A Cross-current Masonry Technology for River Pole and Rock Dam in Distribution Network Maintenance and Construction

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Abstract: Some areas of the distribution network involve the installation of line poles through seasonal ditches or channels. In the design of rock dam construction, the traditional method has great resistance to water, which reduces the service life of rock dam itself after the formation of severe scouring. In this paper, the masonry technology of rock dam is analyzed, and a kind of cross-current dam masonry technology is designed to reduce the impact of water flow, which solves the problem of rock dam damaged by the impact of water flow and extends the practical service life of rock dam greatly.

1. Reason for choosing a topic

At present, the erosion of many poles in rural grid lines caused by river diversion or channel diversion is harmful to the rod foundation, which is not conducive to the safe and stable operation of the distribution network. Statistically, floods frequently occur in Northeast China, the Yellow River, the middle and lower reaches of the Yangtze River, Huaihe River Basin, Pearl River Basin. The main reason for floods is the continuous precipitation for a short period. With the change of monsoon intensity, the torrential rain and natural disasters have occurred frequently in some areas of our country in recent years. The flood disaster can damage the power grid and cause a large area of upside-down rod to break the wire, and interrupt the power supply. Damage to power systems is often difficult to recover in a short period of time. Therefore, the dam is required for poles in many rural grid areas.

The traditional dam is in a simple hemispherical or conical shape directly made of rubble and cement in accordance with a certain proportion. Generally, large blocks of rubble are placed in the lower part, small pieces of rubble are placed in the upper part. The gap should be filled well with large and small rubbles. The appearance remains flat, the plane is outward. There is little difference in size. The traditional dam can satisfy the condition when the water intake is small and the water capacity is not large. Nonetheless, in the case of a large amount of incoming water, such as diversion of rivers during the flood season or continuous and uninterrupted erosion of upstream currents, it is easy to
damage the dam structure and reduce the service life of dam affected by the volume of the rock dam and the design of upstream face, thus causing the failure accident of inverted rods and broken lines.

In order to solve the problem of traditional dam, a special QC scientific research group was set up. In February 2015, it began to study and design a concrete scheme to improve the masonry method of pole dam.

2. Target setting
To find method to reduce the pressure on the upstream face of the rock dam and to reduce the erosion of water flow. This method should be simple, easy to implement, and should take into account the characteristics of safety, reliability and durability.

3. Selection of scheme
After QC scientific research group identified the initial design goal of reducing the pressure on the upstream face of the rock dam and the erosion of water flow, it established three schemes combining with the site actual situation with a master tile craftsman with practical experience, a line maintenance master at the power supply station at the grass-roots level, the technical personnel of the county water conservancy bureau and the relevant production technicians of the power supply company.

The first scheme is to design the rock dam as a ship form, to form a sharp angle on the upstream face, to decompose the pressure of incoming water on the dam body (involving adding the amount of raw material of the rubble and the amount of cement);

The second one is to build the upstream face of the rock dam into a slope to reduce the hydraulic scour force (involving adding the amount of raw material of the rubble and the amount of cement);

And the third one is to simulate the turbine engine inlet of aircraft pursuant to the hydrodynamics method and design the middle of the rock dam into two cross-current water tunnels (not adding the external volume of dams without involving adding the amount of raw material of the rubble and the amount of cement);

Based on the hull design, the third method is to design the upstream face into sharp angles, separate the water currents and reduce the pressure of incoming water on dam. However,
This design increases the dam volume and coverage area, and further increases the sand, rubble, cement raw materials and the material cost, transportation cost, labor cost. Therefore, the design scheme is abandoned. The second method is to build the upstream face of the rock dam into a slope to reduce the hydraulic scour force. The slope formed by this method can slow down the erosion of water flow and avoid damage to the dam body, but it will also greatly increase the material cost, transportation cost, labor cost. Therefore, the design scheme is abandoned. The third approach is to simulate the turbine engine inlet of aircraft pursuant to the hydrodynamics method and design the middle of the rock dam into two cross-current water tunnels. The method does not involve the increase in external space volume of dam, land occupation area, material cost, transportation cost or labor cost. Therefore, QC team agreed to use this scheme for masonry of dam, as shown in Figure (1).

The basic principle of the scheme is:

On the basis of the original design of hemispherical rock dam, two elliptical water holes are set up on the middle side of the dam in the course of masonry, which not only facilitates the flow through, reduces the impact resistance of water flow on the dam body, but also does not affect the structural strength of the dam itself.

The special construction methods are shown as follows:

1. The dam foundation is excavated around the poles which need to be strengthened, the debris is removed, the branches, weeds, stones and soft soil are removed. The foundation that is 40CM in depth and 100 CM in width is excavated.

2. Rocks not less than 150MM in size and no more weathered on the surface should be used (Pebbles, flakes should not be used). The rocks are roughly upright and foursquare. Attention should be paid to the water resistance and good antifreeze of the materials. The rocks should be watered and wetted in advance to make the surface absorb water sufficiently. The ratio of concrete should be reasonable, the mixing time should not be less than 3 minutes, and the proportion of cement should be increased according to the need.
3. The masonry shall be built with a mortar laying method in different layers. The thickness of mortar shall not be lower than that of 3-5cm. Besides, no gap is allowed between the upper and lower joints and the core should be filled well. The hole masonry can be started when building to the position horizontal to ground. The hole shall be set to meet the direction of the incoming water. Ellipses with 20cm wide and 250cm high are left on both sides. Keep the hole smooth and flat as far as possible. The inner wall of the pole should be kept at least 10cm thickness, and the pole should not be exposed to prevent water erosion. Concrete can be added to the top of the rock dam to ensure the integrity of the closure.

4. Pointing and polishing should be properly conducted in the cracks of upstream face.

4. Countermeasure formulation and implementation
After the scheme was finalized, QC team developed a countermeasure implementation plan and changed the technical drawings three times over a period of more than half a year. The masonry technology of river pole cross-current dam has been successfully developed and has passed the joint acceptance of the technicians of county water conservancy bureau and the technical personnel of distribution network production in power supply company. In September 2017, it began to be used in a small scale in the company, and the maintenance staff of distribution network at the grass-roots level generally reflected that the application effect is very good, and this design has a wide range of practical application value.

5. Confirmation of research and development effect
After statistical analysis, the technology was applied in the power supply range of the eastern mountain area of Tieling Power Supply Company from 2015 to 2019, and the materials and effects were compared:

1. With regard to the use of materials, due to the increase of 5% of the stone material used outside the cross-current dam body, there is no significant increase in the cost of materials used as rubble, cement and other materials as compared with the traditional masonry method of dam.

2. In the aspect of service life, the service life of the traditional dam is usually 2-3 years. It is necessary to strengthen, maintain and repair the dam, clean up the dam body, replenish the block, solidify cement, and so on. There is a need to consume manual maintenance costs and increase the cost of repair materials. However, the cross-current dam can be used continuously for 4-6 years on the premise that there is no man-made damage, because it increases the overall strength and reduces the damage caused by water erosion, and the service life of the dam is increased by 2 times. During this period, only the visual inspection of the dam body is required when the line is patrolled. In this regard, the labor maintenance cost and material cost are saved. The power supply reliability of the power grid is improved, and the maintenance funds of the power grid are saved. At present, the technology has applied to the State Intellectual Property Office for patent protection of invention.

Reference
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