Research and Application of Waterproof Structure of Coated Flexible Cover Plate

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Abstract. This paper introduces the technical principle, technical characteristics and application scope of the brush-coated flexible cover-plate waterstop. With the example of Taihu reservoir CFRD project, the detailed engineering application of the new type waterstop structure is presented, including the design scheme, construction technology and quality control, etc.

1. Waterproof structure of coated flexible cover

1.1. Technical principle
The water-stop technology of the coated flexible cover plate is to apply SK single-component polyurea to the surface of plastic filler and concrete panel, and form a fully enclosed flexible anti-seepage coating after curing. It is bonded with the concrete panel, which can be used as a water stop layer and protect the lower plastic filler. This is a flexible surface water stop technology that can effectively and completely close the panel joints.

1.2. Technical characteristics
The water-stop technology of the coated flexible cover has the following characteristics. First of all, its construction process is simple and fast. Secondly, the SK single-component polyurea coating is firmly bonded to the surrounding concrete and has a good water-stop effect. Thirdly, SK single-component polyurea coating has great flexibility and strong adaptability to deformation. Fourthly, SK single-component polyurea has good resistance and will not cause rust problems. In addition, it is bonded to the panel without damage. Finally, the SK single-component polyurea coating is non-stick to ice and has a good protective effect. It can be used for repairing and strengthening seams of newly built panels and water damage of existing panels.

1.3. Specific problems solved
The water-stop technology of the coated flexible cover plate overcomes the gap between the cover plate and the concrete panel surface of the traditional anchor-type coiled material. In addition, it is difficult to guarantee the construction quality of the joint, and the defect of the cover plate is prone to occur in cold areas. This material can be used as a protective layer of plastic filler, as well as an...
independent water-stop layer, which significantly improves the safety, durability and reliability of the panel joint anti-seepage, and ensures the panel's anti-seepage safety.

2. Application of coated flexible-cover water-stop structure in Taihu Reservoir

2.1. Project Overview

The Taihu Reservoir Project is located upstream of the Xunwu Main Stream. The dam site is located in Dahu Village, Shuiyuan Township, Xunwu County, Ganzhou City, Jiangxi Province, about 47km from Xunwu County. This project can not only provide water for people, but also provide irrigation and flood control. This is a comprehensive medium-sized water conservancy project. The total storage capacity of Taihu Reservoir is $2384 \times 10^4$ m³. It provides an average annual water supply of $5.53 \times 10^4$ t to Xunwu County, and it improves the irrigation area by $8.46 \times 10^4$ mu. The level of this project is III medium-sized project. The main building is level 3, and the secondary building is level 4. The project is mainly composed of reinforced concrete face rockfill dam, spillway, water delivery tunnel, and highway.

The outline of the dam is as follows. The top of the concrete face rockfill dam is 8.0 m wide and the dam axis is 312.4 m long. The height of the dam crest is 447.4 m, and the height of the top of the anti-wave wall is 448.6 m with the 62.5 m maximum height dam. The upstream dam slope is 1:1.4 and the downstream dam slope is 1:1.3. Downstream elevation at 427.4 m and 407.4 m are set a 2.0 m wide horseway. In addition, the dam face is divided into 38 pieces, of which 25 pieces are 6m wide and 13 pieces are 12 m wide. The panel joints are J1~J39. Among them, the joints J1 and J39 are considered as the peripheral joints, and the length of the peripheral joints is 395m. Furthermore, J2-J11 and J25-J38 are tensile seams with a length of 1434.18 m. J12~J24 are compression seams with a length of 1193.10 m. The bottom joint of the anti-wave wall is 306m, and the expansion joint of the anti-wave wall is 28, with a length of 89.60 m.

2.2. Water stop design plan

The surface water-stop structure design of the joint surface rockfill dam of the Taihu Reservoir Project adopts a protective cover on the surface of the plastic filler. It is connected to the panel by means of anchoring, and we consider that the flatness of the surface is difficult to control in the construction of the concrete panel. In order to improve the construction efficiency and ensure the construction quality, we improve the safety, durability and reliability of the water and impermeability of the surface of the panel joints. We use the coating type flexible cover water-stop structure.

