Contractor

NEW ZEALAND'S CIVIL CONTRACTING INDUSTRY MAGAZINE

CIVIL • GENERAL • ROADING • QUARRYING • TRAINING • CRANES • HEAVY HAULAGE • RURAL • CONCRETE

Vol 31 No 3 APRIL 2007 $6.95

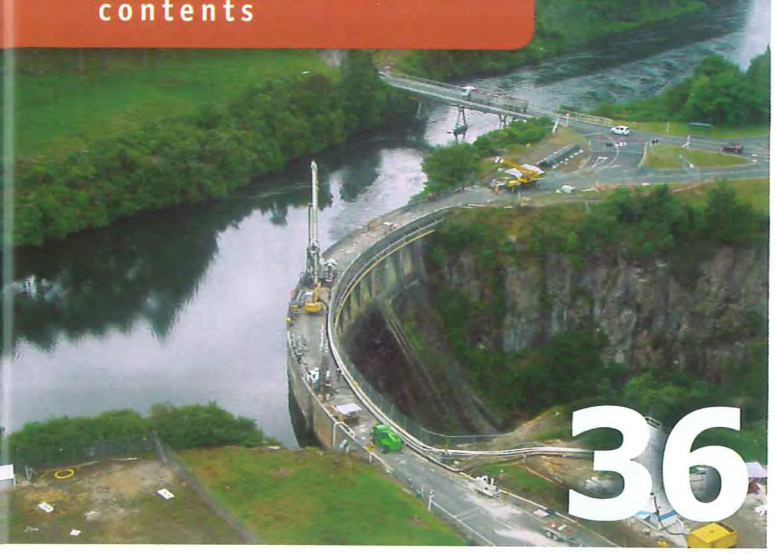
Fully loaded

The Doosan DL400

9 770110 138009 >

AND INSIDE:

Super circuit: Hampton Downs' new racetrack shapes up • Arapuni dam repairs a world first • Book excerpt: The wonderful Bulldozer • The 'can do' attitude of Fibretek • Tackling the skilled labour shortage



