Research on Field Inspection and Control Strategy of RCC Dam in Water Conservancy Project

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Abstract. This paper discusses the on-site inspection and control strategy of dam RCC construction quality in water conservancy project, taking project A as an example. The dam of the project is a RCC gravity dam with a height of 103m and a total installed capacity of 920MW. Through the detailed analysis of raw materials, mix ratio, construction quality control, engineering quality detection and results, this paper summarizes the key points and strategies of RCC construction quality control, including unloading, liquidation, rolling operation control, mixing dry humidity and compaction control. The test results show that all the technical indexes of dam RCC meet the specification and design requirements, which provides a useful reference for similar projects.

Keywords: water conservancy project dam; RCC; construction quality and inspection method

1 Introduction

The construction quality of water conservancy project dam is directly related to the safety of life and property of the downstream people[1]. As the main material in dam construction, the construction quality has an important impact on the overall stability and durability of the dam[2]. Therefore, it is of great significance to strengthen the field inspection and control strategy of RCC construction quality to improve the dam construction quality. This paper will take the dam of project A as an example to discuss the control strategy of RCC construction quality in detail, in order to provide reference for similar projects.

2 Project Overview

Project A is located in the main stream of Lancang River in Lanping County, Nujiang Prefecture, Yunnan Province. It is the seventh level power station in the upper reaches of Lancang River. The normal water level of the reservoir is 1477m, and the total storage capacity is 293 million m^3. The underground workshop is equipped with 4230MW hydrogenerator set with a total installed capacity of 920MW. The dam is a

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RCC gravity dam with a height of 103m. Construction was started in May 2015 and completed in January 2019.

3 Raw Materials

The RCC of project A adopts P · O42.5 ordinary Portland cement, fly ash grade I ash, fine aggregate (natural sand 0~5mm), coarse aggregate (pebble: small stone 5~20mm, stone 20~40mm, stone 40~80mm), HS-GJS polycarboxylic acid high-performance water reducing agent, HS-YQ gas diversion agent. After the inspection, the above raw materials test results are in line with the requirements of the relevant regulations and specifications.

4 Mix Ratio Control and Determination

According to the design technical requirements of dam concrete construction, through the production test to determine aggregate grading, sand rate, admixture dosage and unit water consumption, concrete setting time relationship, selected mix, water glue ratio, proposed concrete construction, and the performance test, finally determine the construction ratio and used after the supervision for examination and approval[3]. RCC construction coordination are shown in Table 1.

Table 1. RCC construction mix ratio of item A.

order number	Design indicators	graduation	Concrete type	position
1	C18015W4F50	two	roller compaction	Back to the surface
2	C18020W6F100	three	roller compaction	upstream face
3	C9015W4F50	two	metamorphosis	Contact place
4	C9020W6F100	three	metamorphosis	Contact place

According to DL / T5112-2009 "Code for Hydraulic RCC Construction", the relative density of the external (water surface) concrete of the building should not be less than 98%, and the relative density of the internal (back surface) concrete should not be less than 97%[4]. Through grinding 6,8,10 times, each measured the average of 5 points, and finally select the optimal number of external and internal concrete times is 8 times. When rolling, no matter how many the number of vibration rolling is, there is no vibration rolling 2 times, and finally static rolling 2 times. See Tables 2 and 3 for the rolling process tests of external and internal concrete.

For the process test of rolling number confirmation, conduct the field sampling test of RCC in time. Ensure the accuracy and timeliness of the test data. See Table 4 for the total performance indexes of RCC experimental bin.

Table 2. External concrete rolling process test table.

Measured bulk weight / (kg · m-³)	compactness /%	average value /%	Roll over the number	Measured bulk weight / (kg · m-³)	compactness /%	average value /%	Roll over the number
2413	99.3	98.0	Quiet 2 to move 6	2385	97.3	97.4	Quiet 2 to move 6
2353	96.8			2422	98.9		
2377	97.8			2343	95.6		
2373	97.7			2362	96.4		
2390	98.4			2425	99.0		
2423	99.7	99.2	Still 2 to move 8	2419	99.4	98.8	Still 2 to move 8
2394	98.5			2435	98.8		
2413	99.3			2420	99.2		
2428	99.9			2431	98.1		
2396	98.6			2403	99.8		
2448	100.7	99.9	Static 2 move 10	2446	99.8	99.5	Static 2 move 10
2422	99.7			2432	99.3		
2430	100.0			2452	100.1		
2420	99.6			2412	98.4		
2418	99.5			2448	99.9		

Table 3. Internal concrete rolling process test table.

Measured bulk weight / (kg · m-³)	compactness /%	average value /%	Roll over the number
2385	97.3	97.4	Quiet 2 to move 6
2422	98.9		
2343	95.6		
2362	96.4		
2425	99.0		
2419	99.4	98.8	Still 2 to move 8
2435	98.8		
2420	99.2		
2431	98.1		
2403	99.8		
2446	99.8	99.5	Static 2 move 10
2432	99.3		
2452	100.1		
2412	98.4		
2448	99.9		

Table 4. Summary of full performance indicators of RCC test bin.

