# Civil Engineering NEWS

RESILIENCY

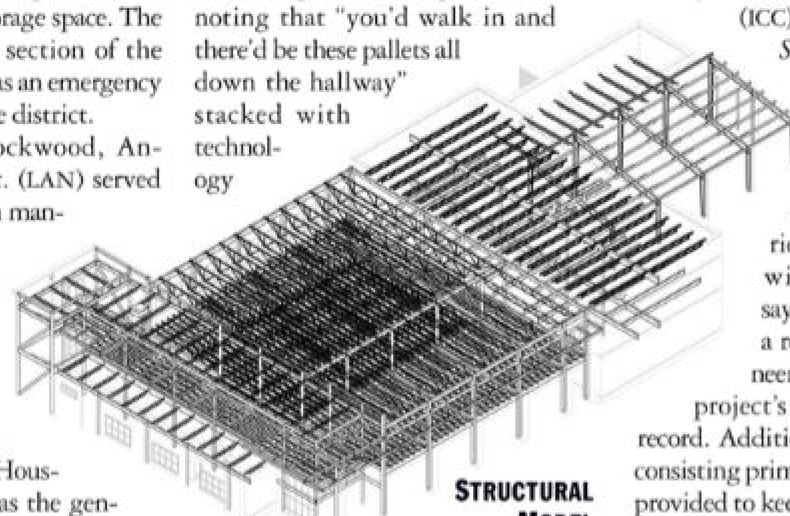
## *Texas School District Constructs Hurricane-Resistant Tech Center*

**The new technology center for the Goose Creek Consolidated Independent School District, located east of Houston, features a hardened area for its computer servers designed to withstand wind speeds roughly equivalent to a Category 4 hurricane.**

THE GOOSE CREEK Consolidated Independent School District (CISD), located in Baytown, Texas, just east of Houston, recently constructed a new technology center that features a hardened area for its computer servers that is designed to withstand wind forces associated with 180 mph, 3-second gust wind speeds, which roughly corresponds to the sustained wind speeds associated with a Category 4 hurricane.

The two-story, 32,400 sq ft facility was designed to store student and teacher data for the district's 16 elementary schools, 5 junior high schools, 3 high schools, and ancillary facilities. The new technology center also provides 3,900 sq ft of training rooms and nearly 3,500 sq ft of storage space. The 2,000 sq ft hardened section of the building can also serve as an emergency operations center for the district.

Houston-based Lockwood, Andrews & Newnam Inc. (LAN) served as the project's program manager. Huckabee, also located in Houston, was the project's architect and structural engineer. Raba Kistner Inc., of San Antonio, was the geotechnical engineer. Houston-based Durotech was the general contractor.



**STRUCTURAL MODEL**

The Goose Creek CISD needed a new technology center because its previous facility was housed in a 30-year-old building that had originally been a skating rink. That building had not been constructed "to withstand severe weather" and did not meet "an industry-level standard for sustained operability," according to the district's website. The previous site was also not dedicated solely to the district's technology needs, housing other departments as well, while the district's technology staff was "scattered all over the district" in various other buildings, notes Van Franks, a senior program manager for LAN.

Storage space was extremely limited in the original building, Franks adds, noting that "you'd walk in and there'd be these pallets all down the hallway" stacked with technology equipment that the district had no place else to put.

The plans for the new technology center went through several iterations and multiple bid processes, Van notes, and not everything the district initially sought for the site was possible within the school system's budget. For example, the district originally requested a building that could withstand a Category 5 hurricane and that had access to two different power grids to guarantee that its servers would never lose power, Franks says. Although the hardened area is not—nor is it ever intended to be—designated as a community or residential storm shelter as defined by the International Code Council (ICC) in ICC 500, *ICC/NSSA Standard for the Design and Construction of Storm Shelters*, the design team ultimately used the structural design criteria for hurricane shelters contained within that document, says R. Craig McKee, P.E., a regional structural engineer for Huckabee and the project's structural engineer of record. Additionally, backup systems, consisting primarily of generators, were provided to keep the power on without spending the millions of dollars that access to a second power grid would have cost, Franks says.

Although the new building appears to be a single facility—rectangular in plan and measuring approximately 240 ft long by 125 ft wide—it is in fact composed of three separate structures, explains McKee. These include the training area, a conventionally framed steel structure with a metal stud curtain wall system, which accounts for roughly 50 percent of the site's footprint; the warehouse space, a pre-engineered metal structure that forms roughly 25 percent of the footprint; and the "hardened" server area that accounts for the remaining 25 percent of the footprint. The three building areas feature structural isolation joints and are therefore structurally independent, McKee adds.

The exterior of the hardened area for the servers consists of grout-filled, load-bearing reinforced concrete masonry unit (CMU) walls that also serve as shear walls for this portion of the building. This area features a heavy gauge metal roof deck supported by open web steel joists that were spaced closer than typical because of the large wind loads applied to the roof deck, McKee says. Both the exterior CMU walls and the roof deck are designed to resist impacts from wind-borne debris that may impact the structure during an extreme weather event, he adds.

The first- and second-floor slabs were designed to accommodate "substantially greater loads than typically required" for similar buildings, McKee notes. For example, to meet the district's current technology needs and provide flexibility for future expansion, the design live load for the entire second-floor slab—on which the servers are located—was 300 lb/sq ft, in contrast to a more typical load of 50 to 100 lb/sq ft, McKee says. The entire second floor was designed to that greater load level to provide the district the ability to expand or reconfigure the server room without the need for future structural remediations or alterations, McKee adds.

While district staff will potentially use the facility as an operations center during hurricanes or other emergencies, McKee stresses that the facility is not intended for use as a public shelter.