Contractor

Vol 31 No 3 April 2007

Highlights

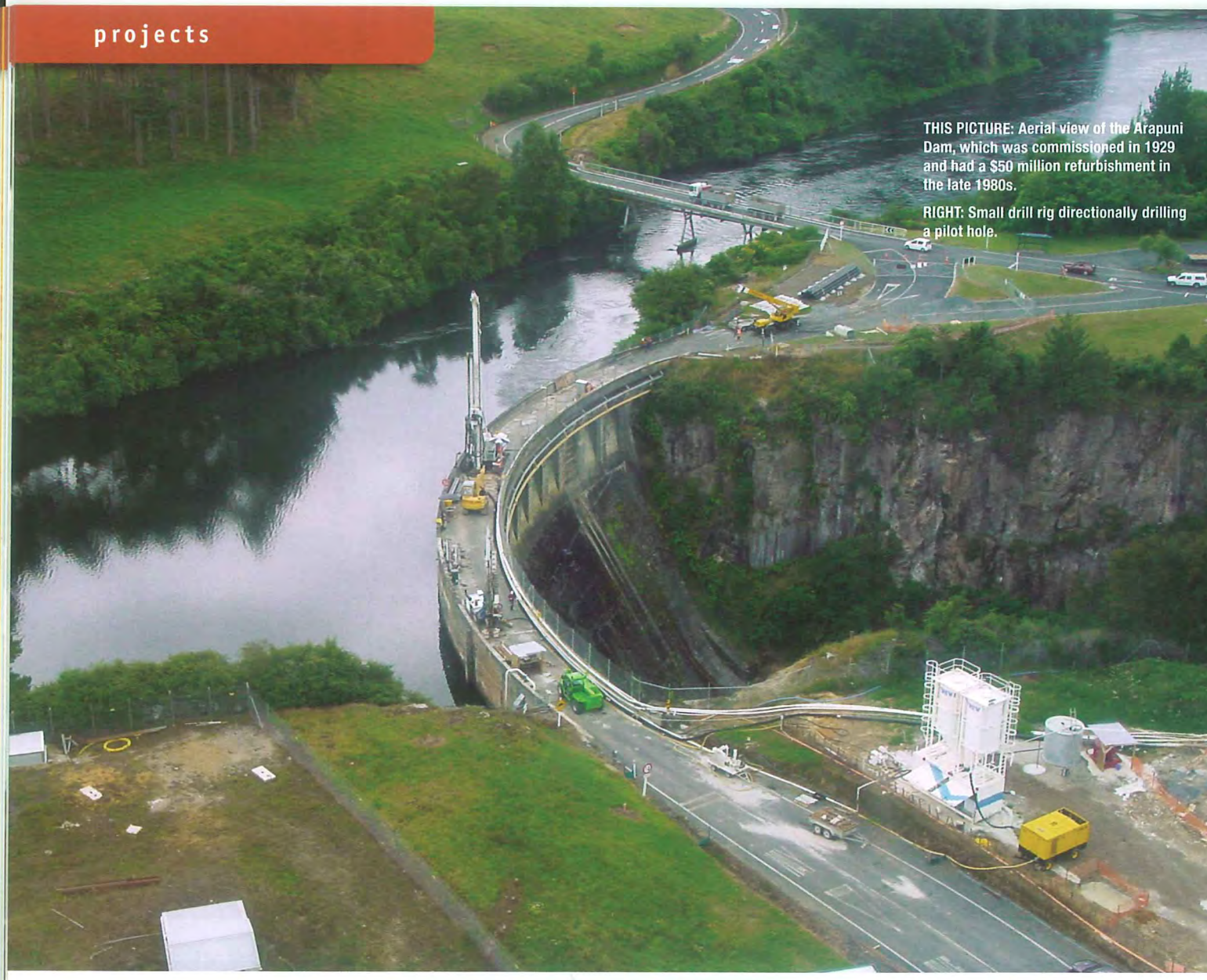
Departments

On the cover...

From its quarry in Linton, Infracon Aggregates supplies rock to the lower North Island. Doing its part by loading rocks onto the trucks is a brand new Doosan DL400 wheel loader.

The loader features a Cummins QSL 9 engine, which offers good fuel efficiency, meaning lower operating costs for the quarry.

See story on page 46.



THIS PICTURE: Aerial view of the Arapuni Dam, which was commissioned in 1929 and had a $50 million refurbishment in the late 1980s.

RIGHT: Small drill rig directionally drilling a pilot hole.

Arapuni task a world first

An international alliance undertakes dam-engineering work that is "pushing the envelope of existing technologies". BY GAVIN RILEY

The quiet Waikato countryside, 16 kilometres from Putaruru off State Highway 1, seems an unlikely spot to find dam engineering work taking place on a scale not attempted before anywhere in the world.

But since September 2005, an alliance consisting of Mighty River Power (the client), Italian foundation-engineering specialist Trevi and Brian Perry Civil has been conducting a unique precision-drilling programme designed to cut off fissures in rock beneath the Arapuni Dam.

When the dam was being built in 1927 (see story on facing page), engineers discovered seepage of water. Treatment was carried out from time to time, though the seepage did not pose a safety risk.

However, in 2000, subsoil monitoring showed a change in pattern and, as a result, a drilling rig was airlifted into the area, exploratory holes were drilled inside the dam galleries and interim grouting work was carried out.

Mighty River Power and design consultant Damwatch Services decided to minimise the risk of future seepage by the construction of cut-off walls across the fissures. The collaborative-option selection process with the contracting team determined that drilling a series of precise holes in the dam and underlying rock, then filling the fissures with concrete, would safely meet project objectives.

The dam would continue to produce electricity and operate normally while the programme was underway. This decision affected the number of potential construction options, and controls some of the construction practices. To manage the safety of the dam, about 60 pressure transducers and flow monitors are in place to give early warning of any changes in the foundation.

Trevi, a world leader in foundation engineering, was the selected contractor and an alliance was judged to be the best contracting method. Through its famous manufacturing subsidiary, Soilmec, Trevi has access to cutting-edge foundation-drilling machinery.

Trevi had worked with Fletcher Construction more than 20 years ago in carrying out rock drilling and installing drains as part of slope-stability work on the Clyde Dam. Through this historical connection, Trevi chose Fletcher subsidiary Brian Perry Civil to work alongside it on the $20 million Arapuni Dam project. >>>

The dam that's often in the news

Commissioned in 1929 by the government, the Arapuni Dam was the first high dam built on the Waikato River and pioneered the development of the region's hydro-electric power programme carried out over the next 37 years.

