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THE CONSTRUCTION PROCEDURE AND ADVANTAGE OF THE RAIL CABLE-LIFTING CONSTRUCTION METHOD AND THE CABLE-HOISTING METHOD

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Abstract：The cable-hoisting method and rail cable-lifting method are widely used in the construction of suspension bridge. This paper takes a suspension bridge in Hunan as an example, and expounds the two construction methods, and analyzes their respective merits and disadvantages.

Key words ： suspension bridge rail cable-lifting cable-hoisting

I. ENGINEERING SITUATION

The bridge is steel truss girder suspension bridge, the main bridge spans to 900 meters, truss width is 27.0 meters, truss height is 8 meters, approach bridge(5*30m) is designed in south shore , another approach bridge(8*30m) is also designed in north shore; both sides of the Straits are used with gravity anchor, door-type reinforce concrete tower, dig cast-in-place circular pile foundation.

Deck to the bottom of the River, vertical distance is about 200m, river width of maximum is 400m, accounting for the main cross 44.4%, average slope rate of gully length is about 0.66 (height / length).

Lifting saddle is arranged in perpetual suspended cable, which dose not occupy the sling steel truss connecting holes. It is convenient for connection of cable head and segmental beam. Meanwhile, it can reduce operation steps of removing suspended saddle and installing the main girder when beam section is being installed saddle. It is also can be able to reduce the lifting height of steel truss girder and improve construction efficiency.

II. CABLE-HOISTING CONSTRUCTION METHOD

A. Design of cable-hoisting system

The main cable crane spans to 900m, the side span is 155m in south shore, the side span is 258m in north shore, both sides of the anchorage are anchored by gravity anchor. The steel tower is assembled by steel tubes. The section weight of steel truss girder is calculated by 160t.

Working principle of the cable crane machine is along the cross bridge to arrange two sets of main cable, each main cable is composed of steel wire rope 10 Phi 60.5, both ends of which are anchored in the gravity anchor on both sides of bridge. Each main cable respectively hangs the two supporting car in midair. At both ends of the bridge, the traction winch and lift winch pull lifting trolley in the bearing cable to roll and lift steel truss girder, which makes girder construction completed. There are 8 sports cars during the working frame of the cable crane, and the erection of each section of the steel truss girder is shared 4 sports cars (i.e., 4 lifting points) and hoisted synchronously

Suspension rope design and related parameters of single cable

Project	Specification for wire rope （mm）	form for wire rope	Unit weight (kg.m－¹)	Breaking tension（kN）	Modulus elasticity （MPa）
Load-bearing cable	10×Φ60.5	6×37S+IWR	1284.3	2075	10500
the sling	Φ32	6×37S+IWR	389.0	546.5	10500
Traction cable	2×Φ36	6×37S+IWR	437.0	701.9	10500

B. Cable crane tower

Cable crane tower is used in scheme that assembles

steel pipe column in bridge tower, each tower with 4 Phi 600 * 10 is made of seamless steel pipe column, flat joint by phi 300 x 8 of the seamless steel pipe, bracing by Phi 200 x 8 seamless steel tube composed of space lattice system, which plays a part in supporting in bridge cable tower, tower has height of 13m. tower is made of the total amount of 54t steel. Its material is Q345 steel. Steel tube tower is connected with the tower frame, in order to increase the overall stability of the tower. At the same time, a transverse eight wind is designed, wind-bearing wire rope with 4 Phi 32 per bank is selected. In order to reduce the longitudinal direction of the bridge tower deviation, unilateral set Phi 60.5 pressure tower wire rope.

C. Hoisting construction

Steel truss girder in assembling field is assembled, when steel truss girder ships load- segment, with floating box controlling the water-level, the top of floating box lies alongside the wharf, and pressure from the ship's load levels system position. At the same time, the floating box and wharves should be fixed and connected, waiting for flat car on board.

III. RAIL CABLE-LIFTING CONSTRUCTION METHOD

A. Equipment And Assembling

The equipment mainly composed of the following parts: beam-transporting trolley, saddle, cable, crane, zenith trolley, a winch etc.

The beam-transporting trolley is the most core equipment in this project, which composed of the pulley group, the triangular distribution beam and the rectangular distribution beam.

B. Saddle

The effect of cable saddle is to provide support, and will convert load from cable to cable. The design of crane saddle incorporate characteristics of pin type sling, with moving the saddle to the direction of top and using the cable clamp as a fulcrum to place it at the top, which make saddle not occupy space of connecting hole of the lower cable clamp. It also uses both sides of the longitudinal positioning lock to ensure the lateral stability and it is convenient for construction. The saddle is composed of a longitudinal beam and a saddle beam.

C. Cable

Rail cable is considered as beam-transporting orbit and the lifeline of the whole system, it is also the parts that has highest safety risk coefficient. Its internal force changes complexly and shows different characteristics on various construction conditions, in order to meet need of its function and have enough safety and operability, after calculating, the staff used Phi 60 wire rope galvanized and sealed. Four single, independent of each other, one end fixedly, one end through the pulley group + keeping four rail cable force basically the same and remain constant with counterweight block.

D. Crane

The bridge had two sets of hydraulic loading crane for lifting type cable, a cable carrier crane by a steel truss beam, two pedrail-walking mechanism on the main cable, two sets of hydraulic lifting equipment (including lifting and traction jacks, hydraulic pump station, control system and steel wire take-up device), with a lifting pole beam, power generation equipment parts.

E. Construction Procedure

The installation and construction method of flexible cable net steel truss beam is used for erection of steel truss beam in the section of hoisting. The main construction steps are:

1. The main cable and permanent slings are used for supporting, horizontal cable is set up , with anchored in the rock mass.
2. A steel pipe Bailey platform is built at the pile cap on both sides, steel truss girder assembling platform is made of Bailey platform and the rest space of pile cap.
3. After lifting section that has been assembled, and then those sections are suspended under the carriage beam trolley.
4. Transporting vertically to the corresponding sling by rail sling
5. The section of the steel truss girder is suspended from the cable borne crane, and the carriage beam carriage is exited.
6. Adjusting spatial position of the segment, and beam butt has been installed, and pin sling.
7. The beam in mid of bridge is first installed and then symmetrically installed from mid of bridge to the sides of bank until the full bridge is linked.

The advantages of rail cable-lifting construction method and cable-hoisting method

1. The assembling field of the steel truss is arranged

on the platform. Compared with the cable hoisting, it can reduce the lifting height of the steel truss girder and the construction time, and improve the safety of the construction. At the same time, two pieces of steel truss girder can be installed, which can shorten the construction time and bring the recessive economic benefits.

2. Transport and erection of the steel truss girder have high construction efficiency, cost savings.
3. The rail cable is used as the main cable as the support, with the good wind stability, the quality of construction can be controllable
4. Compared to the cables, rail cable needs less bearing steel wire rope.
5. When using cable-hoisting method, it needs more operators, and cable-hoisting system technology is complex, it has high demands for the operation and personnel quality . Rail cable has a high degree of automation, it needs less operators when moving the beam. Construction technology is stable, the impact of environment is small, easy to standardized operation.

IV. CONCLUSION

Rail cable-lifting construction method and cable-hoisting construction method is more and more mature, but there are still many places should be improved, such as whether rail cable-lifting construction method can cancel cable carrying crane or not, in terms with controlling the main cable wire linearity in cable-hoisting construction method

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