The Tower at PNC Plaza is a bold green statement in a historically industrial town.

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Greening STEEL TOWN

Sippel Steel Fab

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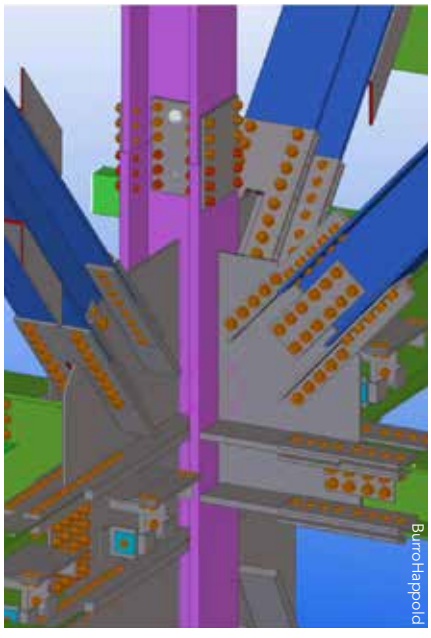
◄ ▲ ▼ ➤ The new 33-story Tower at PNC Plaza sits on a five-story podium and houses more than 800,000 sq. ft of commercial office, auditorium, lobby, cafeteria, parking and amenity spaces. The superstructure is entirely steel-framed, using composite steel beams with a steel braced lateral system.



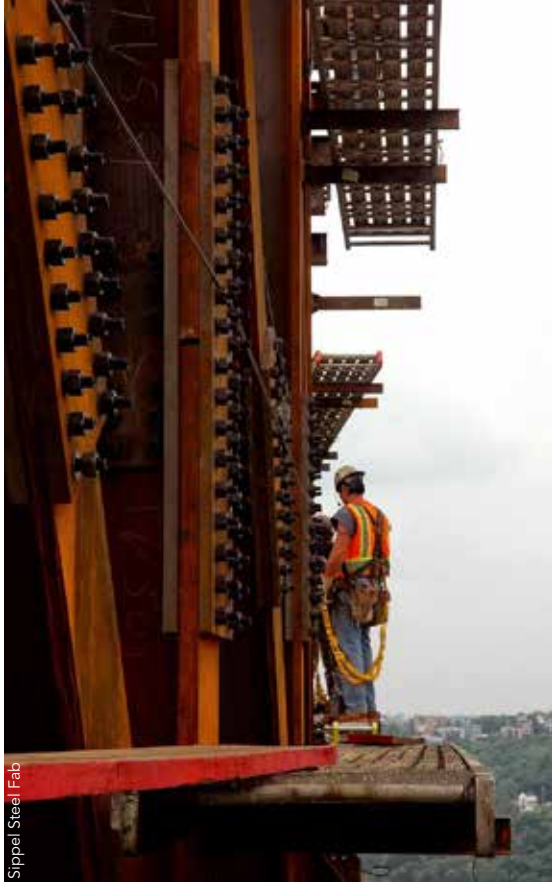
IN ENVISIONING ITS NEW HEADQUARTERS, PNC Bank wanted to set a new standard in sustainable commercial design.

To achieve these lofty aspirations, a holistic design approach was essential. Detailed coordination with architecture and mechanical systems yielded an innovative structure that earned LEED Platinum certification. The new 33-story Tower at PNC Plaza sits on a five-story podium and features nearly 800,000 sq. ft of commercial office space, as well as an auditorium, a lobby, a cafeteria, parking and other amenities. The superstructure is entirely steel-framed, using composite steel beams with a steel braced lateral system. In all, the project uses 8,000 tons of steel and 200,000 bolts.

A Tower that Breathes

One of the boldest sustainable features of PNC Tower is natural ventilation, which allows it to "breathe" passively without mechanical assistance. To achieve this, the design team incorporated two vertical open-air shafts within the central core that extend through the height of the building and terminate at the underside of a 30° sloping roof. Coordination of an efficient two-story, X-braced lateral force-resisting system was crucial to achieving airflow inside the open-air shaft with minimal turbulence.

