The Influence of Tension Sequence of Prestressing Steel beam on Prestress Loss

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Keywords: prestressed concrete box girder, prestressed tension sequence, prestress loss, representative section

Abstract. Based on the analysis of the influence of prestressed beam tension on the concrete box girder structure, this paper puts forward the characteristics of the construction of viaduct. It is based on the construction characteristics of viaduct. The reasonable tensioning sequence of prestressed concrete box girder with the characteristics of viaduct construction has been put forward. To obtain the stress displacement value and the prestress loss value in the different tensile sequence, follow works have been done: The finite element software Midas/civil is used to establish the finite modal, and select the typical cross section has been select. Then, compared prestress loss of the prestressed concrete box girder in different steel beam tensioning sequence. Case 3 (abdominal - top - bottom) is the most reasonable.

Introduction

Prestressed steel beam is the lifeline of continuous box girder bridge. Prestressed tension is a very important link in the process of continuous box girder bridge construction. Xu Guangbin Based on the Lao Wo River Bridge, the typical working conditions are obtained, and the prestressing loss of the first tensioned roof beam is slightly smaller than that of the first tensioned beam[1]. Yue Pengcheng takes the Ziya River as the research object, The stress distribution of the beam caused by the longitudinal prestressing of the prestressed beam is relatively uniform and the prestressing loss is small. The method of segmented tension can effectively reduce the priestess loss[2]. Based on the theoretical analysis of the effect of prestressed tensioning on the deformation of box girder and the influence of structural force, the results show that the prestressed tension is applied to the prestressed tension "The bending box on the cross section of the principle of tension[3].The prestressing priestess of prestressed beam is affected by the tensioning order, and the current research is less. In order to reduce the priestess loss effectively and improve the structural stress, the construction of the viaduct of the reconstruction project of Xiongchu Street is the engineering background.

The general situation of the project

Xiongchu Avenue(Chu Ping Road overpass～The Third Ring Road overpass) transformation of the project from the west of Chuping Road K7+320 of the Xiongchu Avenue of City Investme section design ending point, end the east of the Third Ring Road overpass. The total length of the main line of the project is 6580m, red line width is 50～65m. Construction model of project take main line viaduct + ground auxiliary road, main line viaduct two-way 6 lane width 26m.

Influence of different tension order on prestressing loss

The finite element analysis software midas/civil is used to model the continuous beam bridge structure(superstructure)[4], The model is shown in Figure 1.

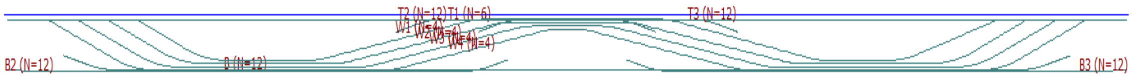

Fig. 1 Schematic diagram of main bridge box girder longitudinal prestressed steel beam layout

According to the difference between the three positions of the top, the web and the bottom plate of the box girder, the tensioning sequence can be divided into the following six steps.

Procedure 1: Roof steel bundle→ web steel bundle→ Floor steel bundle.

Procedure 2: Roof steel bundle→ Floor steel bundle→ web steel bundle

Procedure 3: web steel bundle→ Roof steel bundle→ Floor steel bundle

Procedure 4: web steel bundle→ Floor steel bundle→ Roof steel bundle

Procedure 5: Floor steel bundle→ Roof steel bundle→ web steel bundle

Procedure 6: Floor steel bundle→ web steel bundle→ Roof steel bundle

Structural stress and deformation.

Summary of stress calculation results of box girder section is shown in Table 1. Thus illustrate, it is not affected by the change of the tension order for the prestressed concrete box girder under the bridge state,which can ensure the safety and normal operation of the structure.

Table 1 Summary of stress calculation results of box girder section

Section	Procedure 1	Procedure 2	Procedure 3	Procedure 4	Procedure 5	Procedure 6
1/4 section	6.8	6.8	6.8	6.8	6.8	6.7
Middle section	7.6	7.6	7.6	7.6	7.6	7.5
3/4 section	5.2	5.1	5.2	5.1	5.1	4.8
Center support section	-2.0	-2.1	-2.1	-2.2	-2.2	-2.5

Stress value and analysis of steel beam.

As the research objects,.Evenly on each steel beam group selected several typical units, to extract the stress of each unit(excluding all losses).

