ISSN: 2414-1895 DOI: 10.6919/ICJE.202405_10(5).0036

Sensitivity Parameter Analysis of Large Span Continuous Girder Bridge Collapse Scheme

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Abstract

Continuous girder bridge has the advantages of strong spanning capacity, smooth traveling, etc., which accounts for a great proportion in the bridge construction in China. Continuous girder generally adopts the construction method of cantilever construction, segmental casting, and specific sequence of merging. Due to the large span diameter of continuous girder, the girder body is divided into too many segments, the construction period is long, and the linear shape of continuous girder is easy to deviate from the design value in the process of construction. In order to study the influence of the order and temperature on the continuous girder bridge formation status, this paper takes a 4-span continuous girder bridge as the engineering background, analyzes the continuous girder bridge formation status under different merging schemes and merging temperatures, and draws the following conclusions: (1) The merging program has an important influence on the line shape of the main girder, taking into account the line shape of the main girder and the change of the internal force, the final choice of merging program is to merge the side spans first and then merge the middle spans; (2) Different merging temperatures have a significant effect on the continuous girder line line rows.

Keywords

Closure Scheme; Closure Temperature; Continuous Girder Bridge; Finite Element Analysis; Main Girder Alignment.

1. Introduction

Concrete continuous girder bridge has the advantages of strong spanning capacity, convenient construction, smooth traveling, etc., which accounts for a great proportion in the bridge construction in China. The continuous girder generally adopts the construction method of cantilever construction, segmental casting, and specific sequence of closing, due to the large span diameter of the continuous girder, the girder body is divided into too many segments, and the construction cycle is longer, the continuous girder construction process is easily affected by many factors, which results in the continuous girder linear deviation from the design value, among which the closing sequence, the closing temperature, and the characteristics of the concrete shrinkage and creep have become the main factors affecting the linear shape of reinforced concrete girder bridges[1-3]. Hao Tang[4] analyzed the main girder bridge formation state by finite element modeling of a four-span continuous girder merging sequence, and the results showed that the merging sequence has a greater impact on the main girder line shape. In order to study the influence of the joining sequence on the stress and deformation of the main girder, Guang Liu[5] used finite element software to simulate the force state of the main girder under different construction sequences, and the results showed that the construction sequence of the first middle span, the second middle span, and the last side-span joining will lead to a large deflection of the main girder, which is not recommended. Chunbo He[6] analyzed the bridge formation state of rigid girders with three different joining schemes, and found that the use of traditional construction procedures is more conducive to the main girder formation state to achieve the expected results.

2. Engineering Background

The project example in this paper is a four-span concrete continuous girder bridge with 100m main span and 60m side spans, with a length of 320m. The main girder adopts a single-cell, single-compartment diagonal web section, and the cross slope of the bridge deck is realized by adjusting the height of the web plate by 1.5%. There are two center span joint sections and two side span joint sections.This bridge uses Midas Civil to establish a finite element model of the main girder for analysis, the span arrangement is 60m+2×100m+60m, the whole bridge is divided into 124 nodes and 106 girder units. The main girder is made of C55 concrete, and the finite element model of the main girder is shown in Fig. 1.

Fig. 1 Midas Civil finite element model diagram

3. Closing Parameter Analysis

3.1 Closing Program

As the most important part of continuous girder bridge cantilever casting construction process, it is necessary to strictly control the elevation of the jointed section during the construction process, so as to meet the design force requirements and main girder lineal requirements. The order of joining has an important influence on the construction of continuous girder, which is a key factor in the control of continuous girder construction. Different order of joining will have different influences on the degree of construction difficulty and different degrees of structural error. Secondly, the main girder at the first merging place changes from the "T" static cantilever state to the super static cantilever state, with the increase of the number of main girder spans, the number of merging spans increases, the structural force and linear solution becomes more complicated, and the structural secondary internal force produced by the system conversion will have a greater impact on the main girder linear and internal force after the bridge is completed;

in addition, the different order of the merging directly affects the merging work of each span, which has a greater impact on the construction time cost and economic cost[7], so it is necessary to parametrically analyze the order of the merging in order to obtain the best merging scheme, and to minimize the adverse effects of the order of the merging on the main girder line shape and internal force.