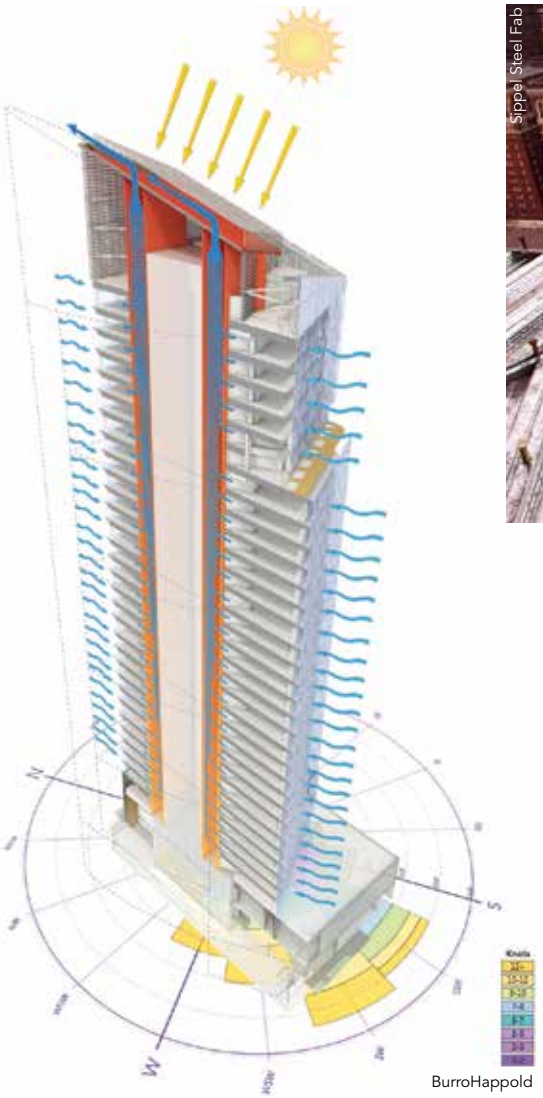
At the tower's top is a striking sloped roof clad in concrete with a glass skylight that creates a solar heat sink that naturally draws air upward through the shaft. In an effort to maximize



▲ ➤ In all, the project uses 8,000 tons of steel and 200,000 bolts.

▼ A diagram of the tower's natural ventilation system.

▲ ▼ The building's owners have hopes that it will be the greenest office tower in the world; it has already earned LEED Platinum certification.



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The tower's steel framing was required to be inboard of the thermal break location to prevent thermal bridging from the outside.

A 120-ft-tall cable-net façade clads the atrium space.

The tower's structural slab edge cantilevers 4 ft, 6 in. beyond the spandrel line to support a double-skin façade.

solar heat gain, the roof grid was offset from the tower grid so the skylight would face the southern sun at an optimum angle. This offset roof grid and the weight of the sloping concrete created a complex engineering problem. The final design creatively used steel framing to achieve long cantilevered spans while providing a structural system that cleverly coordinated the precast panel module, skylight support frame, curved upper catwalk and offset tower grid below.

Living on the Edge

The building's structural slab edge design is unlike any other commercial tower in the U.S. Not only does it cantilever 4 ft, 6 in. beyond the spandrel line to support a double-skin façade, it does so while incorporating a thermal break component embedded within the thin depth of the slab. The two skins of the façade are essential to the natural ventilation strategy while also creating a cavity that was uninterrupted by columns. The thermal break unit consists of several components including insulation, fire protection board, pressure bearings and stainless steel rebar that, when combined together, form a lightweight premanufactured assembly that prevents unwanted thermal transfer between the cavity and the interior space. This helps to reduce energy load on the HVAC system and create a more comfortable working environment.

The design team actively coordinated early in the design phase with the thermal break and façade manufacturers to verify the acceptable location of the thermal break in relation to the façade anchors as well as the structural loads it was to be designed for. Short W10 outriggers were aligned with the infill steel beams inboard of the spandrel line and moment connected to create an adequate back span, which controlled deflection at the slab edge. Shear studs were welded to the W10 top flange to develop composite action between the cast-in-place concrete and structural steel. The steel framing was required to be inboard of the thermal break location to prevent thermal bridging from the outside.

BuroHappold Engineering detailed the steel rebar on both sides of the thermal break in order to achieve proper compatibility between the cantilever concrete slab and composite steel deck floor system. Once construction documents were issued, BuroHappold worked with the general contractor to mock up a typical slab edge condition in order to verify installation sequence and location of façade cast-in anchors, thermal break and steel reinforcement. These mock ups proved beneficial as they enabled the construction of this complex slab edge to keep pace with the steel erection and reduce any negative impact to the construction schedule. The end result is a breathtaking space at every floor that plays a crucial role in the sustainable strategy of the tower.

