

Research on Disaster Prevention and Mitigation Countermeasures of Key Bridges of Sichuan-Tibet Railway Based on Characteristics

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Abstract

From the perspective of disaster prevention and mitigation, this paper takes the double-line special bridge in the north of the north of the Panjiang as an example, analyses the influencing factors of the disaster prevention and mitigation design of major railway bridges, tunnels, high steep slopes and key disaster work points, selects the characteristic attributes of key project cases, and establishes a model of key railway key engineering case representation based on characteristic attributes. On this basis, suggestions for disaster prevention and mitigation are given. Provide reference ideas for the optimisation of disaster prevention and mitigation design.

Keywords

Disaster Prevention; Sichuan-Tibet Railway.

1. Introduction

The Sichuan-Tibet railway area is a typical high altitude, high elevation difference, complex and difficult mountainous area. It has the characteristics of active local stress, significant topographic height difference, sharp climate difference, complex geological conditions and other characteristics. Many lots can only rely on major engineering structures such as high-pier bridges and deep buried long tunnels to pass through, and often the project cost is High, at the same time, it also plays a control role in the safety of the whole line. Once it is affected by disaster, it will cause huge economic losses and casualties. Therefore, the study of disaster prevention and mitigation countermeasures in major projects has always been one of the important contents of railway disaster prevention and mitigation design.

2. Quantification and Standardisation of Characteristic Attribute Indicators

Most of the factors affecting bridge safety are uncertain factors, that is, qualitative factors, which reflect the differences and changes of people's subjective understanding, which is ambiguous. Qualitative data often need to be converted into quantitative data according to certain principles (such as expert scoring method, etc.) before participating in the calculation. However, the factors that affect bridge safety are many and complex. The same index may belong to the stability level at the same time, but the degree of membership belonging to each stability level is different. At present, there is no systematic research on this[1].

2.1. Standardisation of Attribute Indicators

To make a unified description of the topographic and geological characteristics of the bridge, we must first standardise each index. After comprehensive analysis, 1-5 attributes are used to

standardise the indicators to reflect the stability of the indicators. The significance of each number represents the following table[2]- [4].

Table 1. The significance of each eigenvalue of the bridge

Attributes	1	2	3	4	5
Safety situation	High	Relatively high	Relatively low	Low	Extremely low

2.2. Quantisation of Attribute Indicators

The following table lists the eigenvalues of each attribute indicator.

Table 2. Characteristics and attributes of bridges in difficult mountainous areas and their characteristic values

Numble	Target	Corresponding value	Decision-making attributes
Y ₁	Bridge length (beam bridge)(M)	8-30	1
		30-100	2
		100-400	3
		400-800	4
		>800	5
Y ₂	Left bank Gradient(°)	<20	1
		20-30	2
		30-40	3
		40-50	4
		>50	5
Y ₃	Right bank Gradient(°)	<20	1
		20-30	2
		30-40	3
		40-50	4
		>50	5
Y ₄	Left bank Slope height(M)	<30	1
		30-100	2
		100-200	3
		200-300	4
		≥300	5
Y ₅	Right bank Slope height(M)	<30	1
		30-100	2
		100-200	3
		200-300	4
		≥300	5
Y ₆	Right bank strata lithology	All of which are hard rock	1
		Most of them are hard rock	2
		Soft and hard interrock	3
		Most of them are soft rock	4
		All of which are soft rocks	5
Y ₇	Left bank strata lithology	All of which are hard rock	1
		Most of them are hard rock	2
		Soft and hard interrock	3
		Most of them are soft rock	4

Numble	Target	Corresponding value	Decision-making attributes
		All of which are soft rocks	5
Y ₈	Geological structure	Very stable and inno impact	1
		Small impact and basically stable	2
		Less impact and more stable	3
		Large impact and unstable	4
		Very large impact and extremely unstable	5
Y ₉	Peak acceleration of vibration	<0.05	1
		0.05-0.1	2
		0.1-0.2	3
		0.2-0.3	4
		≥0.3	5
Y ₁₀	Annual rainfall (mm)	0-500	1
		500-1000	2
		1000-1500	3
		1500-2000	4
		≥2000	5
Y ₁₁	Volume of water	Extremely small water content and extremely low water level	1
		Very small water content and very low water level	2
		Small water content and low water level	3
		Large water content and high water level	4
		Very large water content and very high water level	5
Y ₁₂	Water quality	No erosion effect on concrete	1
		Minimal erosion effect on concrete	2
		Less erosion on concrete	3
		a great effect on concrete erosion	4
		an extremely huge effect on concrete erosion	5
Y ₁₃	Plant coverage rate	Extremely high	1
		Very high	2
		Low	3
		Very low	4
		None	5
Y ₁₄	Average annual temperature(°C)	15-25	1
		25-30 or 10-15	2
		30-35 or 5-10	3
		35-40 or 0-5	4
		>40 or <0	5