Of the seven stations built on the Waikato River during that period, only Maraetai exceeds Arapuni in capacity.

Built by the British firm of Armstrong Whitworth across the Arapuni Gorge, the dam stands 64 metres high from its foundations to the roadway running along its crest, and raises the water 42.7 metres above its old level.

The water flows about 1.2 kilometres in an open headrace, then through penstocks to the powerhouse at the base of the gorge. The powerhouse is a reinforced concrete structure 136 metres long, 22.8 metres wide and 22 metres from tailrace water level to roof.

Eight steel-lined penstocks each 3.6 metres in diameter feed the water from the forebay to the turbines. The eight vertical Francis-type turbines have a total capacity of 164MW. From the main busbars at the outdoor station, power at 110kV is supplied to the North Island system.

The Arapuni Dam is no stranger to being in the news.

Armstrong Whitworth began construction in 1924, the diversion tunnel was completed in 1926, and the site was dewatered soon after. Good progress was made with the head works, but at the powerhouse site there was disagreement between the contractor and the Public Works Department over the suitability of the foundations.

This impasse was broken by the department taking over the works in late 1927.

The works progressed in the face of extensive difficulties, not the least of which was severe flooding. However, the first 15MW unit was put into service in mid-1929 and a year later three generators were in service with work well advanced towards the fourth.

Then a crack developed between the end of the spillway and the adjoining structure. There was a small but definite movement of the entire land above the powerhouse – a movement which partly reverted when the spillway water level was drawn down to empty the headrace. The station was then shut down and not put back into service till 1932.

Two Swedish experts and two leading New Zealand geologists were engaged and recommended various remedial measures, which were carried out, including an impervious lining to the headrace.

A powerhouse extension, doubling its original size, was built from 1934 to 1937 and two more machines installed in 1938. The final two machines were commissioned in 1946, bringing the station's total capacity to 162MW, at that time by far the largest in New Zealand.

In the late 1980s the headrace lining showed signs of deterioration and had to be replaced. As this involved a complete station shutdown, it provided an opportunity to refurbish the whole operation.

This $50 million refurbishment, undertaken by Fletcher Construction, was carried out in two stages.

Stage one (featured over three pages in the June 1989 issue of *Contractor*) involved the construction of a diversion channel incorporating four radial control gates to enable the full Waikato flow to be diverted away from the Arapuni headrace and intake structure.

Stage two involved the replacement of the headrace lining, channel widening, and the raising of the existing intake platform and spill weir. The tailrace was deepened and a radial gate installed to control the tailrace water level. The new structure resulted in increased flood storage capacity of the Arapuni Lake, helping flood control of the Waikato River.

At the same time the powerhouse was refurbished, a new control room was built, and new plant and equipment was installed.

With the foundation engineering work currently taking place, the Arapuni Dam should be good for many more years of power generation.


CE410

Mighty River Power project manager Tom Newson says the two contractors consulted his company's independent advisers, including a grouting specialist in Pennsylvania and a project peer reviewer in Denver, and decided the best way to carry out the work would be small-diameter overlapping piles, using reverse-circulation drilling.

"The only other reference we could find anywhere of an overlapping pile wall through an operational dam was in Brazil," Newson says.

"That was using a similar technique for 120mm-diameter piles, whereas we're doing it with 400mm diameter. I think they went to a maximum depth of about 30 metres in the dam, and we're working through the dam foundation, down to 90 metres.

"In reverse-circulation drilling, all the cuttings are sucked out of the hole, as opposed to direct drilling where the cuttings are washed out."

With the reverse-circulation method agreed upon, Trevi went back to Soilmec's workshops in Italy and adapted guides and drilling equipment to meet the Arapuni challenge. After trials carried out in a quarry proved successful, the machinery was shipped to New Zealand.

Contractors arrived on site in July-August 2005 and drilling of the 136 holes got underway in September. Originally it was thought the work might be completed in a year, but the challenges and difficulties of such a leading-edge project have pushed the completion date back to later this year, despite the Trevi-Brian Perry crews working round the clock (two 12-hour shifts) six days a week.

