

Shotcrete, an Artform—

The *Jardin Zoologique* Project Experience

by Patrick Giroux and Joe Hutter



Figure 1: Australian Bunya-Bunya tree (15 m [45 ft]).

An extension to the Quebec City Zoo in Quebec City, Canada, will incorporate over 100 acres of new landscaping that will house more than 500 animal species from five different continents. The *Jardin Zoologique* construction project will host a new zoological garden that will be used to exhibit a spectacular expansion of its bird collection as well as an accentuation and harmonization of its horticultural infrastructures.

The architects on the project (a European and Quebec collaboration) are specialists in the field of architectural shotcrete and were asked to investigate various available options for the design of the architectural exhibits of this important new zoo expansion. Atelier Artistique du Béton



Figure 2: Wet-mix shotcrete pump.



Figure 3: 12 mm (0.5 in.) low volume nozzle.

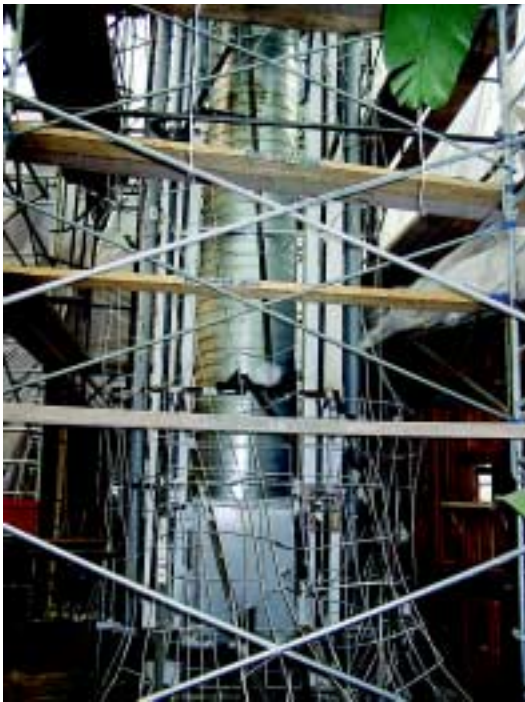


Figure 4: Bunya-Bunya tree erection—steel structure.



Figure 5: Bunya-Bunya tree—partially complete.

(AAB), a French company specializing in the use of shotcrete for this type of project, was approached to participate. They decided for logistical reasons to partner with a local company, Béton Projeté MAH. MAH had extensive experience with architectural shotcrete (both wet and dry process) in the Quebec market.

During the early stages of construction, both contractors approached King Packaged Materials Company to assist in the development of a wet-process shotcrete mix that would provide batch-to-batch consistency and meet stringent requirements for plastic and hardened properties. King was required to supply a product in which all admixtures and pozzolanic materials were inclusive, ensuring the contractor would only be required to add a predetermined amount of clean, potable water. The mix had to be very thixotropic in nature with excellent pumpability, stickiness, and a long working time to allow artists to carve and shape the exhibits.

Extended working time was one of the critical requirements due to the sequence in which the shotcrete material was to be placed and finished. The shotcrete crew was required to shoot the mix during the mornings; and for the artists to complete their work, they required a five-step finishing operation that would extend into the afternoon. The artists responsible for turning a mass of freshly placed shotcrete into a 13.5-m-tall (45 ft) tree (Fig. 1) or similar structure would also require increased water retention (no bleeding) to properly carry out the carving and finishing process.



Figure 6: Penguin Pavilion—before.



Figure 7: Penguin Pavilion—complete.



Figure 8: Sacred Hindu Temple—housing Siamang monkeys.



Figure 9: Sacred Hindu Temple wall.



Figure 10: Sacred Hindu Temple—before.

Two central mixing stations were used to feed the shotcrete to the nozzlemen; and, in some cases, it was necessary to pump the mix both horizontally and vertically over a distance of 45 m (150 ft). The wet-mix shotcrete mixer/pump used was a P-13 Putzmeister equipped with a continuous feed water metering system, a paddle mixer, and a hydraulically powered unloading material system (Fig. 2). The specially designed spray nozzle assembly was equipped with a 12.5 mm (0.5 in.) nozzle opening to ensure accurate, low volume shotcrete placement (Fig. 3). The nozzlemen chosen to shoot the material by Béton Projeté MAH were ACI/ASA trained and certified and were required to work very closely with the five experienced carving/finishing artists recruited from Ireland, France, Italy, and Quebec. Their expertise was evident in the many detailed replicas of trees, rockscapes, and architectural façades found throughout the new zoo expansion.

One of the major challenges faced by the architects on this project involved keeping the animals in an environment similar to their indigenous habitat, which required hiding the complex ventilation and climate control system. Four large bunya-bunya trees, native to the rainforest communities in Southeast Queensland, Australia, were erected and shaped around galvanized wire mesh forms, reinforced with welded, galvanized rebar. These structures were used to hide the electrical wiring and piping that formed an integral part of the climate control system (Fig. 4). The trees towered 15 m (45 ft) above the base of the tropical solarium and the base of the tree measured 4.5 m (15 ft) in diameter (Fig. 5). To simulate foliage and create the familiar crown at the top of the bunya-bunya tree, artists drilled small holes into the surface of the shotcrete and anchored over 4800 small twigs (each containing 25 replica leaves).

Within the tropical solarium, the climate conditions replicated those in the tropical rainforest and included requirements for daily simulated sunrise and sunsets, all to ensure the arboreal kangaroos (tree kangaroos), Siamang monkeys, and hundreds of species of exotic birds would be comfortable in their surroundings.

Other notable sections within the new addition are a penguin pavilion (Fig. 6 and 7) and an eagle exhibit—both containing shotcreted rockscapes and caverns. A 5 m (16 ft) high x 6 m (20 ft) wide replica of the Sacred Hindu Temple (Fig. 8 and 9), which houses the famous Siamang monkeys, was also constructed by shooting the specialized shotcrete mix over concrete blocks (Fig. 10). This section was surrounded by a large 3.5 m (12 ft) x 7.5 m (25 ft) shotcreted, artificial rockscape constructed over a steel structure.

The shotcrete portion of the new *Jardin Zoologique* project has now been completed and the projected June 2003 opening is on schedule. The owners and architects are extremely pleased with the attention to detail displayed by the Béton Projeté MAH shotcrete crew and the artists. The King Packaged Materials shotcrete mix met both the functional and artistic requirements of both partners in the project. Béton Projeté MAH has since been awarded a second contract incorporating the same shotcrete mix and placement/carving system at the Quebec Aquarium in Quebec City, Canada.

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Patrick Giroux is Technical Representative for King Packaged Materials Company, a supplier of pre-packaged shotcrete mixes for the North American shotcrete industry. He is a graduate civil engineer from Sherbrooke University, Sherbrooke, QC, Canada, with a master's degree in civil engineering from Laval University, Quebec City, Quebec, Canada, with an emphasis on cement and concrete technology and shotcrete repairs.



Joe Hutter is Vice-President, Sales, for King Packaged Materials Company. He has more than 15 years of experience in the cement/shotcrete industry. He has been an active member of ASA and has chaired the ASA Marketing Committee since its inception.