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Construction and Control of Large Span Steel Tube Concrete Rigid Frame Arch Bridge

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Abstract: The skeleton of concrete filled steel tube arch bridge is made at the first step, then liftsegmented frame until the closure of arching, finally,the stiff skeleton as scaffold bear construction weight of internal pouring concrete and outsourcing concrete, and the outsourcing concrete as a partof the stress of main arch. Taking the glass ditch bridge as an object, this paper introduces the manufacture, assembly, construction and control of concrete filled steel tubular arch rib.

Keywords: Concrete filled steel tube;Construction; Outsourcing concrete

1. Introduction

The steel pipe with large caliber as chord, channel steelangle steel as an abdominal rod composed of space truss structure, which first make of steel frame, then hoisting and closing arch. Using the steel pipe frameas the bracket, which cast steel pipe concrete, until after the concrete strength reaches a certain degree,and form steel tube concrete rigid skeleton, then the template is hung on the skeleton, concrete is pouredon the template until the formation of the arch section, which is stiffness skeleton arch bridge construction [3].

Due to the light weight of steel pipe lifting, steel tube filled concrete have large rigidity, the steel tube filled with concrete stiffness, restraint of concrete filled steel tube, which make the concrete in three dimension stress state and improveconcrete strength and anti-deformation ability [1]. In addition, the first pouring concreteas a the part l of load-bearing structure and the steel tube togetherform a rigid skeleton; at the same time, because concrete in the steel and steel skeleton together bear concrete gravity, the steel frame with steel reduce, the cost is relatively low; the structure system of steel tube concrete rigid frame arch bridge is reasonable, so the construction does not require a lot of brackets. The above-mentioned advantages, the concrete filled steel tube skeleton arch bridge structure in recent years has become one of the large span arch bridge used and construction method.

2. Engineering Profile

Glass ditch bridge which is located in YalongjiangLianghekou Hydropower Station Reservoir rehabilitation County Road X307 line xi industry and trade channel to Euler Xigouis a concrete filled steel tube skeleton arch bridg, within the glass ditch Mizoguchi about 150m near across the glass groove, Mizoguchi exist X037 highway. Origin destination number of mileage is K69+239.79 to K69+487.00, main hole span is 170m, span arrangement is 3×13m continuous slab +170m concrete filled steel tube skeleton arch bridge + 30m simply supported hollow slab, bridge length is 247m. Yajiangcoast is3×13m continuous slab bridge on plane curve. Bridge deck width is2×3.5m roadway and2×0.5m anti-collision guardrail, bridge full width is 8m; design load is RoadI; bridge longitudinal slope is 1.6%.

The main bridge of steel reinforced concrete box arch net span is 170m, span ratio is 1/5, the net loss of high is 34m, arch axis coefficient is m=1.543. The arch width is 8.2m, height is 3.2m. Arch structure is double column frame,deck9-20m simply supported hollow slab, transverse is composed of 8 pieces of prestressed concrete hollow slab; each hollow plate is 1 m wide and 1m high. Main arch ring adopt equal section catenary ecardinal arch, arch section of the arch is 3 rooms box type, standard, top, bottom plate thickness is 0.4m; web thickness is 0.3m. Arch at the foot is a 1.2m solid, solid section to the first row of arch column for transition section,top, bottom plate thickness is 0.8m gradient to 0.4m, edge web thickness is 0.55m gradient to 0.3m, web thickness unchanged.

3. Construction Technology

This project because the bridge span is big, crosses the valley depth, if project uses the traditional scaffold or the hoisting construction method,which is difficult to realize. Through a variety of programs than the election, the project decided to use the two sides of the rock mass to take a cable, the cable hoist construction of the strength of the skeleton and the deck system.

3.1. Stiff skeleton construction

The steel skeleton is made in the factory section in advance, andtransported to the site, then welded together with the length of the hoisting section, finally installed from the arch foot section to the crown section. During construction, the flange block is arranged at the outer part of the steel skeleton segment and the segment joint, so that the joint can be formed quickly lifting and positioning, and finally, the position of the arch axis of the construction arch can be adjusted accurately. The steel skeleton installation accuracy requirements: plane vertical error is less than 8mm, surface level error is less than 13mm, the steel skeleton of relative error is less than 11mm, the span error is less than 7mm[2].

