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Nongsheng Street Mi River Bridge Construction Monitoring

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Abstract

Shounong Shengjie Mihe Bridge main bridge is a single tower cable-stayed bridge.The bridge span is arranged with 90+90=180m, tower pier beam solidification, ribbed bilateral girders for the main span, prestressed concrete main girders for the side spans, and A-shaped bridge towers for the main tower, with prestressed concrete structure.The main beam is constructed by the bracing method, and the diagonal cable adopts the secondary tensioning scheme.To ensure smooth construction monitoring, finite element software was used to establish a spatial model to review and verify the design calculation process.Construction monitoring of cable-stayed bridges constructed by the bracing method using an adaptive method to analyze the cable-stayed forces under different construction steps, etc.The results showed that the main beam was reasonably stressed during the conversion of the drop frame system by initial tensioning, and the monitoring values were all within the control range; after the completion of the second adjustment, the main members were reasonably stressed, and the control indexes were all in the safe range.

Keywords

Cable-stayed Bridges; Construction Monitoring; Bracing Method Construction; Solly Monitoring; Numerical Simulation.

1. Project Overvie

The project is located in Shouguang City, Nongsheng Street (Jinhai Road - Mihe Dongba Road), the transformation area from the east of the intersection of Jinhai Road in the west to the east of the Mihe Dongba Road, the site near the current situation mainly Shouguang City Government, Exhibition Hall, Mihe, green land, Chenming Group and the current road.Line length 1139.303m, road width 38m, standard cross-sectional arrangement for 4m sidewalk + 30m carriageway (4.0 + 3.5 * 2 + 3.75 + 0.5 + 3.75 + 3.5 * 2 + 4.0).Design speed 60km/h, of which the bridge is 449m long, the main bridge adopts 90+90m A-shaped single tower cable-stayed bridge, and the approach bridge in the river trough adopts 29m/31m span uniformly considering avoiding the old piles, and the river bank section selects 20m pre-stressed concrete hollow slab.The general arrangement of the bridge is ((4×20)m+(3×29)m)(approach bridge)+(2×90)m(main bridge)+((2×31)m+(2×20)m)(approach bridge).The main tower is A-shaped bridge tower 5m above the bridge deck for the steel-mixed combination surface, above the steel box structure, below the concrete structure. The main beam is a longitudinal and transverse beam system, using ribbed bilateral beam, concrete strength grade C50, according to the design of prestressed concrete class A members.The diagonal cables are arranged with double cable faces, 32 pairs of diagonal cables are arranged in the whole bridge, the spacing on the tower is 2m, the spacing on the beam is 5m, the diagonal cables use A7 epoxy coated high strength parallel steel wire, the standard strength of the wire is 1670MPa, the safety factor is more than 2.5.

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2. Construction Monitoring Overview

2.1 Construction Monitoring Principles

Construction monitoring is based on the construction monitoring of structural parameters, material parameters of the true value of the construction stage calculation, determine the elevation of each stage of the mold, and in the construction process according to the results of the construction monitoring of the error analysis, prediction and adjustment of the next stage of construction procedures, in order to ensure that the bridge deck alignment and structural internal force state in line with the design requirements after the completion of the bridge.

2.2 Construction Monitoring Means

The purpose of construction control is to ensure the reliability and safety of the structure during the construction process, to effectively control the target of the bridge state, to correct the impact of various parameters that affect the target of the bridge during the construction process, and to ensure that the structural forces and alignment meet the design requirements after the bridge is completed.

The main beam was constructed using the bracing method. In this construction stage, after the calculation is completed based on the feedback from the actual measurement data on site, the construction is carried out according to the adjusted elevation instruction.

The diagonal cable is tensioned twice. The first tensioning is carried out after the steel box girder is assembled on the support and after the system conversion, and the second tensioning is the adjustment after the bridge is completed, both tensionings need to control the cable force precisely, so the construction control means in this stage is mainly based on the cable force control.

2.3 Construction Monitoring Process Analysis

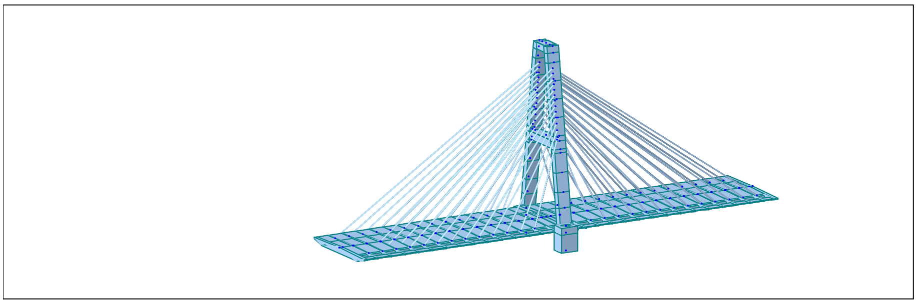

Fig. 1 Finite element calculation model of Nongsheng Street Mi River Bridge

Table 1. Nongsheng Street Mi River Bridge Construction Phase Division

Construction Phase	Job Description	Explanation
1	Main bridge main pier construction	
2	Main tower welding construction	
3	Pouring the main beam, inner cross beam and end beam of section A,B	Tensioning the corresponding prestressing steel bundle
4	Pouring of main beam and inner crossbeam of section C	Tensioning the corresponding prestressing steel bundle
5	Installation of diagonal cables.	
6	Upper phase II constant load, installation of bridge deck system, removal of brackets	
7	Shrinkage, seo-change.	Usage Stage

