

Al Ain Wildlife Park & Resort Retaining Wall and Artificial Rocks

By Huiqing He, Jolly Miller, Denis Beaupre, and Jean-François Dufour

The Al Ain Wildlife Park & Resort is a multi-faceted development spread over 2220 acres (900 ha) at the foothills of Jebel Hafeet. This project is a symbol of the United Arab Emirates' (UAE) commitment to wildlife conservation, and it deeply reflects the local culture and values of the UAE by building a world-leading commercially and environmentally sustainable resort. "Deserts of the World" is the theme of the entire development, featuring many species of animals from around the globe, ranging in size from termites to elephants. It is an excellent project to showcase biodiversity and provide a vibrant, fascinating demonstration of sustainable desert living.

The Scope of Work

The scope of shotcrete work included three parts: 1) the structural retaining wall at Nok Safari; 2) artificial rocks; and 3) the ha-ha retaining wall. The total concrete quantity was about 4480 yd³ (3500 m³). The project started on August 26, 2010, and was completed on July 6, 2011.

In general, the work included extensive structural work for placement of shotcrete and various artifacts. Coloring, dying, and tinting of shotcrete rockwork surfaces was required to achieve the desired finish.

The scope of work for the structural retaining wall at Nok Safari included building a retaining wall over 1.86 miles (3000 m) in total length. The work included the ground excavation, concrete blinding (often called mud slabs in the U.S.), cast-in-place concrete foundation and core

wall, steel reinforcement, shotcrete placement (core and surface work), final texture finish, and concrete paint.

The scope of work for the artificial rocks included building a rockscape imitation of the surrounding mountain area for over 21,500 ft² (2000 m²), divided into 10 different zones throughout the project. The size and shape of the rockscape included many significant color ranges and texture types designed to complement the local geographical rock environment. The surface texture was made by hand-carving and embossing.

The ha-ha wall was also a retaining wall where shotcrete was used to place concrete over 1480 ft (450 m) in total length.

The project owner was Al Ain Wildlife Park & Resort, the architect was EDSA, the general contractor was Hilalco, the shotcrete contractor was Imagineering, and the wet-mix shotcrete material supplier was UNIBETON Ready Mix. The parties involved were all from the UAE, with the exception of Imagineering, which was from the U.S. Figures 1 and 2 demonstrate the shotcrete equipment and placement.

Shotcrete Challenges and Solutions

The selection of shotcrete over cast-in-place concrete was an obvious choice due to its versatility, natural appearance, ease of free form shaping, artistic transforming, and sustainability advantages.

The challenges faced for the design, supply,



Fig. 1: Concrete supply by UNIBETON Ready Mix



Fig. 2: Shotcreting by Imagineering



Fig. 3: Shading for hot summer operation

and placement of shotcrete were to meet the project's specific requirements with consistent workability, strength and durability, artistic appearance, shotcrete temperature control, and extremely hot weather conditions.

The wet-mix shotcrete mixtures were supplied by UNIBETON Ready Mix, a well-established leader in the ready mix concrete industry in the UAE, specializing in the design and supply of a wide range of concrete products using customer-focused concrete technologies and solutions.

Two shotcrete mixtures were supplied to the project. The mixture designs were composed of locally produced portland cement and imported silica fume with a maximum aggregate size of 0.20 in. (5 mm), which was also locally supplied.

High-range water-reducing and retarding admixtures were specifically selected and formulated to ensure that concrete remained workable for 2 to 4 hours despite the extremely hot climate. The shotcrete was placed with a 0.40 water-cement ratio (*w/c*) along with the addition of polypropylene fibers on site. The fibers were added for crack control purposes and increased durability.

To closely represent local geologic features along with a more sustainable approach, regional materials were carefully selected, such as the Al Ain dune sand, which is a typical colored fine sand contributing to a regional natural look.

The placement of shotcrete was performed in extremely hot weather conditions, typical of this region throughout the majority of the year, where the highest temperature can easily reach up to 113 to 122°F (45 to 50°C). This significantly increased the overall challenge. The shotcrete was produced using combined cooling controlled techniques, including a skillful use of shading, ice-making at the batch plant, and temperature control considered in the concrete mixture design. It also included controlled admixture dosages for proper hydration retardation, which enabled the artwork shaping of the fresh shotcrete to be performed by the shotcrete contractor, as initially designed (Fig. 3 and 4).

These hot weather shotcreting challenges required a high level of cooperation, communication, and mutual support between the



Fig. 4: Artificial rocks blended with the mountains of Jebel Hafeet

shotcrete material supplier and the shotcrete contractor's on-site team. This allowed for maintaining the shotcrete's required workability and pumpability to ensure that the designed artworks were created and artistically blended into the surrounding area—the mountains of Jebel Hafeet.