(1) Side-span jointing first, then center-span jointing;

(2) Mid-span jointing first, then side-span jointing;

(3) Side span and midspan are jointed at one time.

By comparing the changes of main girder line and internal force under different jointing sequences, the best jointing scheme is obtained, and the maximum values of main girder deflection and internal force under different jointing schemes are obtained by using Midas Civil finite element software, as shown in Fig. 2 and Table 1 in the subsequent construction phases:

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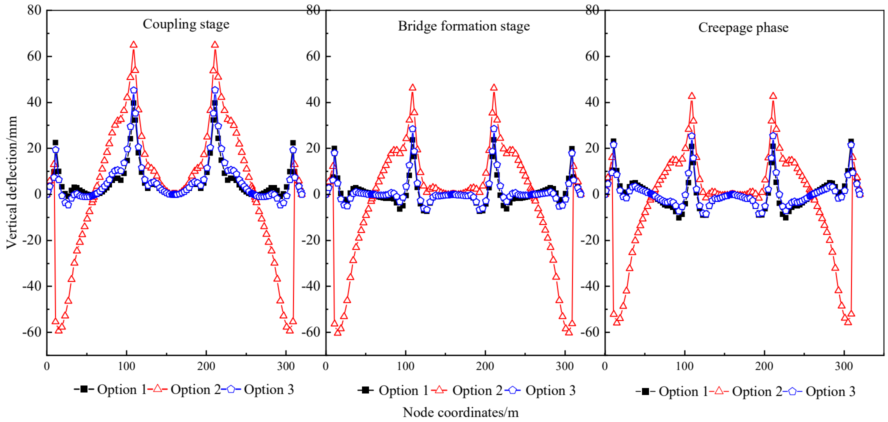

Fig.2 Deflection diagram of each construction stage under different closure schemes (unit: mm)

Table 1. Maximum internal force of the main beam at each construction stage with different closing schemes

Closing program	Coupling stage		Bridge formation stage		Creepage phase	
	M/kN·m	F/kN	M/kN·m	F/kN	M/kN·m	F/kN
Option 1	98065	-234537	64910	-235713	-76617	-232496
Option	133033	-235199	-90201	-236011	-80051	-232645
Option 3	101021	-234733	67651	-235684	-75934	-232516

Note: M stands for bending moment, F stands for shear force.

As can be seen from Fig. 2, the maximum positive deflections of the main girder caused by scheme 1~3 are 39.7mm, 64.9mm and 45.4mm respectively, and the maximum negative deflections are -0.86mm, -59.41mm and -4.62mm respectively, in the stage of bridge formation and creep, the vertical deflection of main girder is downward and continues to be deformed, and there is a significant reduction in the positive deflection. The midspan alignments under different schemes are closer to each other, while the side span alignments have huge differences, and the positive and negative deflections of scheme 2 are significantly larger than those of the other two schemes. The absolute value of the maximum deflection of the three schemes is 12.9mm, 13.3mm and 17.0mm respectively under the action of late-steepening, and the comparison can be seen that the main girder line shape of Scheme 1 is more uniform during the service period of the bridge, which is obvious that the third scheme of the merging program, and the main girder positive and negative deflections caused by Scheme 2 are larger in value, which will shorten the service life of the bridge seriously.

As can be seen from Table 3, the shear force of the main girder at each stage of construction under the three schemes is basically the same, but the bending moment values are quite different. Considering the line shape and internal force of the main girder under different joining schemes, Scheme 1 was finally selected as the joining scheme for this bridge.

