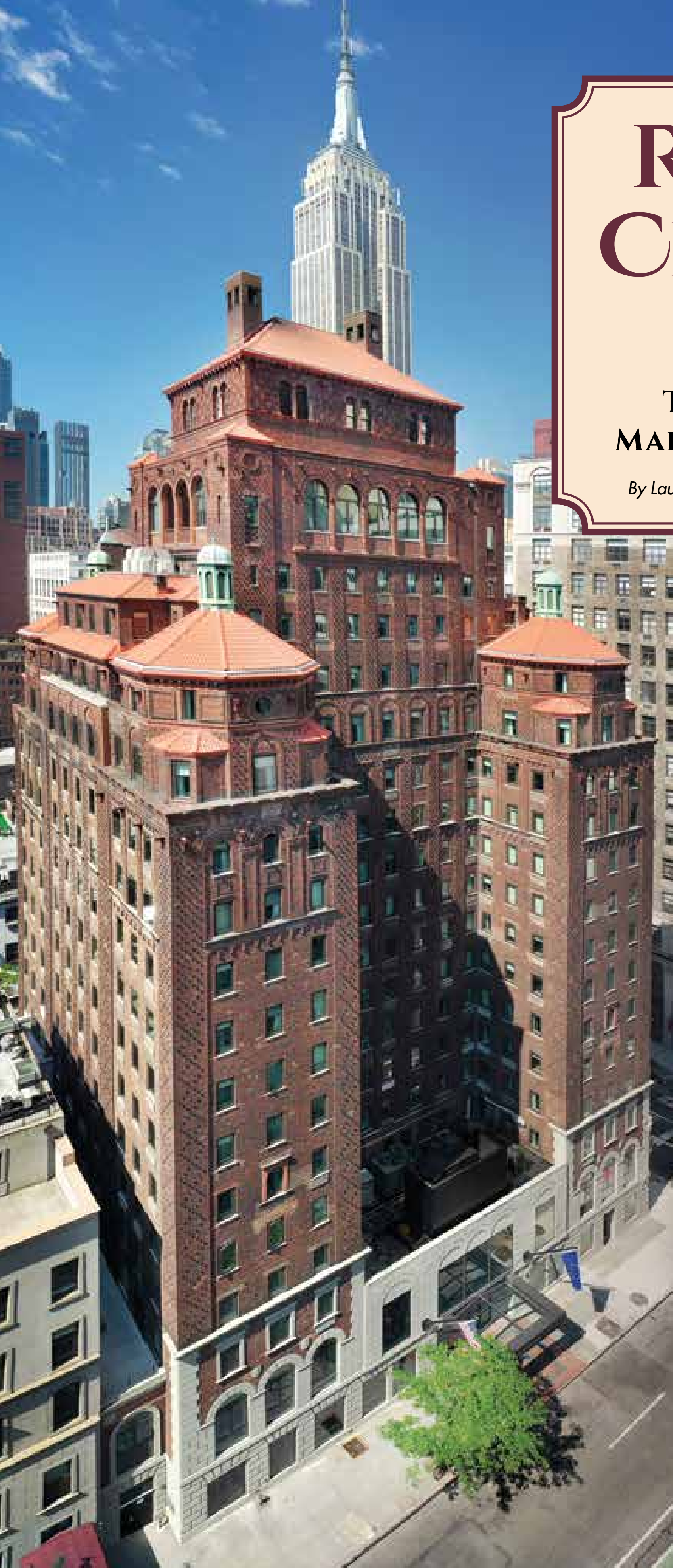

Restoring a Century-Old Building

The NH Collection New York Madison Avenue Hotel Renovation

By Lauren Feinstein, P.E., Jordan Weinstein, P.E., and Kevin Poulin, Ph.D., P.E.

