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MULTI-PURPOSE CEMENT FOR UNIQUE CONDITIONS ON HYDROPOWER PROJECTS

With an increasing emphasis on finding alternative energy sources, NuPlanet looked at the possibility of utilising the current water release from the Lesotho Highlands Water Project to generate electricity (hydropower). During a feasibility study in 2002, two sites were identified near Bethlehem.

The first scheme is located on the Merino Farm, along the Ash River and the second scheme is adjacent to the existing Sol Plaatjie Dam.

Under the ownership and operation of developer company, Bethlehem Hydro, the 3 MW Sol Plaatjie and 4 MW Merino hydropower plants will produce approximately 40 GWh of electricity yearly for the Dihlabeng Local Municipality. The carbon credits resulting from this clean energy development will be sold to a European buyer. Anton-Louis Olivier, managing director of NuPlanet, says the company has also secured the rights to a 10 MW hydropower scheme in the same river system and is currently busy with the feasibility study.

Initial financing for the feasibility study of the scheme currently under construction was granted by the Dutch government while the implementation

thereof was debt financed by the Development Bank of South Africa (DBSA) and through private equity.

"We appointed Aurecon Group (previously Ninham Shand) because they have the most experience in terms of hydropower within the South African market," Olivier says. "After completing feasibility studies the next stage was to secure all the necessary statutory licences. This, in itself, was a difficult challenge as the last private hydropower station to be connected to the national grid was constructed in the mid 1980's.

"The next challenge was to find a buyer for the electricity generated in order to make the project financially viable, power purchase agreements had to be drafted from scratch to comply with the current legislation as no precendence existed."

Bertrand Collet, senior engineer at Aurecon, says the power plants are mirror images of one another. Both power houses are approximately 16 metres high, 22 metres long and 8 metres wide. Each power station comprises a generator floor, the switchgear room, control room and external transformer yard.

On the Sol Plaatje Dam power plant, up to 29 m^3/s of water is being diverted through the power station instead of the continuous spill from the dam. At Merino, a small diversion weir was built across the river to a 650 metre long canal. The canal ends in a forebay dropping to the power station intake thus

maximising the 16 metre head available at this site while minimising water losses.

The project was a technically challenging one which required engineering expertise and design flexibility to ensure successful completion.

Eigenbau (Pty) Ltd, the main contractor on site, has vast experience in the construction of water treatment plants, bridges and general civil engineering construction, and was therefore able to address the challenges faced on this project.

Ed Ross, managing director of Eigenbau, says that the major challenge faced by the company was the sheer depth of the excavations required. "The excavations were up to 23 metres deep, which included digging 8 to 10 metres below the level of the flanking river. This required constant pumping due to the natural ground water and thus naturally increases both the risk as well as the cost on a contract of this nature.

"We decided early on that we would have to use hydraulic hammers to break the rock in the excavation. If we had used blasting it would have opened up fissures to the river resulting in a much larger flow of water into the works. Naturally, we had to factor in extra contract time because of this decision," Ross says.

"When excavations started at the Merino site we discovered that the sandstone and mudstone were interlayered. This meant that the exposed areas of mudstone in the excavated area had to be protected to avoid early decomposition. This was achieved by using AfriSam high strength cement (HSC) in a concrete mix, together with reinforcement and anchors, to clad the mudstone. There are two mudstone layers at Merino approximately 2 metres thick over the entire power station and forebay area. This required some 200 m^3 of concrete," Collet says.

The original site for the Merino power station had to be abandoned because the founding material was not suitable, and would have increased the cost of the project. "The subsequent redesign of the power station and realignment of the canal necessitated deeper excavations in solid rock," Ross adds.

Ross says that the company has also taken on the installation of the mechanical equipment. "While this was not originally in our scope of work we have the necessary experience in our mechanical engineering division. The turbines and generators were sourced directly from Boving Fouress of Bangalore, India."

