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Berg River Project

Concrete face construction at Berg River Dam

THE BERG WATER PROJECT is being implemented and funded by TCTA on behalf of the Department of Water Affairs and Forestry. The project will augment the yield of the Western Cape Water System by 81 million cubic metres per year at a forecasted cost of R1,6 billion.

The Berg River Dam with a gross storage capacity of 130 million cubic metres is the main component of the project. Construction of the dam by the Berg River Project JV consisting of Grinaker-LTA, Group Five, WBHO and Western Cape Empowerment Contractors commenced on 1 June 2004. Construction is now in the completion phases with impoundment imminent, in time for the 2007 rainy season in the Western Cape.

The dam is a concrete faced rock fill dam (CFRFD) and is 65 m high with a 980 m crest length. One of the main advantages of this type of dam is that the consolidation and curtain grouting is done from the upstream plinth and not under the main fill. This has major programme advantages.

Whereas the construction of the whole dam may be considered a feat of civil engineering, the focus of this article is on the reinforced concrete upstream face.

The construction of the upstream face slab commenced in May 2006 and was completed in May 2007.

The concrete face was constructed in 63 panels, each 15 m wide and the longest 105 m long. Some 27 000 m^3 of concrete was poured to construct the face slab. Two identical slip forms complete with a concrete placing platform as well as a finishing platform were manufactured. One was used to construct the leader slabs, while the remaining slide was used mainly to construct the infill panels. A transverse concrete feed conveyor was shared between the two slip form platforms. The slip forms were moved up the face using 15T hydraulic jacks and steel jacking teeth. The jacking teeth were connected to IPE120 beams. The system was designed for a production rate of 3 m per hour.

One of the main challenges was safety, the main risks being people or material falling down the face. Access steps were installed on the joints for access by the workforce. Mostly ropes were used to lower items down the face. The larger items were transported using the winches and the relevant trolleys. Risk assessments were done for all the activities on the face and the assessments discussed with employees at regular intervals.

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▶ *Left: Face slab sliding operation*

SURVEY AND SETTING OUT

The area of the upstream face that had to be surveyed was 65 000 m^2. A 3 m by 3 m grid was installed on the upstream face of the dam. The survey was used to ensure that the minimum specified slab thickness was achieved at all times.

MORTAR PAD CONSTRUCTION AND COPPER WATER STOP INSTALLATION

Mortar pads, 400 mm wide, were constructed to provide an even bedding surface for the copper water stops that were installed on the joints between the panels. The mortar pad thickness, in conjunction with the surface survey, controlled the resulting slab thickness.

The w-shaped copper water stop was installed on the joints between all the panels using a copper-extruding machine. Before the copper installation, a double layer of five-ply malthoid was lowered on top of the mortar pad. These layers serve as further protection to the copper water stop to prevent piercing by sharp objects in the mortar pad, especially when the slip form travels on the side forms during concreting. The copper-extruding machine was positioned at the top of the embankment from where the copper was extruded.

Reinforcing installation

Y20 reinforcing mats, 14,8 m by 7 m, were prefixed on the crest of the wall. The mats were manufactured in a jig to ensure accuracy. They were transported down to their final position using the rebar trolley operated by an 8 t winch. The mats were supported in their final position by pins, at a 3 m grid, driven into the substrate and vertical bars welded to these pins. All the reinforcing supports, the pins as well as the welding of the vertical bars, were done using rope access.

SIDE FORM AND RAIL INSTALLATION

Leader panels

The slab design is such that it decreases in thickness with an increase in elevation, the thickest part being 440 mm at the bottom of the dam decreasing to 320 mm at the crest. The 2 m sections of side forms were designed to follow the slab thickness, in essence this means that the first section at the bottom of the longest panel will be 440 mm high with an even decrease in height to 320 mm for the last section of 2 m side form at the top. The side forms were plumbed and clamped to the reinforcing of the adjacent panel. The side forms were built from the bottom. The IPE120 rails were installed from the top, first installing the anchorage then the rails. The rails were manufactured in 6 m sections with fish plates and three M16 high tensile bolts as connection between the rails. Great care and proper supervision had to be exercised with the connection of the rails, bearing in mind that the jacks propelling the slip form will jam on any significant irregularity in the rails or on the joints between the rails. The rails were kept in position on top of the side form with a T and wedge system.

Infill panels

When casting the infill panels, the side forms are no longer required. The rails are installed on the existing concrete. In this case the rails are fixed to the concrete by coach screws with fish plates – similar system to that used by the Railways to fix the rail to the sleeper.

CONCRETE CASTING

Two methods of concrete placing were used, the first being three lines of 250 mm uPVC pipes to transport the concrete from the crest to the slip form. This method was used on the shorter panels. The second comprised a single line of half-round chutes installed outside the panel to transport the concrete to the discharge hopper of the conveyor platform.

The concrete team comprising four concrete hands vibrating the concrete in front of the slip form, three concrete hands floating the final product to the required finish, one slip form operator, one conveyor operator (if being used), four general labour assisting in the disassembly of the pipes or chutes depending on the system used, a section leader supervising the labour and a foreman supervising all the activities and enforcing safe working procedures. The fresh concrete was covered by a drag sheet extending 10 m behind the slip form. This serves as protection against the elements such as rain scouring the surface of the concrete or direct sunlight drying the surface of the concrete.

Curing of the concrete commenced as soon as the placed concrete had achieved initial set. Continuous water curing was used by connecting a 15 m perforated waterline to the slip form, following it up the wall at a distance of about 20 m behind the platform. Another method used was two pivoting sprayers following the platform at the same distance. Once the panel was finished, a permanent perforated waterline was installed at the top to cure the slab for the remainder of the specified 21 days.

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CHALLENGES, ADVANTAGES AND DISADVANTAGES

One of the major disadvantages of this system is that it is extremely sensitive to the slump of the concrete being used. A concrete slump that is too low would cause delays due to a higher intensity of required vibration. A slump that is too high would cause delays due to sagging and slumping of the skin which can only be countered by drastically slowing the upwards progress.

Panels had to be constructed in one continuous operation, therefore requiring detailed planning regarding concrete supply, equipment performance, weather forecasts, access requirements, etc. The Cape winter and high wind velocities created big challenges and sometimes frustration.

A major advantage of using the conveyor platform is the ease with which concrete is distributed over the 15 m wide panel. The conveyor makes it possible to pour the concrete where it is needed, thereby increasing the pace at which the slip form progresses up the face. The pipes provide limited variation in placing position.

Safe access to the work area created a big challenge. Works were executed over a span of 12 slabs at any given time. Access ropes had to be inspected on a regular basis to ensure the safety of all involved. The access steps had to be moved on a regular basis to ensure quick and efficient access to the workplace. The steps were inspected on a weekly basis and signed off by the responsible person on site.

Safety on the face was taken extremely seriously. A lot of time and effort went into the risk assessments and the toolbox talks that were held every morning to stress the risks involved and to keep everybody involved in the face construction focused and alert at all times.

The construction of the concrete face of the Berg River Dam played a critical role in the dam's integrity and posted challenges to the construction team. Challenges such as these make being a civil engineer on a construction site an exiting and gratifying experience. ◻

▶ *Bottom: Dam concrete face nearing completion*

Source:
http://www.saice.org.za/downloads/monthly_publications/2007/CivilEngJuly2007/#/0