The newly renovated NH Collection New York Madison Avenue Hotel, located at 22 East 38th Street in Midtown Manhattan, is housed in the former Renaissance Revival-style Fraternities Club Building constructed in 1923. The seventeen-story building is approximately 125 feet wide by 100 feet long by 220 feet tall and has multiple setback roofs. The NH Hotel Group, SA (NH) hired Simpson Gumpertz & Heger, Inc. (SGH) as the Engineer of Record, and HLW International, LLP (HLW) as the Architect of Record, to modernize and transform the hotel. The work included creating two double-height lobbies, updating the facilities, and modernizing the guest rooms. These upgrades required strengthening and repairing the existing structure. NH engaged Newgrange Construction (Newgrange) as the contractor for the renovation.

Without the benefit of design drawings from the original construction, SGH investigated and documented the existing building structure – a transitional masonry superstructure (a historic hybrid system comprised of a steel skeleton embedded in the exterior brick masonry walls) with draped-mesh, cinder-concrete floor slabs. Since the hotel remained open during the investigation phase, surveying the existing conditions could not disturb the guests or affect the architectural finishes. As a first step, Langan Engineering, Environmental, Surveying, Landscape Architecture, and Geology, DPC (Langan) was retained to survey the columns and perimeter masonry walls, and SGH performed localized ground-penetrating-radar (GPR) surveys to locate existing steel beams. SGH also used a comparative-loading analysis, where possible, to eliminate the need for additional probes and subsequent analysis of the structure. SGH strategically documented probes at a limited number of back-of-house locations to obtain representative steel column sizes and beam sizes for analysis. They targeted areas critical to the design and planned to verify the remaining structure during construction.

As the contractor removed interior finishes during construction, SGH discovered the undocumented structural history of the building and encountered a series of unforeseen conditions. For example, despite assumptions about uniform floor plans, the beam layouts varied substantially throughout the building, leading the project team to address an unexpected scope of strengthening and repair, in addition to several redesigns, during construction.

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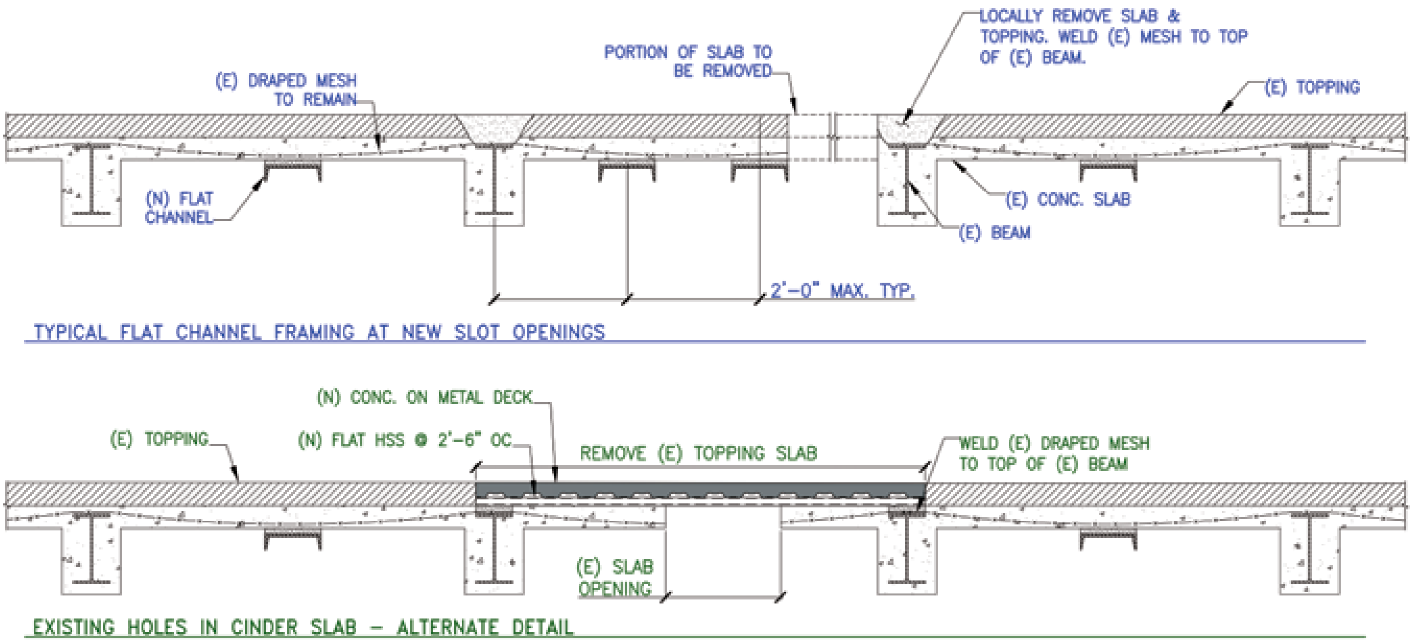

