Analysis and study on typical diseases of hydraulic concrete buildings

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Abstract

Starting from the current situation of the typical hydraulic dam engineering, the development of the cracks in the hydraulic concrete dam structure is expounded. The reasons for the cracking of the concrete and the cause of corrosion of the steel bar are analyzed, and some suggestions for the prevention and control of the concrete durability are put forward.

Keywords

Cracks, hydraulic concrete, Corrosion of steel bar.

1. Introduction

Concrete cracks are caused by various factors. Damage degree of crack on the water conservancy and hydropower concrete building a serious cracks not only endanger the integrity and stability of structure, but also can produce a large number of Water Leakage, water, and even endanger the safe operation of the building. Fracture often leads to the occurrence and development of other diseases, such as leakage corrosion and environmental water erosion, freeze-thaw damage and the expansion of the concrete carbonation and steel corrosion, these defects and cracks form a vicious spiral, produce great harm on the durability of hydraulic concrete structures [1].

In the investigation of the more than 70 projects, both the dam or sluice, workshop or aqueduct water conservancy facilities, are to some extent crack failure problems, and some engineering crack is quite serious, has posed a potential threat to the safe operation of production safety and the hydraulic structures of hydropower station, should pay close attention to and solve take measures as soon as possible.

2. Analysis of concrete cracks in typical engineering

2.1 Danjiangkou hydropower station

During the construction of the dam of Danjiangkou hydropower station, 3332 cracks were found. After two tests, 1152 cracks were found and more than 90% of the cracks appeared after the operation of the dam. There are 171 cracks in seepage leakage and through the cracks in the dam, accounting for 14.8% of the total [2]. In the cracks in the Danjiangkou dam, the areas that are more serious in nature and may affect the safety of the dam are:

1) Right extension dam section

Due to the reasons of design and construction, the quality of the dam itself is relatively poor, and there are many cracks, and the leakage of seepage is widespread in addition to the drainage pipe in the dam body. Seepage leakage is the 42.1% of the total cracks in the dam. There are penetrating cracks in the basic corridor, water leakage at the bottom of the dam body, and horizontal seams at the height of 143 to 145m, and the problem is more serious.

2) No.18 dam section

The elevation 123m of No. 2 dam section and the elevation of No. 3 dam section are below 110m, and the top of the upstream seepage prevention board has been disconnected from the dam body. There are cracks in all the corridors in each layer, especially the elevation 131m corridor dripping throughout the year, and water seeping in the downstream of the corridor.

3) Pier of overflow dam

During construction, there are penetrating cracks in the area. During operation, cracks on the piers developed due to frequent opening and closing of gates. For example, under the condition of high water level and strong earthquakes, there may be damage.

Figure 1 Danjiangkou hydropower station

In addition to the cracks in the dam body of the Danjiangkou hydropower station, the cracks in the reinforced concrete structures such as the power plant are also noticeable. As the main building at the top of the asphalt aging sealing cracks and concrete cracks off, there are also many irregular: main building internal ceiling concrete cross exists in many of the crack width of 0.3 ~ 0.6mm; existence of circumferential and radial cracks within the main building around the concrete generator ground; generator bracket concrete layer all produce shear crack; reinforced concrete the highway bridge also appears vertical cracks [3].

2.2 Jingjiang flood diversion project

The project is a large scale of the Yangtze River flood control water conservancy project, the main building is the north gate and flood import export control South gate. North gate is a reinforced concrete structure of a long 1054m, a total of 54 holes, the north gate floor from upstream to downstream were divided into anti-seepage plate, resistance plate, chamber bottom plate and slope bottom, stilling slope bottom and stilling basin.

Figure 2 Flood diversion sluice

The 54 - hole skid plate in front of the sluice is completely cracked, and the steel corrosion is serious in the crack, which has lost the anti - seepage and drag - resistance effect. The size of the hindrance plate is 15m×19.5m×0.5m. Concrete strength R28=140kg/cm2. After the dam was built, cracks appeared, and the cracks continued to develop in the future. Generally, there is a penetrative crack in the middle of the long and wide direction of the slide plate. The plate is divided into 4 parts, some of them appear two cracks in the middle side of the larger size, and the board is divided into 6 parts. The sampling inspection shows that the cracks have cracked the floor. The corrosion length of the main rib of 12mm in the crack is 1/3, and the 6mm steel has been rusted and broken [4]. The concrete quality surface is still available, but the bottom honeycomb is many and the quality is poor. It was found that the total length of the crack in the skateboard was 4350.4m, and the penetration was 2042m.

North Gate of the 54 hole of apron, stilling slope bottom and the gate body on both sides of the downstream wall there are cracks, crack depth is 3 ~ 40cm. There are many cracks in the South sluice, only the bridge of highway bridge has 7213 cracks, the general width is about 0.2mm. The crack distribution has certain regularity, the eastern half of the west gate half crack 723, which may be related to the settlement of sluice in two things about the uneven [5]. At the same time, non-reinforcing holes and cracks and cracks fixing hole 495, mainly because the reinforcing hole span is small, and the structural stiffness and strength are higher than non-reinforcing hole.

Figure 3 North Gate of the 54 hole of apron

Causes of Jingjiang Flood Diversion Project of North Gate floor serious crack is complicated. According to a preliminary analysis of brake pipe, mainly in the following aspects: structure design defects, such as the bottom plate of large size, large amplitude natural temperature; the construction quality is not uniform, the surface quality of concrete is good, but the quality of concrete surface below 10cm; the change of operating conditions, poor management, such as anti-slider exposure not timely maintenance, in large temperature differences amplitude common cracks [6].

