Research on key technology of self-compacting rockfill concrete construction for reservoir dam

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Abstract: Self-compacting rockfill concrete (RFC) construction technology is a new type of concrete construction technology based on SCC construction technology. It makes use of the high fluidity, good separation resistance and self-flowing characteristics of self-compacting concrete. The dam structure is the core link of the reservoir. Taking a medium-sized reservoir in Chongqing as an example, the application of this technology in construction engineering is studied, and the technical characteristics, advantages and technical matching advantages are analyzed. The results show that this technology is a brand-new technology in Chongqing. In the actual engineering construction, some large-sized block stones are filled at first, and then the gaps in the block stones are filled by using the high flow resistance of self-compacting concrete. Finally, the cast concrete structure has a series of advantages such as low cost, stable structure, low carbon and environmental protection. Since its appearance, the construction technology of self-compacting rockfill concrete has been well applied in water conservancy and hydropower projects, and achieved good application results. This paper provides experience for similar projects.

1. Introduction

Self-compacting rockfill concrete (SCC) is a kind of mass concrete with high strength and low hydration heat, which takes advantage of the good separation resistance and self-flowing characteristics of SCC, and randomly fills the rockfill voids in the larger-sized blocks. Great changes have taken place in the construction methods and concepts used, and a number of modern techniques have been integrated, and different terrain and terrain structures can be used for corresponding construction, which not only improves the construction speed, but also ensures the construction quality, reduces the cost and makes the construction more orderly [1].

Great changes have taken place in the construction method and concept, and many modern techniques have been integrated, and different terrain and terrain structures can be used for corresponding construction, which not only improves the construction speed, but also guarantees the construction quality, reduces the cost and makes the construction more orderly. Self-compacting rockfill type construction technology has the characteristics of good fluidity, no segregation and good uniformity in actual project construction, and in the pouring process of the project, the material can fully flow only by its own weight, thus omitting the vibrating operation in the general pouring process, which not only ensures the overall compactness of the dam structure, but also accelerates the advancing speed of the project by omitting a certain operation. Rock-fill concrete construction technology has been used in Hengshan Reservoir, Qingyu Reservoir in Shanxi Province and Songlin Reservoir in Yunnan Province. Practice has proved that rock-fill concrete technology has many advantages, such as economic efficiency, reliable quality, energy saving and environmental protection, and greatly improving construction speed [2].

2. Characteristics of self-compacting rockfill concrete technology

2.1. Simple and convenient process

The process is simple and convenient. The construction process of self-compacting rockfill concrete is simple and convenient, which saves the process of flat paving and vibrating in the

concrete construction process. The construction quality of concrete can be better controlled, and the site management is relatively easy in the construction process. Self-compacting rockfill type construction technology has the characteristics of good fluidity, no segregation and good uniformity in actual project construction, and in the pouring process of the project, the material can fully flow only by its own weight, thus omitting the vibrating operation in the general pouring process, which not only ensures the overall compactness of the dam structure, but also accelerates the advancing speed of the project by omitting a certain operation. Even under the condition of dense reinforcement and complex shape, the gap of rockfill can be filled evenly and compactly only by self-weight without vibration, which brings great convenience to the construction operation [3].Reservoir dam construction is shown in Figure 1



Figure 1 Reservoir dam construction

At the same time, self-compacting concrete is called "the most revolutionary development of concrete construction technology in recent decades" [4], which has the advantages of improving concrete quality, improving construction environment, speeding up construction progress, increasing labor productivity and reducing project investment. In addition, in the specific construction process, for the application of this technology, it has the advantage of low cost, the construction is very simple, and it will not bring great pollution [5]. The use of self-compacting rockfill concrete technology, analyzed in essence, is to fill the gaps in the stone blocks of grain size with self-compacting concrete, and its high flow anti-segregation ability can ensure the uniform distribution of concrete. The construction of self-compacting rockfill concrete requires a large number of block stones which meet the technical requirements. As the main filling raw material, block stones can effectively reduce the use of cementing materials. Besides, the construction process such as vibrating is omitted during construction, which further reduces the labor cost and mechanical cost in engineering construction. For example, natural dense rockfill concrete mix is shown in Table 1.

Table 1 Mix proportion of natural dense rockfill concrete

Material	Cement	Fly ash	Sand	Stone	Water	Admixtures
Dosage	240	842	884	165	145	7.3

2.2. Material selection of self-compacting rockfill construction mode

It is the foundation of self-compacting rockfill dam project construction, and the quality of rockfill should be ensured. In order to facilitate the construction of the project and ensure the freshness of the rockfill, the rockfill can be mined in the area near the dam project. This way of rockfill material selection can improve the rock's good integrity and high compressive strength. The size of stones without certain specifications used in self-compacting rockfill concrete should not be less than 300mm[6]. The requirements for rockfill materials are: fresh, complete, hard and free from spalling and cracks. When choosing the type and specification of cement materials, silicate cement materials are generally used for the construction of self-compacting rockfill dams. This type of

cement materials can not only ensure the good workability and uniformity of the dam structure, but also facilitate the formwork removal operation at the later stage of the project, creating a foundation for the improvement of the construction quality of self-compacting rockfill projects. Self-compacting concrete raw materials mainly include cement, fly ash, coarse and fine aggregates and additives [7].

