



# Water Sport Complex: A Perfect Application for Shotcrete

by Marc Jolin & Alain Ferland

This project took place at a water sport complex near Quebec City, Village des Sports, Valcartier, Quebec, Canada. The owner already had a number of slides and two large swimming pools, but wanted to add an "Amazon River" ride to the park. A specialized shotcrete team was approached by the contractor to discuss the various possibilities available. The first

phase of the Amazon project was to shotcrete the 500 meter (1640 ft) canal having an average cross section of 6 meters wide by 1.4 meters deep (20 ft by 4½ ft), and a large artificial rockscape out of which three 7.5 meter (25 ft) high water falls would drop into the canal. Immediately following the first construction, the owner asked for three large, artificial rocks to be

shotcreted along the canal, one of which has an overhanging overhead portion of almost 3.5 meters (12 ft) in length.

A year later, the concept of the tropical river ride having proved its virtues, the owner contacted the same shotcrete contractor and offered them another attractive project. The course of the

river was to be lined with a number of trees and statues made of shotcrete, and a 6 meter (20 ft) tall "active" volcano! The only information the owner provided was the location of the construction, and four 100 mm (4 in) tall statues as well as a 400 mm (16 in) tall tree made of play-dough, to serve as models for the construction.

Starting at the bottom of the existing river canal, the construction of the four statues and the six trees required only three weeks of work by eight men. One acted as the nozzleman, and two men were dedicated to finishing and sculpting. The five other workers tied the reinforcing steel, removed rebound, and operated the shotcrete equipment.

## Construction

An important aspect which made this project challenging for the contractor was that the construction method was left to his discretion. Although wet-mix shotcrete had already been successfully used for construction of the canal and the largest



*Texturing makes it difficult to tell artificial rocks from the real thing.*



rockscape, the finer details and precision needed for the trees and sculptures made the nozzleman and finishers opt for the dry process in this case. To allow for the required texturing and fine detail finish of the surfaces, the mix design was a basic mortar made of concrete sand and normal Portland cement, with a sand to cement ratio of about 3:1 by volume. The shotcrete was conveyed using a double chamber gun with a 38 mm (1½ in) hose. This type of gun was selected since the feed wheel, which has a large number of small compartments, allows for low flow rate of material at the nozzle without surging.

The construction sequence for a given feature started by drilling holes in the bottom of the canal and grouting in vertical reinforcing bars to properly anchor the 1.3 m (4 ft) wide circular base of each statue. A complete steel cage of 10 mm (¾ in) diameter bars was then constructed to support each 5 meter (16 ft) tall statue. The lower section of the structures, approximately 1.5 meters (5 ft), was warped and cast with regular concrete in the middle to make sure no water infiltration problem inside the statues would occur once the canal was filled with water. The four steel cages were erected at the same time, because shooting would have to be done by applying successive vertical layers of shotcrete. In order to provide sufficient time for the finishers to carve the shotcrete after each application of a vertical layer, no accelerators were used.

The general surface of a statue required up to four passes of shotcrete, with some detailing, such as noses and ears, taking four to five subsequent small thickness applications. The making of these statues went relatively quickly, since the finishers could easily direct the nozzleman as to where to apply shotcrete. The entire surface of each statue was carved, with some details as deep as 125 mm (5 in).

The construction of the trees was somewhat more difficult. The slender shape of the trees and the tropical type appearance of the finish on the trunks made the carving very challenging. The trunks are 3.6 meters (14 ft) high with a base diameter of 1 meter (3 ft), and were shot directly on a galvanized steel pole which was previously covered with a wire mesh.

After a few days of curing, the sculpted faces and trees were painted with diluted latex paints. The results are highly satisfac-



*Final shape and texture of shotcrete trees*



*Statues in the river before the addition of water.*

tory. Some of the pictures presented were taken five years after the actual construction.

### **A proven team and process**

The success of this job is attributed to two important factors: the individual effort put in by every team member and the construction method adopted. Proper coordination of the work, as well as a good knowledge of the steps involved in a shotcrete application proved beneficial to the construction schedule.

Architectural applications such as these could not be done as economically without

shotcrete. The cost related to the industrial manufacturing of elements such as the trees and statues using casting processes would be prohibitive. The use of shotcrete for the construction of these elements as well as all the artificial rocks offered a fast and economical way to build an attractive environment in this water sport complex.

### **Conclusion**

It is important to mention that for this particular project, the owner of the water sport complex gave complete control of the means





*Sculpturing one of the statues*



*Final appearance of statue*

water sport complex in the Province of Quebec. Not only were a canal and artificial rockscapes built, but realistic large-scale statues and trees with fine details were also constructed using dry process shotcrete. The success of this project is attributed to the advantageous shotcrete placement method when used by a well-organized and motivated shotcrete team. ➡



**Mark Jolin**

*Marc Jolin and Alain Ferland first met three years ago when they offered their first shotcrete nozzleman training course together in Quebec city. Alain Ferland is a nozzleman with 18 years experience who is associated with Marc-Aurèle Boivin, Marc Ferland and Harold Ferland, in a company named "Béton*

*of construction to the contractor, requiring only a specific end product. As shown in the various pictures in this article, this led to a shotcrete project considered by everyone involved to be a great success.*

*The use of wet and dry-mix shotcrete allowed for impressive architectural applications in this*

*contractor based in Quebec, Canada. Marc Jolin is a Research Associate in the Department of Civil Engineering of Laval University in Quebec, Canada. Both authors can be reached through Marc Jolin at 418-656-3163 (phone), 418-656-3355 (fax) and mjolin@gci.ulaval.ca.*

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