UT's New Hackerman Experimental Science Building Inspires Teamwork

Part 2

By Michael Brack, P.E.

The 300-foot-long colonnade required special attention to detail to relieve thermal expansion/contraction stresses. Courtesy of Tom Bonner, 2011.

The 300,000-square-foot Norman Hackerman Building replaces the old Experimental Sciences Building (ESB) on the campus of the University of Texas (UT) at Austin. Part 1, in the September 2011 issue of STRUCTURE® provided general information about the project and discussed the structural system selection and schedule challenges. This article describes some of the additional challenges encountered and the innovative solutions that the design and construction team developed. Key team members include CO Architects, Taniguchi Architects, The Beck Group and Datum Gojer Engineers.

Site Challenges

A 40-foot-deep hole was required – 20 feet deeper than the original ESB basement – to sink the new building into the ground. This strategy allowed UT to maximize its use of the site without building a structure so tall that it would overwhelm the site and surrounding campus scale.

Of particular concern related to the large, deep hole was the adjacency of several buildings and utilities, most critically the Nano-Science Technology (NST) building directly to the north. The NST had been designed and built a few years before as the first step in replacing the old ESB. The decision to build the new Hackerman building right up against the NST, combined with the decision to sink the new building as deep as possible, created the risk of undermining the seven-story tall NST.

The new excavation would be 4 to 10 feet deeper than the skin friction zone of the NST piers, and 2 to 4 feet deeper than the bottoms of the NST piers. Datum Gojer worked together with The Beck Group to develop a sequence of excavation and underpinning to keep the NST stable. The excavation for Hackerman was taken down to a level equal to the top of the skin friction zone of the piers. Next, a low-overhead drill rig was used to install deeper 30-inch-diameter underpinning piers on either side of each existing pier. This solution

The 40-foot-deep excavation for the new NHB was surrounded by buildings and campus roads. Courtesy of The Beck Group.

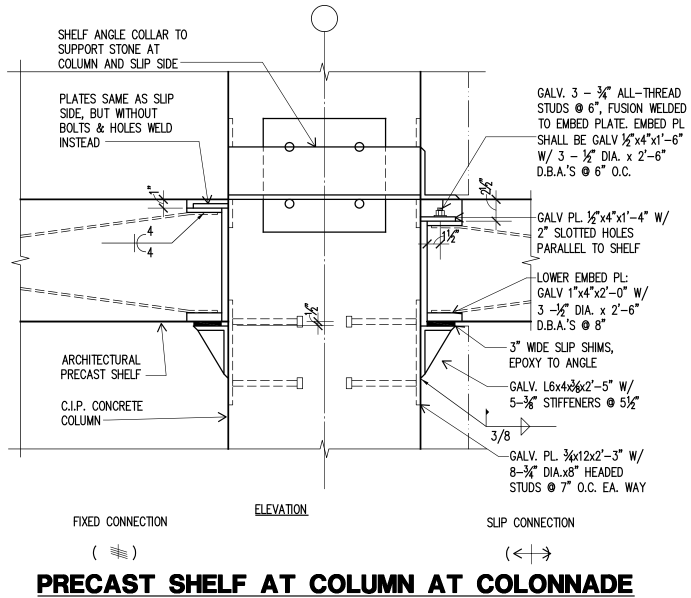
was helped greatly by the fact that a deep basement wall exists along the south face of the NST, allowing vertical loads from columns above to be redistributed without retrofitting the building superstructure. After the underpinning piers were installed, excavation was allowed to continue as deep as needed for the new building.

During the demolition, excavation, and underpinning operations, vibration sensors were set up in adjacent buildings to monitor construction-induced vibrations in these critical facilities. The sensors would send an alarm to the contractor's cell phones when the threshold levels were breached, and construction activity would be modified or deferred to a less sensitive time.

Basement and Earth Pressure Challenges

Some of the mechanical systems were strategically located in the windowless basement. The space was double height to accommodate two levels of mechanical space separated by a catwalk. This meant that the basement columns (with the heaviest loads) had 26-foot unbraced lengths, compared to 14-foot in the rest of the building.

The double-story height of the deep basement, along with the need for an expansion joint near the middle of the long building, created a very large bracing force requirement at the first elevated level, due to lateral earth pressures. The delivery of this large force through the basement walls, into the floor framing and back into the perpendicular basement walls, was tracked carefully to ensure an adequate design and load path. The slab reinforcing was increased to provide more diaphragm shear strength, and girders were checked for combined compression plus bending, with axial forces derived from the earth pressures.



