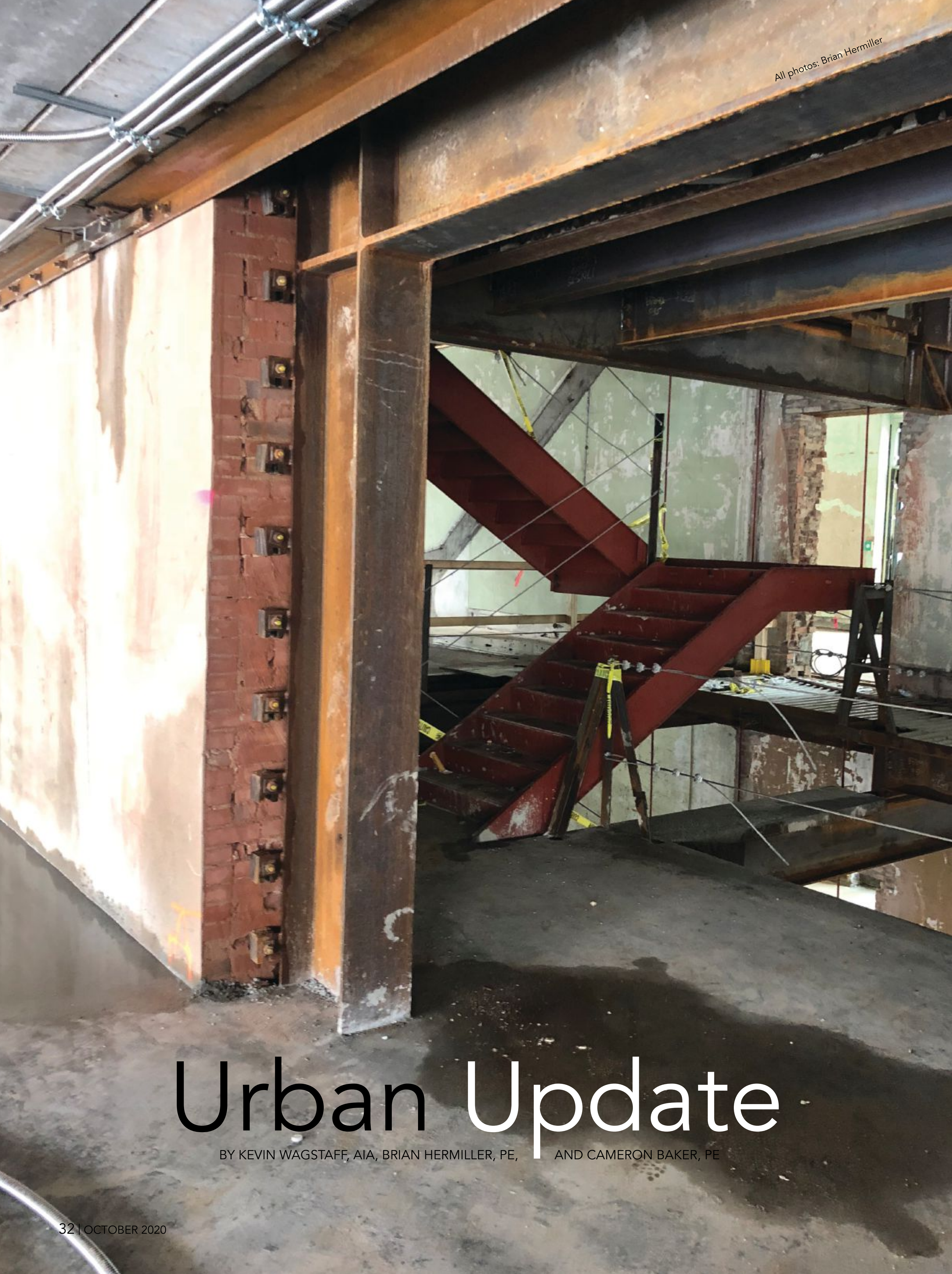

All photos: Brian Hermiller

Urban Update

BY KEVIN WAGSTAFF, AIA, BRIAN HERMILLER, PE, AND CAMERON BAKER, PE

A downtown Pittsburgh structural expansion blends steel history with steel present.

