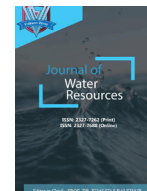




ISSN: 2327-7262 (Print)
ISSN: 2327-7688 (Online)
CODEN : JWROB9



ARTICLE

TREATMENT METHOD FOR LEAKAGE OF EXPANSION JOINTS IN SEDIMENTATION TANKS OF WATER PLANTS

Christian Tathy*

Department of Environmental Science, National Technical University of Athens, Athens, Greece

*Corresponding Author E-mail: christianathy@gmail.com

This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ARTICLE DETAILS

ABSTRACT

Article History:

Received 18 January 2020
Accepted 19 April 2020
Available online 26 April 2020

Taking the leakage maintenance project of the sedimentation tank of Shanghai Qingpu Water Plant as an example, the specific reasons for the leakage of the sedimentation tank are analyzed. According to the existing construction technology and experience, the treatment method of embedded water expansion strips is adopted to prevent seepage. The effect of leakage, the treatment method is summarized and improvement measures are put forward. This kind of construction plan has certain promotion value.

KEYWORDS

Leakage, water-swellaable tape, double-pack (MS) sealant, butyl tape, EPDM Ω -shaped waterstop, stainless steel bead, waterproof coating

1. BACKGROUND INTRODUCTION

Leakage from expansion joints of structures is a common problem in water plants, most of which are caused by the material of rubber water stop not meeting the requirements. A water plant in Hefei Province was completed and put into operation in 1992, and then expanded twice in 1994 and 2008. 500,000 m³/d. Among them, there are three advective sedimentation tanks in Phase II, 5, 6, and 7, with a single sedimentation time of 2.5hr, a horizontal flow rate of 13.23mm/s, and a tank depth of 4.0m. The reserved mud thickness is 0.20m, the ultra-high is 0.30m, and the effective water depth is 3.5m. On February 19, 2021, the water plant reported that the two side walls of the expansion joints of the sedimentation tank and the main outlet channel were dislocated on the plane after the low temperature in winter, and differential



Figure 1: Expansion joint leakage

settlement occurred vertically [1]. On the plane, the side wall plate appears dislocation inside and outside the tank, and the phenomenon of differential settlement occurs vertically. Figure 1: the leakage position appears at the connection position of the sedimentation tank at the expansion joint, the connection position of the channel, and the position of the sludge discharge valve. No. 5 to No. 7 sedimentation tanks have leakage, among which No. 6 and No.7 sedimentation tanks have serious leakage, and there is water column leakage at the bottom of the expansion joint of the wall plate [2, 3].

2. THE CAUSE OF LEAKAGE

2.1 Caused by Lax Construction Procedures

Water plant pools generally use reinforced concrete thin-walled structures. The density of steel bars is relatively high. It is necessary to carry out follow-up work based on water treatment process measures. However, various facilities that constitute the pool are prone to leakage problems, so it is necessary to carry out follow-up work on the basis of water treatment process measures. However, the various facilities that constitute the pool are prone to leakage problems, so it is necessary to use a flexible waterproof layer to ensure the anti-leakage performance of the pool. Due to the high difficulty of construction of the pool in the water plant and the complex processes, it is easy to cause problems such as concrete cracking and leakage during the construction process, which will have a certain impact on the appearance and function of the pool. There are many factors that lead to the leakage of water pools in water plants. First of all, the pools are generally poured with reinforced concrete, and the quality of concrete is closely related to the leakage of pools. In the construction process, factors such as concrete mix ratio, temperature and slump will directly affect whether the pool will leak. The concrete mix ratio will have a certain impact on the temperature performance, strength and durability of the concrete. The effect of the concrete temperature control also determines whether the concrete

will crack under the action of stress under the condition of temperature change, the slump and workability of the concrete. The relationship between them is very close. If the slump is too large, the probability of concrete segregation and shrinkage cracking is relatively high. The pouring sequence and layering control effect will also have a certain impact on the quality of concrete stubble. Concrete curing level is directly related to whether shrinkage cracking will occur due to premature water loss. Secondly, if the construction joints and pull bolts of the pool are not properly handled, it may also cause leakage problems in the pool. For example, there are foreign objects such as steel bars and sawdust on the joints, or there is a certain gap after the processing mold is removed. The water-stop treatment on the joints is not in place, and there is no requirement in the current rules and regulations to lay a layer of cement mortar on the construction joints, just because the upper and lower concrete bonds are not very strong, which leads to leakage problems.