Table 2 the stress of the steel beam group [B] under various processes (excluding all losses) Unit (N/mm2)

Element	Process 1	Process 2	Process 3	Process 4	Process 5	Process 6
5	1204.88	1180.81	1206.15	1201.18	1177.12	1142.99
8	1214.39	1173.55	1216.19	1206.40	1165.69	1128.20
12	1230.51	1207.06	1231.03	1216.44	1193.13	1158.35
17	1241.58	1251.45	1240.69	1234.79	1244.91	1223.64
21	1229.24	1216.26	1228.98	1213.54	1201.08	1168.12
25	1218.49	1178.02	1220.17	1209.05	1168.71	1131.22
28	1205.85	1170.58	1207.52	1200.61	1165.60	1128.79

（1）In the steel beam group [B] , element 5, 8, 12, 17, 21, 25, 28 were selected as typical elements[5]. The stress of each typical element under different process (excluding all losses) as shown in Table 2 and Fig 2.

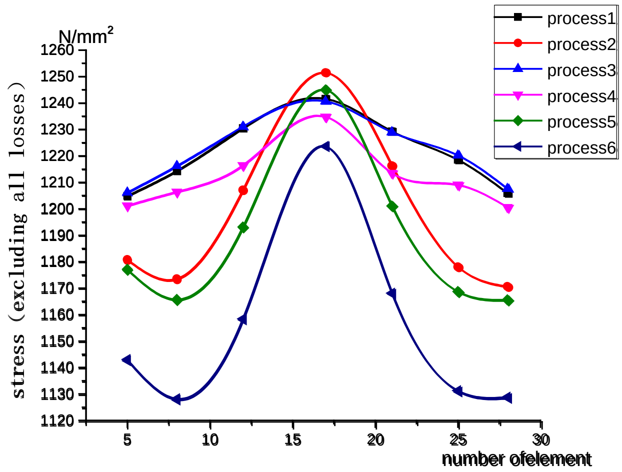

Fig. 2 the stress of the steel beam group [B] under various processes (excluding all losses)

Under the situation of process 1 and process 3, the total stress of steel beam group [B] losses are relatively small. When under the case of process 6, the total stress of steel beam group [B] loss is relatively big.

（2）In the steel beam group [T2] , element 5, 8, 12, 17 were selected as typical elements[6]. The stress of each typical element under different process (excluding all losses) as shown in Table 3and Fig 3.

Table 3 the stress of the steel beam group [T2] under various processes (excluding all losses) Unit (N/mm2)

Element	Process 1	Process 2	Process 3	Process 4	Process 5	Process 6
5	1229.20	1229.06	1242.62	1246.96	1233.14	1219.33
8	1249.03	1248.76	1252.89	1262.74	1258.75	1237.98
12	1216.72	1216.59	1232.67	1250.60	1234.12	1225.42
17	1180.07	1180.45	1203.46	1222.16	1198.63	1194.05

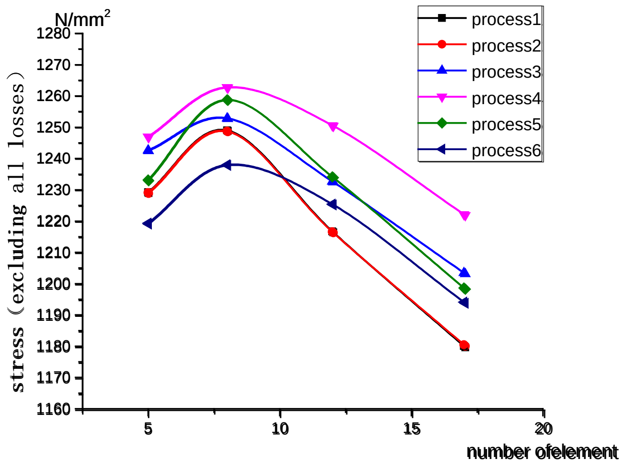

Fig. 3 the stress of the steel beam group [T2] under various processes (excluding all losses)

Under the situation of process 3 and process 4, the total stress of steel beam group [T2] losses are relatively small. When under the case of process 2 and process 6, the total stress of steel beam group [T2] loss are relatively big.

