A Lesson in Modular

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Collaborative university office space built on collaborative team approach.

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The new modular College of Liberal Arts building at the University of Texas Austin. Photo: Mark Gaynor

The new College of Liberal Arts building provides a centralized home for the largest college on the University of Texas at Austin campus. Before this building, the various College of Liberal Arts departments and its 14,000 students were scattered across the campus. As such, the college lacked a cohesive identity as well as a place to gather for interdisciplinary collaboration. A new building was seen as vital to the college's continued success and enhanced reputation.

The new facility needed to provide 126,000 net usable square feet of mostly departmental office and meeting space in a 200,000-gross-square-foot building. It also needed to link to the new Student Activity Center building directly to the west because the upper floors of that building were being built to accommodate liberal arts space. Additionally, the Student Activity Center would leverage deliveries in part through a new loading dock to be built at the College of Liberal Arts Building.

Through a highly collaborative effort involving the owner, design team, and construction manager, the team delivered a 213,000-gross-square-foot building with 147,000 square feet of net usable space, yielding 17 percent more usable space than originally required. The project came in nearly 13 percent below budget, which enabled the college to keep many programs they originally thought they would have to cut. And it was all delivered to the owner an entire semester early.

The challenge

Traditional funding sources for this sorely needed building were unavailable. But the College of Liberal Arts was so committed to the need for the building, they set out to fund the project themselves through program cuts. That meant that every dollar spent on the building was one less dollar the college would have available to spend on faculty, staff, curriculum, and research.

The design team took up the challenge to create a highly efficient, highly collaborative facility for the client. To do this, the design team's process had to become highly efficient and highly collaborative as well.

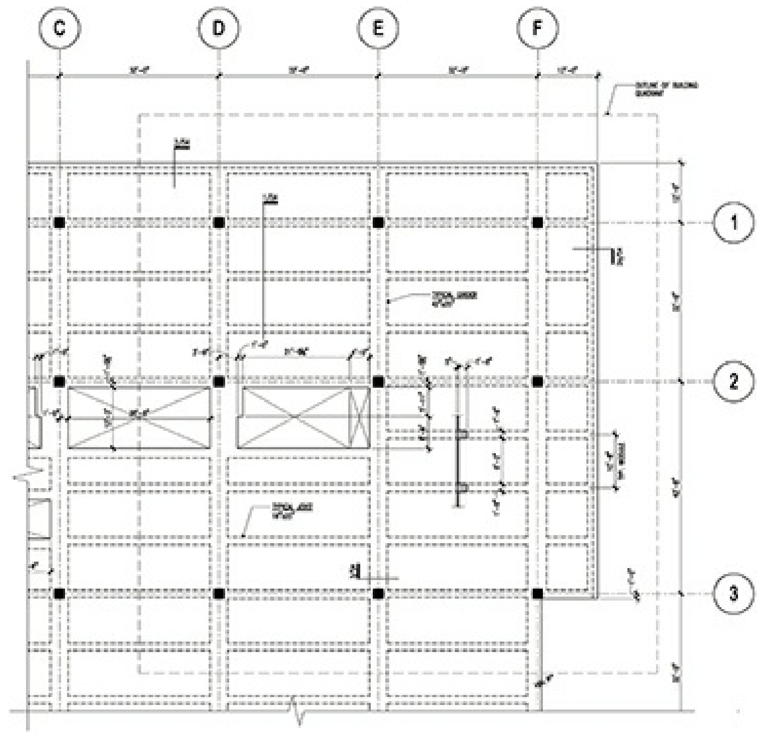

Figure 1: Typical building floor quadrant framing.

The response

A truly integrated design process was crucial; architects and engineers worked collaboratively to maximize the efficiency and effectiveness of the entire building system, rather than simply looking at each design decision in isolation. Several design charrettes were held throughout the design phase to explore concepts for integrating the design. The architects of Overland Partners spearheaded this approach and challenged the other team members to work together closely to understand how their systems could integrate most efficiently and effectively with one another.

Construction Manager SpawGlass participated as a full team member throughout the process, providing real-time feedback on the cost and schedule impacts of various design options and decisions, while leveraging Building Information Modeling along the way. Their contribution was critical to measuring the efficiency of the building as an integrated system so the design team could make informed decisions.

Knowing that modularity and repetition would be effective ways to maximize the efficiency of the building, structural engineers Datum Gojer Engineers, LLC set out at the beginning of the design process to conceive a very regular, repetitive structural system.

Datum Gojer pushed for this idea at the earliest design charrette meeting with the team, and the idea caught on. A 10-foot, 8-inch module was conceived for the building; all building systems were built around this module for efficiency and regularity. The design team also realized a highly modular building with large bays would provide an extremely flexible building for a long-term owner and multi-department college like Liberal Arts.

From there, a formal structural system selection study was performed to ensure the most efficient structural system would be used for this project given the time, location, and market conditions. The team studied two structural steel framing systems, and a cast-in-place reinforced concrete system.

Based on this study, the reinforced concrete system proved to be the least expensive system by itself. In addition, the reinforced concrete system had lower costs for miscellaneous metals, and no premium for lateral stability. It also required a shallower floor-to-floor height, resulting in significant savings by eliminating 6 feet of skin from the height of the building, along with associated long-term energy savings. All of this, combined with its inherent fire resistance, durability, and superior vibration performance characteristics, made reinforced concrete construction an ideal choice for this project.

The system

The floor framing for the building is a 25-inch-deep, reinforced cast-in-place concrete skip-joist, or beam-and-slab system (5-inch-thick slab plus 20-inch-deep pans). Taking advantage of form reuse, the main roof is also framed using this same concrete system, and was designed to accommodate future green roof loads.

