Study on the Monitoring Method of Stress Point of Steel Tube Concrete Pipe Structure

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Abstract: Prestressed concrete filled steel tube (PCCP) has the advantages of impermeability, tensile resistance, corrosion resistance, compression resistance, earthquake resistance, long service life and low cost of operation and maintenance, so it is widely used in the construction of water conveyance pipeline in water conservancy project. PCCP pipe fittings refer to the components connecting key components in PCCP pipe construction. The total amount generally accounts for about 4% of the total length of the pipeline. The quality control of PCCP pipe fittings and effective control and preventive measures are of great significance and practical application value to ensure the safety and durability of PCCP pipe engineering.

1. PCCP Special Requirements for Concrete

Prestressed steel tube concrete pipe (PCCP) fittings play an important role in the construction of water conveyance pipeline in water conservancy project (PCCP). Starting PCCP the general requirements of fittings quality control, this paper expounds the quality control of fittings raw materials, welding, steel pipe, socket ring and so on, which is of great significance and practical application value to ensure the safety and durability of PCCP pipeline engineering.

By analyzing the PCCP concrete, the following characteristics and basic requirements can be obtained.

(1) High strength concrete. The strength C50~C60, is mostly C60, cement consumption is large.

(2) Small aggregate size. The contract stipulates that no more than 30 mm, is limited by the supply of aggregate plants, and 5~25 mm aggregate are generally selected. The amount of cement is larger than that of ordinary hydraulic concrete.

(3) Concrete slump is large. Due to the limitation of technology and vibration conditions, concrete slump is large. Each plant has different slump values according to its own technology and equipment conditions. Pipe plants generally take slump 8~11 cm, individual take 7~9 when pumping larger.

(4) High early intensity is required. Under the restriction of the storage site and the comprehensive consideration of the technology, it is generally necessary to obtain higher early strength by steaming ,1~3 d reach more than 70% of the design strength, and the selection of admixture and admixture is limited, especially fly ash.

(5) Low steaming temperature and limited time. The steaming temperature is set at 32~52℃; requires static stop 4 h、 heating 4 constant temperature 8 h、 cooling 2 by mold turnover limit, hiree constant temperature time generally will not exceed 8 h, can not obtain higher early strength through steaming, especially fly ash concrete.

(6) The content of water-soluble chlorine ions in concrete shall not exceed 006% of the weight of cement.

(7) Admixtures in concrete shall not exceed 20% of the weight of concrete.

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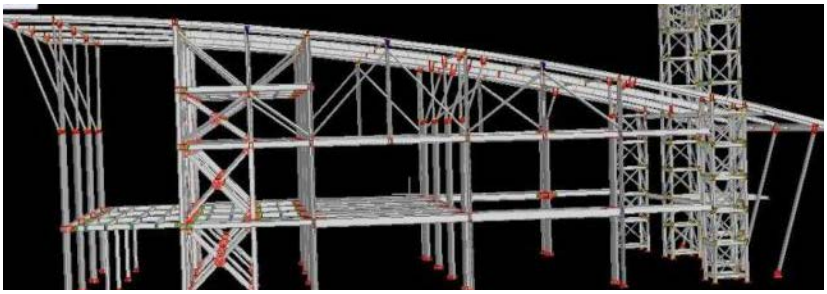

Figure 1 Steel tube concrete pipe

2. General Requirements for Quality Control Content of PCCP Accessories

The design, manufacture and acceptance of steel containers for PCCP pipe fittings shall comply with the requirements of the Guidelines for the Design and Installation of Steel Pipes (AWWA M1)(GB/T19685-2005), and the design of steel pipe works shall be mainly in accordance with the manufacturing specifications; PCCP annexes to the Pencil Inventory Installation and Verification in Hydroelectric Engineering (dl5017 or GB 50766-2012) shall establish a quality management system, including quality control systems for owners, regulators, contractors and governments; and through a series of measures to promote the effective operation of the quality management system, the quality control of PCCP connectors mainly includes geometric dimensions (shape and position tolerance, angle), welding track, wire fence, cement wall cover, anticorrosive coating on exposed steel parts surface, double shell, for sampling and splicing, installation and connection to standard PCCP pipe.

