SERVING INDUSTRY
for over 50 years

THE CIVIL ENGINEERING CONTRACTOR

Subscription-based electronic and print media serving the construction industry

March 2019
Vol 53 No 3

ANNUAL SUBSCRIPTION:
11 print editions + 24 email bulletins

South Africa R1 955
International USD170

ISSN 0009-7888

“The cheque is in the mail”

INSIGHT: Are we serious about safety? I think not!

ON SITE: Fast-tracking water to a parched region of Mpumalanga

BUSINESS INTEL: Project preparation is the key to bridging Africa’s infrastructure gap

Fast-tracking water to a parched region of Mpumalanga

This is an adjacent reservoir by Corestruc, further along in the process.

Photos by Eamonn Ryan

By Eamonn Ryan

Precast-concrete specialist Corestruc is constructing a 10 megalitre (Mℓ) reservoir in the Thembisile Hani Local Municipality north of Pretoria using precast walls. It is part of a programme by the municipality to strengthen water supply to the towns of Bundu, Boekenhouthoek, Mathysenloop, and Machipe in Mpumalanga.

Hilly terrain, a rural environment, and the distance from economic centres were key challenges. Works commenced in 2018 with the construction of a concrete weir and abstraction works, both commissioned in August 2018, and a bulk pipeline from Bundu to Boekenhouthoek completed before the end of September as part of the first phase of the programme.

Meanwhile, the construction of the first module of a 7.5Ml/day water-treatment plant in Bundu was completed in June 2018. Notably, this will be Bundu's first water-treatment plant and the entire facility is on track for completion by mid-2019. A total of 5Ml/day of water will be sourced from the Moses River to alleviate much of the pressure on existing supplies from various water service authorities.

Previously, the municipality sourced 15Ml/day from the City of Tshwane Metropolitan Municipality, 5Ml/day from Dr J S Moroka Local Municipality, and 35Ml/day from Rand Water Board. This supply was inconsistent and, as a result, led to widespread water restrictions in Bundu, Boekenhouthoek, Mathysenloop, and Machipe.

Tshwane-based Ceenex, a local water infrastructure specialist, has been involved in the project since the early master-planning phases. The firm of consulting engineers was also later appointed by the municipality to supervise the construction works, which includes the 10Ml command reservoir that was built as part of the second phase of the project.

On this component of the programme, Ceenex is a subconsultant to Monde Consulting Engineers & Project Managers, which is supervising the construction of the reservoir. Both consulting engineers assisted in refining the unique design of the 10Ml structure, which is only the second in the country to be built using a new novel precast-concrete system. The other was built in Kwa-Mahlangu as part of a larger water-supply scheme that is also being driven by Thembisile Hani Local Municipality.

Sarel Holtzhausen, executive director of Ceenex, says that a decision was taken right from the outset to construct the reservoir using prefabricated concrete technologies to accelerate construction times.

"Reservoir walls are an extremely specialised undertaking. It would have taken a specialist contractor up to 14 months to complete using cast-in-place methods without the risk of having to correct the construction of the walls or reseal the structure. This is opposed to the five to eight weeks using this new system," Holtzhausen says.

Rudi Bezuidenhout, Mbako Projects & Trading, the main contractor on this component of the project, concurs: "The wall panels were dispatched to site on a just-in-time basis and then lifted and placed by Corestruc's team onto the ring beam. This negated many of the challenges associated with building these walls using conventional *in situ* techniques. These include the need to establish tonnes of formwork and coordinating the various teams, and counting the steel fixers, shutter hands, and concrete gangs."

Specialist activity

While Mbako did the surrounding water infrastructure of the project, as well as the floor and ring-beam of the reservoir, Corestruc designed and manufactured the wall system that is being used in combination with its tried-and-tested roof technology. The latter has been used to assist in quickly delivering structures as large as 50Ml in rapidly expanding metropolitan municipalities.

As a specialist subcontractor to Mbako Projects & Trading, it was also tasked with installing the modular roof and wall system on site. The wall system comprises 60 precast concrete panels, each weighing eight tonnes, 9.8m in length and 16.4m in width. This is in addition to four buttress panels, each weighing 11.4t. They were produced by Corestruc using forms that were designed and manufactured especially for this project.