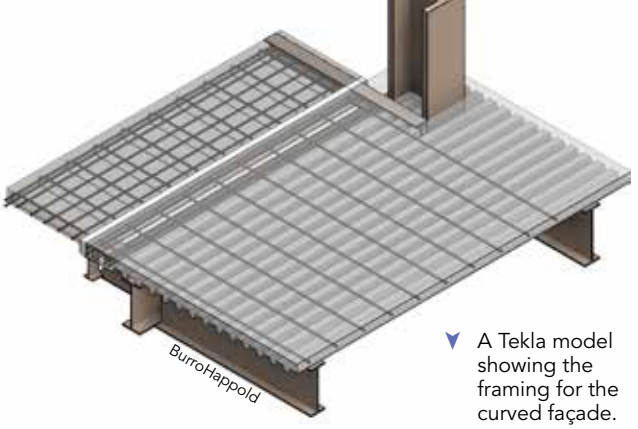
Inspiring View

Groundbreaking sustainable features aside, the PNC Tower works to elevate the typical high-rise

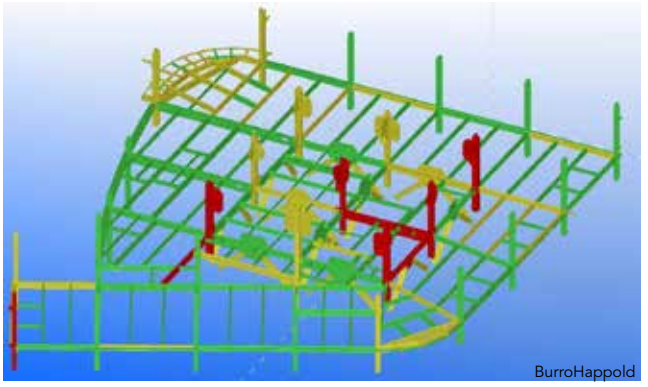
▲ A segmented steel truss supports the cable-net façade.

➤ A diagram of the cantilever slab edge.

▼ The truss supporting the cable-net truss handles 45 tons of cable force at 5 ft intervals along its length.



▼ A Tekla model showing the framing for the curved façade.



workplace environment by creating two-story "neighborhood" spaces on alternating floors. The signature neighborhood space is on the 28th floor, where a five-story atrium overlooks downtown Pittsburgh.

A segmented steel truss spanning 105 ft supports the 120-ft-tall cable-net façade that clads the atrium space. The truss is 23 ft, 6 in. tall with a total weight of 59 tons in six shipping pieces, three upper and three lower. The top and bottom chords are horizontal but curved in plan to match the building exterior. The bottom chord of the truss, at level 33, was temporarily shored from level 28 until fully assembled. The use of 3D modeling, CNC processing and shop preassembly yielded excellent fit-up at erection (the most challenging aspect was the 100% CJP welding of the truss node points).

Consisting of W14 members, the truss supports 45 tons of cable force at 5-ft intervals along its length and engages the floor system at the top and bottom chords to resist substantial torsion induced by the 2-ft eccentricity of the cable forces. This ingenious truss system creates a column-free space with unobstructed views of Pittsburgh's famous three rivers, making it an ideal place for occupants to gather, collaborate and enjoy.

Alternate Delivery Method Saves Time and Money

To expedite the compressed schedule, BuroHappold provided a Tekla 3D steel mill order model to the contractor, PJ Dick, for use in bidding, which allowed for a higher degree of accuracy in steel estimates and gave the client a faster and more competitive bidding process. This mill order model helped to eliminate duplicative modeling and allowed steel fabricator Sippel Steel Fab and the detailers to begin detailing steel earlier, thus saving time.

Unprecedented for a building of this size and type, steel shop drawings were submitted to PNC's team in a 3D Tekla model as the official medium for review as required per the structural steel specifications. This virtual 3D steel shop drawing process facilitated the review of the steel submittals and was especially helpful for review of the complex steel nodes in the lateral system where beams, columns and braces come together in PNC Tower's core and roof, and allowed portions of the model to be reviewed quickly instead of reviewing thousands of 2D PDF files. Tekla's capabilities were leveraged to create customizable reports so the reviewers could easily extract large quantities of information and export into spreadsheets for clearer and faster interpretation of steel assemblies within a given submittal. This 3D in-model-review approach saved significant time and yielded greater accuracy in the review of steel shop drawings. PJ Dick also used the 3D steel fabrication models, with connections included, to assist in a more accurate and rigorous BIM coordination with the architectural and MEP systems, which helped solve coordination issues in the office instead of the field—again, saving significant time.

The Tower at PNC Plaza officially opened its doors this past October and is a shining testament to how a holistic and innovative design approach can advance building sustainability while also reinventing the future of the modern workplace environment. ■

Owner
PNC Bank

General Contractor
PJ Dick

Architect
Gensler

Structural Engineer
BuroHappold Engineering

Steel Team

Fabricator
Sippel Steel Fab

Detailers
Axis Steel Detailing, Inc.
International Design Services, Inc.
Steel Structures Detailing, Inc.