Prediction and Evaluation of Water Environmental Impact of Zhaoqing Bridge Extension Project

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Abstract: For the construction of Zhaoqing Bridge expansion project, based on the investigation of the status quo of regional surface water environmental quality, COD and SS were selected as the influence prediction factors, and the two-dimensional steady-state mixed water quality model was used to simulate and predict the influence range and degree of suspended solids on water environment during the construction period. The results show that the expansion project of Zhaoqing Bridge has little impact on the local surface water environment, and the project construction is feasible. Further requirements and suggestions are put forward for the corresponding engineering design and operation, in order to provide reference for more comprehensive and effective pollution control projects. It also provides reference for the prediction and evaluation of the impact of similar construction projects on surface water environment in the future.

Keywords: Expansion Project; Surface Water Environment; Prediction Evaluation

1. Introduction

In recent years, Zhaoqing, a transportation hub city located in the golden waterway in the middle reaches of Xijiang River, has developed rapidly by virtue of its superior geographical environment, and is an important part of the economic circle of Guangfo Hajime. The Zhaoqing Bridge across the Xijiang River connects the Zhaoqing city and Gaoyao City. It is an important traffic bridge. With the economic development of Zhaoqing, there will be more and more vehicles passing through Zhaoqing Bridge. Therefore, the expansion of Zhaoqing Bridge has important economic and strategic significance, which can further promote the development of local economy. However, the expansion of Zhaoqing Bridge is bound to have some impact on the water bodies along the road. Therefore, before the construction project starts, according to the actual impact of the construction project on the water bodies along the road, relevant national legal documents are studied, and after careful analysis, relevant regulations and management regulations on environmental protection of the construction project are strictly followed, and environmental impact report is approved. After the above work, The adverse effects of construction projects on water environment should be evaluated and corresponding protection measures should be proposed [1,2].

2 Project Overview

2.1 Overview of the Original Construction Project

Zhaoqing Bridge was built in 2001 and opened to traffic according to the first grade highway technology. The full width of the main bridge is 22m, the full width of the approach bridge is 17m, and the width of the roadbed is 24.5m. It is a two-way four-lane road. In May 2005, the 4.8km section of Zhaoqing Bridge south approach road from Zhaoqing Bridge toll station to Guangzhao Expressway Baitu Interchange toll station square was expanded and rebuilt into a roadbed of 28.5m with four two-way lanes.

2.2 Construction Scale

The starting point of this project is connected with Yandu Avenue, located at the intersection of Yandu Avenue and planned Huanggang Road, passing Duanzhou Interchange,

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Zhaoqing Bridge and South approach Road, and ending at Guangzhao high-speed Baitu toll Station. Zhaoqing Bridge is extended by upstream unilateral widening, and the span of the widened bridge is consistent with that of the original bridge. After widening, the total width of the main bridge and the 40-meter-span approach bridge is 41.5 meters, while the total width of the remaining approach Bridges is 36.5 meters, and the distance between the old and new Bridges is 3 meters to 5.5 meters. The main bridge of the expanded Zhaoqing Bridge is a two-way eight-lane bridge [3,4].

3 Prediction and Analysis of Water Environmental Impact

3.1 Assessment Results of Surface Water Environment Status

According to Table 1, from the analysis of water quality standard indexes of each item, it can be seen that DO, COD, BOD5 and ammonia nitrogen of Songlong River tributaries of this project are not up to the standard, and the water quality index of each monitoring section of Xijiang River meets the corresponding requirements of the Class II water quality standard (GB3838-2002).

Table 1. Standard Index of Water Quality Monitoring Items of Each Monitoring Section

Sampling point	pH	DO	COD	BOD	Ammonia nitrogen	petroleum
Xijiang River (bridge site)	0.58	0.01	0.67	0.58	0.52	0.60
Xijiang River (100m downstream of the bridge site)	0.62	0.05	0.67	0.58	0.49	0.60
Xijiang River (1000m upstream of the bridge site)	0.60	0.07	0.67	0.62	0.51	0.60
Songlong River Tributary (project location)	0.80	4.63	1.70	1.27	6.19	0.60

3.2 Prediction and evaluation of water environmental impact during construction period

3.2.1 Influence analysis of domestic sewage during construction period

The construction project is located in Zhaoqing City, and the construction personnel mainly live in two living camps at the beginning and end of the project, which are located at the intersection of Duanzhou Interconnecting main line and planned Huanggang Road and Baitu toll station respectively.

