National "Truss" for Historic Preservation

Courtesy of Silman

A new truss brings structural modernization to a century-old Washington apartment building.

BY JASON MYERS, SE, PE, SHANE MAXEMOW, SE, PE, AND TIMON HAZELL

1789 MASSACHUSETTS AVENUE NW has housed the high society of Washington, D.C., for more than a century.

One of the oldest luxury apartment buildings in the city, it has been home to several distinguished individuals over the years, including millionaire industrialist and art patron Andrew Mellon. And in 1976, it became home to the National Trust for Historic Preservation.

In recent years, the owner proposed long-needed repairs and modernizations. These included a new penthouse above the existing roof and a full floor added below the original historic building footprint.

New Truss

From a structural and architectural standpoint, perhaps the most notable feature of the building was a new assembly space, which required the removal of multiple columns at the first floor. But how to do it? Introducing traditional transfer beams would have disrupted the historic exterior and required a lower ceiling height in the new space. Instead, structural engineer Silman devised a story-deep truss, incorporated into a corridor wall on the floor above, to transfer loads in the direction parallel to the long dimension of the assembly space. This counterintuitive solution maintained the ceiling depth, moved the work zone away from historically sensitive areas and greatly reduced floor deflections that would have potentially endangered some historic finishes.

In most truss designs, configuration of the connection geometry is equally important to the optimization of member

Jason Myers (**myers@silman.com**) is an associate, **Shane Maxemow** (**maxemow@silman.com**) is a senior engineer and **Timon Hazell** (**hazell@silman.com**) is a senior BIM engineer, all with Silman.

Multiple existing columns were removed at the first floor to create a new assembly space, and a story-deep truss was incorporated into a corridor wall on the floor above to transfer loads in the direction parallel to the long dimension of the new space.

Courtesy of Silman

sizes. This was even more the situation with this particular truss. The conceptual design of the truss started with the existing steel structure. The goal was to incorporate as much of the historic steel structure into the truss as possible, and where not possible, to envelope the existing steel to minimize protrusion into architectural space.

An advantage of steel construction is this ability to implement connections that accommodate varying existing steel construction. The 72-ft-long, 14-ft-deep, 20-ton truss incorporates existing historic steel columns as truss verticals and support columns. The existing columns were 10H and 12H sections, oriented in different directions. Therefore, 12-in. wide-flange sections were chosen for the top chord, oriented web-horizontal and nested underneath the existing third floor beams. This allowed the connection plates to sandwich the existing columns and align with the chord flanges for a simple full-penetration weld. The floor beams at the bottom chord were removed and replaced with 12-in. wide-flange sections, oriented web-horizontal and connected through the columns like the top chord. Truss diagonals were also chosen to be 12-in. wide-flange web-horizontal sections, thus allowing the connecting gusset plates to align with top and bottom chord flanges and top and bottom chord sandwich plates.

The existing support column to the east was reinforced for the additional load by boxing the column with steel plates. This allowed the gusset plate for the chord and diagonal to sandwich the existing column and bear directly on the reinforcement plates. The existing support column to the west had a plan offset of 1 ft to the north, which allowed a new steel column to be nested adjacent to the existing and take the entire load of the new truss.

An additional challenge was ensuring that the existing column splices were stable for the truss verticals with compression and could transfer tension when needed. To accomplish this, the gusset plate connections were extended up and a sequence was devised to remove existing cap and splice plates that protruded from the face of the columns while attaching the new gusset plates.

All truss work was completed with the existing structure in place, except for the floor beams that were removed for the bottom chord. The existing steel columns were hydraulically jacked within the first floor to remove load, then thermodynamically cut in a sequential controlled process. The jacks were then released to allow the truss to engage. Actual deflections at column locations immediately after column removal were ⅛ in. less than analysis predicted given the actual state of the structure above.

Reinforced Stair

Another notable feature of the design was the central historic marble-clad steel stair. The ability to make sensitive surgical modifications to the existing steel stair with new steel elements allowed it to become a feature of the building. This stair, partially supported by corner posts from an elevator to be removed, required new supports to be hidden from view. New HSS columns were placed behind the existing stair wall, with plates cantilevered to the inside corner of the stair to provide support for the existing steel plate stringers where the elevator posts were removed. Each outside steel plate stringer was notched to accept two kinked 1-in. by 7-in. steel plates, one on each side of the HSS column, to slip through and connect to the inside corner of the stair stringers.