The Merino plant also required the construction of a coffer dam to divert the river to facilitate construction. "The river was diverted through the completed intake works and through a section of the canal to allow for the construction

of the weir on the riverbed. Thereafter the canal was closed using the bulkhead gates and the water was returned back to the river," Ross explains.

"The canal had to be realigned when it was decided to relocate the power station," Collet says. "It became apparent, when excavations began, that suitable founding conditions were much deeper than expected. As a result the design was changed to extend the canal and move the power station which was then positioned in the existing rock abutment," Collet says.

"During the feasibility study for Sol Plaatjie power station we investigated the possibility of drilling a hole into the existing concrete wall. This would have required the construction of a sophisticated steel coffer structure to allow for dry drilling. The power station was then located on the left bank," Collet says. "We determined that siting the power station on the right hand bank was more advantageous from the point of view of both space and access, which would mean easier and safer construction. And would eliminate the need to "drill" a hole in the existing dam wall."

The Merino and Sol Plaatjie power plants are situated some 30 km apart and it was necessary for each site to have its own concrete batch plant since the amounts to be poured would have been too expensive if supplied as Readymix. "We chose AfriSam's high strength cement (HSC) as general purpose cement is not available in bulk, which we deemed as a contract

consideration based on the volumes required. In addition, AfriSam was able to guarantee supply capability," Ross adds.

AfriSam sales consultant, Gijon van Wyk, says that the company supplied approximately 85 truck loads of cement to site with a total mass of 2 835 tons from its Ulco factory in the Northern Cape, via its Bloemfontein depot. "The client conducted tests on the product to ascertain its suitability for the variable temperatures encountered on site and the cement passed these tests with flying colours.

"A blended cement extended with limestone, HSC has a strength of 42.5 N," van Wyk says. "The typical high early-strength of AfriSam HSC offers outstanding benefits in terms of time saving and meeting production deadlines, especially in fast track construction and concreting in cold weather."

The extremely fine particles of the mineral components act as nuclei for the formation of calcium silica hydrate, giving a fine-filler effect to produce a denser, more homogenous microstructure in the hardened cement paste and in the aggregate paste interfacial zones.

"We poured 3 500 m^3 at Merino and 2 200 m^3 at Sol Plaatjie," Ross says. "On both sites the climatic conditions played a huge role in the mixing and casting of the concrete.

"In Bethlehem early morning winter temperatures are between -8°C and 5°C, rising to about 16°C during the day. This meant that concrete could only be cast at certain times of the day and we needed to provide for contraction and expansion joints in construction due to temperature differentials. In addition the temperature of the water was so low and often frozen that we could only start batching after 09:00 in the morning," Ross says.

While power was available at the Sol Plaatjie site, generators had to be used for batching at the Merino site, which obviously added to the contract costs.

"In spite of the large number of challenges and obstacles the team faced, the positive attitude and high levels of professionalism exhibited by all contractors and suppliers, has resulted in the satisfactory completion of the project," Collet concludes.

PROJECT TEAM

NuPlanet – developer and project manager

Ninham Shand (now known as Aurecon) – consulting engineers

BWG Hydro – mechanical engineers

Merz & McClellan – electrical engineers

Eigenbau – civil contractor

Boving Fouress – mechanical and electrical contractors

CAPTION FOR HYDRO 01: The Sol Plaatje power station during construction.

CAPTION FOR HYDRO 02: Inlet to the Merino power station.

CAPTION FOR HYDRO 03: The Sol Plaatje power station.

CAPTION FOR HYDRO 04: The access stairway to the machine floor at Sol Plaatje.

CAPTION FOR HYDRO 05: The nearly completed Sol Plaatje power station viewed from downstream.

CAPTION FOR HYDRO 06: Diversion weir at the Merino site.

CAPTION FOR HYDRO 07: Excavation of the tailrace completed at Sol Plaatje.

CAPTION FOR HYDRO 08: A view of the forebay at the Merino site.

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