An Architectural Geode

Arizona State University's Walton Center takes its inspiration from the desert

by Deborah R. Huso

When Arizona State University (ASU) set out to design and build a new high-performance research facility and northeast gateway to the campus in Tempe, AZ, USA, sustainability was a priority. The university has aspired to become entirely carbon neutral by 2035.

However, building sustainably and creating a structure that uses minimal energy in its daily operation is no small task in southern Arizona. Summer temperatures can reach 49°C (120°F), and the searing sun shines more than 300 days a year.

The Rob and Melani Walton Center for Planetary Health (Fig. 1) is perhaps the university's most ambitious sustainable building project yet. The structure rises from a triangular lot at the state's busiest intersection like a giant cracked-open geode—a hollow, spherical rock found in the desert that contains crystals on the inside. The 26,100 m^2 (281,000 ft^2) interdisciplinary science and technology building combines the survival features of native flora and the natural shading provided by desert topography in its structure and materials.

Clad in a shell of glass fiber-reinforced concrete (GFRC), the building's paneled façade is based on biomimicry of a saguaro cactus' orientation to the sun. The cactuses shield themselves from the desert heat with the deep pleats of their skins, the same way the south-, east-, and west-facing angled concrete windows of the Walton Center do, while the north-facing windows are barely covered.

"The desert was the soul of this project right from the beginning," said Tom Reilly, Partner with Tempe, AZ-based architectural firm Architekton. He said the project team wanted to emulate how people in the desert settle around water sources. "We wanted a gateway building and hub. The research corridor, university campus, community, and innovation corridor all surround the [Walton Center]. This is the living room of the campus."

Fig. 1: The Rob and Melani Walton Center for Planetary Health at Arizona State University, Tempe, AZ, USA *(courtesy of Grimshaw)*

Designing for the Desert

The Walton Center, which opens to the street like a desert slot canyon, directs the infiltration of wind, light, air, and pedestrian flow into its central courtyard. In winter, the sun provides passive solar warming of the courtyard, while in summer, the sunshine is blocked to keep the courtyard and its native plant species cool. Architects found inspiration for the courtyard's design by studying the orientation and form of the Ancestral Puebloan cliff dwellings in the southwestern U.S.

According to Reilly, designers would have normally looked at an east-west orientation for the building that surrounds this protected courtyard but instead ended up with a structure that hugs the triangular lot with the light rail to the south, roadways to the north and east, and a pedestrian bridge going over University Drive to the light rail.

The triangular building site (Fig. 2) informed the structure's design, particularly its foundation, according to Carlos Diaz, Project Director with Phoenix, AZ-based McCarthy Building Companies, Inc. "The intersection was tough," he said. "It's the busiest intersection in the state in addition to being the northeast entrance to the campus."

The site is also bisected by an active waterway (which the Walton Center now straddles) that crews had to temporarily relocate and then build back into the final project. The building is just a few feet from the city's railway line and away from University Drive. "It's basically a triangular site with the hypotenuse as an active railway," Diaz explained. "The site logistics were extraordinary."

"The geode idea wasn't so much an inspiration as an analogy," explained Bill Horgan, Partner in Charge at architectural firm Grimshaw in New York, NY, USA. "What that means is that you have this protective, solid exterior skin that shelters and shades the building from Arizona's intense sun and heat. And then on the inside, you discover this more crystalline and transparent series of façades enclosing the courtyard."

Fig. 2: The Walton Center site plan *(courtesy of Grimshaw)*

The building façades that face the interior courtyard have sufficient shading to allow them to be more transparent. Some are glass, and some are colored metal. Additionally, the design team chose to make an existing canal cutting through the building lot into a public amenity that would add "coolness" within the courtyard.

"We were looking to maximize thermal comfort and performance in the courtyard," Horgan said, "and move away from the concept of an air-conditioned atrium." Instead, the Walton Center's "atrium" is the shaded courtyard, which, like a slot canyon, is open to the prevailing breezes moving from east to west. "The building itself creates shaded gathering spaces."

The courtyard contains native, drought-tolerant plants that are exposed to sunlight for 6 hours of the day. With the building openings to the east and west, the courtyard receives an almost constant breeze from prevailing winds, while the open canal beneath the building provides a feeling of coolness.

According to Reilly, 50% of the Walton Center's floor plate does not touch ground. "The whole southwest edge is lifted two stories [Fig. 1]," he explained. "Part of that is to allow for canal access, but it also provides daylight in the winter months for plants."

Another unique feature of the Walton Center is its lack of enclosed and conditioned stairwells. "This building breaks apart the labs from the office and teaching space and has no enclosed stair core," Horgan explained. "The three primary stair cores for people moving between floors are open to the air in the courtyard. This helps further minimize energy use in the building because of the reduction in conditioned space."