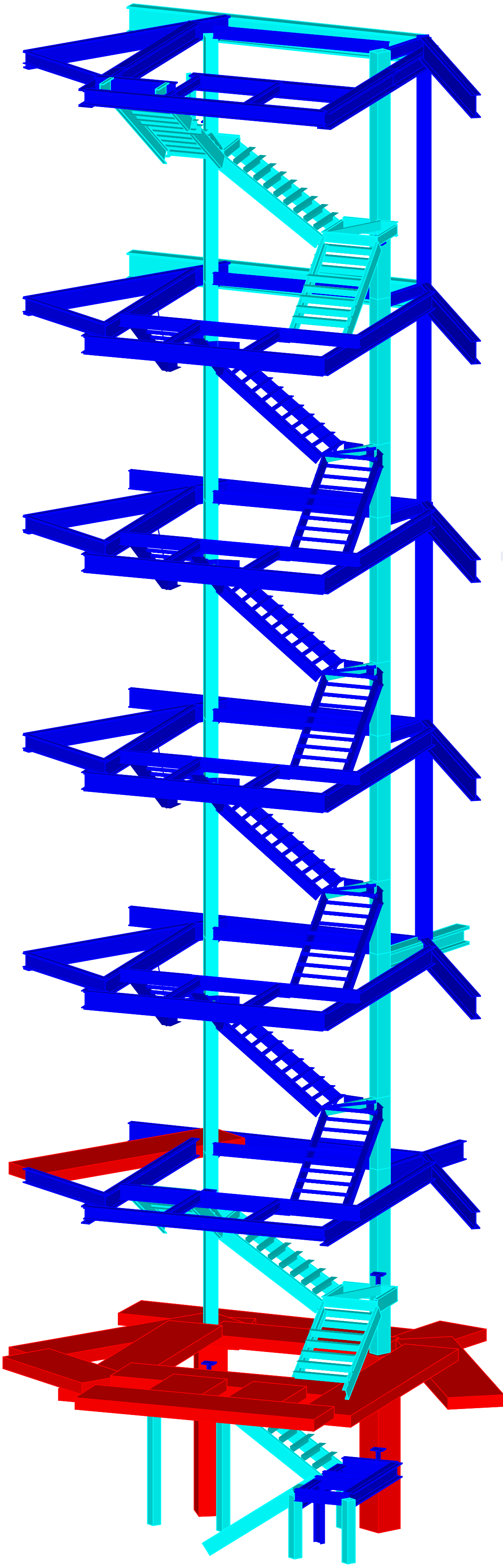
New Support from Below

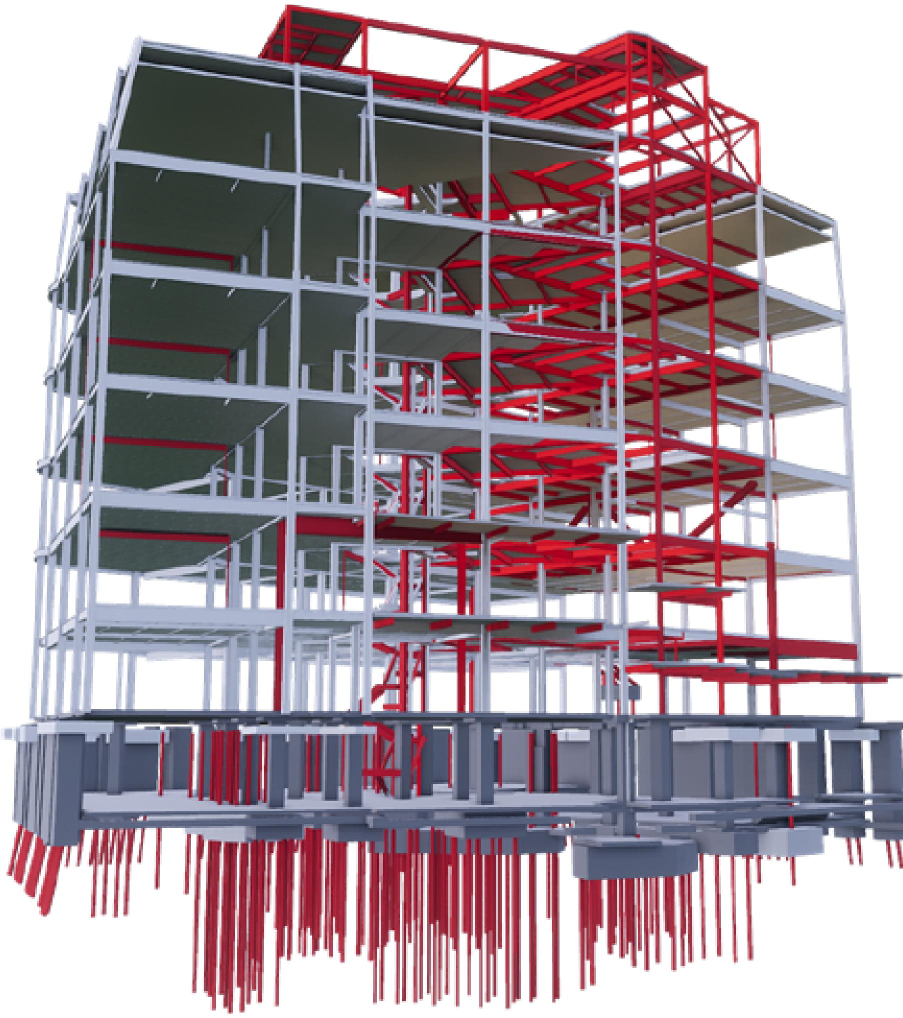
A third notable feature of the project was the full-story excavation beneath this historically sensitive building. The design for 1789 Mass. Ave. required an approach that maintained a high level of sensitivity to the historic integrity of the façade and other nonstructural elements while incorporating heavy load transfers and aggressive excavation. Interior columns were re-supported on new 9 ⅝-in.-OD steel micro-pile groups (four per column) drilled through existing foundations prior to excavation, with wide-flange steel grillage spanning from micro-pile to column. This steel grillage was used to hydraulically jack load into the micro-piles prior to excavation. The micro-piles were socketed 15 ft into rock that was approximately 20 ft below the lowest level. As excavation proceeded, the micro-piles were temporarily laced together with steel angles and gusset plates for stability.

Once the bottom of the new excavation was reached, a new pile cap was placed around the piles, and the load was hydraulically jacked into a new column extending to the lowest level. New basement walls combined traditional underpinning pits along the perimeter extending down to engage new steel micro-pile foundations in order to limit differential settlement. Throughout the process, building conditions and movements were monitored continuously to establish movements rela-

Courtesy of Silman

The new truss incorporates existing historic steel columns as truss verticals and support columns.





above: Model views of the stairwell and entire building, showing new (red) and existing (gray) steel framing.

left and below: The central historic marble-clad stairwell, partially supported by corner posts from an elevator to be removed, required new supports to be hidden from view. New HSS columns were placed behind the existing stair wall, with plates cantilevered to the inside corner of the stair to provide support for the existing steel plate stringers where the elevator posts were removed.