PITTSBURGH'S STEEL STORY continues to this day.

Like many American cities that experienced rapid expansion during the industrialization of the late 1800s and early 1900s, Steel City has many "transitional" structures from that era integrating structural steel framing with various cladding and fire-resistive systems, terracotta floor and wall systems, mass masonry, and wood.

These structures are generally considered to have maintained robustness for floor loading, but the way systems were originally integrated does not lend to easy structural modification for adaptive reuse. In addition, the refined craft and preservation skills needed to work with these historic materials make them challenging to maintain and modify.

The McNally and Bonn Buildings in downtown Pittsburgh are two such transitional structures. The buildings, both eight stories with full basements, were built in the 1890s and encompass a combined total of 65,600 sq. ft of space. Both are long, slender structures with footprints approximately 25 ft by 140 ft. The McNally Building has perimeter masonry bearing walls and structural clay tile flat arch floor and roof construction supported by steel beams that span the width of the building. The Bonn Building has perimeter masonry bearing walls and wood floor deck supported by timber joists that span the width of the building. In fact, the two buildings share a masonry bearing wall.

And now they share much more. The $35 million Eighth and Penn project has combined these two historic structures with two new steel-framed buildings to create a total of 173,100 sq. ft of mixed-use space featuring 136 apartment units and street-level retail and restaurant space. The resulting structure is an elegant ensemble with an exterior that appears as a collection of old and new buildings and an interior that functions as a single building.

The design presented a number of unusual and complex structural challenges, including:

- Integrating a new vertical circulation system to serve three different floor-to-floor heights in a single core
- Integrating old and new at the interface between the existing structures and the new construction
- Maintaining the structural integrity of the mass shear walls of the historic buildings while removing large sections to make connections to the vertical circulation core in the Bonn Building

New Vertical Circulation

For optimal circulation and to maximize natural lighting in the apartment units, the new stair and elevator core were centrally located within the existing Bonn Building. Because the floors in the historic buildings and the adjacent addition do not align, the core was made accessible from four sides on each floor, with a front and rear opening elevator, ramps, and steps resolving the varying floor elevations at each story. And because the difference in floor elevations is inconsistent throughout, unique steel framing solutions were devised for each level of the new core. Each of the access points to the core required different steps and ramp designs at most levels. In order to accommodate these varying elevations throughout while maintaining clearances above and below, the team designed and fabricated mitered steel "Z-beams" that span the width of the Bonn Building. Posts and hangers were also used to support beams that could not span across the width of the building without causing interferences, even with a mitered beam configuration.

Connecting Historic to New Construction

The new portion of the project consists of two wings. The 11-story main wing, directly abutting the Bonn Building, is similar in height to the historic buildings but has lower floor-to-floor heights, allowing for three additional stories in the same building height. The steel framing cantilevers from the new column grid to avoid imparting gravity loads on the existing wall. The second wing, the rear wing, is seven stories