If the construction personnel live at the starting point of the project, the domestic sewage (mainly fecal sewage and part of the construction wastewater) generated by the pretreatment has reached the level 3 standard of Guangdong Provincial Water Pollutant Discharge Limit (DB44/26-2001) in the second period, and then it is discharged into Yuelong Sewage Treatment Plant for treatment through the municipal sewage network. The construction camp sewage and construction wastewater at Baitu toll Station are treated by the integrated sewage treatment facility to meet the level 1 standard of the second period of "Guangdong Provincial Water Pollutant Discharge Limit" (DB44/26-2001), and then discharged into the surrounding channels, and finally into the tributaries of Songlong River. Therefore, construction sewage has a small impact on the water environment [5,6].

3.2.2 Influence analysis of construction wastewater during construction period

The influence of construction wastewater mainly includes the following three aspects:

(1). Influence of suspended substances in pier construction: When the water platform is built at the early stage of construction, the river bottom will be partially disturbed around the site, thus increasing the suspended substances such as sediment in the local water body.

(2). Oil leakage pollution: Oil leakage of bridge construction machinery and equipment, residual oil in the process of mechanical maintenance and oily wastewater during cleaning construction machinery may cause serious oil pollution to water bodies along the line. Therefore, preventive measures must be taken to prevent oil leakage pollution of construction machinery [7].

(3). Construction yard: If construction materials (such as asphalt, oil, chemicals and some powdered materials, etc.) of operation yard and material yard are stacked near water bodies and enter water bodies due to poor storage or erosion by rainstorm, water bodies will be polluted. Residual materials from abandoned building materials yard will enter water bodies along with surface runoff and cause water pollution[8]. Without strict shielding and covering measures, the yard of powdery materials will generate dust and pollute the water [9].

Among them, the biggest influence is the influence of suspended solids in pier construction. The specific analysis is as follows:

(1). Predicted source strength

According to the construction project investigation and analysis, the SS produced by the construction of pier foundation, pier and temporary support and other underwater structures will have a short impact on the water quality, the discharge estimate is shown in Table 2, forecast respectively using protective measures and no protective measures under the condition of the maximum source strength, that is, assume all construction process at the same time. Among them, under the condition of protection measures, 0.40kg/s underwater excavation, 0.1kg/s drilling, 0.003kg/s bored pile construction, the maximum source strength is 0.503 kg/s.; Without protection measures: underwater excavation 1.33kg/s, drilling 0.31kg/s, drilling pile construction 0.042kg/s (pile foundation drilling pile construction produced mud, drilling slag 3600 m³, SS concentration 1000mg/L, continuous construction within a day), the maximum source strength is 1.682 kg/s.

Table 2. Estimation of SS emission during pier construction

Main construction technology	Rate or concentration of emissions produced		Remarks
	No protective measures	protective measures	
Underwater excavation	1.33 (kg/s)	0.40(kg/s)	Maximum discharge according to 100 ㎡/h, copper protection cylinder
borehole	0.31 (kg/s)	0.1(kg/s)	Steel protection drum, timely removal of drilling scum
Drilling slag settling tank	500～1000 mg/L	＜60 mg/L	Protection measures for the outside of the embankment slag field sedimentation tank or container

(2). Prediction model

According to the hydrological characteristics and river characteristics of Xijiang Main stream and Technical Guidelines for Environmental Impact Assessment (HJ/T2.3-93), a two-dimensional steady-state mixed water quality model was used to simulate and predict the influence range and degree of suspended solids. Meanwhile, the maximum impact is considered and the discharge point is assumed to be located on the shore [9].

The calculation formula of two-dimensional steady-state mixed decay water quality model is (1).

$$c(x,y) = \exp\left(-K_1 \frac{x}{86400\ u}\right)\left\{c_h + \frac{c_p Q_p}{H\sqrt{\pi M_y x u}}\left[\exp\left(-\frac{uy^2}{4M_y x}\right) + \exp\left(-\frac{u(2B-y)^2}{4M_y x}\right)\right]\right\} \quad (1)$$

In formula:

c(x,y) -- vertical average concentration of pollutants at point (x,y), mg/L;

cx -- Water quality concentration of predicted sectional pollutants, mg/L;

ch -- Concentration of pollutants in the upper reaches of rivers, mg/L;

cp -- pollutant emission concentration, mg/L;

Qp -- wastewater discharge, m³/s;

Qh -- river flow, m³/s;

H -- mean water depth, m;

B -- mean river width, m;

u -- X Velocity in the direction (represents the average velocity of the section in the river),m/s;

