Lofty Ideas

By Oliver Osterwind

The conversion of a vintage New York City warehouse into condominiums included adding four floors and creating a dramatic cantilevered addition—all framed with structural steel.

The Porter House, located on the corner of 9th Avenue and 15th Street in New York City, is at the junction of three historic yet vibrant and growing neighborhoods: Chelsea, the Meatpacking District, and the West Village. Originally, the seven-story structure, built in 1905, served as a warehouse and was used for wine storage. Since then, it has lent itself to a variety of purposes—most recently a furniture factory and artist studios.

The program was to convert the structure into a condominium building with 22 high-end residential units. SHoP architects proposed a residential conversion with an addition of four stories and a penthouse. To comply with New York City zoning laws, the addition had to incorporate a 15′ setback from the adjacent street and a 10′ setback from the adjacent avenue in order to reduce the loss of natural light at street level. This loss of square footage within the addition was partially made up by purchasing the air rights above an adjoining low-rise building to the south and creating a dramatic cantilevered section of new structure. Including this cantilevered portion, which starts at the fifth floor of the original building, the expansion added approximately 21,000 sq. ft to the existing building, for a total of 55,000 sq. ft.

The primary structure of the base building consists of a load bearing perimeter brick exterior wall and cast iron columns on spread footings. The floor system is made up of two layers of heavy timber planking on 10″ x 14″ solid timber joists of yellow pine spaced at 4′ centers. These frame into 18″-deep steel girders, which in turn are supported on the circular cast iron columns and walls on a 16′ grid, which reduce from a 12″ diameter at the basement level to 7″ at the roof level.

In renovation cases like this, the New York City Building Code mandates that any new construction be non-combustible and that the additional floors be separated from the old by a fire-rated barrier. Therefore, it was decided to construct the new floors out of concrete slabs on metal deck supported on a steel frame.

The new residential use of the building generates only a fraction of the warehouse design loads of the original. Field measurements, supporting calculations, and subsurface investigations suggested that the lower four stories of columns, including their foundations, as well as

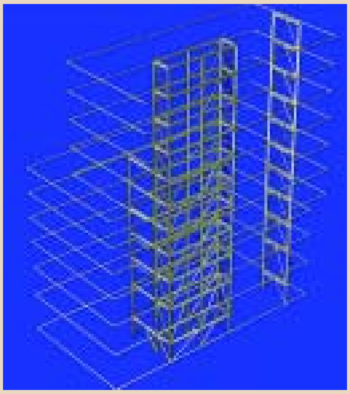
This one-story tall steel truss supports the cantilevered addition by suspending it from above.

the exterior walls, were able to support the additional gravity loads.

A unique, lightweight façade system helped limit the weight of the addition as well. It is a composite system of exposed zinc panels mounted on a cold-formed steel frame spanning between floor slabs.

The new steel columns of the braced frames were placed into the existing column grid where possible to minimize the loss of existing floor framing. This had numerous implications in the construction process, the most significant being that it was necessary to implement an elaborate steel shoring system to temporarily support the existing structure while the old columns were removed and replaced by the new ones. The shoring system had to provide temporary vertical and lateral support not only to seven stories of existing floor framing, but also to large areas of exterior brick wall.

Because the unreinforced exterior brick walls that comprised the original lateral-force resisting system were inadequate, a new steel core provides lateral stability to both the existing building structure and the addition, and also supports some gravity loads.



A new central steel core provides lateral stability to the original structure and counteracts the overturning forces from the cantilever addition (not shown in this model).

The cantilevered portion of the addition resulted in a permanent overturning force. The addition is supported on a one-story tall steel space truss propped on the southern exterior brick wall and tied to braced frames. The wall was reinforced with a concrete bond beam at the level where the cantilever started, and with concrete piers that extended to the original foundation wall. This configuration assures support to the cantilever during a seismic event, sacrificing the brick in the south wall.

Overall, approximately 225 tons of steel were consumed. Eighty-five tons went into the braced frames and 25 tons went into the cantilevering space truss.

To give the existing structure stability, the original path of lateral forces had to be reversed from collecting at the exterior masonry walls to collecting at the new steel braced frames in the center. A continuous plywood floor diaphragm was laid over the existing timber flooring and any new infill framing at the lower floors. The exterior brick walls were then tied to the diaphragm along the entire perimeter of the building with steel straps anchored into the brick and nailed to the plywood floor at 4′ centers. The floors were then tied to the braced frames through collector beams running in both directions. The collector beams were outfitted with nailers bolted to their top flanges.

This new building geometry—a series of new floor slabs with a relatively large footprint and a comparatively narrow, centrally located core—leads to large uplift and compression forces within the braced frames. In order to deal with overturning under lateral loads, the braced frames were supported on small piles, capable of resisting both tension and compression forces, tied together by pile caps. Each pile consists of one #20 high-strength deformed steel bar inside an 8.5″-diameter concrete casing. The piles were extended into the bedrock at approximately 50′ below grade and essentially served as rock anchors capable of supporting compression loads through side friction. The design forces for the piles were 100 tons in tension or compression.

The actual erection of the structure proved to be a challenge, as the process of weaving two structures together to form one created a host of technical problems. Field fixes and modifications to the construction documents were handled by an on-site structural engineer from Buro Happold, virtually eliminating the need for RFIs. All construction issues could be dealt with on the spot, in the form of field sketches and direct instructions, and could be incorporated into the shop drawings in a real-time manner. Regular site presence also expedited the EOR's review of temporary works proposals by the coordination of structural stability inspection work.

From design to completion, the Porter House project remarkably required a mere 15 months, with the installation of the foundations and superstructure taking only seven months. Numerous elements contributed to this fast-track schedule. First and foremost, the excellent condition of the original building allowed construction to commence without delays from remedial repairs. The continuous site presence by both the architect and the structural engineer ensured quick resolution of the construction issues that were bound to arise while breathing life into an old building—and enriching it with a new one. ★

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