

Shotcrete: A Versatile Construction Solution

by Dr. Dudley R. "Rusty" Morgan

In the inaugural edition of *Shotcrete* in February 1999, I had the privilege of writing the first Shotcrete Corner for the magazine. In that article I listed a range of different shotcrete for underground support projects around the world that I had either worked on or been able to visit during 1998. These projects have now all long been completed and have provided a valuable contribution to the world's infrastructure.

They include:

- A hydroelectric project in the Himalayas in India with four very large underground desiltation chambers with steel fiber-reinforced shotcrete (SFRS) final lining;
- A water-supply tunnel in Hong Kong;
- A railroad tunnel in Alaska, which was being converted into a combined road and rail tunnel (with some demanding water and ice control requirements);
- Undersea tunnels at Tromso (70 degrees north latitude) in Norway, with state-of-the-art SFRS-based ice control systems;
- A new road tunnel connecting Sydney Airport to downtown Sydney, Australia, (being built in time for the 2000 Summer Olympics) with an SFRS final lining in conjunction with corrosion-protected rock and cable bolting; and
- An SFRS final tunnel lining, with a 70-year design life, for the Stave Falls hydroelectric project in British Columbia, Canada.

In the 10 years since that first Shotcrete Corner article, it has been interesting to see the wide range of different applications for shotcrete and see the growth of the industry. Projects I have worked on in the past decade include:

- Application of a special dry-bagged shotcrete in a decline in a mine at 13,120 ft (4000 m) elevation, under a glacier, in permafrost ground conditions in the Kyrgyz Republic in Asia;
- Underpinning of the Stanley Park Seawall in Vancouver, BC, Canada, using macrosynthetic fiber-reinforced, wash-out resistant, wet-mix shotcrete¹;

- Seismic retrofit of the undersea sunken box tube Massey Tunnel on Highway 99, Delta, BC, Canada; multiple layers of heavily reinforced dry-mix shotcrete were applied to the soffit of the fresh air plenums²;
- Shotcrete construction of the bobsleigh/luge track for the 2010 Winter Olympics in Whistler, BC, Canada³;
- Seismic retrofit of the oldest (six-story high) heritage masonry building in Chinatown, Vancouver, BC, Canada, using ready-mixed supplied wet-mix shotcrete;
- The first use in Calgary, AB, Canada, of structurally-reinforced wet-mix shotcrete for construction of the exterior walls for five floors of the underground parking structure at Jamieson Place. (Since the successful completion of this project, another half dozen similar projects have started up in Calgary using the same methodology);
- Lining of cut-off ditches around a tailings dam at the Pogo mine in Alaska, using macrosynthetic fiber-reinforced wet-mix shotcrete;
- Lining of the declines and drifts in the New Gold Inc. mine near Kamloops, BC, Canada, using robotically applied, macrosynthetic fiber-reinforced wet-mix shotcrete; and
- Wet-mix shotcrete lining of the 6.9 mile (11 km) long Wachusett Aqueduct in Eastern Massachusetts that was built between 1897 and 1903 to supply drinking water to the city of Boston.⁴

These are but a few of the shotcrete projects in which I have been involved over the past decade, but they demonstrate well the versatility of this construction medium. At World of Concrete in Las Vegas on February 2, 2009, American Shotcrete Association President Chris Zynda and I will be speaking on the topic "Shotcrete: A Versatile Construction Solution." This seminar will highlight some of the aforementioned projects, as well as others, to demonstrate the remarkable versatility of the shotcrete process.

Shotcrete Corner

References

1. Morgan, D.R.; Ezzet, M.; and Pfhof, C., "Rehabilitation of the Seawall at Stanley Park, Vancouver, BC, with Synthetic Fibre Reinforced Shotcrete," *Second International Conference on Engineering Developments in Shotcrete*, Cairns, Australia, 2004, pp. 201-208.
2. Morgan, D.R.; Kazakoff, K.; and Ibrahim, H., "Seismic Retrofit of Immersed Tube Tunnel with Reinforced Shotcrete," *Shotcrete for Underground Support X*, Proceedings of the Tenth International Conference on Shotcrete for Underground Support, Whistler, BC, Canada, 2006, pp. 270-284.
3. "2007 Outstanding Infrastructure Project: Whistler Sliding Centre," *Shotcrete*, V. 10, No. 3, Summer 2008, pp. 37-41.
4. Town, R., "Restoring the Century Old Wachusett Aqueduct," *Shotcrete*, V. 6, No. 3, Summer 2004, pp. 16-18.



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