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Flying High – Qatar's Desert Nest Pavilion for Floriade Expo 2022 Features World's Tallest 3D Printed Tower

For the 2022 edition of the Netherlands' international horticultural exhibition Floriade, the Qatari Public Works Authority collaborated with Dar to deliver Qatar's unique and exceptional Desert Nest Pavilion. Merging Qatari heritage with state-of-the-art construction technologies, the Pavilion exhibits and celebrates Qatar's innovations as well as its bold vision for transforming the desert into the perfect place for green and sustainable cities. The lynchpin of the Pavilion is Burj Al-Hamam – a modern reimagining of Qatar's traditional and well-known pigeon tower – which was recently incorporated into the Guinness World Record Book as the world's tallest freestanding 3D-printed concrete tower. This article explores the significance of the Pavilion and its role as a bridge linking Floriade Expo 2020 and the Doha Expo 2023.



Growing Green Cities - Floriade Expo 2022

The United Nations' Department of Economic and Social Affairs estimates that by 2050, some 68% of the global population will live in cities on a mere 2% of the earth's surface area. Against such expectations, this year's edition of Floriade – an international horticultural exhibition that takes place in the Netherlands once every ten years – takes place under the theme "Growing Green Cities." With four subthemes, the event aims to inspire visitors and present creative, green, and sustainable solutions that make cities more fun, liveable, safe, and healthy.



- **Greening the city** - revealing the importance of greenery in converting CO2 into oxygen, and showing how greenery purifies water, produces food, and forms the basis of human life.
- **Feeding the city** - making visitors aware of the impact their food habits have on climate change and the alternative choices they can make for improved food supplies.
- **Healthifying the city** - showing the value of greenery for cities and how, through more conscious living, greenery can yield significant physical and psychological health benefits to residents.
- **Energising the city** – exhibiting a 'hardware' and 'software' interpretation of energy, displaying how smart and sustainable energy solutions can be intertwined in the design of cityscapes.

Sustainable desert cities – the vision driving Qatar's Desert Nest Pavilion

Inspired by nature and life in the desert, the Desert Nest Pavilion responds to these subthemes by offering a forward-thinking vision for innovative and sustainable ways to create green cities that live in harmony with even the harshest of environments.

For starters, the Desert Nest Pavilion is a prototype for future building technologies, showcasing Qatar's pioneering move towards sustainable construction. The Pavilion's nature-informed parametric design was brought to life through 3D printing, using renewable energy and reclaimed and recyclable materials to practically eliminate construction waste and deliver a model of sustainable construction for greener cities in the desert. Indeed, the Pavilion was designed in such a way as to make it possible to return as many of its materials as possible to nature at the end of the Expo, when the Floriade site will be redeveloped into Hortus: a green, healthy urban district for the future. The Pavilion also validated 3D printing as a viable construction method for large-scale projects: the 12.1-m-high officially entered the Guinness World Record Book as the world's tallest freestanding 3-D printed concrete tower.



The Pavilion's 3D-printed Burj Al-Hamman

- Height: 12.1m
- Weight: 56 tons
- Printing time: 100 hours
- Construction time: 11 days
- Construction system: 3D printing
- Material: concrete

Sustainable living in the desert

The Desert Nest incorporates a series of sub-themes related to future sustainable living, with each sub-theme ultimately playing a key role in the Pavilion's interpretation of the overarching theme of Future Green Cities. At their essence, these sub-themes present solutions that can help develop and transform arid landscapes into resourceful, liveable, and joyful green environments, while reducing their carbon footprint:

- Automation and self-building construction systems (in the form of 3D printing) that optimise the use of energy and construction materials and reduce building footprints.
- Vertical farming, hydroponic technologies, and sustainable urban farming trends that showcase the latest food production technologies Qatar is using to improve food security and future resilience.
- Wildlife protection and re-population as the main tower is inspired by the Qatari pigeon towers and works as a nest in the desert, to provide shelter for birds during the migration season.
- Renewable energy, harvested on site, using sun, kinetic and wind power to achieve net zero and minimise carbon footprint in future green cities.