Courtesy of Silman

Interior columns were re-supported on new steel micro-pile groups (four per column) drilled through existing foundations prior to excavation, with wide-flange steel grillage spanning from micro-pile to column.

Courtesy of Silman

tive to those predicted, and contingencies were made for anticipated levels of repairs.

In addition, a nonlinear analysis was implemented to evaluate both the contribution of the existing masonry façade on the lateral/torsional resistance of the steel-framed building and to limit damage to the historic façade under seismic forces thereby reducing internal lateral force-resisting elements.

The success of the modernization was entirely dependent on having a highly qualified design team to perform thorough initial investigations into the historic construction as well as the geotechnical conditions at the site. Steel material testing was performed to understand weldability and inform methods to connect new steel to historic steel (165 tons of new structural steel was incorporated in all). These initial investigations and tests were critical to understanding the nature and sensitivity of the structure to settlement-induced damage, the potential foundation options and the risks of immediate and long-term settlement at the point of transfer of loading.

The historic fabric of this National Historical Landmark was paramount during renovation of the structure. Through advanced analysis techniques, intimate knowledge of historical steel within the structure and careful execution of sensitive modifications to and with steel, the beauty of this landmark was preserved. ■

Owner
American Enterprise Institute for Public Policy Research

General Contractor
Grunley

Architect
Hartman-Cox Architects

Structural Engineer
Silman

Specialty Foundation Contractor
Berkel & Company Contractors

Steel Fabricator, Erector and Detailer
Superior Iron Works AISC CERTIFIED FABRICATOR