2.2 Leakage Caused by Rubber Waterstop Material Not Meeting Design Requirements

The rubber waterstop that meets the design requirements has the requirements of tensile and deformation resistance, and can resist a certain degree of uneven settlement and staggered deformation of the wall. The rubber waterstop that does not meet the design requirements has poor ductility and tensile properties, especially in winter when the temperature is low, the waterstop becomes brittle and the ductility is reduced. There is a water leak. Through on-site observation and analysis, the cause of water leakage in the sedimentation tank of the water plant is mainly caused by the tearing of the waterstop caused by uneven settlement. The foundation of the sedimentation tank is treated with graded sand and gravel replacement. After the water stop on the bottom of the sedimentation tank is damaged, the local backfill compaction coefficient is inconsistent due to construction reasons. The hose was further torn and damaged. At the same time, in the winter of 2020, it experienced a cold wave, and the phenomenon of thermal expansion and cold contraction was obvious, which made the water leakage worse.

3. REPAIR PLAN

Generally speaking, if water seepage and water leakage occur soon after the construction of the newly built water plant, and the settlement has a further growth trend, it is necessary to determine whether the foundation needs to be reinforced in combination with the site conditions, so as to play a "cure for the root cause"; If leakage occurs in a water plant that has been in operation for many years, and the settlement of the pool has become stable, the effect of reinforcing the foundation on reducing the leakage of the pool is not obvious. At this time, the repair plan is mainly based on the treatment of leakage points.

According to the results of settlement monitoring: In 2016, Hefei Surveying and Mapping Design and Research Institute conducted 10 on-site monitoring on the observation point of No. 7 sedimentation tank. The maximum accumulated settlement is 2.9mm (S1 point). The settlement of each building site is basically uniform, which is normal settlement during the observation period, and the settlement of the water plant has been basically stable. Therefore, it is recommended to repair the leakage of the waterstop, and supplement the observation of settlement.

The scheme adopts the form of sticking a circle of water stop tape inside the pool or channel to repair the water stop. The specific implementation scheme is as follows.

Remove the foam filler in the original expansion joint with a depth of 10cm on the inner surface, clean and trim the gap with an electric hammer, keep the concrete edges on both sides of the expansion joint on the inner surface of the joint parallel, and chamfer the corners of the structure to ensure that the compressed sealing body is in It can play the sealing function in a large range and adapt to the settlement and deformation of the seam Figure 2.

Press the water-swellable rubber waterstop into the repaired seam.

Seal with MS sealant on the water-swellable rubber waterstop.

Butyl putty leveling construction.

Attach the omega back stick waterstop.

A stainless steel pressure plate is added to the water stop, and expansion bolts are inserted on both sides to fix it.

Cover with quick-setting rubber to seal.

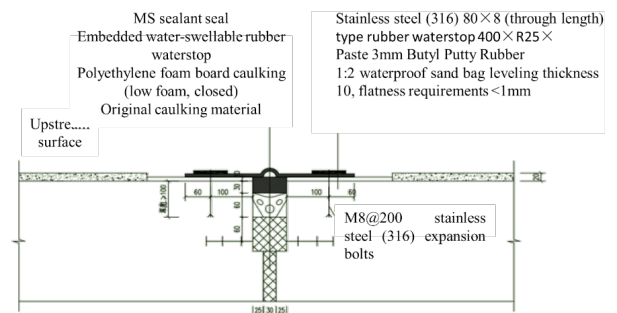


Figure 2: Construction drawings.

3.1 Preparations Before Construction

To ensure the safety of personnel on the construction site, safety warning signs should be made on each channel before the start of the sedimentation tank leakage plugging project to ensure that the construction period can be carried out as scheduled. The stagnant water and sludge in the sedimentation tank were basically cleaned up to provide guarantee for the follow-up work.

3.2 Expansion Joint Cleaning, Pressure Grouting

The first step in plugging the expansion joints of the sedimentation tank is to clean up the damaged rubber strips and other materials that remained in the expansion joints, and at the same time, cut off the gap between the tank wall and the bottom plate and the surrounding mortar layer. When removing the mortar layer around the expansion joint, the thread should be stretched first, and then the cutting machine should be used for cutting to ensure the depth and flatness of the expansion joint to the greatest extent.

According to the construction situation on site, there are the following three suggestions that need to be paid attention to during construction:

There should be some voids in the lower part between the pool wall and the bottom plate through cuttings. It is necessary to use pressure grouting to fill and solidify the voids and soil at the bottom of the bottom plate. It is determined as appropriate according to the situation of slurry on the outside of the pool.

To clean up the gap, it is recommended to cut the exposed steel bars first, and then use an air compressor with a pressure of 0.4MPa or more to clean up the loose concrete, debris and water between the gaps, and at the same time, cut off the damaged rubber waterstop to reduce aggregation. The effect of physical waterproofing mortar.