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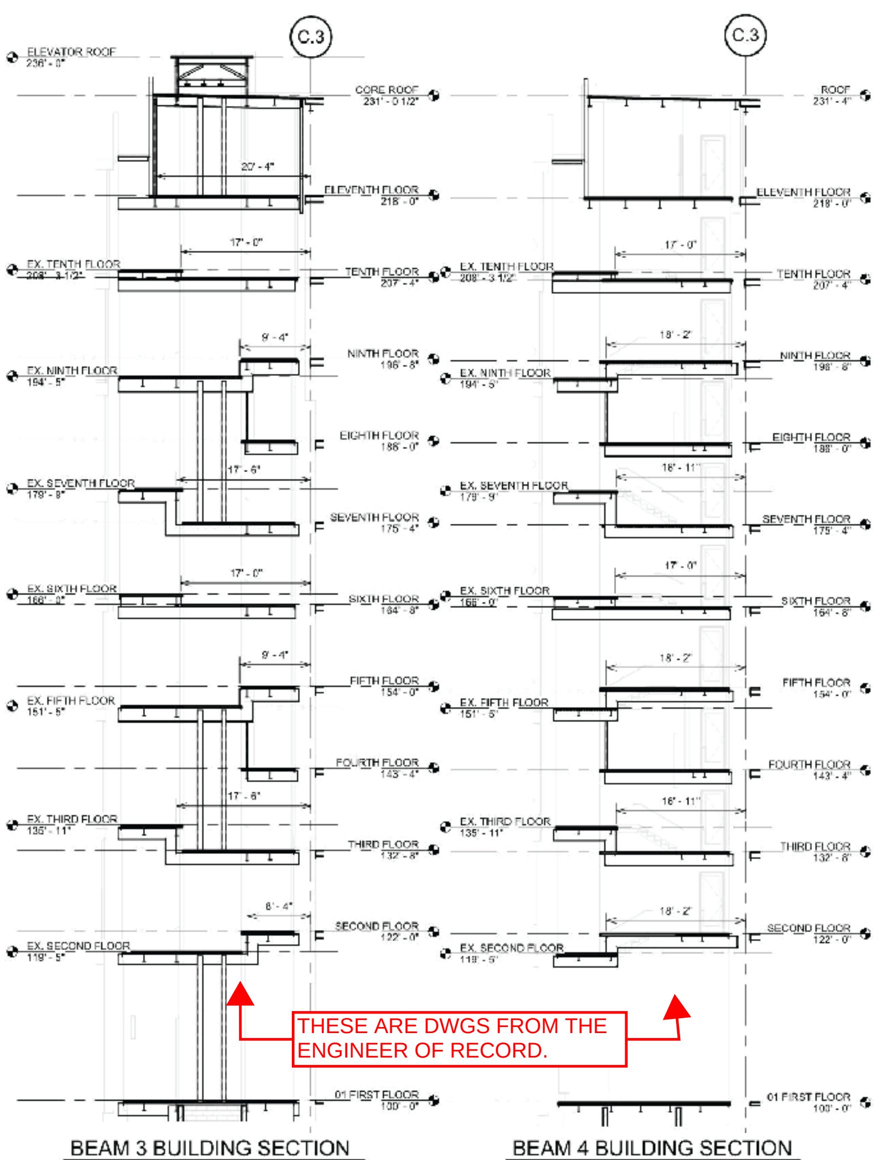
In order to accommodate varying elevations while maintaining clearances above and below, the team designed and fabricated mitered steel "Z-beams" that span the width of one of the existing buildings.

with a usable green roof and a connecting element to the main wing that bridges over a public walkway. The new portion uses a grout-topped hollow-core concrete plank floor system supported by a 700-ton structural steel frame and is stabilized by shared existing shear walls and moment-resisting frames.