A -- offshore distance of sewage discharge outlet, m;

My -- transverse mixing coefficient, m2/s; The following formula is used for calculation:

My = (0.058H +0.0065B)SQRT(gHI) (2)

K1 -- oxygen consumption coefficient, 1/d;

G -- acceleration of gravity, m/s2;

I -- hydraulic gradient

3.2.3. Parameter selection

(1) Hydrologic condition

According to the hydrological records of Xijiang Gaoyao Station, the maximum discharge of Zhaoqing reach of Xijiang River is 47200m³/s, the average annual discharge is 7030m³/s, and the runoff is 221 billion m³/year. The width of the river surface is generally 1000m-1500m, and the depth is 5-13m. The flow rate is 1.5m/s and the slope is 0.98%. The highest water level of this hydrological station is 13.85m, the annual water level is generally 9-11m, and the lowest water level is 0.276m. The average dry month flow value for 90% frequency is about 1400m³/s. The hydrological parameters of Duanzhou section of Xijiang River are shown in Table 3.

Table 3. Hydrological Parameters for Prediction

River name	Flow rate Q (m3/s)	River width B (m)	Water depth (m)	Flow rate u (m/s)	I(m/m)	Diffusion coefficient My(m2/s)
Xijiang River	1400	800	1.2	1.5	0.00098	0.50

(2) Forecast range

According to the characteristics of the project and the hydrological conditions in dry season, the predicted range is 8km downstream of the bridge site, of which 3km is the water intake of Xijiangdong Water Plant in Gaoyao City.

3.2.4. Forecast result

Table 4. Prediction Results of SS Concentration of Xijiang River under Protective Measures during Construction Period(Unit: mg/L)

y \ x	5	10	30	50	100	200	300	400	500	800
5	4.1750	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	15.4830	0.1073	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	25.0722	2.0875	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	26.9832	5.1449	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50	26.0686	9.6447	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
70	24.2196	11.9047	0.0061	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
80	23.3354	12.5349	0.0166	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
90	22.5128	12.9576	0.0358	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
100	21.7541	13.2320	0.0658	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
200	16.7088	13.0313	0.9193	0.0046	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
500	11.1011	10.0504	3.4799	0.4172	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1000	7.9747	7.5879	4.4649	1.5459	0.0107	0.0000	0.0000	0.0000	0.0000	0.0000
1500	6.5423	6.3290	4.4442	2.1914	0.0797	0.0000	0.0000	0.0000	0.0000	0.0000
2000	5.6771	5.5377	4.2479	2.4996	0.2081	0.0000	0.0000	0.0000	0.0000	0.0000
2500	5.0822	4.9822	4.0299	2.6366	0.3609	0.0001	0.0000	0.0000	0.0000	0.0000
5000	3.5917	3.5562	3.1983	2.5870	0.9571	0.0179	0.0000	0.0000	0.0000	0.0000
6000	3.2755	3.2485	2.9737	2.4919	1.0881	0.0396	0.0002	0.0000	0.0000	0.0000
8000	2.8299	2.8124	2.6320	2.3052	1.2383	0.1031	0.0016	0.0000	0.0000	0.0000

Table 5. Prediction Results of SS Concentration Increment in Xijiang River without Protective Measures during Construction Period(Unit: mg/L)

	5	10	30	50	100	200	300	400	500	800
5	13.9610	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	51.7743	0.3589	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	83.8399	6.9803	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	90.2300	17.2042	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50	87.1717	32.2512	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
70	80.9887	39.8084	0.0204	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
80	78.0322	41.9161	0.0554	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
90	75.2813	43.3293	0.1196	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
100	72.7442	44.2470	0.2202	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
200	55.8730	43.5757	3.0740	0.0153	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
500	37.1213	33.6078	11.6365	1.3950	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

1000	26.6667	25.3734	14.9303	5.1695	0.0358	0.0000	0.0000	0.0000	0.0000	0.0000
1500	21.8770	21.1638	14.8612	7.3278	0.2664	0.0000	0.0000	0.0000	0.0000	0.0000
2000	18.9838	18.5177	14.2047	8.3584	0.6959	0.0000	0.0000	0.0000	0.0000	0.0000
2500	16.9947	16.6600	13.4757	8.8167	1.2068	0.0004	0.0000	0.0000	0.0000	0.0000
5000	12.0105	11.8917	10.6950	8.6508	3.2006	0.0600	0.0001	0.0000	0.0000	0.0000
6000	10.9532	10.8628	9.9439	8.3327	3.6386	0.1323	0.0005	0.0000	0.0000	0.0000
8000	9.4630	9.4044	8.8012	7.7084	4.1407	0.3447	0.0055	0.0000	0.0000	0.0000