Detail of the "slip" and "fixed" support conditions for the precast shelves. A shelf angle attached to the column allows the masonry to float above the slip side. Courtesy of Datum Engineers.

The bottoms of the deepest walls were trenched and socketed 3 feet into rock to keep the large lateral forces from buckling the basement floor slab.

Colonnade

Among the interesting aspects of the design, both architecturally and structurally, is the two-story colonnade which wraps around most of the south and east façade, forming deep porches and two-story lobby spaces. The colonnade serves to humanize the scale of the building, and prevent the visual monotony that can happen in a large rectangular building with a strong module.

Architecturally, the colonnade appears to be a random assortment of solids and voids formed by masonry pilasters. A 14-inch-deep precast concrete shelf provides a horizontal boundary between the upper and lower parts of the colonnade, allowing the random pilaster pattern to alternate above and below it.

Cast-in-place architectural concrete was considered for the shelves, but would have created a construction sequence problem, and was considered to be less reliable from an appearance standpoint, in addition to being more expensive. The precast shelves fit with the design concept of a masonry colonnade.

The colonnade creates double-height columns up to 39½ feet tall (two 16-foot stories plus a 7½-foot drop at the east end of the first floor to work with the sloping site). Because the architect desired slender columns, these columns were made rectangular (24 x 29 inches) with the narrow edge facing out, and the architect worked them into the apparently random pattern of the masonry pilasters.

Because the colonnade and precast shelves are exposed to the elements on the south face of the building, there was concern about the expansion and contraction that would occur with 100-degree temperature changes over the course of a year. Specifically, the concern was that the buildup of thermal contraction forces over the 300-foot length could cause a brittle pull-out failure of the connections of the precast shelves to the columns. To prevent this, a plan was devised to provide for slip along the longitudinal axis of the precast shelves, at every other bay.

The detail includes stiffened steel angle haunches connected to embed in the column. The precast shelves rest on shims on the haunches for erection. On top of the precast shelf is either a welded connection (fixed condition) or a bolted connection with slotted holes (slip condition).

Shelf angle collars were installed directly above the precast shelves, to support the masonry wraps around the columns at the slip side.

These final details were carefully developed among the architectural, structural and construction team, including the masonry subcontractor, to ensure constructability and tolerance. The design and layout of the random masonry pilasters was an iterative effort of teamwork and close coordination between the architect and structural engineer.

Other Challenges

Although the Hackerman building is very large and regular, there were many opportunities for challenges throughout the project. These included:

- A concrete staircase that appears to spiral up through the building. The stair engages each floor on the south end, as well as a shear wall in the northeast corner and an intermediate beam in the northwest corner.
- A massive 15,000 square foot solar water heater array on the roof of the penthouse. The array required its own grillage of steel tube framing to suspend it above the roof to provide access for future roofing maintenance during the life of the building.
- A light shade canopy around the top of the building, which cantilevers up to 24 feet in each direction at the corner of the building.
- A series of concrete beams that are offset 2 feet vertically at midspan to create room for a massive 48- x 144-inch lab exhaust air duct. The 2-foot offset creates a complicated knuckle joint which required an intense layout of reinforcing to work with the change in direction of forces in the rebar.
- 48- x 60-inch post-tensioned transfer girders spanning 48 feet to carry 5 levels of building above the first-floor auditorium.
- This was one of the structural firm's first Revit projects (started in 2006). They learned a great deal during the project; however it went relatively smoothly thanks in part to the fact that the client, CO Architects, had produced two similar large lab projects like this one before.

Conclusion

Many projects have unique challenges, some more monumental than others. But the most rewarding thing is tackling those challenges together as a team. This project was a huge success because of the teamwork among the owner, architects, engineers, and construction manager, and their willingness to collaborate on solutions.▪

*Michael Brack, P.E. is President of Datum Engineers, Inc., a Texas-based structural engineering firm. Credit for this fantastic project is rightfully shared with his in-house team of Jeremy Klahorst, P.E., Igor Teplitskiy, P.E., Emily Cleland, and Kelly Thibodeaux, as well as the good people of CO Architects, Taniguchi Architects, The Beck Group, and The University of Texas. Michael can be reached at **michaelb@datumengineers.com**.*