Design indicators	graduation	age /d	compression strength /MPa	Axis tensile strength / MPa	Ultimate tensile value / x10-4	Axft pull mode $x10^{4}$ / MPa	Anti-seepage grade	Anti-freezing grade
C18015W4F50	two	28	19.0	-	-	-	-	-
C18020W6F100	three	180	25.2	-	-	-	≥W4	≥F50
C9015W4F50	two	28	22.1	-	-	-	-	-
C9020W6F100	three	180	29.2	-	-	-	≥W6	≥F100

5 RCC Concrete Construction Quality Control

Warehouse surface quality control includes unloading, closing, rolling control, as well as dry humidity and compaction control[5], and the quality management system is shown in Figure 1.

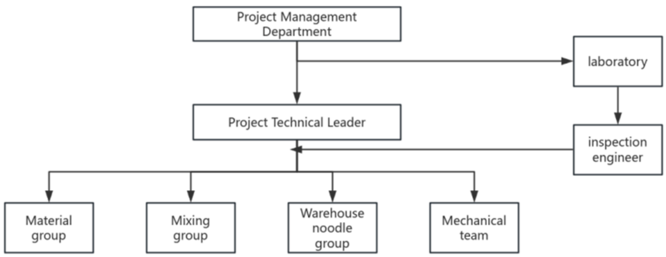

Fig. 1. Quality Management System.

(1) In the process of unloading, closing and rolling, several aspects should be done: ① to reduce aggregate separation; ② to control the material thickness and control the deviation within ± 3cm; ③ to reduce the disturbance damage and pollution at the rolling level. All kinds of machinery in the warehouse should strictly prevent oil leakage, and oil pollution should be removed. When the car directly enters the warehouse, wash the vehicle and dehydration the warehouse before entering the warehouse. When the bulldozer is used to close the position, avoid rotation in place. Brush and flushing, to master the time, if the time is too early, it is easy to cause the loose stone, is not conducive to the good combination of the level. The level shall be kept clean, and shall be kept wet until the upper concrete can be covered by spray or sprinkling; ④ several time intervals shall be mastered. After the concrete mixture comes out of the machine, its characteristics change constantly over time. In order to obtain good quality, transportation, unloading, closing, vibration pressure and covering and rolling of upper RCC shall be carried out as quickly and continuously as possible. The time interval from the mixing of the first layer is the most important time interval, which

should not exceed the specified allowable interval, otherwise it, the plastic combination between the two layers cannot be guaranteed[6].

(2) The appropriate dry and wet degree of compaction mixing is the prerequisite for compaction. In order to measure the VC value of the mixture in the warehouse, the VC tester can be set on the warehouse surface, or the nuclear moisture density meter can be used to determine the moisture content of the mixture[7]. The fastest method is to observe with the naked eye and make judgment by experience. Whether the suitability of the dry and wet degree of the mixture can be judged according to the following conditions in the rolling process. When the mixture is too dry, after 3~4 times, there is no obvious mortar flooding on the surface, and the coarse aggregate is crushed, or some strip cracks appear on the surface. When the mixing object is too wet, after the vibration rolling 1~2 times, the surface will obviously have mortar out, or more mortar stuck on the vibration wheel. If the humidity of the mixture is moderate, after the vibration rolling for 3~4 times, the rolling surface is obviously ash out, the surface is smooth and shiny, showing a certain elasticity. When the dry humidity of the mixture is found to be inappropriate during the rolling process, it shall be adjusted in time.

(3) RCC only to achieve a high compaction, can have the expected strength, impermeability and tensile strain capacity[8]. The influence of compaction degree on the performance of RCC is very significant, so enough attention should be given to the compaction degree of RCC, and it should be strictly controlled as one of the main indicators of construction quality.

6 Project Quality Inspection and Results

6.1 Field Compaction Degree Test

In pouring, 1 point was tested for 100~200m according to the specification, and 11649 points were tested for dam RCC. Among them, 8146 points were detected in the C18015W4F50 concrete area, and 3503 points were detected in the upstream surface seepage control area and the downstream surface step area of C18020W8F100. The test results all meet 98% of the technical requirements of the design.

6.2 Concrete Quality Test

The compressive strength of the 871 dam roller compacted concrete meets the standard, as shown in Table 5, and conforms to the design requirements of the specifications.

Table 5. Comsive strength of RCC.

Design strength grade / Cn	age /d	Number of test groups (n)	compression strength /MPa			standard deviation)Pa	Guarantee rate /%
			crest value	least value	average value		
RccC18015W4F50	180	613	30.4	17.8	24.9	1.98	97.7

AbnormalC18015W4F50	180	39	28.9	20.9	24.7	2.20	96.8
RccC9020W6F100	180	185	37.6	23.9	30.4	2.44	98.6
AbnormalC9020W6F100	180	34	36.9	24.7	30.3	2.46	96.4

7 Conclusion

Through the above process, it is concluded that in the quality control process of testing of the laboratory, it is very important to strengthen the machine port and the field. From the perspective of the testing mechanism, it is for the progress and quality of the project, and its goal is for the overall consideration of the project. The quality control of RCC is from the strict quality control of raw materials, ingredients mixing, transportation, warehouse surface pouring and other links of RCC. All the concrete construction tasks of the dam in the main part of project A water conservancy project have been completed. During this period, through the joint efforts of all parties involved in the construction and under the guidance of relevant experts, RCC has been effectively controlled from raw materials to intermediate products, and all technical indicators meet the specifications and design requirements.

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