The predicted results are shown in Table 4 and Table 5. What do you know? Under the condition that protective measures are taken, the maximum increment of Xijiang SS appears at 30m, which is 26.9832mg/L, mainly distributed in the concentration zone 500m long and 10m wide. At 5000m, the increment of concentration is relatively low, which is 3.5917mg/L. In line with the "fishery water quality standards" (GB11607-89) on the artificial increase of SS should not exceed 10mg/L requirements. In the absence of protective measures, a concentration zone of 6000m in length and 30m in width with an added value higher than 10mg/L appears, indicating a great impact on the SS of drinking water source protection areas [10,11].

3.3 Analysis on the influence of Rain Runoff on Road and Bridge

3.3.1 Pollutant concentration in pavement runoff

It can be seen from the field situation that the concentration of suspended substances and oil substances in rain water is relatively high from the initial stage of rainfall to 20 minutes after the formation of pavement runoff. After 20 minutes, the concentration decreases rapidly with the extension of rainfall duration. BOD5 decreased slowly with the increase of rainfall duration, and pH value was relatively stable. After 40 minutes of rain, the road surface was basically washed clean.

3.3.2 Road runoff and total pollutants in road runoff

According to the average concentration of measured pavement runoff pollutants and the calculation result of pavement runoff, it can be calculated that the total amount of pollutants carried by pavement runoff during the operation period of this project is about SS 45.1t/a, 4.1t/a for petroleum and 16.2t/a for COD.

3.3.3 Road and bridge rainwater runoff treatment scheme and effect analysis

The Xijiang River along the project belongs to Class II water body, and the runoff from the bridge deck and road surface passing through these river reaches is collected into the roadside sand settling pond and other storm-water treatment systems for treatment. The sewage outlet of storm-water treatment system is located in the tributaries of the main stream more than 100m away from the dike, and can be discharged only after the treatment reaches the level I discharge standard, so as to avoid directly entering the Class II water body. After the treatment system collects and treats the rainwater in the earlier stage, the rainwater in the later stage dries naturally or enters the nearby agricultural irrigation channel [12].

Table 6. Size List of Bridge Deck Rainwater Collection System (Sedimentation Tank)

Serial number	Water	bridge	Rainstorm intensity (L/s * ha)	Maximum runoff (m3/h)	Sedimentation tank volume (m3)	Recommended size for each pool
1	Xijiang River	Zhaoqing Bridge	151.36	5147.07	858	8*5.5*5

According to the calculation of the surface runoff of the previous bridge and the monitoring data of the pollutant content of the road surface, the content of pollutants (mainly the average value of pH, BOD, SS, Pb and petroleum) basically meets the first class standard (DB44/26-2001) after the rainfall lasted for 40 minutes. According to the actual normal rainfall, if the rainfall of the first 10 minutes is taken into account, the volume of the precipitation tank for collecting rainwater sewage should not be less than 858m³(also considered as an accident risk emergency pool), and the volume of the oil separation and slag tank should not be less than 50 m³. If the rental fish pond (as a collection system) area is not less than 900 square meters. The system considers two sedimentation tanks on each side of each bridge, with a total of 2 groups (total of 4). The specific results are shown in

Table 6. It is recommended that the sedimentation tank (emergency tank) and grease trap be buried and marked for protection during daily idle. This scheme is relatively feasible in terms of economy, actual operation, pollution prevention and control, and emission standards [13].

4. Environmental Protection Countermeasures and Measures

4.1 Water Environmental Protection Measures during Construction Period

The influence of construction period on water quality mainly comes from the pollution of water and soil loss, drilling slag, waste mud, construction workers' domestic sewage and operation wastewater to the irrigation canal along the line. During the construction of the construction project, the construction personnel shall strictly implement and abide by the Interim Regulations on Civilized Construction and Environmental Management of the Construction Site of the Construction Project, systematically arrange the discharge of surface water, and strictly prohibit disorderly discharge.

(1). The oil pollution of the construction machine repair shall be treated with sedimentation tank precipitation measures, and it is prohibited to discharge exceeding the standard; Do not throw the waste cloth with oil stains anywhere after use to prevent it from falling into the water along the line and causing pollution. Collect and treat it uniformly;

(2). Construction materials such as oil and chemicals should be stacked outside the riverbed. Temporary canvas or other measures to prevent rain erosion should be taken to prevent leakage. During the transportation and storage of bulk materials such as cement and earthwork, windproof measures should be taken to reduce the entry of wind dust into water bodies along the route.