The mix proportion design is carried out according to the self-compacting performance required by the structural conditions, construction conditions and environmental conditions of the components. The mix proportion design is based on the comprehensive strength, durability and other performance requirements, and the absolute volume method is adopted for the mix proportion design. When the mixing station is far away from the structure, it should be transported by concrete mixer truck, and the unloading should be completed within 45 meters. When the mixing station is near the building, a concrete pump can be installed under the discharge port of the mixer, and the mixing material can be directly pressed into the warehouse by the pump [8]. This project adopts concrete pump delivery mode. Fine-tuning results of mix design of natural dense rockfill concrete are shown in Table 2.

Project	Extension	Funnel	Slump	3dStrong	28dStrong
Result	650	13.22	220	12.3	25.8
Achievement	620	7.2	245	12.6	20.1

Table 2 Fine-tuning results of mix design of natural dense rockfill concrete

3. Construction technology research

3.1. Select materials

As an important foundation of dam construction, the stones of a reservoir in Qijiang were purchased in Qingjiang Stone Yard. The rockfill materials used in rockfill concrete should be fresh, complete, hard and free of spalling layers and cracks. The particle size of rockfill should not be less than 300mm, and the maximum particle size of rockfill should not exceed 1/4 of the minimum side length and 1/2 of the thickness of the structural section. Rock materials shall not be less than 30MPa according to saturated compressive strength. Concrete should be kept warm in low temperature season or when the temperature drops suddenly. After curing in winter, we must follow up the heat preservation in time, and cover the heat preservation quilt at night. When the seasons alternate and the temperature drops suddenly, heat preservation measures should be taken for the poured concrete, and tarpaulins, grass curtains, quilts and other materials can be used for heat preservation. The formwork removal of new concrete will be delayed for one week, otherwise the temperature difference will cause concrete cracking [9]. When selecting the admixture in the construction of self-compacting rockfill, it is necessary to combine other basic materials used in the construction of the project and scientifically select the admixture. By applying admixtures to the construction of self-compacting rockfill dam structures, concrete materials can be guaranteed to have good fluidity characteristics and plastic retention effect. Choose fresh tuff mined near the dam site, the rock is hard and brittle, with good integrity, and the saturated compressive strength meets the technical index requirements of C20 self-compacting rockfill concrete for rockfill [10].

However, in some areas, due to the special geological environment and the influence of ecological environment, there will be some deficiencies in rock performance. If it is applied in the formal construction process, the overall structural stability of the dam will be affected. Therefore, before construction, for the selection of rockfill materials, it is necessary to combine the comprehensive quality of the rocks in the region, make detailed analysis and investigation, and then select them.

3.2. Maintenance of self-compacting rockfill concrete

The rockfill materials used in rockfill concrete should be fresh, complete, hard and free of spalling layers and cracks. The particle size of rockfill should not be less than 300mm, and the

maximum particle size of rockfill should not exceed 1/4 of the minimum side length and 1/2 of the thickness of the structural section. Rock materials shall not be less than 30MPa according to saturated compressive strength. Concrete should be kept warm in low temperature season or when the temperature drops suddenly. After curing in winter, we must follow up the heat preservation in time, and cover the heat preservation quilt at night. When the seasons alternate and the temperature drops suddenly, heat preservation measures should be taken for the poured concrete, and tarpaulins, grass curtains, quilts and other materials can be used for heat preservation.

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4. Conclusions

After excavation to the foundation surface, loose stones, sundries, soil, etc. must be removed, and high-pressure water guns should be used to rinse them off without water accumulation, which will lay a good foundation for the subsequent work. Dump trucks are used to transport blocks to the warehouse surface, and excavators are used to stack blocks manually. Self-built mixing station is selected to mix concrete, and the mixing station is built about 100m downstream of the dam body. The concrete is transported to the working face by a concrete ground pump and poured by a spreader, which has a high degree of mechanized construction, saves a lot of labor, and improves the work efficiency. In the self-compacting concrete mixing construction, the concrete batching list should be strictly followed, and the batching list should not be changed without authorization. Before the production of self-compacting concrete, the water content of all coarse and fine aggregates should be measured, the water consumption should be adjusted according to the change of water content, and the mixing time should be strictly controlled.

The mixed concrete should be put into construction at the first time to avoid long-term placement. The second is pouring. The main materials of the project are basically the same, that is, they are mainly composed of cement materials, construction pulverized coal ash materials and orthopedic materials with different specifications. One of the keys to ensure the construction quality of the self-compacting rockfill project is to design the material ratio value scientifically, and to formulate the most scientific matching scheme according to the dam construction standard and the dam use environment. Check the workability of the mixture, including slump and slump expansion, and if necessary, use model and reinforcement model test to evaluate the fluidity, separation resistance, filling property and gap passing ability of the mixture.

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