The concrete construction technology is as follows: the whole bridge frame is divided into 5 sections.

The stiff skeleton is welded together with the vertical and the lower part of the bridge, andthe geometric parameters, the machining quality and the transverse connection of the segment are in accordance with the design requirements.

Stiff skeleton was tied up with a rope to hoisting. Hangingpoint deduction adopt bundle connection, which set at a distance from the end of 6 to the node location and the vertical bar 8m brace at the intersection of hanging points. The cables are all through 30 tons of H plate, the steering wheel and the carrying pole, tied rope and skeleton winding steel pipe connection. Bundling Jack rope safety factor should be greater than 8, each hanging point of stiff skeleton use Phi 32mm bundled Jack line, the deduction use phi 38mm bundled Jack line. At the same time, the location of the hanging point is arranged at the node between the brace,prevent the binding rope slip before and after.

Skeleton closure construction technology:

Lifting the two arch foot section at first, which is not less than 15cm pre elevation value in the construction[7];

Installing the second two sections, which set up not less than 30cm of the construction of the pre elevation value;

Vault are suspended and transported to a cross in, and delegated to about higher than the design elevation, and on both sides of the symmetrical cycle gradually devolved arch foot section of cable and the second buckle cable and vault segment of the trochlear group, the joint slowly move closer to, try to avoid vault Jane branch shelve impact in the second paragraph.

Folded rope control: When the vault are delegated to the second segment elevation of the joints which are basically the same, on the one hand, connection between crown section and the second section is flanged, on the other hand, then slowly rope to joint gradually and move closer connection.

Buckle cable and hoisting tackle ropein the process, in addition, while the two sides symmetrical cycle gradually transfer to a lower level of arch foot section of cable, the second buckle cable and crown section block, the crown section lifting pulley group and the buckle cable once rope length should be as small as possible, by increasing the number of cycles to achieve cable relaxing the basic purpose, to ensure construction safety. rope take fixed length rope method, cable a rope amount can be used 2 ~ 3cm, lifting tackle running head is 20 ~ 30cm, and with a piece of chalk on the pulley group run head on a tightrope well marked; each song a cable (symmetric), a joint and crown elevation observation should be carried out, and according to the feedback of the elevation data at any time to adjust the volume of the rope. The cable adjusted by pulley and hoist.

Concrete filled steel tube adopt C50 micro expansion self-compacting concrete, anduse the pumping, the two sides of the arch foot pour into the crown. The strength of concrete in the pipe can reach 80%, and the second string can be poured into the pipe. Perfusion sequence:

the inner bottom of steel pipe→the medial upper steel pipes→the lateral lower steel pipe→the lateral upper steel pipes.

3.2. Arch construction

Concrete poured in the ring section on the skeleton, "according to the symmetry between the two sides, the upstream and downstream synchronization" principle of organization construction, single arch rib is divided into 4 rings and 8 working faces, each face separate 6 times at the same timepouring construction[4].See Figure 1.

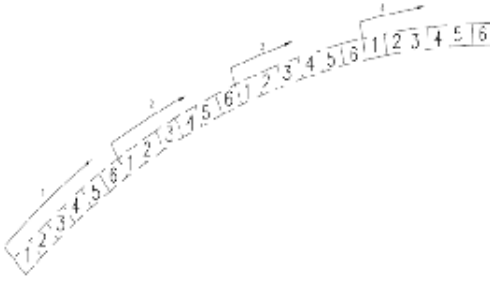

Figure 1. Section of the longitudinal arch pouring section

Outsourcing concrete pouring sequence:

Concrete poured on both sides of the box bottom platein first ring; concrete poured onboth sides of diaphragm and web and arch foot solid web section, closed arch, the arch formed hingeless archin second ring; concrete poured on middle box bottom plate in third ring;concrete poured on arch box roof in fourth ring.The principle that follows in the construction is: in the last part the concrete strength reach 90% above the design strength, concrete can carry on the next ring pouring. According to the bridge of the annual temperature conditions (the lowest is -9.3℃; the highest is 41.1℃), to preventproducing stress due to temperature difference is too large to, the pouring of concrete arch of temperature difference should be within

plus or minus 3℃, closure temperature of concrete of each loop are 15℃.See Figure 2.