Artistic Design and Transformation

Creating naturalistic habitats and living environments required the use of specialized construction methods that combined artistic ability with traditional construction techniques.

The artistic creation of the shotcrete works and their natural blending with the surrounding area required talented artistic design to bring the vision to completion. The architectural vision that went into the retaining walls and the artificial rockscapes came from the project landscape designer's rich imagination and experience to replicate realistic sandstone and rocks' natural visual structures, which blend naturally with the mountains of Jebel Hafeet in the background (Fig. 5 and 6).

To ensure that a natural-looking retaining wall and artificial rocks were created, various shotcrete surface textures and finishes were used for a better appearance of the wall and better blending of artificial rocks within the surrounding natural environment. The finishes used were natural as shot, scratched, smoothed, troweled, carved, aggregate-exposed, and painted. Each of these required different skills and required more than one step to complete, as illustrated in Fig. 7 through 10.

Immediate concrete surface curing was also a key element after shotcrete placement and finishing to minimize plastic shrinkage cracking under these hot temperatures.

Concluding Remarks

Overall, the Al Ain Wildlife Park & Resort development is one of the few shotcrete projects to take place in the UAE using sustainability and the existing surrounding natural environment as guiding

principles for the design and completion of the work. The project was delivered to the client on time and met all the technical and environmental requirements. Throughout the course of the project, shotcrete proved its versatility and flexibility as a method of placing concrete once again despite the extremely hot working conditions, technical challenges, and demanding requirements of the project's design.



Fig. 5: Gateway blended with surrounding nature



Fig. 6: Artificial rock with designed shape and texture and blending effect with the mountains



Fig. 7: Retaining wall design and surface details



Fig. 8: Gateway at the entrance



Fig. 9: Artificial rocks with designed shape and texture



Fig. 10: Artificial rocks with designed shape and surface details

2011 Outstanding International Project

Project Name
Al Ain Wildlife Park & Resort

Project Location
Al Ain, UAE

Shotcrete Contractor
Imagineering

General Contractor
HILALCO

Architect/Engineer
EDSA

Material Supplier/Manufacturer
UNIBETON Ready Mix

Project Owner
The Zoo and Aquarium Public Institute in Al Ain



Huiqing He is a Deputy Operations Director for UNIBETON Ready Mix. She received her PhD in material engineering from the University of Montreal, Montreal, QC, Canada and has professional expertise in operations, technical and project management, green and sustainability solutions, and research and development as a director, project manager, consultant, application specialist, and researcher in the fields of civil engineering and material engineering in the UAE, Canada, and China. She has received five awards for “Advances in Science & Technology” and three awards for “Green and Sustainability” and has published 28 papers.



Jolly Miller has been a leader in the shotcrete and exhibit industry for over 30 years, winning seven Association of Zoos & Aquariums (AZA) Best Exhibit Awards; five Significant Achievement Awards; and many other awards for using shotcrete to build top-down parking garages, buildings, soil-anchored retaining systems and—most notably—naturalistic zoo exhibits, aquariums, and larger savannas. After selling Jolly Miller Construction in 2002, Miller continued as a Consultant with Cemrock Landscapes, winning the Best Exhibit Awards for the Australia Exhibit at the Baltimore Aquarium and the Russian Grizzly Exhibit at the Minnesota Zoo. Following Cemrock, Miller continued to work with architects and owners designing new projects and then mobilizing build crews. The crews that Miller assembles are generally made up of artists, craftsmen, and construction workers who enjoy the challenges of using the latest concrete mixtures, hydraulic concrete pumps, and innovative design to raise the industry standards to higher levels.



Denis Beaupre received his PhD in civil engineering from the University of British Columbia, Vancouver, BC, Canada, in the rheology of high-performance shotcrete. He was a Professor and Researcher in Concrete Technology at Laval University for 9 years before his current position for 9 years as Operations Director for UNIBETON Ready Mix–UAE. He is the inventor of the IBB rheometer and the IBB workability probe. He has authored many papers in the fields of shotcrete, concrete rheology, pumping, repair, and durability of concrete.



Jean-Francois Dufour, MSc, PEng, is the General Manager for UNIBETON Ready Mix–UAE, a leading ready mix concrete producer in the UAE and the Middle East. He is a Graduate Civil Engineer with a master’s degree in civil engineering from Laval University, Quebec, QC, Canada, and has been practicing as a Civil Engineer in the field of concrete since 1995. Dufour is the Canadian Representative of the International Tunneling Association in the Working Group 12 (Shotcrete Technology) and has chaired technical committees for the American Concrete Institute (ACI) and ASA.