3. Case Study of South Kunke Special Hill North South Panjiang Double-Line Special Bridge

According to the relevant design data of China Railway Second Hospital Engineering Group Co., Ltd., the railway crosses the Nanpan River at the mileage DK601+059 to DK601+139. Qiu North and Nanpanjiang Double-line Special Bridge is located in 103°34'57.37" in the east and

24°6'42.64" in the north. The southern Panjiang River is bounded, the left bank is Maile County, Honghe Hani and Yi Autonomous Prefecture, Yunnan Province, and the right bank is Qiubei County, Wenshan Zhuang and Miao Autonomous Prefecture. The bridge spans the Nanpan River. The main bridge is an upper-bearing reinforced concrete arch bridge, and the hole span of the upper beam is arranged as a 2-line (4×39.5)m prestressed concrete continuous beam.

3.1. Terrain and Geological Characteristics of Bridges

1. Topographic characteristics

(1) The total length of the bridge deck: the bridge length is 859.56 metres.

(2) Cross-strait slope and slope height: the ground height of the bridge site area is about 960-1520m, the relative height difference is 80-560m, and the terrain is steep. At the main pier on the left bank (the bright side) of the bridge site, the steep river valley is composed of medium and thick limestone in thin layers. The slope is about 42.5°, and the slope length is about 1500m, extending to the top of the mountain. The right bank is the valley steep slope, with a slope of about 43°, and the slope length of the slope is about 245m.

2. Geological characteristics

(1) Formation lithology on both sides: the ground cover the ground of the bridge site area with the fourth series of new unified artificial landfills, slope block stone soil, scattered block stone soil, alluvial soil, pebble soil, slope residual red clay, powder clay, gravel soil, etc. The bedrock of the lower part of the surface are the upper mud shale of the Triassic Zhongtong Franc Formation, the mudstone sandwich sandstone and the lower limestone and mud limestone.

(2) Geological structure: The bridge site area belongs to the intersection of the Shangyangzi platform of the Yangtze platform and the right river fold belt of the Kalidong skirt in South China. It is located in the Shade-stick area of the Maitre (G-48-31). The main geological structure is fault, followed by the joints caused by structural stress and the dense unloading cracks affected.

(3) Earthquake Peak Acceleration: The peak acceleration of seismic motion is 0.05 to 0.15g, and the peak acceleration of seismic motion in the bridge site area is 0.10g.

3. Meteorological hydrology

(1) Annual rainfall: an average annual rainfall of 1000~1270mm.

(2) Surface and groundwater: the width of the Nanpan River in the bridge site area is about 100 metres wide and the depth of the river is 10~20 metres. The water quality belongs to HCO₃-Ca²⁺ type, HCO₃-Ca²⁺·Mg²⁺ type water. When the environmental action category is chemically erodes the environment, the SO₄²⁻, Mg²⁺ and PH values in the water are not corrosive to the concrete structure.

Groundwater is mainly soil pore-type diving, bedrock rift water and karst water. Soil pore diving is mainly stored in the sand and pebbles of the river bed. The sand and pebbles are rich in water content, and the water content of the rest of the mountain slopes is poor and the water content is low. The bridge site area has a high mountain body and abundant water volume, but due to the development of the ditch valley in the bridge site area, the Nanpanjiang River Valley is deep, and the groundwater level of the bridge crossing area is low.

(3) Plant coverage: The slope of the bridge site area is densely vegetation, of which the steep slope of the bridge platform of the large mileage (Kunming direction) is woodland, and the small mileage (nanning direction) bridge platform is bushes, and the vegetation has not been damaged.

(4) The average annual temperature climate is generally monsoon climate of the subtropical plateau, with an average annual temperature of 13.2-19.7°C[5]- [7].