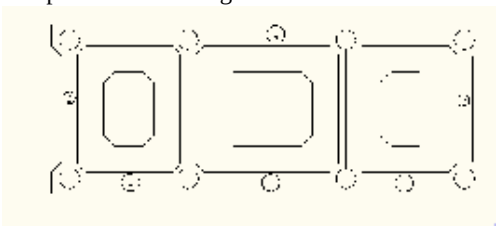

Figure 2. Arch section transverse ring construction diagram

In the concrete box arch pouring process, project want to any collection of the control section (around the arch of the foot, L/4, L/2, 3L/4 section) stress, arch axis linetype change information which support for the decision of the construction, especially the arch box began to be formed, linear must be strictly controlled in the allowable range.

3.3. Arch construction

Arch building adopt the symmetrical and balanced construction, firstly complete abdomen empty pier, and then the bridge panel mounted longitudinally and symmetrically which were transverse widening work to complete the full bridge installation.

Specific construction sequence: arch column and beam are poured from the arch foot to the crown of the pouring symmetrical uniformity, and hollow anchor boltembedded; in hollow slab hoisting, arches were vertical from the arch of the foot to balanced and symmetrical, cross bridge are sequentially arranged four pieces of beamto cross each from the middle to both sides, the formation of channels and working platform and other plate girder symmetrically installed; precast pavement plates and rail installed; remove cable hoisting equipment; continueto deck paving, sidewalks, railings and lighting installed, finally complete bridge construction.

4. Construction Control Points

Arch bridge construction control is a construction, testing, identification, correction, notice, the cycle process of construction. The purpose of construction control is to ensure the safety of the structure in the construction process and the shape and internal force to meet the design requirements. The main construction phase of the bridge monitoring content and acquisition parameters are as follows:

4.1. Steel pipe frame installation phase

Test content: the lifting node and the key control point elevation, control arch axis horizontal and vertical alignment, to ensure that the steel tube stiffness skeleton installation is completed, which reach design of the arch axis line.

Arrangement of measuring points: each lifting node and critical control point (L/8, L/4,3L/8, L/2,5L/8,3L/4,7L/8 and arch foot) at the upper end of the flange or arch back establish the surveying markers.

Test method: the level of each measuring point is measured with a precision level gauge or total station instrument.

4.2. Main arch concrete pouring stage

Test content: the lifting node and critical control point elevation, control of arch axis horizontal and vertical alignment are measured to ensure completion of the construction phase of the meet the design arch axis linear and the control section stress and strain, guarantee in the construction phase of the stress in line with the requirements of design and specification[5].

Measuring point arrangement:the critical control points (L/8,L/4,3L/8, L/2,5L/8,3L/4,7L/8 and arch foot) set up elevation measurement mark; stress test measure on the main arch of arch foot, L / 4, L / 2, 3L/4 section, measuring points also need to appropriate adjustments on some sections in the actual construction according to the actual condition of the structure.

Test method: the surface stress of the steel tube is tested by vibrating wire strain gauge. The concrete stress test is made of concrete string vibration type strain gauge.

4.3. Temperature field observation

Test content: arch axis deviation, elevation and the relevant section of the stress and strain and section temperature field synchronization, which are tested to master the influence of temperature on structural deformation and stress[6].

Layout: 12 points arranged in a main arch standard section (L/4).

Test method: project choose high-precision thermal resistance, use high-precision automatic temperature data acquisition system; temperature components are embedded in the main beam of the standard sectionin order to measure the temperature field distribution.

5. Conclusion

Construction practice tells us: lateral stiffness of steel pipe concrete rigid skeleton before the arch pouredin forming is small, the problem of stability cannot be ignored; also because the concrete arch ring poured molding, concrete will appear stress not equal phenomenonin different time, which should be paid more attentiondur-ing the engineering construction.

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