"We're really pushing the envelope of existing technologies in terms of the size of the drill hole, the depth, and the accuracy we require," Newson says. >>>

LEFT: Various Trevi and Brian Perry Civil machines at work on the dam crest.

ABOVE: Trevi's 30 tonne Soilmec drill rig used for the main drilling

IMAGES COURTESY OF MIGHTY RIVER POWER

LEFT: Pouring slot for concrete using a tremie pipe.

ABOVE: A line of pre-drilled holes five metres deep.

"These holes have to pass down through the dam, avoiding internal elements and at a certain distance from the face, so that we're not inducing unacceptable stresses in the upstream face of the dam.

"We're drilling through concrete which is reasonably hard aggregate, up to 60MPa, then going through into a soft foundation material. We're having to tune the drilling operation to achieve the ultimate production rate."

Trevi project manager Marco Lucchi agrees that the alliance is pushing the boundaries in drilling overlapping holes to such a depth. But he says Trevi is always looking for difficult projects round the world – and indeed that was one reason Mighty River Power invited it to tender for the work.

"We have a lot of competitors around the world, and easy jobs or traditional work will be taken by local contractors," says Lucchi, whose overseas assignments with Trevi have included projects in Mozambique, Nigeria, Ethiopia, Singapore, Hong Kong and Malaysia.

"We are much more competitive in challenging projects. We have the experience, expertise, people and equipment.

"When the client called tenders for this remedial work, they knew it was going to be difficult so they invited only a few companies.

"It was quite a tough interview for the project, it lasted a couple of days. They came to the conclusion that Trevi had the most experience in this field."

Lucchi says the Arapuni work has proved to be even more challenging than he anticipated.

"The main reason is because the work requires a particular technique. It has not been common on other projects. It is also more challenging because we are drilling to depths of 90 metres and the hole has to be very technically precise.

"Also, the concrete of the dam is very strong and we need more time in drilling this part of the hole than was anticipated."

To cope with the demands being made on it, Lucchi says the Soilmec drilling rig had modifications to its hydraulic components, rotary head and drilling tools, which were necessary for the reverse-circulation drilling system.

Trevi has seven staff working at Arapuni and Brian Perry up to 10, including project engineer Gus Pembroke. Client Mighty River Power contributes a site engineer and the Damwatch safety team.

Although Mighty River Power had completed intensive investigations, as with all foundation jobs there are still unknowns to be encountered and dealt with during construction.

"It's unique, one out of the box. No one's ever worked on anything like this before," says Gus Pembroke, who worked in Britain before joining Brian Perry two-and-a-half years ago.

"It's been very much a learning curve from day one. The drilling itself has been a lot slower than we thought.

"It's been a big challenge right from the start. Just when you think you're on top of things, something else will pop up and you have another problem to solve."

Pembroke says the Trevi-Brian Perry team drills between six and eight overlapping holes at a time, depending on where they are on the dam. Concrete is poured through a tremie pipe, then another six to eight holes are drilled and concrete poured.

Each hole requires about 10 cubic metres of concrete, making a total of nearly 1400 cubic metres (all supplied by Holcim) by the time the job is finished.

Damwatch and Mighty River Power's Tom Newson are in agreement that there is currently no pressing concern over leakage at the dam.

"The project is about removing the potential for leakage," emphasises Newson.

He adds: "We've got infill present. If we didn't have infill it would be a nice simple grout job. We'd just drill down into the area of these defects, pump the grout in and go home."

As it is, quietly and unspectacularly, the alliance has had to carry out work that has no known equal anywhere on Earth.

While that sounds dramatic, according to Marco Lucchi it remains to be seen whether the new techniques successfully developed and used at Arapuni can be translated to benefit other projects overseas.

Arapuni is Lucchi's first experience of an alliance project and he says the arrangement has been a success.

"We don't have any issues between us. I think the staff of Trevi and the staff of Brian Perry Civil match very well. We have found a good way to work together and we have a good relationship on site. Everybody respects each other.

"It [an alliance] has to be used on a particular type of contract. I think the client was very careful in choosing the people, and this contractual approach to the project looks very successful now."

Tom Newson is also convinced an alliance was the correct choice. "For this project it was the only way to work," he says.