Four towers, four themes: the Desert Nest Pavilion and its journey through time

Dar's design for the Desert Nest Pavilion draws inspiration from the mesmerising and elegant pigeon towers that once dotted the landscape of Qatar and offered refuge to migrating birds and wildlife. Similarly, the Pavilion takes visitors on a journey through time, from rich Qatari heritage to the future of the nation as a pioneer in sustainability. In designing the Pavilion, Dar focused on ensuring that each of the Pavilion's four towers realised six key visitor experience points: imagine, touch, learn, explore, contribute, and change.



Figure 1 A topside view of the Desert Nest.

Figure 2 The photo features Dar's Guylaine Raphael, Francesco Roesler, and Georges Samir.

Figure 3 Visitors explore the Vertical Farm.

Figure 4 Visitors explore the Energy Tower.

Figure 5, 6 Visitors explore the Community Tower.



The Past - Burj Al-Hamam

The standout feature of the Desert Nest is the elegant, 3D-printed Burj Al-Hamam, which was designed as a modern interpretation of the pigeon towers, a vernacular architecture typical of Qatar and the Gulf region. Birds have always held special significance in Arab civilisations, and ancient communities built these characteristic dovecotes to provide sanctuaries for migrating birds as well as nests and breeding spots for local birds. The Pavilion's Burj Al-Hamam reimagines that traditional architecture, celebrating its role in enhancing biodiversity. Inside the tower's accessible indoor exhibition, visitors can view images and projections that feature Qatari culture, the commitment to Future Green Cities, and a connection with Doha Expo 2023, the next international horticultural exhibition following Floriade 2022.

The Burj Al Hamam represents a milestone in the 3D printing industry and offers a glimpse at the future of sustainable construction. To deliver this ground-breaking tower, the project team used parametric design, which translates traditional design into codes that robots can read in order to print building components. A series of tests were carried out by the 3D printing specialist, Beamix, to optimise the tower's shape and make it freestanding, free of columns or steel frames, and respectful of the original concept design.

The tower itself was then printed in sections, in a controlled environment, and then assembled on site in only 11 days. Construction faced numerous challenges, mainly due to the scale of the project, the concrete viscosity, the foundation system and, most importantly, the timescale. However, the final result is an outstanding example of how design, engineering, and technology can break the constraints of traditional construction methods and open pathways towards new possible futures.

For Dar, the project was a new step forward in the company-wide effort to improve the synergy between designers and 3D printing specialists from the early stages of future projects, to come up with new innovative solutions that help save time, money, and materials while also creating projects that are more sustainable and forward-thinking.



The Present – the Vertical Farm and Energy Tower

A pioneering reinterpretation of the bird house and inspired by nature, the Vertical Farm is a biophilic vision for the future of green cities and a resilient design that integrates Qatari tradition with innovative technology for the future. The Vertical Farm comprises an integrated hydroponic system to grow food inside and outside the pavilion, transforming the site into an urban farm for on-site food production. The tower skin has the double function of growing food and insulating the indoor space, keeping the temperature controlled to make it possible to grow food through hydroponic technology.

The Energy Tower, meanwhile, generates its own energy via photovoltaic cells, and initiates kinetic human interaction through its playful facade, light shows, and projections.



The Future - Community Tower

What statement will Qatar leave for future generations? And how can we all come together in greening the desert?

Posing these questions and more, the Community Tower is the bridge, connecting two significant events across continents and time: the end point of the journey in the Qatari Garden in Floriade and the beginning of a new, longer one in Expo Doha 2023. This semi-enclosed pavilion offers visitors the master plan for Doha Expo 2023, which was also prepared by Dar. The tower looks incomplete as, ideally, it will attain its final shape at the Doha Expo.



The Desert Nest Garden Planting Strategy - Inspired by Qatar's Landscape

The three gardens in the Desert Nest exhibition feature typical terrains found in Qatar, and the planting schemes are informed by each landscape's characteristics.