Joist ribs are spaced at this same 10 feet, 8 inches on center. Joists span 32 feet (or three 10-foot, 8-inch modules) across five bays in the east-west direction, with 12-foot cantilevers at each end. Girder spans follow a pattern of three and four module spaces, for spans of 32 feet; 42-feet, 8 inches; 32 feet; 42 feet, 8 inches; and 32 feet. Girders also cantilever 12 feet at each end. Post-tensioning tendons were used to control long-term deflections at the cantilevers and long-span girders (Figure 1).


Figure 2: Exterior cantilevered perimeter. Photo: Dror Baldinger

By stretching the bays a little bit for the 32-foot and 42-foot, 8-inch spans, and cantilevering the perimeter bays 12 feet, as many as 20 columns and piers were eliminated from the building design, saving time and labor in the project. In addition, space planning around the perimeter of the building was made more efficient by eliminating the perimeter columns. At the ground floor, the building enclosure was held back from the cantilever, which added the benefit of allowing the upper floors' cantilevered perimeter to provide shaded walkways adjacent to the building (Figure 2).

The highly repetitive, highly efficient flush-bottom modular reinforced concrete system also generated a positive impact on the schedule, with reduced floor cycle times for forming and placement of rebar. This led to compounded cost savings.

Impacts of integration of systems

Perimeter beams are held back from the edge of the building by 2 feet, with a simple cantilevered slab edge, to maximize the amount of daylight that can get into the building, reducing mechanical loads and energy demand from artificial lighting.

The mechanical systems take advantage of the widely spaced beams and the predictable structure depth in the layout of overhead ductwork and piping. This powers the architect's goal of creating a 10-foot, 8-inch typical ceiling height around the perimeter, further maximizing the natural daylight penetration into the building. Furthermore, the shallow flush-bottom structural system provides room for chilled beams to be installed, essentially providing “free” cooling for the perimeter offices by using the chilled water leftover after the main mechanical systems for the core have used it once. This led to an energy savings of 48 percent compared with baseline building designs. The wide spacing of beams also reduces above-ceiling space congestion for ease of access when the chilled beam systems require maintenance.

Creating spaces

Figure 3: Interior concrete stair. Photo: Kelly Thibodeaux

When time came to carve away from the building to create voids in the massing of the building, as well as connecting open spaces in the floor plates inside, the team continued its efforts to maintain the building’s modularity. Datum Gojer gave guidelines to Overland Partners for where the overall building’s rectangular floor footprint could be “subtracted from” without adversely affecting the remaining floor framing. These areas of “subtraction” took advantage of the module of the integrated architectural and structural systems; they ranged from subtracting small cantilevered building corners to entire bays. This allowed the architect to study multiple options with the knowledge that they wouldn’t compromise the structure.

The result was freedom for the architects to carve both exterior portions and interior portions of the building mass to achieve enhanced aesthetics, increased day-lighting to the building’s interior, and reduced unnecessary square footage.

Creating a collaborative space for the users

In a bold move, the architect decided to make all stairways for the building featured elements of the design, rather than hiding them in dark corners of the building and using performance spec steel stairs. All four stairs are open, highly visible reinforced concrete elements, to encourage use and to promote vertical connectivity and collaboration among the users of the building on the several floors.

An interior detail of the new College of Liberal Arts building at the University of Texas Austin. Photo: Dror Baldinger

These four stairs were designed as exposed cast-in-place concrete scissor stairs, supported only at the floors, and kept completely free from the stairwell walls. They are beautiful, impressive design elements, which are highly functional and critical to the success of the building for the users. The monolithic concrete architectural stair construction provides a clean, pure look consistent with the rest of the building. Building occupants use the stairs frequently during the day, helping tie together the various departments on different floors (Figure 3).

Integrated aesthetics, structure, and energy savings

A series of canopies extending beyond the building exterior were strategically located by the architect to further control sun exposure. At the main roof level, a high shade canopy extends nearly 20 feet beyond the column line, creating a shaded terrace at the level below. Exposed structural steel outriggers and splayed struts, maintained on the 10-foot, 8-inch building module, were used to frame this high canopy. Given the long expanse of this canopy, careful placement of splices in the canopy's continuous members were coordinated with the construction manager to facilitate field erection of large shop-fabricated sections, with the added benefit of relieving thermal stresses in the steel as the building cycles through temperature changes. The exposed pieces of steel were modeled to a higher BIM Level of Detail during design to let the "sculpting" of the steel connections happen during the design, rather than during construction.

At several lower levels of the building, smaller "eyebrow" canopies were framed using steel outriggers hung from the cantilevered concrete floor joists. As with the high shade canopy, these eyebrows were used by the architect to control sun exposure. By hanging the outriggers from the concrete joists above, the module was inherently kept intact, and mitigated potential ceiling conflicts with the above ceiling ductwork, plumbing, and conduit. Thermal transmission of both the high shade canopy and the lower eyebrows was studied and ultimately led to the idea of placing a thermal break within the steel outriggers of the canopies, aligning near the exterior wall insulation.

The results

Rick Archer, principal at Overland Partners, summarized the team's work this way: "Because the new College of Liberal Arts Building was being funded by operational cuts in the College of Liberal Arts, the owner asked that the building be delivered as cost-effectively as possible, without compromising quality. To accomplish this, we asked the design team to collaborate across disciplines to optimize the efficiency of all systems, including the structural system. This resulted in a concrete structure that minimized columns and drilled piers, maximized spans, and facilitated long-term program flexibility. It also allowed us to expose the structure in critical, iconic areas such as the open fire stairs. The structural solution was integral to the success of the project — LEED Gold, a semester ahead of schedule, and 13 percent under budget."

UT Austin President Bill Powers called the new Liberal Arts Building "one of our most iconic buildings," which "redefines the campus," and "one of the university's most innovative building projects."

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