3. PCCP Accessories Raw Material Quality Control

3.1. Steel

the steel plate for pencil core shall conform to the design document requirements; the missing steel ring cross section shape and geometric dimensions shall conform to the design requirements; the wire diameter for connecting devices shall be less than 4 mm; the grid size shall not exceed 50' punching 215;100 mm', incoming steel plate shall conform to the design requirements on-site inspection of material quality certificate, mechanical properties, chemical composition, inspection specifications, dimensions, thickness, appearance; plate surface marking and kiln lot number; after approval, it shall be recorded and stored in the storehouse, marking reasonable storage; rain, rust, deformation, stacking; With the disk issued for inspection, according to the furnace number and heating requirements can be sampled and sent to the competent inspection unit for mechanical characteristics and chemical composition inspection.

3.2. Welding Materials

Selection of suitable welding materials according to the type of steel, welding materials have been purchased and used, prohibit the use of welding materials stored for too long in engineering, strictly control the quality of welding materials, complete rules and regulations for the purchase, registration, storage, storage, baking, distribution, recovery of welding materials, welding materials should be material certification, operating procedures, specifications model, inspection material specifications model, operating procedures and operation certificate, and registration and inspection. before using the electrode, the batch number, certificate of qualification, appearance quality should be checked and dried according to the operation rules. the dried electrode should be stored in 100-150{851; incubator and taken out if necessary.

4. Welding Quality Control

The welding process specification is the main technical document to check the welding quality of the product, and the welding process specification and the corresponding welding process are

designed and tested.

4.1. Welding Specifications and Process Requirements

(1). there are three welding forms: front welding wall on longitudinal line, manufacturing factory clear pipe circumference, reserved pipe circumference, closed pipe circumference, inner elastic cushion circumference, two pipe limit joint, Ding Ji welding, pipe wall and reinforced cap welding, class II welding does not belong to class I secondary stress welding, gypsum welding, steel ring, water stop, tie rod welding, drainage hole, steel foreskin; longitudinal welding and band welding. The third stage welding does not belong to the first and second stage welding.

(2). welder qualification: welder engaged in the first or second class weld shall be in accordance with the DL/T679,SL35,GB/T50766; boiler pressure vessel pressure welder examination and management rules. Pass the examination, and have the welder certificate issued by the corresponding competent department, welding steel type method, location should be the welder himself after the examination of the qualified items in accordance with.

(3). NDT personnel: shall hold the technical qualification certificate issued by the electric power, water conservancy industry, quality and technical supervision department and NDT society and suitable for their work. operation, the evaluation should be 2 personnel above grade II.

(4). weld internal flaw detection: can choose ultrasonic or ray.

(5). weld treatment appearance inspection: visual inspection, template, gauge ,5 times magnifying glass inspection. The test items such as crack, surface slag inclusion, edge cutting, underwelded full, blowhole, welding slip, fly shallow, weld residual height, butt joint weld width, fillet weld, welding angle size and so on should be in accordance with the regulations.

4.2. Control Links and Control Points

Good condition of welding equipment, weekly inspection of instruments used in resource condition. Welding materials: procurement, acceptance re-inspection, custody, baking, distribution and recycling. 3 Evaluation of welding process. Welding process: After the preparation of process documents, it is necessary to test, change, to implement. Welders management should: training, examination, certification, establish welder performance files. Product welding management requirements: environment, welding process discipline, welding process and inspection. Welding test board: by test board preparation, cutting and test board assembly welding inspection. Welding if there is a defect need to repair: one or two repairable defects; over-repairable need special approval, the base metal defects should be repaired.

Figure 2 Steel tube concrete pipe

4.3. Control of Design of Welded Structures

(1). should meet the requirements of practicality, reliability, processability, economy, etc.

(2). structural design principles: reasonable selection of materials; good use of materials; reasonable design; structural form; favorable welding automation; reduce welding capacity; reasonable arrangement of welds; convenient construction; conducive to production organization management, transportation, welding deformation, pre-welding preheating, elimination treatment, quality inspection, assembly, etc.

5. Quality Control for Steel Pipe Manufacture

(1). steel plate blanking: length, width ±1 mm、 diagonal less than or equal to 2 mm, corresponding edge less than or equal to 1 vector height 0.5.

(2). longitudinal joints of the tube joints shall not be set on the horizontal axis and the vertical line of the lead and the axis shall be greater than 10. above, the arc distance should be greater than 300 mm and 10 times the thickness of the plate.

(3). The longitudinal joint of adjacent pipe joints is more than 5 times thick and not less than 300 mm..

(4). adjacent longitudinal joints shall not be less than 500 mm. on the same pipe joints

(5). girth spacing, straight tube should not be less than 500 mm; curved tube, gradient tube is 10 times wall thickness ;300 mm,3.5 √ R • S; take a large value. General experience bend pipe, pipe section distance should be more than 300 m..