The water-stop structure of the coated flexible cover plate is to apply SK single-component polyurea to the surface of plastic filler and concrete, and form a fully enclosed flexible anti-seepage coating after curing. It is bonded with the concrete panel, which can be used as an independent water-stop layer and can protect the lower plastic filler. This is a surface water-stop structure that can effectively and fully close the panel joints. The key to the waterproof structure of the coated flexible cover is the choice of the flexible protective cover material. We chose to apply SK single-component polyurea as a flexible protective cover. It requires high mechanical properties, good durability, and guaranteed construction quality. Table 1 lists the main technical indicators of SK single component polyurea.

| Item                        | Technical index | Item                        | Technical index |
|-----------------------------|-----------------|-----------------------------|-----------------|
| Tensile strength, MPa       | ≥15             | Hardness, A                 | ≥50             |
| Elongation at break %       | ≥300            | Bond strength, MPa          | ≥2.5            |
| Tear strength, kN/m         | ≥40             | Water absorption, %         | < 5             |
Figures 1 to 4 are the design drawings of the joint water-stop structure of the Taihu Reservoir dam panel. The surface water stop is designed to have the following steps. First, we placed PVC glue sticks along the seam. Then, we covered the plastic rod with plastic filler. Next, we painted SK single-component polyurea on the plastic filler. The average thickness of the polyurea coating is 4.0 mm, and each side of the seam extends 20-25 cm wide.

2.3. Construction technology and quality control
The construction process of the panel joint water-stop adopts the coating type flexible cover plate water-stop structure as follows. First, we need to clean the joints of the concrete panel. Secondly, we need to apply SK primer. Next, we need to place PVC glue sticks and extrude the plastic material. Finally, we applied the interface agent and SK one-component polyurea. We use spiral extrusion to form the extruder. The filler is extruded from the die that meets the design section requirements, and the shaped filler directly falls into the gap between the plates (see Figure 5). Then, the machine can extrude the shaped filler with beautiful appearance and dense interior (see Figure 6). After being heated by spiral extrusion, it is sticky and soft, and can be better bonded to the concrete surface and the cover plate.
2.4. Coated water-stop structure construction

(1) Base surface treatment. We polished within 50cm along both sides of the seam to remove dirt on the concrete surface and V-groove, and cleaned the groove with high-pressure air.

(2) Placing PVC rods. We pressed the φ50mm PVC rods into the bottom of the groove in turn. Then, we tightly stick the wall of the rod to the joint wall, and the axis of the PVC rod should be consistent with the center line of the side seam. The connection of the rubber rod can be cut to a certain slope at the end and bonded with an adhesive.

(3) Brushing the primer. We apply the primer evenly on the surface of the dry slot concrete, and the brushing width of the primer should reach the edge of the plastic filler.

(4) Plastic filler construction. We choose the forming section and then continuously feed during the feeding process of the extruder to meet the feeding speed of the extruder and ensure that the extruded GB plastic filler meets the requirements. In addition, we choose the appropriate length and manually place it on the side seam after cutting. During the construction process, the surface to be pasted should be kept dry. After the embedding is completed, it cannot be torn arbitrarily, causing human damage.

(5) Brushing the interface agent. We need to manually apply the interface agent, and apply it thinly and evenly without leakage.

(6) Brush polyurea composite Nonwoven cloth. After the interface agent dries (within 1 to 4 hours), we need to apply polyurea for the first pass. The contact width between polyurea and concrete is 25 cm. After the polyurea surface is dry (after 3 hours), we apply polyurea twice and paste it immediately. The overlap length of the Nonwoven cloth and the concrete surface is 10cm, and it is integrated with SK hand scraping polyurea. After the polyurea surface dries, we apply the third polyurea pass, and then we continue to apply the fourth polyurea pass, and we paste the second layer of base fabric. After the polyurea is dry, we apply polyurea for the fifth to seventh times, until the thickness of the polyurea at the joint reaches 4mm. Each application requires uniform application and one-time molding. We cannot paint back and forth to prevent the appearance of small packets.

(7) Natural conservation. We need to prevent trample and disturbance.
3. Conclusion
The water-stop structure of the coated flexible cover has the advantages of surface protection and easy construction. It overcomes the shortcomings of the traditional anchored water stop. It can be used as a protective layer of plastic filler and an independent water-stop layer, which significantly improves the safety, durability and reliability of the panel seam impermeability. The plastic filler is mechanized and extruded to realize the one-time extrusion molding of the panel joint filler. The cross-section is beautiful, which not only bonds well with the concrete base surface, but also bonds with the SK single-component polyurea coating. Taihu Reservoir dam face joint adopts coated flexible cover plate water-stop structure and plastic filler mechanization technology, which further enhances the surface water stop and anti-seepage performance, making the dam face joint water-stop system safer and more reliable. This provided a guarantee for the long-term safe operation of the dam in the future.

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Figure 7. Peripheral seam cleaning, filler extrusion, and interface agent brushing.
Figure 8. Painting Vertical seam polyurea.
Figure 9. Brushing polyurea around the seam.
Figure 10. Overview of painting polyurea on panel seams.
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