(3). Environment-friendly toilets are set up on the construction platform, and the feces generated are collected and sent to the septic tank in the living quarters for treatment on a regular basis; Household refuse generated by construction personnel should be piled up in fixed containers.

(4). If the area around the construction camp is close to the agricultural irrigation canal, the construction wastewater and domestic sewage can be discharged into the agricultural irrigation canal after reaching the first level of treatment. If there are no drainage channels such as agricultural irrigation channels near the construction camp, the sewage that reaches the treatment standard can be collected by renting or building a pond by itself for natural drying [14].

4.2 Water Environmental Protection Measures during Operation

During the operation period, the impact on water quality is mainly caused by dust, aerosols, automobile tires and ground wear and driving leakage, which bring pollutants into water bodies along the line through rainwater runoff and wind.

(1). The precipitation buffer pool is set at the outlet of the drainage ditch of Zhaoqing Bridge, and the bridge deck rainwater collection system is adopted to reduce the concentration of pollutants through a series of treatments, such as dilution, precipitation and pollutant adsorption by sediment of the collected rainwater.

(2). Strengthen the management of vehicles, prohibit all kinds of damaged, leaking, overloaded and speeding vehicles on the road, in case of dangerous goods leakage, the ground can be set through the oil trap sand sink as an emergency pool, to avoid the impact of any discharge of dangerous goods on regional water, soil and ecological environment. The faulty vehicle shall be towed to the corresponding maintenance area for repair, so as to avoid the waste oil, vehicle parts and other omissions on the bridge deck [15,16].

(3). Set up warning signs on the bridge to warn people not to litter on the bridge.

5 Conclusion

5.1 Water environment Status Investigation and Evaluation Conclusion

From the analysis of the water quality standard index of each project, it can be seen that the DO, COD, BOD5 and ammonia nitrogen of the Songlong River tributaries of this project are not up to the standard, and the water quality index of each monitoring section of Xijiang River meets the corresponding requirements of the Class II water quality

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standard (GB3838-2002).

5.2 Conclusion of Water Environmental Impact Assessment and Prediction

5.2.1 Evaluation and prediction of water environmental impact during construction period

Construction wastewater mainly includes SS wastewater generated by construction drilling and oily sewage generated by maintenance and cleaning of construction machinery and equipment. The impact of construction wastewater on regional environment mainly comes from: soil erosion caused by subgrade filling and digging, stacking and transportation, erosion into water bodies along the road with surface runoff and rainwater, resulting in a substantial increase in the concentration of suspended matter in water bodies; Improper storage of construction materials and chemical supplies, which are washed into the surrounding environment by rain, affecting the soil and ecological environment along the line; Construction machinery running, taking, dripping, leakage of dirty oil and open construction machinery by rain erosion of oil-bearing wastewater and the impact on the surrounding soil, ecological environment.

Construction camp a total of two, respectively located in Duanzhou District and Gaoyao City, Duanzhou District construction waste water after treatment through the municipal pipeline into Yuelong sewage treatment plant for treatment; Gaoyao City after the construction of sewage treatment standards into the Songlong River tributaries. In general, after taking the above prevention and control measures, the project construction wastewater has little impact on the regional environment.

5.2.2 Operation period water environmental impact assessment and forecast conclusions

In order to prevent the impact on the regional environment caused by the arbitrary discharge of pavement runoff, the pavement rainwater is collected through the rainwater pipe and transferred to the municipal pipe network. The river bridge is also collected through the rainwater pipe, respectively into the sand trap on both sides, and finally into the Duanzhou district of the rainwater pipe network and Gaoyao City of the Songlong River tributaries. Moreover, all kinds of damaged leakage, overloading and speeding vehicles should be strictly prohibited on the road. Once dangerous goods leak, the grease trap set on the ground can be used as an emergency pool to avoid the impact of any discharge of dangerous goods on regional water, soil and ecological environment.

5.3 Comprehensive Conclusion

The implementation of Zhaoqing Bridge extension project is in line with the overall development plan of Zhaoqing City, the route selection is reasonable, and the evaluation is reasonable from the perspective of water environment. Although the construction period and operation period of the project will inevitably have some adverse effects on the water quality and residents' life along the route, as long as the protection measures proposed in this report are carefully implemented, the adverse effects can be effectively controlled. Based on the above analysis, the report believes that the construction of Zhaoqing Bridge extension project is feasible.

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