Voided Slabs and Fly Ash for Sustainability

Construction of the Walton Center began in January 2019. A key feature of the design and construction teams' commitment to building sustainably was their effort to reduce the amount of concrete in the structure. "Looking to decarbonize the building was an absolute priority," Horgan said.

"We understood one of the central premises of the project was sustainability," said Stephen Curtis, Principal with the New York office of structural engineering firm Buro Happold. So, they suggested a voided slab system to reduce the building's concrete footprint. "It's not a particularly common technology in the United States," Curtis said, "and this was the first deployment in Arizona."

The team selected voided slab technology for the concrete deck. The construction crew was working with simple flat slabs containing thin, recycled plastic spheres with concrete placed around them (Fig. 3). The voided slab system can save 30% on the volume and weight of concrete over traditional flat slabs, Horgan indicated. There's also less load, which means reduced use of concrete in foundations and columns.

"You're using voids, plastic spheres, to displace concrete volume where the concrete volume isn't really helping," Curtis explained. "You're casting a flat slab, with a clean soffit, but it's not totally solid." The void-form plastic spheres come preassembled within reinforced steel mesh cages that are of transportable sizes and are placed on the concrete form to be cast within the slab. The voided slab system resulted in a 35% reduction in dead load and reduced the structure's concrete use by 255 m^3 (334 yd^3).

Fig. 3: The voided form installation and concrete placement for the elevated deck *(courtesy of McCarthy Building Companies)*

"You are lightening the heaviness of the slab but still maintaining the integrity of reinforcement and increasing the slabs' ability to free span between columns," Diaz explained.

The elevated concrete decks on the non-lab side of the building feature the voided deck technology. However, it couldn't be used on the lab side of the building due to vibration concerns. "When you lighten the slab to achieve greater space between columns, you provide less rigidity, which didn't meet the lab side requirements," Diaz noted.

While the voided deck technology was based in Canada, the company was able to source recycled plastic and use a fabrication shop in southern California for better proximity to the project site.

The project team also reduced the carbon footprint of concrete by replacing 40% of the portland cement with fly ash. This widely applicable sustainable option was used throughout the building, including in the voided slabs. "Typically, high-fly-ash mixes are used for the utility of controlling heat of hydration and less frequently when quality of finish is a concern," Diaz explained. "While reducing the carbon footprint by reduction of cement has a positive environmental impact, the higher fly ash content can 'marble' the concrete finish. It also comes with a slower strength gain and makes it more difficult to work with when finishing a slab surface."

McCarthy conducted batch trials with the concrete producer and admixture provider to develop a concrete mixture with fly ash, water-reducing admixture, and high-range water-reducing admixture. "Through a few trial placements, we found we could achieve the finish quality we needed from an exposed concrete standpoint and the required consolidation properties required from the concrete mix," Diaz said. "What we could not avoid was the fly ash marbling of the concrete. It's noticeable, but it became symbolic of [the building's] sustainability story."

Protective GFRC Façade

"Right from the outset, we knew we needed a building that would be analogous to this geode idea with a solid exterior shell," Horgan explained. "We wanted to optimize the thermal performance of the envelope." That meant keeping the glazed area of the structure to 25 to 30% on the east, south, and west façades.

Fig. 4: The GFRC panels with their "eyelids" protect the building's glazing while still allowing daylight in and offering views to people inside *(courtesy of Buro Happold)*

"The design approach was to create a rocky, earthy shell for the exterior," Diaz said. "It's hard to do that with anything other than a rocky material." He pointed out that the team could have used precast concrete for the Walton Center's façade, but with the shape and depth of panels, the building shell would have been incredibly heavy. "As the load on the slab edge increases, concrete thickness increases, and, as a result, foundations, columns, [and] supporting elements increase as well," Diaz added. "That would have been counterintuitive to the goals of the project."

Barzin Mobasher, Professor at ASU's School of Sustainable Engineering and the Built Environment, said the primary reason for using GFRC panels for the building's façade was to reduce the weight of the shell. "Standard precast concrete is 4 to 5 in. [102 to 127 mm] thick and has to be reinforced," he noted. "That's dead weight because it's permanently attached to the building." GFRC allowed for reducing the panel thickness to 20 mm (0.8 in.).

Because GFRC panels weigh significantly less than precast, hoisting or lifting options were increased, allowing the crew to quickly adapt to constraints around the project site. "Each elevation of the building presented a different challenge—so the team had to strategize about the sequencing and unitization of materials when placing the exterior elements," Diaz said, noting the jobsite wouldn't have allowed room for traditional scaffolding or any single application of exterior access.