Control the surface elevation of the polymer waterproof mortar and clean the interface well. Considering that the cutting depth of the expansion joints on the bottom plate is deep, the original buried waterstop has been damaged, and it cannot block the load on the backwater surface and cannot be used for subsequent caulking. When the water-swellable rubber waterstop is used to support the bottom, it is necessary to reinforce the expansion joint. The reinforcement method used is filling with structural glue or polymer cement mortar. In order to ensure the effect and prevent the subsequent structural layer from falling off, the glue injection method needs to use pressure grouting. Before grouting, it is necessary to remove foreign objects in the joints and keep them clean.

After preparing the materials and tools required for pressure grouting, start to work on site. First use the machine to make the slurry, adjust the grouting pressure, pour the mortar into each expansion joint in turn and observe the situation, and stop when the other side of the expansion joint is grouted.

After grouting, it was found that the caulking joint on the westernmost

side was in a condition, and the grouting was seeping from the joint. After analysis by the technicians, it was determined that the reason was that the grouting hole was not blocked, and the depth was large. After all the grouting is completed, all grout holes need to be blocked. At the same time, the grouting of the west side joint is re-blocked and re-opened for grouting according to the secondary adjustment plan. When the pressure value reaches 0.7Mpa, the internal sealing layer collapses (same as the first case). Check the outer wall and found no pulp. After inspection, the outer bottom has been repaired many times, and there are many grouting holes.

3.3 Construction of Water-Swellable Strip and Double-Pack (MS) Sealant

Figure 3-6: after all pressure grouting is completed, a period of maintenance is required to ensure that the grouting is firm. At the same time, check whether the purchased rubber strips meet the requirements. After passing the inspection, start the construction of the water-swellable rubber strips and MS sealant.

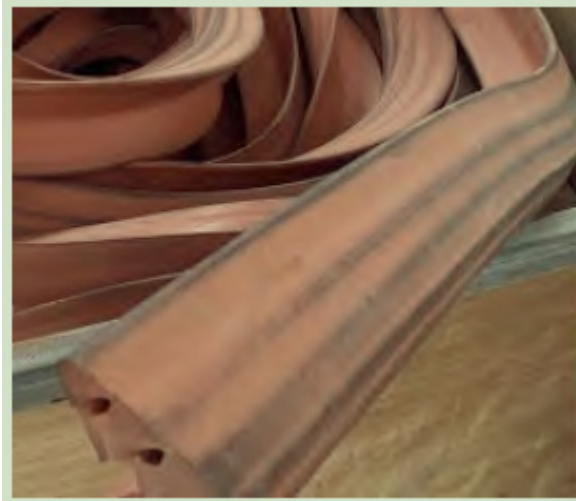


Figure 3: Water-swellable adhesive strip.

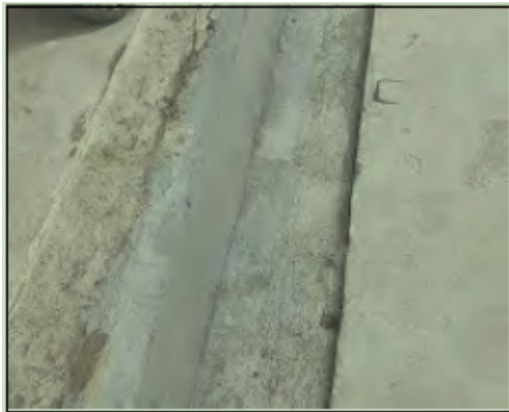


Figure 4: Double packet (MS) sealant application

3.4 Butyl Tape and EPDM Omega Waterstop Construction



Figure 5: Butyl tape



Figure 6: EPDM Ω-shaped waterstop

3.5 Construction of Stainless Steel Bead

When carrying out the construction of stainless steel beading, it is necessary to confirm the screw type and size with the material supplier in advance, and the construction can be carried out only after meeting the requirements. When ready, drill holes first, then use air pipes and wire brushes to clean up debris, and finally inject glue and screw into the screw. It should be noted that the newly arrived chemical bolt glue must be suitable for wet environment, bolt and bead construction Figure 7.

When tightening, the loose screws should be pulled out in time, and the bolts should be re-inserted after the accumulated water has been treated. After the bolts in the pool are all tightened at the top of the water stop, cut them at a uniform height and seal them with sealing compound. The full water test can be performed after all adhesive strips are laid, stainless steel platens are placed, and chemical bolts are tightened.



Figure 7: The construction of stainless steel bead is completed.



Figure 8: No leakage point for 24 hours at full water level.