Rawdat

Sand and silt pans and larger natural depressions often become flooded during the rains and may retain moisture for some time afterwards. Soils often have higher quantities of organic matter than other desert areas. Rawdat are usually characterised by stands of trees and shrubs comprising *Acacia* spp., *Prosopis juliflora*, *Ziziphus nummularia* and *Lycium shawii* and are often rich in annual and perennial herbs and grasses. Characteristic species of silt pans include *Cymbopogon commutatus*, *Pulicaria undulata*, *Andrachne telephioides*, *Astragalus eremophilus*, *Althaea ludwigii* and *Corchorus depressus*.

Sabkha

Salt pans are usually low-lying areas of sandy desert which have been inundated by seawater or rainwater that has dried out, leaving a salt encrusted surface. They occur mainly on or near the Qatari coast, with larger ones occurring east of Dukhan and at Mesaieed. Most are too salty to support any vegetation, but many have a marginal zone (referred to as 'sabkha edge') that is often dominated by halophytic species such as *Limonium axillare*, *Salsola* spp. or *Tetraena qatariensis*. Native species of *Tamarix* may also occur.

Wadi

These linear features may flow with water during times of heavy rainfall. In Qatar, they are generally not well defined in terms of depth or gradient, but they are characterised by linear or oval patches of accumulated sand, often within otherwise featureless hamada or gravel desert areas. Although dry and rocky, wadis support distinctive types of vegetation, composed of certain grasses and perennial and annual herbs, and also often support stands of *Lycium shawii*. The Lily Dipcadi *Erythraeum* is especially characteristic of small sandy runnels.



Figure 7, 8 Rawdat garden.

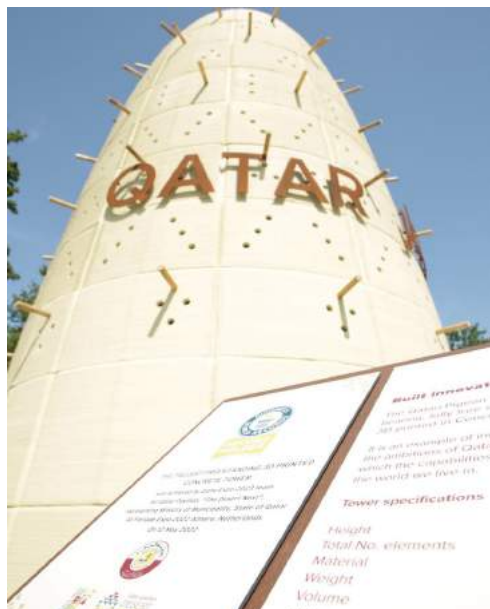
Figure 9 Sabkha garden.

Figure 10 The wadi.

Figure 11 Burj Al-Hamam named Guinness' world record holder for tallest freestanding 3D printed tower.

The Desert Nest Implementation and Project Teams

- Dar - Design Lead Team
- KPM3 - Main Contractor
- Saint-Gobain Weber Beamix - 3D Printing
- OP3 Global - Event Organiser
- Expo Pavilion Group - Content Creator



From Almere to Doha

The Desert Nest Pavilion offered the world a modern reimagining of traditional Qatari heritage as a pathway towards sustainable, innovative, and green new cities. It underscored Qatar's commitment to take a leading role in reclaiming deserts and transforming them into vibrant, dynamic spaces for humanity and biodiversity to live and thrive. And as the mantle for hosting the world's largest horticultural exhibition passes from Almere to Doha, the Desert Nest Pavilion offered visitors a glimpse at what to expect in Doha, come 2023.

Dar was exceptionally honoured to successfully support the Qatari Government's Public Works Authority both in leading the design of the Desert Nest Pavilion for Floriade 2022 and in preparing the master plan and detailed design of the Doha Expo 2023 site – linking the two events and reinterpreting the subthemes of both these international horticultural landmark events through educational, visual, and experiential contents. ♦

Combining cutting edge 3D printing construction techniques with the concept of the traditional Qatari pigeon towers that provided a resting place in the desert for migrating pigeons and birds, the Desert Nest Exhibition celebrates Qatar's developments and innovations as well as its bold vision for transforming the desert into the perfect place for green and sustainable cities.