In view of the cracks above the north gate, especially the 54 holes before the sluice, all of them are broken through, which has lost the original anti-seepage and drag function, and may pose a great threat to the stability of the sluice during operation. At the same time, the sluice floor is also generally cracked, and nearly half of the crack depth is more than 40cm.

3. Analysis on the cause of cracks in hydraulic concrete

There are many works in this investigation. The factors such as the type, function, natural environment, construction condition and raw material of the building are also different. There are many reasons for the cracks in concrete.

In the cracks of hydraulic concrete buildings, especially in the structures with larger size or larger size, the cracks are often related to the excessive thermal stress.

3.1 Temperature stress is not considered in the design

The pier, floor and other parts of some small and medium-sized water conservancy projects, in the design process will pay no attention to the problem of temperature stress (including the construction and operation of the temperature stress), did not take structural measures necessary, nor to the construction or management unit of temperature control measures, resulting in the structure appeared cracks in construction or operation process. Such as Henan Luhun reservoir spillway pier, Beijing Yongding River and Xiaoqinghe River sluice pier construction stage cracks, Jing Jiang diversion north gate Antislider at run time due to poor maintenance caused by cracks [7].

3.2 Cracks in temperature control measures

Most of the dam concrete construction, the design is put forward in the construction of the temperature control, but not very good control, such as placing temperature, pouring block surface insulation is

not enough, the intermittent time is too long, too large height difference of adjacent block, etc. will make well fracture early cracks of the concrete dam [8].

3.3 Low strength and poor uniformity of concrete are the internal causes of cracks

For poor design or construction and so on, the low strength and poor uniformity of the concrete will make the concrete crack resistance low, and often cause cracks. Such as the construction of the dam of Zhexi Hydropower Station, lax quality control, concrete water cement ratio is 0.90, the grade of cement is low, various types, and the appropriate pressure low cement dosage (only 97kg/cm3), and mixed with very low activity burnt clay, so that the low strength of the concrete dam in the following [9]. The surface elevation is only 65.6% 126m, reached the design requirements. These constitute the inner causes of cracks in Zhexi dam. In the dam construction of Huanren hydropower station, the quality uniformity of concrete is poor and the CV value is more than 0.20. This is also a reason that causes more cracks in the Huanren dam.

3.4 Cracks in the structure caused by improper arrangement

It is found that many cracks exist in spiral case concrete of eight hydropower stations such as gorge and the Fuchun River. The occurrence of these cracks may be related to structural design. For example, Fengtan Hydropower Station dam height 107m corridor, design of the bottom plate and the top arch, side wall plate above a separate pouring, pouring, and the bottom to top arch center line into two pieces were pouring, due to shrinkage of concrete floor, which will top arch fracture.

3.5 Cracks in concrete structures caused by earthquakes or other reasons

After the earthquake of the Xinfeng river water power station dam, a long 80m runs through the upper and lower reaches of the 14~17 pier at the 108.5m elevation of the right bank pier.

The cause of the crack is caused mainly by the seismic stress, and it is also related to the change of the shape of the dam in the shape of the dam. In addition, some reinforced concrete sluices in Tangshan area of Hebei province have produced many cracks due to the morning of Tangshan. Such as run River tide gate in 1976 after the earthquake, cracks in each hole parapet, width of maximum 5mm. Another example is the Fengnan county west draining floodgate, because of the earthquake and the upstream apron and downstream stilling pool, sea immersion, produced uplift and slope on both sides of the broken crack, serious, serious cracks in parapet, maximum width of up to 3mm [10].

4. Corrosion of steel bar

There are two main reasons for the corrosion of the steel bar in the reinforced concrete structure of hydraulic engineering. One is the concrete erosion of carbon dioxide in the air, the alkalinity decreased and the formation of carbide, when the concrete carbonation depth to thickness of reinforced protective layer, the passivation film on steel surface will make damage to the original, then reinforced in water and oxygen is produced under the action of electric chemical corrosion, resulting in corrosion of steel. On the other hand, the hydraulic reinforced concrete buildings in the coastal area are invaded by Cl^- in seawater, sea breeze and salt fog, or in the reinforced concrete structure construction, some admixtures, such as calcium chloride, are mixed with Cl^- in the construction.

Cl^- is a strong activator for corrosion of steel bars. Some foreign data show that when the content of Cl- in concrete reaches 0.4% of the weight of cement, the steel begins to rust. Once the steel reinforced concrete structure in the occurrence of corrosion, will appear volume expansion, expansion in 2~4 times, this time in the concrete will produce great expansion stress, which will be reinforced outside the protective layer of concrete cracking, the formation of cracks along the reinforcement, called "longitudinal crack". While the cracks, and the carbon dioxide, oxygen and water in the air more easily into the concrete, which accelerated the development of carbonization and corrosion, bonding force between steel and concrete is greatly weakened, the external protective layer of concrete was caving, exposed steel bars, the effective cross section due to corrosion and weakened, the bearing capacity decreases rapidly, collapse finally, even may cause the entire building or structure.

Figure 4 Corrosion detection of steel bar

5. Conclusion

The durability of water conservancy and hydropower project is relatively common. Some of the engineering diseases are still more serious, which may endanger the safety and normal operation of the dam. The research on durability of hydraulic structures should be further studied, and effective repair measures should be adopted as soon as possible to ensure the safe operation and prolong the service life of the existing projects, so as to further play the economic and social benefits of these projects. Measures should be taken to improve the durability of concrete in construction and construction, so that water conservancy and hydropower projects should play its due great benefits.

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