Pedestrian Tunnel at Billy Bishop Toronto City Airport

By Matt Croutch

In early 2012, construction began on an underwater pedestrian tunnel that will link Billy Bishop Toronto City Airport to the mainland in Toronto, ON, Canada. The project will provide a predictable, efficient, and convenient access route for the airport's users. Tunnel construction will be complete by Winter 2014/2015 (Fig. 1).

The pedestrian tunnel will feature a modern, mechanized, underground walkway and will be powered by 100% green energy. To provide access to the pedestrian tunnel, a new pavilion will be constructed on the mainland, while an extension will be added to the airport terminal building on the island side.

Technicore Underground, a leading tunneling contractor, began excavation on the mainland and island shafts in May 2012. Once the shafts were dug, two purpose-built, Canadian-made tunnel-boring machines (TBMs), dubbed "Chip" and "Dale," were launched to bore the seven interlocking "tunnel drifts," forming what would become the unique arched-crown design of the main tunnel. The TBMs were designed and manufactured by Technicore Underground (Fig. 2). Three of the tunnel drifts were built to include new city of Toronto sanitary and water mains, which will help save Toronto taxpayers an estimated $10 million in duplicate construction efforts. Excavation of the tunnel was completed in October 2013, and shotcrete, waterproofing, and reinforcing steel layers were installed.

Fig. 1: In early 2012, construction began on an underwater pedestrian tunnel that will link Billy Bishop Toronto City Airport to the mainland

Original plans called for the use of wet-mix shotcrete, supplied from an on-site batch plant, to provide initial support during the tunneling process. A steel fiber-reinforced mixture with a specified fiber type and dosage was required in the original shotcrete specification. A number of factors led Technicore's project management team to investigate the use of dry-mix shotcrete. The ability to stop and restart the shotcrete process as required, without significant cleanup, was one of the key factors in choosing the dry process. Technicore turned to King Shotcrete Solutions to design a dry-process shotcrete mixture that met the hardened property requirements outlined in the specification.

King's Technical Services Team offered the option of both steel and macrosynthetic fiber-reinforced versions of its MS-D3 Accelerated Shotcrete. To meet the requirements of the specification, flexural toughness testing was mandated. Testing according to ASTM C1550, "Standard Test Method for Flexural Toughness of Fiber Reinforced Concrete (Using Centrally Loaded Round Panel)," was performed at Laval University, Québec, QC, Canada. Three panels were shot on site and after 24 hours were transported to the university, where they were tested for energy absorption at 7 days. The average corrected 7-day energy absorption value was 280 joules (0.27 BTUs).

After receiving the test results, Technicore submitted the macrosynthetic fiber-reinforced

Fig. 2: Two purpose-built, Canadian-made tunnel-boring machines, dubbed "Chip" and "Dale," were launched to bore the seven interlocking "tunnel drifts," forming the unique arched crown design of the main tunnel

mixture to the project engineers for approval and were soon given the authorization to proceed. Over 1200 tons (1010 tonnes) of King MS-D3 Accelerated Macro-Synthetic Fiber Reinforced Shotcrete were applied throughout the 550 ft (170 m) tunnel using an Aliva AL 252 dry-mix shotcrete machine (Fig. 3).

King provided a complete shotcrete solution, which included mixture design, equipment supply, material supply, and technical support. Representatives from King were on-site throughout the project to assist with all aspects of the shotcrete operation, from equipment operation to product placement.

The next phases of the tunnel project will include construction of the connecting terminal structures; installation of the moving walkways, escalators, and elevators; landscaping; as well as electrical, mechanical, and final finishing work.

When it opens, the pedestrian tunnel (Fig. 4) will have four moving sidewalks traveling at 1.4 mph (2.3 kph). From a bank of six elevators on the mainland side, travelers will go 100 ft (30 m) down to access the tunnel and travel along the passageway to the escalators, which will take travelers to the airport's check-in area. The complete journey will take fewer than 6 minutes and will dramatically improve passenger flow.

This is not the first attempt at building a tunnel to the Island Airport. In May 1935, Parliament approved $1 million to build the tunnel, with another $600,000 coming from the city of Toronto. On October 8, 1935, City Council voted to approve the plan and work began in earnest only days later.

A long ditch was hollowed out along what is now the Eireann Quay roadway, toward the seawall of the Western Channel, while another ditch was burrowed on the island side leading to the north seawall. Steel sheet piles were hammered into the ground to shore up the seawalls and enable excavation.

But work on the project ended as quickly as it had started when, shortly after construction began, the Federal Government issued an order to cease all work on the tunnel and fill in the holes and ditches.

As for the steel sheeting, it had no effect on the topography or surrounding environment, and was left in place. Fast-forward 77 years to the construction of the new pedestrian tunnel at Billy Bishop Toronto City Airport. Geotechnical plans and documents of public record indicated that there were tunnel remnants underground, but no one knew for sure what the pilings looked like.

Fig. 3: Over 1200 tons (1010 tonnes) of King MS-D3 Accelerated Macro-Synthetic Fiber Reinforced Shotcrete were applied throughout the 550 ft (170 m) tunnel using an Aliva AL 252 dry-mix shotcrete machine

In August 2012, shortly after construction began, history met modern day when certain steel pilings were found at the end of a tunneling drill bit. The drill bit needed to be replaced, but the pilings were soon removed and construction soon resumed.

The use of shotcrete continues to play a major role in many of Toronto's ongoing tunneling projects, including the continued expansion of The Toronto Transit Commission subway system, the upgrading of Toronto Hydro's tunnel network, and the progress of a number of significant water distribution projects.

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Fig. 4: Three-dimensional cross section of pedestrian walkway. Billy Bishop Toronto City Airport Pedestrian Tunnel Project