The concrete of middle span action at temperatures will produce thermal stress, so the closure temperatures are key factors[5].

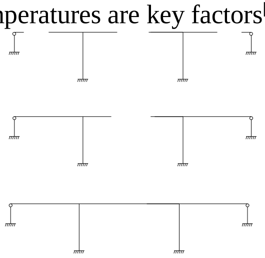

Fig 1. First side span than middle Schematic diagram

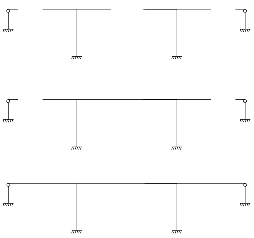

Fig 2. First middle span than side span schematic diagram

III. ENGINEERING CALCULATION ANALYSIS

Taking a case impact analysis bridge closure scheme to bridge the force brought, The bridge is a high-speed line bridge in Yunnan province. The bridge across the valley, the bridge is divided into left and right picture, The bridge is 90 m + 160 m + 90 m variable cross-section single box single chamber structure, The box girder with vertical web , the width of top palate is 12 m, the width of bottom palate is 6.5m,the length of flange plate is 2.75 m, The height of NO.0 section is 10 m, The height of the box grider in middle span is 3.5 m, The web with a variable thickness from 100cm to 50cm, The bottom palate is from 140cm to 32cm. The length of NO.0 section is 12m, The length of closure section in middle span is 2m. Side span cast-in-place length of 8.8 m, side span cast-in-place section of the guide beam bridge construction. The cantilever is divided into 20 pieces of paragraphs .The super large bridge box girder cantilever pouring using triangle hanging basket construction. Box girder is shown in figure 3.

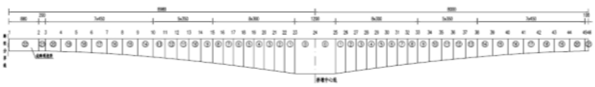

Fig 3. Box girder

Due to the high transition bridge pier, is not conducive to the erection of the bracket, so the original design side span construction using the guide beam hanger cast construction. When the middle span closure is for the support of the construction side of the hanging basket. The original design closure scheme for the first side span than middle way of closure, which is the scheme I. During the construction process the reason behind schedule due to the construction and use of terrain cannot support construction in side span cast-in segment. Therefore decided to adjust the final closure order, use the closure way of first middle span than side span namely is adjusted for scheme II. In the same time middle span closure erection nose girder side beams and templates to achieve the purpose of shortening the construction period, and when appropriate to reduce the side span closure counterweight.

Using finite element software Midas civil 2012 3 d simulation analysis of the bridge. Box grider and piers are the beam element simulation, the whole bridge workers were divided into 156 units and 159 nodes. Three-dimensional finite element model is shown in Figure 4.

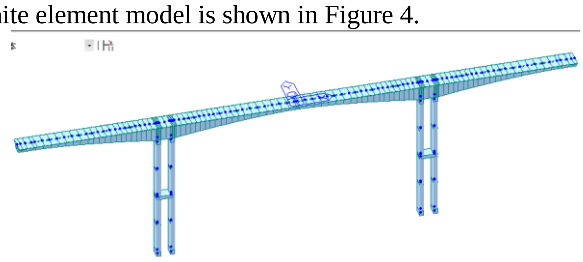

Fig 4.the finite element model of long span continuous rigid frame

In the cantilever pouring construction program remains unchanged, adjust the construction phase closure, where in the side span of cast segment and closure section with nose girder hanger frame construction,, middle span closure section is based on the construction side of the hanging basket do support the way the following is a comparison of the construction phase of the closure of two schemes:

A. Scheme I: the closure order of first side span than middle

①Applying side span cast segment counterweight ②Side span cast segment pouring ③Applying side span closure segment counterweight ④ Side span closure segment pouring ⑤ Side span closure Segment tensioning tendons ⑥ Applying middle span closure segment counterweight ⑦ Middle span closure segment pouring ⑧ Middle span closure segment tensioning tendons

B. Scheme II:: the closure order of first middle span than side span

① Applying middle span closure segment counterweight ② Middle span closure segment pouring③ Middle span closure segment tensioning tendons ④ Applying side span cast segment counterweight ⑤ Side span cast segment pouring ⑥ Applying side span closure segment counterweight ⑦ Side span Closure Segment pouring ⑧ Side span Closure Segment Tensioning Tendons