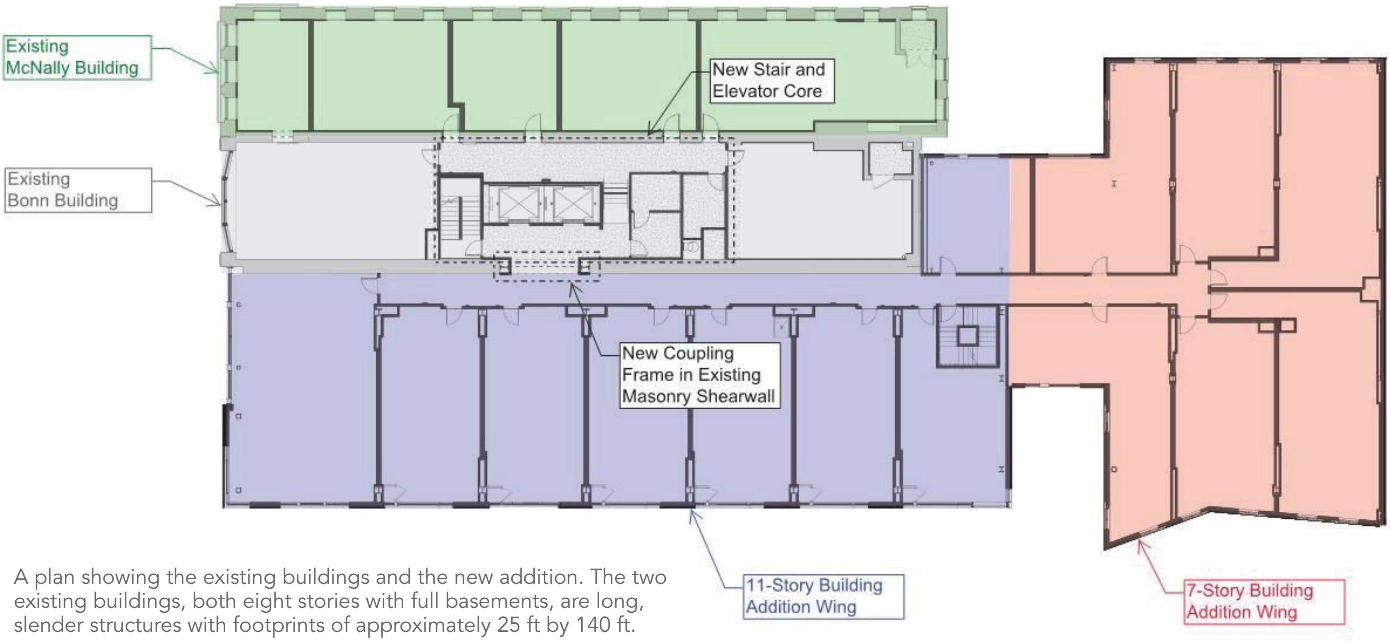
The uneven surface of the Bonn Building's exterior masonry wall also created a challenge, especially since the height and scale of the elevation did not lend itself to conventional survey techniques. To overcome the challenge of connecting to this uneven surface, the general contractor retained local firm Cadnetics to create a 3D point cloud of the existing wall to map the existing conditions. The steel detailer (Sippel Steel, also the project's steel fabricator) then used this data to coordinate the final dimensioning of new steel framing with the existing conditions. The 3D point cloud allowed Sippel to adjust the length of the cantilevers throughout to the surveyed location, and a field adjusted pour stop allowed the erector to close the gap after erection and plumbing of the frame were complete but before the hollow-core plank was grouted.

Reestablishing Lateral Integrity

The two historic buildings relied on perimeter brick masonry shear walls for lateral stability in their long direction. Early in the project, it was determined that these existing shear walls would be sufficient to brace both the new and existing construction in one direction once the addition was completed. However, as the design of the stair and elevator core evolved, it was necessary to remove a large section of the masonry between the Bonn Building and the main wing of the addition, essentially breaking one long wall into two shorter shear walls. A Vierendeel-style steel coupling frame was installed to reestablish the connection of the two resulting shear walls with comparable stability to the original wall.



Where the Z-beam framing scheme could not clear span the building, posts and hangers connecting to adjacent levels were used to support the framing.



A plan showing the existing buildings and the new addition. The two existing buildings, both eight stories with full basements, are long, slender structures with footprints of approximately 25 ft by 140 ft.

To stabilize the original shear wall, the designers and construction team had to carefully coordinate demolition sequencing for the existing wall segment, installation of the coupling framing, and erection of the new construction. To maintain overall building stability, wall demolition was not performed until the new construction was completely erected and the permanent lateral system was established. Sections of the coupling frame were lowered into position by crane between the new and existing structures. Crane capacity and reach and shipping size limitations were constraints that drove fabrication decisions for the coupling frame, and splice

1. The two existing buildings prior to construction of the new portion.

2. Erection of the 11-story addition.

locations were chosen to eliminate field welding, which would have been nearly impossible given the location of the frame between two completed structures.

In the short direction of the existing buildings, there was inadequate lateral bracing to meet lateral loads mandated by today's building codes. Improving or supplementing the existing shear walls was determined to be cost-prohibitive and impractical without significant disturbance to the buildings' historic architecture. Therefore, a new lateral load resisting system was designed for the new building to provide stability for the entire completed ensemble. Steel moment-resisting frames were selected to accommodate expansive glass facades and the open first-floor plan. Drift limitations higher than those mandated by code were necessary to assure deformation compatibility with the existing masonry walls and to minimize second-order effects that result from the mass of both existing buildings leaning on the new structure.

3. The new steel is topped out.

4. Substantial completion of the new addition.

The Eighth and Penn project is an example of a creative structural adaptation that brings modern amenities, accessibility, and resiliency to a historic building while maintaining the urban fabric of a vibrant downtown area. It's an excellent illustration of the flexibility of structural steel as a framing option to solve complex geometric challenges when joining old to new. ■

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