Many hours were also invested in the design of the four buttresses, which contain numerous cast-in components that were manufactured in-house using computer-numerically controlled machines. They each weigh 11.4t and were also lifted into place by Corehire, a subsidiary of Corestruc.

Holtzhausen says that this modular approach to constructing the walls and roof of the structure is ideally suited to rural areas that are not adequately serviced by ready-mix producers. "This is a real challenge in rural areas. Ready-mix operations tend to be located in the main urban hubs where there is a higher demand for the construction material. It is simply not feasible to transport ready-mix concrete over long distances. The only other alternative, therefore, would have been for the contractor to batch its own concrete on site — an option that would have possibly prolonged construction times and required further extensive quality controls."

Holtzhausen says that the technology also provides a more cost-effective means of constructing larger structures than *in situ* techniques. This is where the real value of the system will be realised, considering the growing backlog in water infrastructure and the pressure municipalities are under to better manage their dwindling budgets.

Works started on the foundations and bases for the columns of the roof which, once completed, was followed by the ring beam and the walls, and

The process of pre- and post-tensioning is what keeps the structure monolithic.

ended with the floor of the structure. The roof structure, comprising precast-concrete columns, beams, and hollow-core slabs, was built by Corestruc in only four days.

Mbako Projects & Trading then proceeded with the construction of the 2.5km pipeline and chambers, as well as the ring beam of the structure, while CoreSlab manufactured the walls in a controlled factory environment. The precast-concrete factory is the heart of the project. It is a labour-intensive undertaking where many skilled people work on multiple projects simultaneously in a controlled and safe setting.

"These factories rely extensively on a high level of skills, so these operations tend to place immense emphasis on training and staff retention to ensure a high quality of the concrete elements. In so doing, they are creating long-term employment in the construction sector, which is in line with government policies," Holtzhausen says.

Meanwhile, ancillary work, counting the pipeline, provided ample employment opportunity for members of surrounding communities, as well as local emerging contractors in line with a typical Expanded Public Works Project that is financed by the Municipal Infrastructure Grant.

"While the walls were still being installed, the centrepiece of the roof was constructed and the first panels for the perimeter of the roof delivered."

Willie de Jager, managing director of Corestruc, says that he is proud to be involved with a municipality that has taken a proactive approach to service delivery, while demonstrating its willingness to test state-of-the-art technology that will assist in accelerating service delivery.

Speed of delivery

The benefit of constructing a precast reservoir is that multiple tasks can be performed relatively simultaneously, which is not possible with the conventional manner. The roof, floor, and walls of a reservoir cannot typically be done simultaneously — at the most, two can, but De Jager explains that when using precast-concrete slabs, all three tasks can overlap. This particular project commenced at the beginning of December 2018 and was due for completion end-January or the beginning of February.

Site manager Casten Kunaka of Mbako describes the precast method as "pretty fast", because in normal circumstances, "If we were going to do the walls with the traditional *in situ* concrete, we couldn't have started with the walls before we finished with the floors — but we can now do it uninterrupted because there is no formwork cluttering up inside. It's a clean site — it makes a big difference."

This process also mitigates the need to coordinate the delivery of construction materials to site. Already having the structure of a roof in place also enables the floor concrete to cure under the best possible conditions.

De Jager says the walls alone were constructed in just eight working days, in comparison to four to six months using the conventional method — the difference being that all that work now takes place off-site in the factory. "It is this factor which

The precast methodology enables all components of the reservoir to proceed simultaneously.

permits the overlap to take place," he explains. The precast sections are manufactured with holes through which cables, with a maximum of 5mm play, are threaded and later post-tensioned to keep the wall panels tightly in place, using Corestruc's unique methodology.

While conventional construction methods use reinforcing and post-tensioning to control applied forces, Corestruc's method uses tensioning vertically and horizontally to resist applied forces. About 6.6km of post-tensioning ducts and cables were installed by hand between the joints of the wall panels, before the grout was pumped around the circumference of the reservoir. This is a vital component of the construction project and the team has to pay meticulous attention to detail to avoid potential future leakages that have been so common in the past using less-sophisticated precast-concrete technologies.