3.6 Full Water Experiment

After the expansion joint of the sedimentation tank has completed all the procedures, the full water test will be carried out. After the test starts, it is necessary to strictly abide by the relevant provisions of the "Full Water Test Safety Technical Disclosure.pdf" to ensure the smooth progress of the test. Figure 8: after a 24-hour full water test, it was observed that the repair effect was very good, and there was no leakage in the full water test.

3.7 Dayu waterproof coating

After the sedimentation tank is full of water, open the valve to drain the water and carry out the waterproof and anti-corrosion treatment of the expansion joint. Before drainage, it is necessary to check again whether there is leakage in each expansion joint. Figure 9: after the inspection is correct, carry out waterproof and anti-corrosion treatment on each expansion joint.



Figure 9: Waterproof paint coating

4. IMPLEMENTATION AND IMPROVEMENT OF WATER SEEPAGE PLUGGING MAINTENANCE PLAN

During the construction process, the construction site is regularly inspected, and the construction quality is strictly controlled to ensure the restoration effect. After the construction of the No. 7 sedimentation tank, the water plant conducted an effect test and found that the repair effect was very good, and there was no leakage in the full water test. The construction unit is required to carry out continuous quality observation to check the repair effect.

Figure 10, 11: after the implementation of the No. 7 sedimentation tank maintenance plan, the experience was summed up and relevant improvement suggestions were put forward. In the original plugging maintenance plan, a stainless steel pressure plate with a width of 8cm was used on the water stop, and the bolts on the stainless steel pressure plate were 8mm in diameter with a single row spacing. 20cm in-line layout, I suggest to widen the stainless steel pressure plate to a width of 12cm, and change the bolts to double-row toothed bolts with a diameter of 10mm and a spacing of 15cm.

This improvement has the following advantages: the diameter of the

bolts is increased, and the fixing is more firm; the distance between the bolts is reduced, and the bolts are arranged more densely. In the new scheme, after a certain screw is loosened, the distance between the nearest useful bolts is 30cm, the distance is shorter and the pressure is firmer; the bolts are changed to double-row tooth arrangement, the fixed area is enlarged, and the waterstop is pressed more firmly; stainless steel pressure plate Widening helps hold down the waterstop.

This repair method is suitable for the application and promotion of similar engineering problems, and has certain economic application value, and it is planned to be implemented during the plugging and repairing process of No.

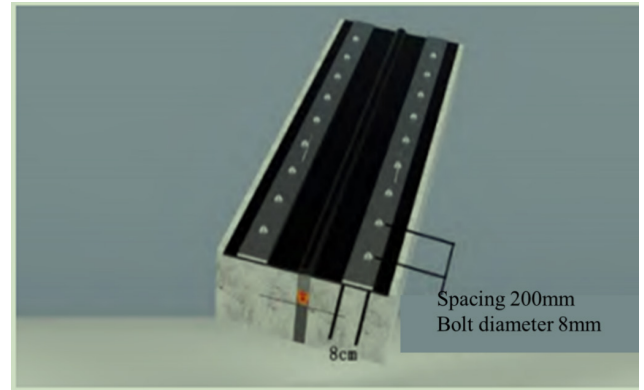


Figure 10: Schematic diagram of the opening of the stainless steel pressing plate in the original scheme

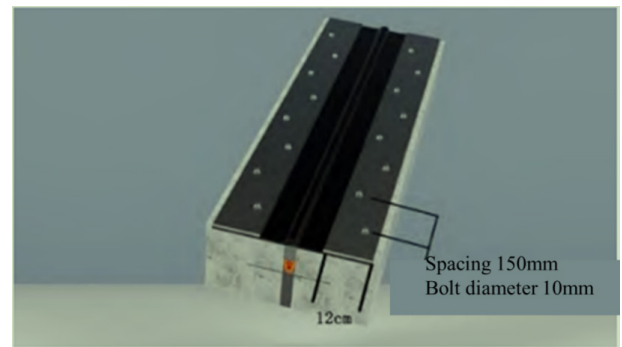


Figure 11: Schematic diagram of the opening of the stainless steel pressure plate in the revised scheme

REFERENCES

- [1] Zhao, L. 2018. How to do a good job of anti-seepage construction technology and common construction quality problems and preventive measures in the construction of ponds in water plants, *Energy Conservation and Environmental Protection*, (10), 45-48
- [2] Luo, G. 2017. How to do a good job of anti-seepage in the construction of water plant pools, *Building materials decoration*, 1673-0038 (2017) 09-0030-02
- [3] Wu, C. 2015. How to do a good job of anti-seepage in the construction of water plant clearing pools, *Science and Technology Innovation Herald*, (19), 112-113

