Centered on INNOVATION

Facilitated by the successful connection of new and existing steel framing, the Pennovation Center reboots an industrial neighborhood adjacent to the University of Pennsylvania's campus.

BY ANGELA FANTE, PE

ONE OF THE NATION'S oldest and most prestigious universities has made it a mission to bridge the intellectual with the entrepreneurial, with the goal of advancing knowledge and generating economic development.

The focal point of this effort is the 58,000-sq.-ft Pennovation Center, a newly renovated flagship building on the University of Pennsylvania's 23-acre Pennovation Works research development site, located across the Schuylkill River from the school's main campus in West Philadelphia. With the vision of creating affordable laboratory and technology incubator space for recent Penn graduates and other promising start-ups, the university tasked the design team with creating an iconic, anchor building to attract innovators. Specifically, the charge was to renovate and add onto the existing building, the former home of a DuPont paint testing facility. The overall goal for this growing innovation ecosystem is to "bring together the university's researchers with the private sector and start-ups, to foster discoveries, entrepreneurship and new alliances and generate economic development for the region."

Bridging Past and Future

Structured in the classic Philadelphia factory style, the original circa-1953 building consists of a concrete-encased steel-framed structure with 11-ft by 22-ft column grids and a combination of one-way concrete, steel plate and precast plank floor systems. Although the existing frame's gravity load system was robust, no apparent lateral system existed beyond the repetitive beam-to-column shear connections.

The 58,000-sq.-ft Pennovation Center was built as a new flagship building on the University of Pennsylvania's Pennovation Works research development site.

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◀ ▲ Structural engineer Ballinger developed a framing concept comprised of a series of diagonal compression props/columns with corresponding tension ties at the floor levels (or vice versa) in order to minimize the new structure's weight and depth.

▲ The angular nature of the addition created unique interior spaces.

▼ Custom gusset plate connection plan details and sections were provided at each of the 28 distinct connection points.

To provide the iconic design desired by Penn, Matthias Hollwich, principal with HWKN Architects, called for the transformation of the existing industrial building into a focal point, with a faceted northern façade that "bursts from the existing building." Reaching toward the university's main campus to the north, the goal of the illuminated façade was to serve as both "a beacon for the center and the interface where invention meets business." Architecturally, this vision manifested itself into a random, geometrically complex, glass-enclosed north addition, housing a "pitch" presentation bleacher, conference rooms, event space and offices.

A highly complex framing system was called for to bring the design vision to life, with the requirement that the same thickness of existing horizontal banding, created by the existing perimeter concrete-encased steel floor beams, be carried northward into the "bursting" north addition. No beams deeper than 10 in. deep were permitted to frame the entire north addition, which was to appear to cantilever 32 ft at its longest point.

On a tight schedule and strict budget, Ballinger's structural engineers had to issue an early structural steel and foundation package 2½ months after the building was handed over to the construction manager for interior demolition. No drawings of the existing structure were available, aside from the foundation plan and first-floor framing plan, thus requiring extensive field survey in a short amount of time.

Diagonal Design

Rather than rely on heavy, deep cantilevered members to frame the north addition, Ballinger developed a lightweight framing concept of maximum W10×33 wide-flange floor members, and HSS8×8 vertical and diagonal members to frame the north addition. These members were arranged as a series of vertical and diagonal compression props/columns with corresponding tension ties at the floor levels (or vice versa) in order to minimize the new structure's weight and depth. Twenty-eight distinct connection nodes exist: seven column bays wide by four floor levels

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high. Each of the seven new column line elevations were analyzed separately to determine the magnitude of compression or tension in each floor member or prop. Then, depending on the location, magnitude and direction of new loads, new wide-flange horizontal in-plane bracing was inserted within the footprint of the existing structure, where the new structure connected to the existing columns, in order to push or drag the new point loads into the existing floor planes.

The horizontal in-plane bracing is in turn laced back to new diagonally vertical braced frames inserted full-height into the existing building. One of these three new braced frames is exposed to view as part of the raw, industrial interior aesthetic while the other two are hidden within solid walls. At the base of the three braced frames, the tension forces imposed by the new addition accumulate into several hundred kips of net vertical uplift. The bases of the braced frames are encased in 22-ft-long by 30-in.-thick, full-basement-story-height ballast walls, with uplift column base anchor rods.

The structural drawings for the north addition were produced in 2½ months—again, with the design phase beginning on the date that the contractor was allowed access to the building to begin interior demolition, and finishing with the issue of contract documents 10 weeks later. Custom gusset plate connection plan details and sections were provided at each of the 28 field surveyed connection points to allow the compression or tension force to be transferred directly into the new network of in-plane horizontal braces. The project would not have been possible using any other structural material, as concrete would have been too heavy and thick, and wood or cold-formed metal framing would not have met the load demands.

The Pennovation Center was completed in 2016 and has become an iconic feature in the neighborhood with its "disrupted" glass façade. Many of the labs and office spaces are leased, with additional fit-out space coming online soon, and the facility continues to be a popular place to hold events for many organizations. ■

Owner
University of Pennsylvania, Philadelphia

General Contractor
Hunter Roberts Construction Group, Philadelphia

Architects
HWKN, New York (Design)
KSS Architects, Philadelphia (Architect of Record)

Structural Engineer
Ballinger, Philadelphia

Fabricator, Erector and Detailer
Steel Suppliers Erectors, Inc., Wilmington, Del.