The new technology center was constructed on an open portion of land that the district already owned, having recently constructed a new elementary school on another portion of the site, Franks notes. Thus, such features as stormwater control measures were largely already in place, and the project merely had to extend a recently constructed retention area rather than install an entire new retention facility, he explains.

The geotechnical conditions were poor, however, with a high groundwater

HUCKABEE/GRANT VAN MOOSE; TOP: HUCKABEE, BOTTOM



## Pittsburgh International Airport Unveils New Terminal Renderings

**WHILE SUBJECT to change, the Allegheny County Airport Authority in Pennsylvania has released early renderings of what the modernized Pittsburgh International Airport may look like when it is completed in 2023. The airport, which serves 9.5 million passengers per year, has embarked on a $1.1-billion terminal modernization plan (TMP) intended to create in a more efficient, enjoyable experience for passengers while also reducing travel and wait times.**

**The centerpiece of the TMP is a 635,000 sq ft terminal facility that will include airport and airline operations, passenger and public spaces, ticketing, baggage claim, a meet-and-greet area, a large security checkpoint, and retail and concession spaces.**

**San Francisco-based architect Gensler and Omaha, Nebraska-based engineering firm HDR Inc. formed a joint venture to deliver the project, and the team worked with Luis Vidal + Architects, headquartered in Madrid, to develop the architectural design vision for the new terminal. HDR will implement the engineering of the design, and Jacobs, of Dallas, is serving as the program manager.**

**The TMP will also include a new roadway system to support the new terminal as well as a multilevel parking garage and a dedicated ground transportation center. Michael Baker International, of Pittsburgh, is leading the landside architecture and engineering team to deliver this part of the project.**

**The airport authority says that when the TMP is complete, visitors will experience a larger security checkpoint area, a 50 percent reduction in the time it takes to get from curbside to airside, a 67 percent reduction in the time it takes to get from the international arrivals area to the curb, three times more covered parking spaces, and only one level change from the curb to the gates. There will also be separate levels for departing and arriving passengers, shorter walking distances for arriving and departing passengers, indoor and outdoor vegetated plazas and gathering spaces, technological improvements, and an emphasis on sustainability.**

GENSLER + HDR IN ASSOCIATION WITH LUIS VIDAL + ARCHITECTS, BOTH

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table and sandy soils beneath expansive clay near the surface that have the potential for volume changes if the moisture content fluctuates, says McKee. To accommodate these challenges, a portion of the expansive clay layer was removed and replaced with an inert, nonexpansive fill material that was then compacted to create the "building pad" on which the roughly 5 in. thick concrete ground-floor slab would be constructed, McKee says.

All the columns, exterior walls, and interior walls are supported by a deep foundation system consisting of drilled piers. Because of the high groundwater table and the potential of the soils "sloughing" during drilling, the piers were installed using a method known as slurry displacement, McKee says. The deep foundation elements at the training and the warehouse areas—which were not designed using the structural design criteria of ICC 500—ranged in diameter from 18 to 24 in. and extended up to 45 ft below the ground surface, McKee explains. However, the piers for the hardened section measured typically 30 in. in diameter and were as much as 60 ft in length to accommodate the increased loads on the foundation at this area of the building.

During the construction phase, Hurricane Harvey struck the Houston area in August and September 2017, saturating the ground with rain and leaving the partially constructed building pad "like an island above the water all around," notes Franks. As a precautionary measure, Raba Kistner evaluated the already installed building pad using a portable dynamic cone penetrometer to determine if the pad had been damaged by the excessive rainfall. The test results led to "a couple of weeks delay" while the site dried out, but the evaluation indicated that the building pad was in good condition, and thus it was acceptable to proceed with foundation construction, McKee notes. —ROBERT L. REID

## Student Union Takes Flight At Aviation University

**THE NEW student union building at the Daytona Beach, Florida, campus of Embry-Riddle Aeronautical University was designed to resemble a bird's wing in flight, according to information on the website of the international engineering firm Thornton Tomasetti, which served as the structural engineer on the project. Designed by Ikon.5 Architects, which has offices in New York City and Princeton, New Jersey, the Mori Hosseini Student Union—named for a notable alumnus and chair of the university's board of trustees—is a four-level, 178,000 sq ft building that features a student convention center, library, cafeteria, student government spaces, common areas, and offices. A 300 ft long, 50 ft wide arching skylight tops a four-story tall open space that serves as an atrium and provides stepped seating areas overlooking the ground-level lobby. Because the number of columns in the building was limited, the structure "required extensive coordination for lateral brace frame layouts, gravity framing, and foundation design," explained the Thornton Tomasetti site. The building's iconic roof features a double-curved, steel-framed surface supported by a central spine girder and a series of wing beams. The spine girder is composed of two laced, wide-flange shapes installed side by side and running the full length of the building footprint—cantilevering approximately 50 ft and extending beyond the facade. The wing beams also cantilever outward to create the roof's overhanging sections. Deflections in the spine girder and the wing beams are controlled by the external arches and vertical struts; formed from built-up box girders, the arches measure 4 ft deep. The design of the building's unique geometry involved expertise from several Thornton Tomasetti offices, including the firm's research and development incubator known as CORE Studio, which is primarily based in New York City but involves other sites as well. Thornton Tomasetti's team used Tekla three-dimensional modeling software—from Trimble, headquartered in Sunnyvale, California—to map "the complicated steel connections that were exposed to view and the curvature of the building materials in the roof." The firm's Newark, New Jersey, office focused on the structural design, and work on the architecturally exposed roof elements was handled by a construction engineering team involving the New York City and Kansas City, Missouri, offices. The office in Mumbai, India, was responsible for peer review of the steel structure and details of the curved steel monumental staircase that connects the first two levels of the building. The project was completed in October 2018.**

CHAD BAUMER