(6). steel plate marking, cutting break should be used semi-automatic cutting machine. By CNC blanking machine, planing machine machining. cutting surface groove ≤2 mm grinding. greater than 2 mm、 repair welding, grinding flat.

(7). the roll plate direction should be the same as the calender line direction, the straight line section caused by the roll plate should be used, the head pressing machine, the placer or the universal coil machine should move the roll pressing head. To ensure the radian of longitudinal seam ,500 mm string length sample ≤2 mm..

(8). weld longitudinal seam: should be single groove or asymmetrical double groove, double side welding. Base welding or automatic bottom welding with submerged arc welding, the current should not exceed 800℃. Longitudinal weld after not easy to return to the circle, longitudinal seam after welding with the template check Radian clearance, template string length 500 mm, diameter less than 5 m, clearance less than 4 mm.. Tube, bend pipe joint tile to be three-wire alignment, can be assembled in vertical groups, or horizontal assembly, to ensure angle, less than 0.2 degrees, straight pipe, bend pipe girth welding should be double-sided welding, two protection welding bottom, as far as possible with submerged arc automatic welding, or two protection welding, welding. Speed, good forming, weld residual height 0~4 mm. The bend pipe adjacent to the two pipe joints, corner 15℃ below, can also be used automatic submerged arc welding, after welding appearance ,100% ultrasonic inspection after inspection ,5% X ray re-inspection.as shown in Table 1.

Table 1 Cement test results

Projects	Cement strength/ MPa		Setting time		Stability	Alkali content	C3A content
	Resistance	Compression	Initial setting	Finalization			
Test results	9.8	54.9	2 h47min	3 h 3	1.0 mm	0.53%	0.79%
National Standard Requirements	≥6.5	≥42.5	≥45 min	≤10 h	mm ≤5.0	No provision	No provision
Contract provisions	Implementation criteria: GB 175					＜0.6%	＜8%

6. Manufacturing Requirements and Quality Control of Socket Rings

bell and socket ring are made. After butt welding of the socket ring, the point beyond the general elastic limit to the plastic limit is also the yield strength point. The expander can enlarge the

working face size. The length of the socket plate before expansion is the blanking length determined by experience, theoretical calculation and welding test. After welding, rolling and expanding, measure the roundness of the working face. chord length 300 mm, clearance less than 1 mm. Face size shall not be greater than the upper limit of tolerance of nominal dimensions mm.0.5-0.7 reserved welding shrinkage and thermoforming shrinkage.

control the diameter and ellipticity error of the socket steel ring transported to the site do not exceed the regulations, check the dimensions one by one according to the quality inspection report provided by the manufacturer; in the process of transportation and hoisting, the damaged socket steel ring should be carefully repaired before it can be put into use.

After welding the steel member and socket, the dimension check should be carried out carefully, and the ellipticity should be corrected again after deformation. After the pipe opening is qualified, it is welded with the meter steel support to prevent deformation during stacking and transportation. The transition ring of the socket ring and its welded transition ring (also including the reinforcing ring) shall be widened as far as possible to increase stiffness and stability. The transition ring consists of several splice bags and welded parts. The weld depth of butt weld is secondary weld, which needs ultrasonic inspection.

References

[1] Wang, Hongtao., Xuanfeng., Zhong, Junbin. Experimental study on bearing capacity of large-caliber prestressed steel concrete pipe jacking. City Road Bridge and Flood Control, no. 8, pp. 268-270, 2016.

[2] Xuanfeng, Ye, Yuanxin., Zhong, Junbin., Xia, Xinlei. Experimental Study on the Performance of Prestressed Steel Tube Concrete Pipe-jacking Ring Structure. Special Structure, vol. 35, no. 1, pp. 28-33, 2018.

[3] Ye, Yuanxin. Application of prestressed steel simple concrete pipe jacking in water supply engineering. special structures, vol. 35, no. 2, pp. 33-37, 2018.

[4] Zhang, Yao., Yan, Zhiguo., Zhu, Hehua. Field Experimental Study on Mechanical Behavior of New Large-caliber Pipe jacking. Geotechnical Engineering Journal, vol. 39, no. 10, pp. 1842-1850, 2017.

[5] Zhou, An., Dai, Hang., Liu, Qiwei. Experimental Study on Structural Properties in Negative Bending Zone of Steel Boxes and Prestressed Concrete Composite Beam. Journal of Civil Engineering, vol. 42, no. 12, pp. 69-75, 2009.