In order to better complete the monitoring task, it is necessary to first perform a basic review of the design calculation process.A spatial model was established for the main structure of the cable-stayed bridge. According to the design drawings, the structural analysis and calculation of the main bridge was carried out using the spatial rod system finite element program MIDAS/Civil2019 for structural finite element analysis and calculation, and the structural units were divided as shown in Figure 1. The original design construction stage division is shown in Table 1.The main girders and towers are simulated with beam units, and the tension cables are simulated with truss units.

3. Soliency Monitoring Results

The tensioning of the cable-stayed bridge at Nongsheng Street was completed on October 16, 2021. According to the design requirements and the actual construction situation on site, the 13,12,11 cables of the bridge were tensioned in two stages during the tensioning process.The first tensioning force is generally 110~130% of the design initial tension, and the second tensioning force is directly to the design initial tension. I monitor the team in collaboration with the construction parties in a timely manner, and the test results of the cable force meter and the hydraulic jack readings for comparison, to ensure that the difference between the second tension and the design of the initial tension within 6%. The following is the comparison of the theoretical and measured values of the whole bridge.

Table 2. Test results of the main tower diagonal cable force (unit: kN)

Slant cable number①	Theoretical value②	Measured value		Difference = Measured - Theoretical		Percentage (%)	
		left panel③	right panel ④	left panel ⑤	right panel ⑥	⑦=⑤/②	⑧=⑥/②
N1	2561	2635	2680	74	119	2.89%	4.64%
N2	2632	2743	2762	111	130	4.22%	4.94%
N3	3104	3095	3100	-4	-8	-0.13%	-0.26%
N4	3171	3032	2991	-139	-180	-4.38%	-5.68%
N5	3125	3043	3018	-82	-107	-2.62%	-3.42%
N6	2865	2883	2888	18	23	0.63%	0.80%
N7	2693	2756	2759	63	66	2.34%	2.45%
N8	2717	2816	2846	99	129	3.64%	4.75%
N9	2716	2862	2840	146	124	5.38%	4.57%
N10	2673	2832	2810	159	137	5.95%	5.13%
N11	2593	2743	2721	150	128	5.78%	4.94%
N12	2611	2754	2740	143	129	5.48%	4.94%
N13	3145	3112	3119	-33	-26	-1.05%	-0.83%
S1	2561	2698	2690	137	129	5.35%	5.04%
S2	2632	2736	2780	104	148	3.95%	5.62%
S3	3104	3082	3120	-22	16	-0.71%	0.52%
S4	3171	3056	3055	-115	-116	-3.63%	-3.66%
S5	3125	3022	3057	-103	-68	-3.30%	-2.18%
S6	2865	2879	2936	14	71	0.49%	2.48%
S7	2693	2765	2731	72	38	2.67%	1.41%
S8	2717	2825	2830	108	113	3.97%	4.16%
S9	2716	2850	2814	134	98	4.93%	3.61%
S10	2673	2786	2803	113	130	4.23%	4.86%
S11	2593	2731	2721	138	128	5.32%	4.94%
S12	2611	2749	2657	138	46	5.29%	1.76%
S13	3145	3058	3047	-87	-98	-2.77%	-3.12%

4. Conclusion

For construction monitoring tasks, it is necessary to perform a basic check of the design calculation process before carrying out on-site monitoring tasks to understand the design intent and thus develop a reasonable monitoring plan.

This project adopts the adaptive method for construction control. By comparing the measured values with the theoretical model calculation data for several times, the corresponding deviations are calculated, and then the model is adjusted to obtain the new ideal state for each construction stage, and the cable force is controlled according to the feedback control method. The method guides the construction on site well and has certain construction reference value.

For the construction of the cable-stayed bridge, the monitoring results show that during the construction process of the initial tensioning to complete the conversion of the drop frame system and then the second adjustment of the cable, the main girders are reasonably stressed, and the girder deflection, tower deflection and cable force values are within the control range, indicating the reasonableness of the construction plan.

The deformation and force of the structure of the Nongshengjie Bridge were always within a safe and reasonable range during all construction stages. After the bridge was completed, the error between the measured and theoretical values was within the tolerance range of 6%. The monitoring results of the bridge were good.

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