（3）In the steel beam group [W4] , element 5, 8, 12, 17, 21, 25, 28 were selected as typical elements. The stress of each typical element under different process (excluding all losses) as shown in Table 4 and Fig 4.

Table 4 the stress of the steel beam group [W4] under various processes (excluding all losses)

Element	Process 1	Process 2	Process 3	Process 4	Process 5	Process 6
5	1167.84	1207.45	1164.66	1164.02	1209.36	1173.96
8	1188.38	1220.28	1180.86	1180.60	1221.44	1178.27
12	1162.41	1183.37	1148.81	1148.93	1183.74	1137.58
17	1146.79	1159.02	1138.15	1138.03	1159.26	1119.81
21	1163.84	1182.24	1150.67	1150.79	1182.61	1138.61
25	1186.51	1215.97	1177.47	1177.47	1216.87	1172.18
28	1180.27	1217.45	1175.62	1175.10	1219.13	1179.62

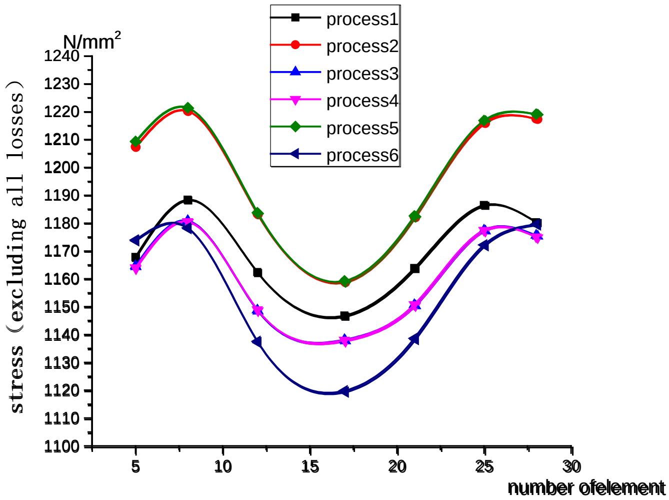

Fig. 4 the stress of the steel beam group [W4] under various processes (excluding all losses)

Conclusion: on 2 and 5 cases of steel beam group [W4] , the total stress loss are small, step 6 cases the total stress of steel beam group [W4] loss is relatively large.

Tress value and analysis of box girder.

Extract the stress of four sections[7], which are 1/4 section,Midspan section, 3/4 section and fulcrum section .All of them are summaried and shown in table 5.

Table 5 The summary of Box girder section stress calculation results (Unit:MPa)

Section	Process 1	Process 2	Process 3	Process 4	Process 5	Process 6
1/4 sectin	6.8	6.8	6.8	6.8	6.8	6.7
Midspan section	7.6	7.6	7.6	7.6	7.6	7.5
3/4 section	5.2	5.1	5.2	5.1	5.1	4.8
Fulcrum ssection	-2.0	-2.1	-2.1	-2.2	-2.2	-2.5

Little box girder section stress size along with the change of the prestressed tensioning sequence change, under process 6 tensioning order section stress is relatively small.

Conclusion

No matter how the prestressed steel bar is drawn, The loss of prestress of pre-drawn steel beam will be caused by elastic compression of concrete due to post tensioned steel beam in the box girder construction. The loss of prestress of steel bar anchored caused by elastic compression of concrete due to post tensioned steel beam is called the prestressing loss caused by batched tension process. The main factors that could influence it are: the elastic modulus of concrete, the elastic modulus of steel beam, tensioning sequence and tensioning tonnage[8]. When modulus of elasticity and tension control stress is determined, tension sequence is important to the prestressing loss caused by batched tension process. Adopting reasonable tensioning sequence can reduce loss of prestress effectively. In bridge design, In the design of the bridge, the normal roof beam is thicker than the web beam and the bottom plate, and the internal force of tensioning the roof beam is more than the internal force of tensioning web plate and the bottom plate bundle.

By the analysis above, combined with the actual situation of the project, loss of elastic compression of concrete due to tensioning the roof beam is more than loss due to tensioning web plate or the bottom plate bundle.Based on the analysis of the loss of prestress, Process 3(web steel bundle→ Roof steel bundle→ Floor steel bundle) is the most reasonable approach relatively.

Acknowledgments

This work was financially supported by Wuhan Municipal Construction Group scientific researching fund(wszky201512).

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