Completed Intake Structure on Pingston Creek

PINGSTON HYDRO PROJECT UPDATE

The Pingston Hydroelectric Project, located approximately 60 km south of Revelstoke, B.C. recently achieved a significant milestone, with the completion, successful commissioning and subsequent operation of the project.

The underground conveyance system consists of a 2170 m upper tunnel connected to a 1450 m lower tunnel by a 445 m 70° inclined shaft. The 2.4 m by 2.7 m tunnels were excavated by drill and blast and the 2.1 m diameter shaft was raise-bored. The project, owned jointly by Canadian Hydro Developers and Brascan Power, was started in April 2001 and completed in March 2003. Design and project management was carried out by Canadian Projects Limited (CPL); Golder Associates provided tunnel design and construction inspection services and materials QA/QC services; EBA Engineering provided design and inspection services for the Diversion weir and Amec Earth & Environmental provided tunnel design services under a contract with Thyssen Mining and Construction Canada Ltd (TMCC). Graham Rawlings Consulting provided Owner's review services while a Technical Review Panel was established, comprising Ray Benson and Andrew Hara. Further information on project design and layout and a summary of the principal participants in the project was provided in the September 2001 TAC Newsletter.

Tunnel excavation was completed in May 2002, with the raise boring completion in June of that year. To expedite the excavation phase, initial ground support consisted primarily of safety support. Permanent support was installed upon completion of tunnel excavation. Applied shotcrete thickness and bond was assessed, with thickening where required. Fibre reinforced shotcrete was used in dry sections and where there were significant water inflows, drainage measures were installed and 'flash' set plain shotcrete was used with welded wire mesh as reinforcement. Final shotcrete thickness was 50 to 150 mm, depending on ground conditions. Two concrete liners were installed in the upper tunnel in areas of wide, clay infilled, shallow shears and a zone where the rock mass had been completely altered to clay. The 30 m long liners were poured utilizing 8 ft diameter liner plate culverts and plywood and beam braced bulkheads.

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Approximately 67% of the tunnel length required only spot or pattern rock bolting for permanent support with the remainder either shotcreted or concrete lined.

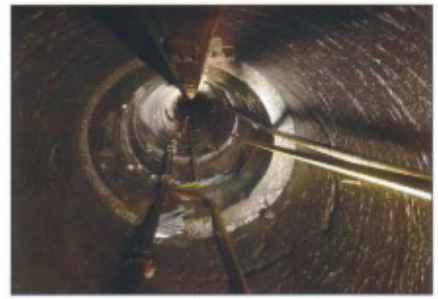
Several areas of poor ground were identified during a remote camera survey of the raisebore, confirming the need for ground support. An alimak was used to gain access within the raise, and along with several less significant areas, a 30 m long concrete liner was installed in an area of particularly poor conditions with high water inflow and extensive overbreak. The minimum 150 mm thick liner was constructed using 2 m slip forms. Steel piping and drainage geotextile were used to control 300-400 L/min seepage inflows. Concrete was batched on site and sent to the lined areas using a 75 mm diameter steel slickline. A modest program of consolidation/ contact grouting was carried out behind the liner. Shaft lining was carried out by JS Redpath of Sudbury.

A 24 m long high pressure penstock plug (480 m of head) was installed approximately 1200 m into the lower tunnel. The plug was the upstream terminus of the 5 ft diameter steel penstock that continued from the plug through the tunnel and down slope to the powerhouse on the west shore of the Upper Arrow Lake. The plug was constructed in four 6 m sections using Self Compacting Concrete which proved to be highly suitable as a method to ease concrete placement and reduce heat of hydration. As a result of the low temperature rise, there was little delay in implementing the high pressure consolidation grouting of the plug.

A tunnel plug was also constructed near the east portal of the upper tunnel. This bulkhead plug includes a hinged steel door for future maintenance access.

A key part of the project commissioning was the development of a detailed water-up procedure for the underground conveyance system. This procedure was designed by CPL with input from Golder and was closely monitored by both parties during filling to measure leakage and to confirm adequate functioning of the tunnel plugs and liners. The water-up plan was developed based on hydrogeological modeling predictions. The model was developed and calibrated using available in-situ testing data, tunnel inflow measurements and head testing conducted in the raisebore pilot hole during construction. During watering up, the rate of water level rise was carefully controlled and several tests were conducted on the system to measure the response against predictions. The system response was very similar to initial predictions, leading to a successful completion and commercial operation of the plant. A fault with a valve at the powerhouse necessitated system dewatering soon after initial filling. This allowed an inspection of the tunnel, confirming that no noticeable damage was sustained during watering up and dewatering.

Powerhouse Located on the West Shore of Upper Arrow Lake



30 m Raisebore Concrete Liner photographed from above before grouting and drainage hole drilling

The Pingston Hydro Project is currently in operation generating the full output of 30 MW since May 8, 2003.

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