KING

Mixing Strength With Satisfaction

McCORMICK DAM & POWER STATION, BAIE-COMEAU, QC

MS-D1 SY

PROJECT:	McCormick Dam & Power Station, Baie-Comeau, QC
CONSULTANT:	Groupe-conseil TDA
SPECIFIER/CONTRACTOR:	BBMarine, Béton projeté MAH Inc.
PRODUCT:	MS-D1 SY
QUANTITY:	350,000 KG (771,618 lb)
COMPLETION:	Fall 2014

The McCormick Dam and Power Station was built in 1952, on the Manicouagan River, by the Quebec and Ontario Paper Company, along with the British Alumni Company. It was named after Colonel Robert R. McCormick, who owned and published the Chicago Tribune. It is currently owned and operated by the Société en Commandite Hydroélectrique Manicouagan. The dam is situated approximately 3 km (1.9 mi) West of Baie-Comeau, Quebec, Canada, in the Côte-Nord area of the province of Quebec.

Groupe-conseil TDA, a well established and leading consulting firm from the Côte-Nord area, was hired to inspect the dam, the retaining walls of the reservoir and the water discharge (tailrace). The consultant was required to determine the condition of the concrete after 60 years of exposure to heavy water-flow and freeze-thaw cycling, and also needed to formulate a plan to rehabilitate the structure. The project was released for tender in early 2013 and was awarded to BBMarine. BBMarine is a specialized marine contractor from the Côte-Nord with over 35 years experience in the construction, inspection, repair and maintenance of marine structures.

The results of Groupe-conseil TDA's inspection confirmed abundant surface-scaling at and below the waterline, along the entire length of the reservoir (basin) retaining walls and the tailrace (spillway). The average depth of the repairs was approximately 5 cm (2"). Damage to the reservoir (basin) retaining walls equated to a surface area of approximately 1,000 m^2 (10,763 ft^2) while the tailrace (spillway) required approximately 600 m^2 (6,458 ft^2) of repair.

The location of the repairs created many logistical and procedural challenges. To overcome those challenges, Groupe-conseil TDA specified that the damaged concrete be removed and replaced using pressure grouting techniques, through which non-shrink grout would be pumped from surface into the forms. Divers would be required to direct the pressure grouting process and to ensure that the water-tight forms retained all of the grout. The thought of forming a total area of 1,600 m^2 (17,221 ft^2), much of it underwater (using divers), concerned the construction team because of cost implications and the effect that this scope would have on the entire construction schedule.

The logistical challenges continued after BBMarine mobilized on-site. The majority of the areas to be repaired provided limited access or room for equipment, materials and formwork. Access to the repair locations was therefore limited to barges. BBMarine initiated discussions with Groupe-conseil TDA, Béton projeté MAH Inc., and King Shotcrete Solutions, to investigate alternative solutions for completing the concrete repairs. The group reached the consensus that if concrete replacement was executed using the shotcrete process, it would allow for easier access to the repair areas and it would contribute to an accelerated construction schedule. More importantly, all parties agreed that replacing non-shrink grout with concrete (as a repair material), would result in more durable and longer lasting repairs, especially considering the extreme freeze-thaw environment.

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For a number of reasons, Béton projeté MAH Inc. elected to use the dry-mix process over wet-mix shotcrete. The dry-mix process allowed the company the ability to start and stop without having to clean out hoses. The challenges associated with the placement of shotcrete on the water (primarily lighter-weight hoses and longer conveying distances) were also better addressed using the dry-mix process. Easier access to the shotcrete material, through the use of 1,000 KG (2,205 lb) bulk tote bags, was another key benefit of the dry process. And in addition to the logistical benefits, such as easier material handling, pre-packaged materials provided much improved consistency which resulted in higher levels of quality control.

Materials Engineers from King Shotcrete Solutions, the material supplier, designed a mix that would provide reduced shrinkage and long-term durability. The silica fume contained in the mix provided a denser matrix and improved cohesion during placement. The use of a powder air-entraining admixtures provided an optimal spacing factor and air-void system to improve durability. The use of micro-synthetic fibers helped to reduce the potential for shrinkage-cracking, which also added to the long-term durability of the repairs. Béton Projeté MAH Inc. was awarded the subcontract to complete the shotcrete placement and finishing. This company has over 120 years of combined shotcrete experience in all aspects of shotcrete placement (repair, new construction, and artistic work). BBMarine retained the responsibility for all other logistics, concrete removal and surface preparation.

In order for the shotcrete process to work, BBMarine worked closely with the shotcrete sub-contractor to develop a procedure for surface preparation, shotcrete placement and finishing. The key challenge was access to the repair areas that were located below the waterline. BBMarine relied on their extensive experience working in marine environments to design a special, mobile cofferdam system that would allow them to move the unit along the 1 km (0.6 mi) reservoir (basin wall). All surface areas to receive shotcrete were prepared using the hydro-demolition method. A special hydro rig was set-up on a floatable barge, which allowed the crew to complete the concrete removal using a 138 MPa (20,000 psi) water blast. The barge that hosted the hydro-demolition rig was set-up ahead of the shotcrete barge and moved along the reservoir basin wall so that the repair area was prepared before the arrival of the shotcrete barge.

Both mobile cofferdam systems were set-up to allow a work area of approximately 5.2 m (17 ft) long by 1.2 m (4 ft) high by 1.2 m (4 ft) deep, and were temporarily anchored to the concrete wall of the reservoir basin. The area of contact between the mobile cofferdam and the surface of the concrete was sealed to prevent water from re-entering the cofferdam. Gas-powered dewatering pumps were then used to remove the water from inside the cofferdam system, and to allow access for the removal crew and the shotcrete crew. The shotcrete crew was provided with a wooden

platform system, set-up behind the cofferdam, which allowed the shotcrete nozzleman to maintain the proper distance 0.9 m (3 ft) to 1.5 m (5 ft) from the end of the nozzle to the receiving surface. Once placement and finishing was complete, the portable cofferdam would be moved to the next section while skipping the section directly beside, in order to be anchored into existing concrete and not the fresh shotcrete.

The flexibility of dry-mix shotcrete process allowed Béton projeté MAH Inc. to set-up the machine on solid ground in areas that gave them access to a forklift, and enough room to maneuver the 1,000 KG (2,205 lb) bulk bags. On average, they required approximately 76 m (250 ft) to 91.5 m (300 ft) of hose to access the work area. With most repair areas submerged, the receiving area was always saturated, which helped to ensure a strong and durable bond between the parent concrete and the repair material. Approximately 350 bulk bags of 1,000 KG (2205 lb) were used on the project. Once the shotcrete reached its initial set, the dewatering pumps were shut-off in order to re-submerge the repair and maintain ideal curing conditions.