IV. Comparative Analysis of Bridge Stress State

This paper analyzes the two closure order after the completion of the bridge (completed phase II pavement), main girder roof, main girder floor and main girder webs stress are as follows:

(1) Stress comparison of the main girder roof:

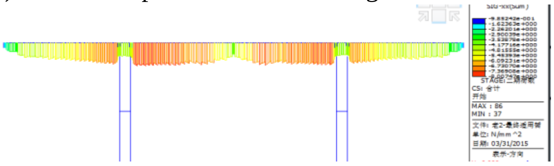

Fig5 Scheme I main girder roof stress diagram

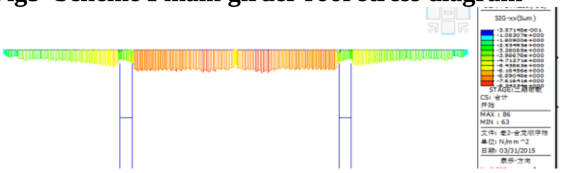

Fig6 Scheme II main girder roof stress diagram

(2) Stress comparison of the main girder floor:

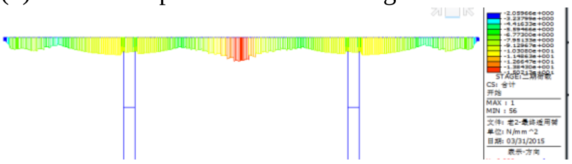

Fig7 Scheme I main girder floor stress diagram

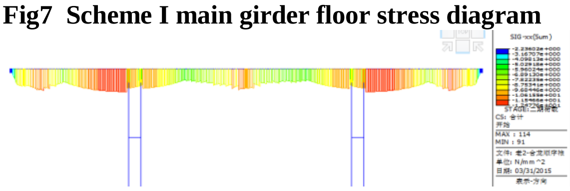

Fig8 Scheme II main girder floor stress diagram

(3) Stress comparison of the main girder webs:

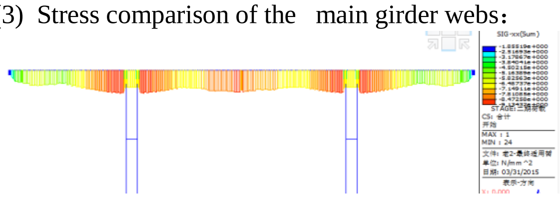

Fig9 Scheme I main girder webs stress diagram

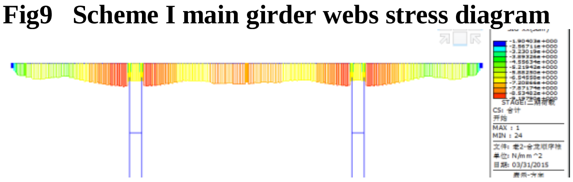

Fig10 Scheme II main girder webs stress diagram

As we can be seen from the figure 5 ~ 10. Two closure order into the final stage of stress state varies, scheme I compressive stress of side span roof than scheme II should be large, especially in the side span cantilever root section, the maximum difference is 5mpa. And scheme I the compressive stress of middle span roof is larger. For the floor of the bridge, the scheme II compressive stress of side span is much greater than the program. While the compressive stress across the span is much smaller, the maximum difference is 9mpa. The web's compressive stress the difference between the two programs is small. In reality, if the order of closure due to construction conditions and other factors that lead to changes in restrictions, the scheme I change to Scheme II, Through the above comparison can know, the compressive stress of scheme II is not ideal. It increases the side span main girder compressive stress, and reduces the compressive stress of middle span. Later in the operation process, as the main girder of shrinkage and creep, the scheme II girder under the states of the decrease of the compressive stress will further, it will bring in continuous downwarping diseases

V. Comparative Analysis of the Construction Phase of the Stress State

For the construction phase of the boom segment, its method and order are the same, so little difference in stress state. Select two of the most unfavorable conditions analysis(applying middle span closure segment counterweight and applying side span cast segment counterweight). construction phase two programs stress contrast, and to propose changes in this two closure order, the need to control the dangerous parts and the need for attention[6].