3.2. Bridge Attribute Analysis Statistics

Table 3. Attribute Table of the Double-line Special Bridge in the South Panjiang River in Qiubei

Bridge-shaped	Arch bridge	
Topographic characteristics	Corresponding value	Security degree
Total length of bridge deck (m)	859.56	4
Left bank slope (°)	42.5	4
Right bank slope (°)	43	4
Left bank Slope height(M)	1013.39	5
Right bank Slope height(M)	167.09	3
Geological characteristics	Corresponding value	Security degree
Left bank formation lithology	Triassic Zhongtong	2
Right bank strata lithology	Triassic Zhongtong	2
Geological structure	Relatively stable	2
Earthquake Peak Acceleration (g)	0.1	3
Meteorological hydrology	Corresponding value	Security degree
Annual rainfall (mm)	1135	3
Surface and groundwater	No erosion effect on concrete	1
	Relatively small water content and relatively low water level	3
Plant coverage rate	Very high	1
Average annual temperature (°C)	16.45	1

4. Conclusion and Comprehensive Advice

1. The strata of the right bank of the Nanpan River are mainly the upper section of the Triassic Zhongtong Franc Formation (mud shale, mudstone sandwich sandstone and lower section (matite sandwich mud limestone). According to drilling, the difference weathering and mudised sandwich phenomenon is serious in the strata. The left bank strata is mainly the lower section of the central franc group of the Triassic system (matite sandwiched with mud limestone, affected by joint cracks, and the rock mass is relatively broken in the upper range. It is best to use the pile foundation in the form of the soil foundation and place at a certain depth of the complete weak weather According to the current design, the shale and mudstone silt silt are designed as friction piles, and the rest are column piles, and the design scheme is reasonable.

2. The rock mass on the left bank of the Nanpan River (Kunming end) is affected by joint fracture cutting. The numerical analysis results and on-site survey found that there are adverse geological phenomena such as dangerous rock falling rocks on the surface of the slope. It is recommended to remove the loose rock mass on the slope and take corresponding branch protection measures before the construction of the bridge; the rock mass on the mountain near the highway is unloaded and present. The elephant is serious. The rock layer has the phenomenon of bending and tilting to the Nanpan River, and the surface layer has a crack development. Under the action of the main pier of the bridge, in order to prevent the further development of unloading, dangerous rock falling rocks, affecting pedestrians and traffic safety, it is recommended to remove loose rock bodies on the floating slope near the area of the bridge site, and for large sections on the slope. The fracture is treated with grouting, and the slurry

protection measures are strengthened for the slope. Due to the construction of the main pier of Kunming, it is inevitable that stones roll down on the hillside. At present, the protective shed on the road under the bridge site plays a very good role.

3. The mud shale and mud rock sandwich sandstone in the upper section (Dinghu) of the Middle Tongfranc Formation of the triassic area of the bridge site area are soft rock. The joint cracks is developed and the rock body is broken. The mud rock has the characteristics of easy to soften in case of water. According to the drilling, the differences in this strata are weathering is serious, so the foundation pit should be closed in time after excavation, and the domestic water and its It discharges water into the foundation pit to prevent the immersion of water and soften the substrate. During the construction of the foundation pit, the interception measures of surface water should be strengthened, and the shaft wall support project should be strengthened.

4. The upper plate of the fault at the end of Nanning has a smooth layer of the rock mass on the shore slope, and the bedrock is broken, and the phenomenon of mudd muddy mezzanine is serious. During the construction of the bridge foundation, the disturbance should be minimised, and appropriate support should be carried out when necessary.

5. Thick red clay is distributed on the slopes on both sides of the bridge area, which is weakly expandible. Corresponding support measures should be taken when digging the slope. In the design, the lower slope of the bridge pier at the end of Nanning is graded for slope protection, and the graded protection at the Kunming end is a necessary measure.

6. The calculation results of finite element numerical simulation show that there are unstable bodies on the surface of the slope, and there will be local stress concentration and large deformation. During construction, attention should be paid to cleaning to ensure the safety of construction. There are different degrees of stress concentration at the foot of the shore slope. Do not dig the foot of the slope during construction, which will affect the stability of the shore slope. After excavation of the foundation pit, there will be excessive stress on the bottom and wall of the foundation pit in the direction of the top of the mountain. The design is to dig the foundation pit wall on the mountain side by step by step, and set the foundation. For a reasonable plan, the rock mass of the foundation pit at the Nanning end is relatively broken. After excavation of the foundation The fall of stones affects the safety of construction personnel. The maximum depth of the foundation pit at the Kunming end is about 28 metres. After excavation, the wall of the foundation pit should be sprayed to prevent falling stones.

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