3.2 Closing Temperature Analysis

In order to avoid concrete cracking due to large tensile stresses caused by thermal expansion and contraction during the jointing process, it is generally desirable to choose the jointing of continuous beams at the time of the day when the temperature is the lowest, so as to ensure that the concrete remains warmed and pressurized after casting[8].

The minimum temperature of the bridge site is -10°C and the maximum temperature is 41°C throughout the year. Three different closing temperatures of 6°C, 16°C and 26°C were selected to analyze the state of main girder bridge formation:

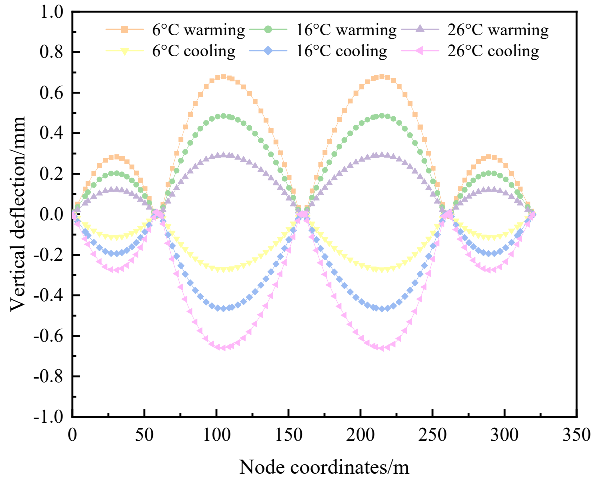

Fig. 3 Linear diagram of main girder lifting temperature under different closing temperatures (unit: mm)

The vertical deflection deformation diagrams of the main girder at different merging temperatures are shown in Fig. 3. The vertical deflections of the continuous beam caused by temperature rise and fall are in opposite directions, and the maximum vertical deflections are in the center of the span. Too high or too low merging temperature will adversely affect the main girder line shape, and when the merging temperature is 16℃, the deflection change of the main girder is the most uniform under the subsequent temperature change.

4. Conclusion

(1) Continuous girder joining adopts different joining schemes to have important influence on the main girder line shape, considering the line shape of the main girder and the change of internal force, finally choose scheme 1 as the joining scheme.

(2) The deformation of continuous girder is significantly affected by system temperature rise and fall under different jointing temperatures, and the deformation of main girder under system temperature can be effectively reduced by choosing suitable jointing temperature.

References

[1] HuiQiu LIU. Research on construction merging program of concrete continuous girder bridge for large-span single-line railroad[J]. Journal of Railway Science and Engineering,2019,16(03):706-711.

[2] Tianliang Xu. Key technology of joining construction of pre-stressed concrete continuous girder bridge[J]. Railway Construction,2017(04):37-39+55.

[3] Jianbiao LIU, Deqing ZHU, Dexiang ZHU. Analysis of the effect of adjusting the closing sequence on the structural internal force during the construction of continuous rigid-frame bridge[J]. Highway and Transportation Science and Technology (Applied Technology Edition),2018,14(03):231-233.

[4] Hao TANG, Yusheng LIU. Comparative analysis of closing sequence of a large-span continuous girder bridge[J]. China Water Transportation (the second half of the month),2019,19(05):189-190.

[5] Guang LIU. Optimization analysis of construction scheme of continuous girder bridge merging section[J]. Shanxi Construction,2022,48(10):141-143.

[6] Chunbo HE. Analysis of the influence of merging sequence on the bridge formation state of continuous girder bridge[J]. Inner Mongolia Highway and Transportation,2021(05):30-32+36.

[7] Bingzhe HE, Yongsheng SHAO. Optimization study of continuous girder bridge merging scheme[J]. Urban Construction Theory Research (Electronic Edition),2012(10).

[8] Juxian Liu. Exploring the effect of merging temperature on bridge formation of continuous rigid structure bridge[J]. Construction Engineering Technology and Design,2015(17):705-705.