A. Applying Side Span Cast Segment Counterweight

Consider side span force closure stage the most unfavorable condition, choose applying side span cast segment counterweight to analyze. For the scheme I, At this time the cross has not been closure, each T-frame belonging to statically indeterminate structure. The middle has been closure, it form a TT type multiple statically indeterminate structure. Therefore, after the closure order adjustment, TT structure can be used in reduced cross a weight distribution. The following is the analysis of changes in the roof, floor and web stress.

(1) Stress comparison of the main girder roof:

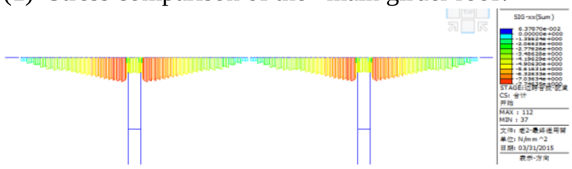

Fig11 Scheme I main girder roof stress diagram

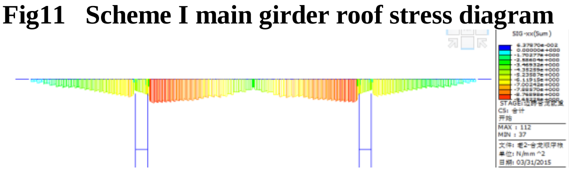

Fig12 Scheme II main girder roof stress diagram

(2) Stress comparison of the main girder floor:

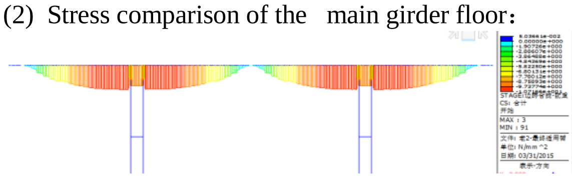

Fig13 Scheme I main girder floor stress diagram

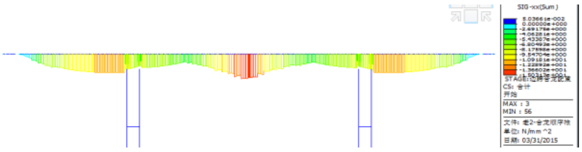

Fig14 Scheme II main girder floor stress diagram

(3) Stress comparison of the main girder webs：

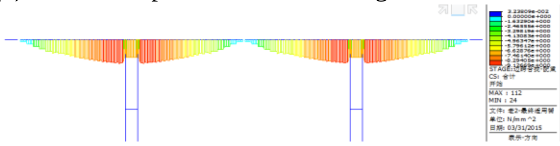

Fig15 Scheme I main girder webs stress diagram

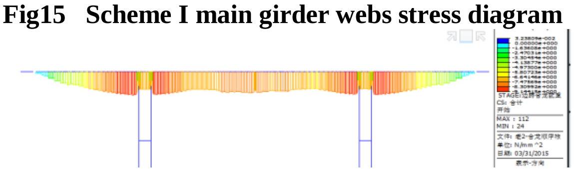

Fig16 Scheme II main girder webs stress diagram

As can be seen from Fig. 11 to 16: while the main girder in the compressive stress across the state, but not the same. For roof stress, the scheme II the main girder span large compressive stress.the maximum difference 5.2mpa, side span the main girder compressive stress is small; to the floor, the scheme II 1/4 across the main girder stress than the scheme I big difference. the maximum difference is 8mpa, and side span a smaller difference between the main girder stress; the web is concerned, the the main girder span across large stress difference, the biggest difference 9.2mpa. Therefore, the above situation, the scheme II values across the compressive stress is large, especially across the main girder root and 1 / 4L in place.

B. Applying side span Cast segment counterweight

Consider middle span force closure stage the most unfavorable condition, choose applying middle span cast segment counterweight to analyze. This time for the first adjustment, side span closure has been applied in the cross-counterweight large. And adjusted side span yet closure, imposed a relatively small weight. The following is the analysis of changes in the roof, floor and web stress.