So instead of 64 to 75 mm (2.5 to 3 in.) precast panels, the team could use 20 to 25 mm (0.8 to 1 in.) GFRC panels. "The initial panel designs required a lot of forms," Diaz said, "but the fabricator, design team, and McCarthy got the façade panels down to six core forms that could be manipulated to make different designs."

According to Architekton Partner Rachel Green Rasmussen, the panel design took its inspiration from the saguaro cactus: "This idea of self-shading that the cactus naturally provides is something we've been exploring for decades. The ribs on the cactus are a direct response to the sun. So, each façade of this building has a very unique relationship to the solar angles. Thus, the [building] skin responds to each façade's needs."

The GFRC panels' "eyelids" protect the building's glazing while still letting in daylight and offering views to people inside (Fig. 4). "We didn't want to eliminate windows entirely," Rasmussen explained. "We wanted people to have a great view. Daylight bounces in to reduce electric lighting.

"It's a very dynamic façade as you move around the building," Rasmussen added. On the north, the glazing is open and exposed to offer unobstructed views, while the east and west are more protected. The south is a balance of both. The inside of the GFRC panels is lined with terracotta paint that is visible as one moves around the building. "Meanwhile, the off-white of the GFRC panels with their angles and facets makes the building come alive as the sun and shadow hit it," she noted.

GFRC also provided the opportunity to create a physical gap between the building structure and its façade. "That space can be controlled as an insulating layer and reduces heat transfer to the building," Mobasher explained. "These panels are only connected to the building at three to four points and are attached in a way that there is no conduction of heat."

According to Reilly, the prefabricated skin of the building beneath the GFRC panels was designed as mega panels with cranes lifting them into place. "We were really snug against the light rail property to the south," he noted. "There was not even the amount of space for scaffolding."

Tempe, AZ-based MKB Construction, Inc., installed the GFRC panels. According to Dustin Williams, Director of Project Management at Salt Lake City, UT, USA-based GFRC manufacturer Unlimited Designs, Inc., MKB installed prefabricated insulated panels with GFRC installed over them. "It is a continuous insulation rainscreen system," Williams explained. "Four GFRC panels were installed over each section."

Unlimited Designs studied how best to manufacture the panels by first using a resin model from Grimshaw. "They designed for a lot of repetition, positioning [the panels] in a way that made it not noticeable," Williams explained. Unlimited Designs made wooden molds using a computer numerical control (CNC) machine. Then, they were all cast out of fiberglass molds. "The finish looks like a southwestern brownish/desert color," said Williams, "and up close, it looks like stone," (Fig. 5).

Williams said his facility manufactured 8825 m^2 (95,000 ft^2) of GFRC, amounting to 1200 panels, including where panels wrap around corners. They used 12 main molds for the project, and almost 900 came out of those 12 molds. The balance came out of 16 corner molds. They also manufactured 150 border pieces and 150 skirt panels. "We blocked the bottom of those original 12 molds to make those skirt pieces," Williams added.

The average GFRC panel weight was about 635 kg (1400 lb), with the largest and heaviest coming in at 907 kg (2000 lb), measuring 4 x 2.5 m (14 x 8 ft).

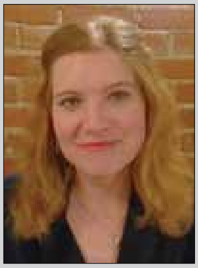
Project Completion

The Walton Center was completed in December 2021, despite construction complications from the intervening COVID-19 pandemic. Total project cost was 156,164,000 USD. The building achieved LEED-NC Platinum certification.

"We didn't design the building; the site did," Reilly said. "What's really fun about this project is that a lot of what we were able to achieve was because we designed and built holistically," he added, not just through LEED requirements but also through the Living Building Challenge. "By employing passive design solutions, engaging in building analytics upfront, and having the builder and trades on board early in the process, we were able to frame what was possible before designing and create solution-based designs."

Upon completion and evaluation of building operations, the Walton Center has exhibited energy use intensity (EUI) that is approximately a 50% reduction from baseline.

Selected for reader interest by the editors.



Deborah R. Huso is Creative Director and Founding Partner of WWM, Farmington, NM, USA. She has written for a variety of trade and consumer publications, such as *Ascent*, *U.S. News & World Report*, *Concrete Construction*, and *Construction Business Owner*. She has provided website development and content strategy for several building products companies, including Cultured Stone and Trex Company, Inc.

Fig. 5: Set of GFRC panels for the Walton Center manufactured by Unlimited Designs *(courtesy of Unlimited Designs)*