The voids between the panels are sealed using a specially designed grout that is pumped between the precast-concrete wall slabs. This grout has been designed to reach a compressive strength of 100Mpa within four days — stronger than the concrete of 70Mpa — and to further react when the medium comes into contact with water when the reservoir is being filled. It is blended and packaged on behalf of Corestruc by Epoxerite, a South African construction chemicals specialist. Self-healing concrete is used for the grouting, which enables the concrete over time to grow tentacles into surrounding concrete surfaces. This is Corestruc's own design, explains De Jager, which leaves 'pure' un-hydrated cement inside the mix into which the tentacles can expand. The company also designed its own post-tension grout as part of its seamless methodology.

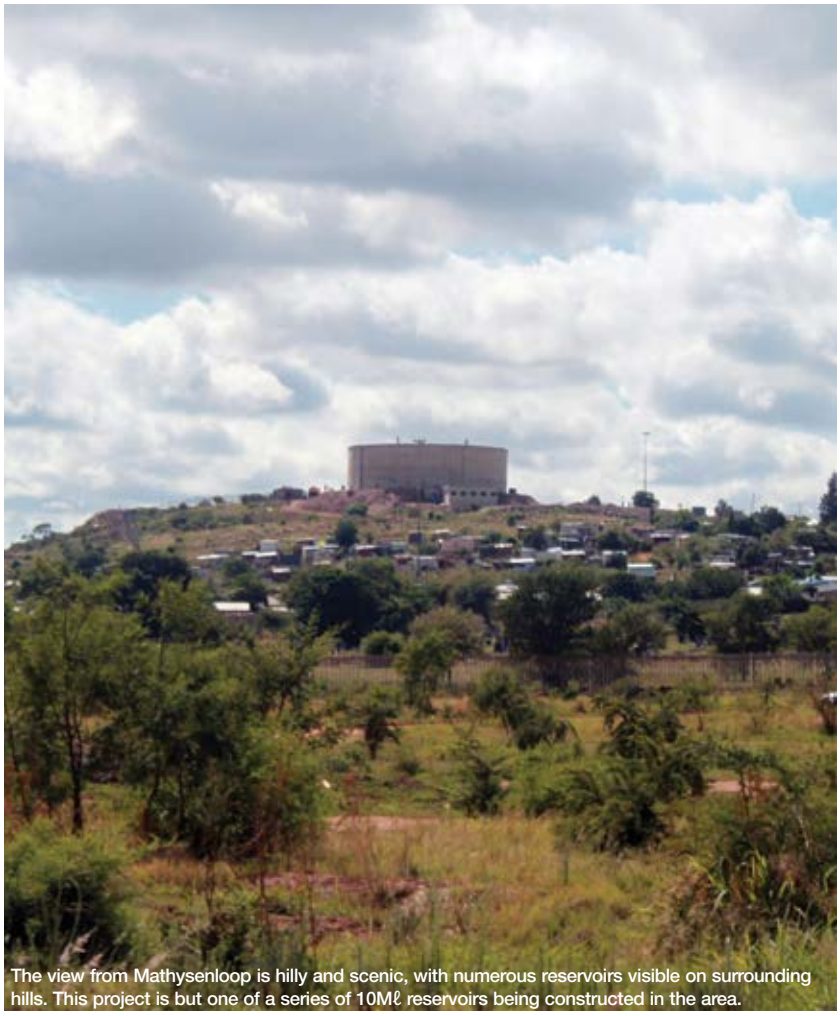
"It is an extremely high-flow grout to flow through all the post-tensioning ducts while being pumped from a single position."The success is achieved in the installation, whereby the open time is extended by cooling the grout down to 7°C — or the grout would set in 30 minutes. This method — which is similarly applied to the roof — forms a single monolithic unit.

What could go wrong but doesn't

The trick lies in careful installation, explains De Jager, as each panel weighs between 8t and 11.5t, which means safety is a priority. The process is constantly monitored using a Total Station that enables each panel to be placed with miniscule error. A 'prism' using GPS coordinates is used to place each slab by crane. If it is out of kilter by even 5mm, the installation will not work, as a bolt in the steel plate grouted in place on top of the ring beam in the structure has to align with a hole in the slab to 5mm accuracy, while steel plates at the top have to similarly line up. "The crane is equipped with a load-moment indicator, but requires expert human rigging to ensure accurate and safe installation. If it doesn't fit, you know you have a problem. If the gaps between each panel are even slightly too large, then the last panel won't fit." However, says De Jager, "It never happens."