(1) Stress comparison of the main girder roof：

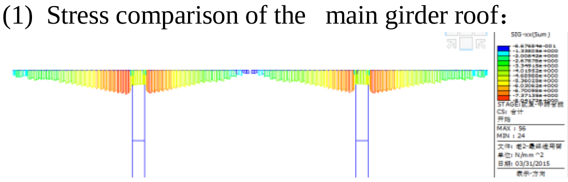

Fig17 Scheme I main girder roof stress diagram

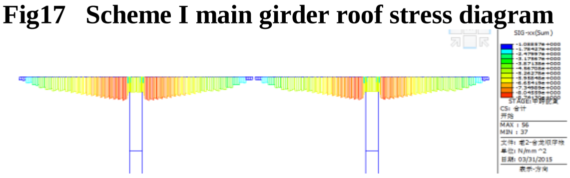

Fig18 Scheme II main girder roof stress diagram

(2) Stress comparison of the main girder floor：

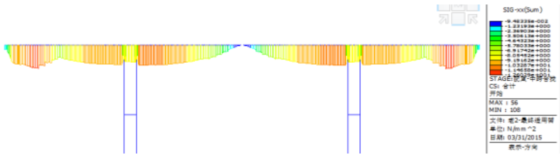

Fig19 Scheme I main girder floor stress diagram

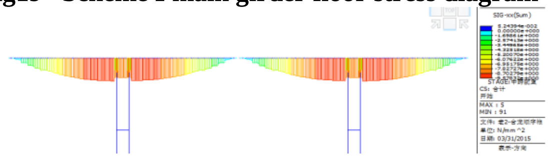

Fig20 Scheme II main girder floor stress diagram

(3) Stress comparison of the main girder webs：

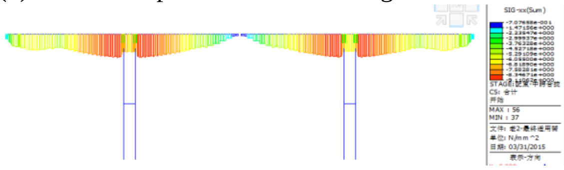

Fig21 Scheme I main girder webs stress diagram

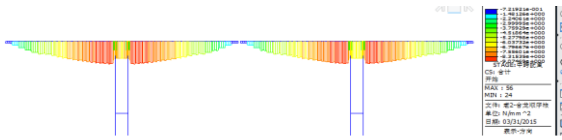

Fig22 Scheme II main girder webs stress diagram

As can be seen from the figure 17 ~ 22, scheme I and II in applying middle span cast segment counterweight, the side span girders in compressive stress state, but each are not identical, for the roof plate stress, scheme II cross girder in the compressive stress is larger, and for web scheme II is relatively small.

C. Control of dangerous parts

By analyzing the sequence of the closure of two of the most unfavorable state shows, the center of middle span, the root of the main girder and main girder of 1 / 4L is that the construction phase of maximum stress points, stress is relatively small reserves, strengthen the construction process monitoring these places can be embedded in the construction process of stress and strain sensors, strengthen observation when closure is applied counterweight hop long pouring, the stress of overrun if found, should immediately stop the construction and inspection problems.

VI. Conclusion

Through the analysis above, the actual construction process may be due to various on-site factors which have led to the case of scheme I can not be achieved, adjust the closure scheme for the scheme II, a greater impact on a bridge stress, reduce stress reserves main girder, may be exaggerated bridge after contraction creep, causing continuous main girder of span deflection other issues. For the construction phase. We should strengthen the monitoring of the main beams and stress pier junction, cross the main girder of and 1/4, etc., and in construction should be taken to avoid unbalanced loads on both sides of the T configuration, such as the high bridge pier most thin-walled flexible piers, unbalanced load is applied after the top of the pier will increase lateral offset of the bridge Internal force and linear influence.

REFERENCE

[1] Zhu S F.*Study on Structural Curve Controlling and Closure Technic of Muti-span Continuous Rigid-frame Bridge*[D]. Chongqing Jiaotong university.2008

[2] Yang B.. *Research on the Different Construction Progress Effect of Continuous Rigid Frame Bridge*[D]. Chang'an University.2010

[3] Liu Y Q. *The study of multi-span rigid-frame continuous bridge construction stability and closure schemes*[D]. Xiangtan University.2014

[4] Zhao J. Study of Closure *Technics for Long Span Continuous Rigid-frame Bridge*[D]. Chang'an University，2010

[5] Wu M Z. *Multi span prestressed concrete continuous rigid frame bridge closure plan research*[D]. Chongqing Jiaotong university.2014.

[6] Yao L W,Xu Q H,Hu X L. *Closure Sequence Analysis and Process Simulation of Aizhai Continuous Rigid Frame Bridg*e[J]. Highway Engineering. 2012.(37):4-7.