

The Mayan Empire Rises Again— Shotcrete Buildings Replicate Ancient Monuments

by Dave Knipe

Tourists are now exploring the ruins of the Mayan Empire in two cities along the Atlantic coast of Florida, thanks to some creative architecture and the clever use of shotcrete as a material for cladding buildings. Zoo visitors in Jacksonville and West Palm Beach can watch Jaguars prowl atop Mesoamerican temples inhabited within by anacondas, poisonous goliath spiders, death's head cockroaches, and the world's largest fresh water fish, the giant silver Arapaima. Shotcrete Mayan carvings adorn the temple walls, and artificial vines entangle shotcrete jungle trees in two of the most remarkable and realistic exhibits ever created in American zoos.

If you had lived in Guatemala or the Yucatan during the first millennium and had the dubious fortune to be among the construction work force that built the magnificent temples and observatories of Tikal or Tulum, then you would know something about the mysterious techniques the Mayans used to heft the huge blocks of carved stone that comprise the ancient treasures of historical Latin American architecture.

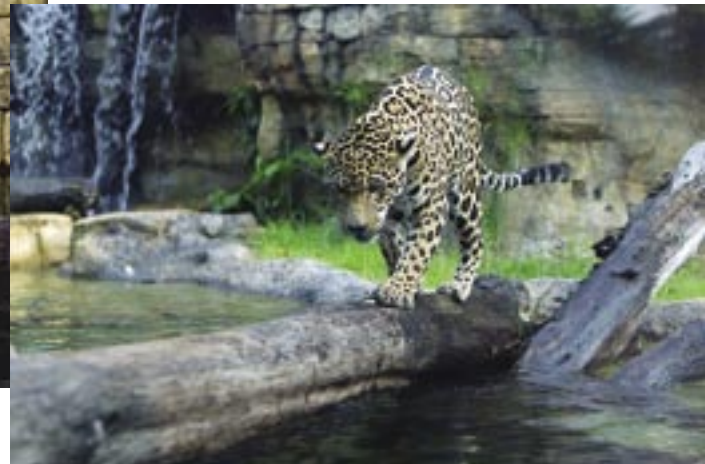
Contemporary construction techniques, however, cannot rely on slave labor, an emperor's fortune, or building schedules that were measured in decades. Fortunately, with evolving sophistication in the carving of wet-mix shotcrete, modern materials and techniques can be used to make concrete temples that resemble ancient buildings but also serve multiple purposes such as education, wildlife conservation, and the entertainment of the general public. They also conform to the present day demands of schedule and budget.

In 2003, the Jacksonville Zoo and the Dreyer Park Zoo in West Palm Beach were both pleased to acquire a number of rare young Jaguars from private collections in South America. These animals are endangered in the wild and are becoming almost impossible to see outside of zoos. They are spectacular creatures that draw large crowds of enthusiastic zoo visitors when displayed in synthesized habitats that mimic the culture and environments of their native region. Jacksonville Zoo Director Dennis Pate claims he has "the two most important jaguars in North America."

The Jacksonville project, appropriately named "The Range of the Jaguar," was designed by the Philadelphia firm of CLR Design. When visitors enter the exhibit, they travel back in time to an archaeological dig site complete with stone pathways, Mayan artifacts, and eroded temple buildings with carved shotcrete decoration inside and out that depict the lost world of the Mayan empire.



The jaguar enclosure at the Jacksonville Zoo resembles an ancient Mayan lagoon



The exhibit was built at a cost of \$14.5 million and covers four-and-a-half acres. The project took 2 years to plan and 18 months to build. Cemrock Landscapes Inc., an award-winning shotcrete specialty contractor based in Tucson, was selected to provide the unusual and stunningly realistic exhibit.

The Dreyer Park Zoo exhibit was even larger and more ambitious. A six-story Mayan tower and a full-sized “Caracol” observatory were built of shotcrete over structural substrates of CMU masonry, structural steel frames, and cast-in-place formed structural walls. The entrance to the jaguar enclosure comprises a crude suspension bridge that emerges beneath a massive artificial ficus tree, also constructed out of shotcrete. Cemrock was the contractor in West Palm Beach as well—its unique crews consisted of concrete experts and theme artists who worked for nearly 2 years in the humid environment of southern Florida to build a remarkable naturalistic environment that showcases many other South American animal species as well as Jaguars.

The Mayan-inspired design, which was the creative masterwork of Torre Design Consortium of New Orleans, required the simulation of several buildings in a fashion that would depict a pre-Columbian village in a pristine state undamaged



The jaguar lair at the Jacksonville Zoo can be viewed from the zoo restaurant

by time. Actual historic carvings and sculptures were recreated in shotcrete by using historical reference photos of antiquarian sites.

“I don’t think there is another building material that can do what shotcrete can,” says Michael Morris, Cemrock’s superintendent on the West Palm Beach project. “We build armatures from reinforcing bar and metal lath or attach directly to the building core. Then we apply our shotcrete to a thickness of as little as 2 in. (50 mm) to as much as 12 in. (305 mm) or more, depending on the amount of relief we want in the final texture.”

Cemrock’s shotcrete mixture designs vary with their intended use, but generally contain low amounts of large aggregates because they use 2 in.



A shotcrete pyramid with authentic historical Mayan detail



Shotcrete artists re-created a full-size Mayan “Caracol” observatory building



A shotcrete jungle ficus tree serves as the entrance to Dreyer Park Zoo's Tropics of the Americas exhibit

(50 mm) diameter hoses for most of their structural shotcrete pumping systems. Fly ash, water reducers, retarders, or other locally available additives are included to control pumpability and lower the need for excessive amounts of cement, which averages approximately 700 lb/yd³ (415 kg/m³), yielding 28-day compressive strengths of over 5000 psi (35 MPa). Facing mixtures for fine texture carving are usually cement plaster and are often mixed by hand on site and applied using small “carousel”-type pumps. All structural shotcrete is plant-mixed because ready-mix providers guarantee quality control and consistency among successive batches.

Modern concrete techniques have sped up and simplified the process of re-creating these amazing buildings and will ensure their longevity—just as many of the great ancient structures have endured for centuries, long after the societies that built them vanished. Color is applied to the new “ruins” by using integral concrete colors and by highlighting and accenting the texture with multiple layers of thinned acrylic latex paint, formulated for durability in harsh weather conditions.

Freestanding shotcrete walls are engineered for structural integrity to resist seismic and wind forces or hydraulic pressures if used to retain earth banks or as vessels for large planting areas.



A sculpted Mayan dragon head ornament formed in shotcrete and reinforcing bar



Cemrock artists replicated Mayan “stellae” using historical reference photos



Coloration of the Mayan temple in Jacksonville progresses by using multiple layers of acrylic latex paint



A rare South American jaguar feels comfortable in its new shotcrete habitat

Moisture proofing of any structures exposed to water is essential. The Jacksonville jaguars (not the NFL football team, which was a major financial sponsor of the project) swim in waterproof shotcrete pools that resemble ancient lagoons.

These ingenious efforts by the shotcrete contractor at re-creating the buildings of the past represent the versatility of shotcrete as a unique material. Innovative techniques allow us to witness a glimpse of Latin American history in our own modern cities, where we can view exotic animals and imagine an earlier time when jaguars ruled the jungles of Ecuador and Honduras and nascent human civilizations carved tropical empires made of stone.



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Assistant Director of Cemrock Landscapes, Inc., an award-winning builder of naturalistic environments, where his responsibilities include estimating and job costing.