Bezuidenhout confirms this, lauding the precision of the process and noting that the final panel fitted perfectly.

"Over the years, we've been through the school of hard knocks," says De Jager. "Through experience we have been able to refine our systems and quality control to the extent that we predict problems before they occur. For instance, the 3D prints didn't work well on a



The view from Mathysenloop is hilly and scenic, with numerous reservoirs visible on surrounding hills. This project is but one of a series of 10Mℓ reservoirs being constructed in the area.

previous project, so we changed the design to position them differently — and now it works perfectly.

"We do the same thing over and over, so our intellectual capital is constantly developing through repetition, enabling us to learn and invest in our technology." The company also does stadiums, bridge beams, and parapets, in addition to structures, namely retail, industrial, and commercial buildings, and bespoke projects.

Where the possibility exists for things to go wrong, says De Jager, is in the accuracy of the factory casting. "Ten panels are manufactured at a time. Each panel has its own drawing and its own quality process and quality documentation recording pre-inspections, post-inspections, and concrete strength (70–80Mpa). The way we achieve these accuracies is by having control of the whole process, and it was for this reason that we opened our own engineering shop, which enabled us to manufacture and cast-in components that we intended while designing the shutters ourselves. Without that total control of the process, something somewhere would likely be missed and then the total installation would not work. It is this total control that speeds up the process."

While the walls were still being installed, the centrepiece of the roof was constructed and the first panels for the perimeter of the roof delivered. These have a 10.8m span and are 250mm thick. The panels are installed without the use of props — except the first — which would encumber the space other workers need. When the first panel of the wall is set with external props, each subsequent panel is set against the previous one. "An important aspect of the design is an understanding of how the different trades all work, so our process does not obstruct any of them," says Meyer van Rooyen, Corestruc's project manager.

A concrete pump on site is required to be highly variable, as the nature of the project means that small quantities of concrete are often required (as little as 5m^3/hour), increasing sometimes to 30m^3/hour.

Willie de Jager, managing director of Corestruc (left), with Rudi Bezuidenhout of Mbako Projects & Trading.

One particular problem of the site, which slowed the project, was the shortage of aggregate, says Kunaka, as there were no suitable quarries or borrow pits in the area. "We initially had access to suitable material from a local borrow pit near Kwaggafontein, but the quality subsequently deteriorated during construction. We had already finished with the earthworks, and because conditions were wet, we initially could not identify changes in the material. But once we finished with compactions and it was dry, the concrete started to crack and that is when we realised the material was unsuitable. We had to rip out the whole floor platform and bring in new material. We required G6, but the borrow pit had downgraded to G7 and G8. In particular, the clay content was too high. We ended up using commercial material after testing all the borrow pits around here but couldn't get the proper material."

The 'mother' ship

The view from Mathysenloop is hilly and scenic, with numerous reservoirs visible on surrounding hills — some part of the broader programme, though not of this particular project, the reservoir at the centre of which is the 'mother' that feeds them by pumps. Currently, many of the existing reservoirs are fed by borehole water, which is insufficient.

Bezuidenhout explains some of the surrounding work: "A 13km pipeline stretches from Bundu to Boekenhouthoek and on to Mathysenloop, where there is a chamber which has an outlet pipe into the reservoir for storage."

The trench for the long pipeline is dug by excavator down to the rock foundation, at which level drilling and blasting is used to get the level down a further 1.5m to 1.8m. "It must be placed at a certain depth because the pressure on this pipe is enormous," says Bezuidenhout.

He explains that the major challenge of the project is the rural nature of the location, which is typical and expected — and there is none of the politically motivated stoppages that affect so many other projects in South Africa. Bezuidenhout explains that local communities have been well involved in the work and supportive, with 30% of the contract work having been allocated to community contractors. "They bid for the work and we selected the best ones. They were involved with digging the trenches, the drilling, and the blasting and they were good." ■■