Figure 1. Draped-mesh cinder-concrete slab strengthening details at floor penetrations

The original structural scope of work for the transformation consisted of redirecting lateral loads around two new double-height lobbies, designing an interior steel-framed glass vestibule, and adding rooftop dunnage to support a new generator, screen wall, and mechanical units. The scope of work also consisted of framing slotted slab openings at new MEP penetrations at all floors and infilling existing double-height spaces with new steel framing and concrete-on-metal-deck slabs to increase the usable floor space.

SGH considered several issues for new openings in the draped-mesh cinder-concrete floor slab. The existing floor system typically consisted of a 3-inch-thick non-structural cinder fill with a 1-inch cement topping slab over a 4-inch-thick structural cinder-concrete slab with draped, steel-wire mesh that spanned one-way between encased steel beams. The draped steel mesh supports the slabs via catenary action. The 1968 *New York City Building Code* (NYCBC) governs modifications to archaic structural systems used on this project and specifically addresses openings and penetrations in this type of floor system. According to the 1968 NYCBC, a single opening greater than 18 inches or multiple openings totaling over 18 inches in any 10-foot width or span of slab must be framed. As the creation of new floor openings comprised a large portion of the structural scope, SGH proposed two options (topside and underside) for slab strengthening (*Figure 1*). Both details satisfied the architect's strict head-height criteria and avoided increasing the floor load enough to trigger additional beam strengthening. The cinder fill was removed locally and replaced with a thin slab on deck that spanned to shallow HSS beams for the topside repair option. This system bypassed the existing slab and was supported entirely on the existing steel floor framing. For the underside repair option, the existing slab spanned as plain concrete between flat channels tight to the underside of the slab spaced at 2 feet on-center.

Additionally, the 1968 NYCBC quantifies that when the mesh is continuous over steel beams at both ends (i.e., middle spans), the slab has approximately 40% more capacity than an equally reinforced end span. For new openings exceeding the above threshold for opening size, SGH reanalyzed cinder-concrete slabs in bays adjacent to the bay of the opening, as end spans due to the discontinuity in the mesh, and designed strengthening, as required. For strengthening adjacent bays, SGH designed a flat channel at the midspan of the bay. While SGH initially intended to use these details for new floor openings, the details were also applicable when the contractor discovered numerous, closely spaced large floor openings from prior renovations that required

Figure 2a. Section loss at corroded cellar steel beams

Figure 2b. Cellar slab deterioration

Figure 3. Cellar column temporary bracing.

support. This unforeseen condition accounted for approximately half of the floor strengthening.

Another unforeseen condition, concealed by ceiling finishes, was extensive corrosion and deterioration in the cellar floor. Maintenance staff informed the project team that steam pipes leaked for decades in the cellar and subcellar. This triggered a thorough investigation of the cellar structure to assess its condition. As shown in *Figure 2a*, some of the steel beams had nearly complete section loss. As shown in *Figure 2b*, all that remained of the wire mesh in deteriorated sections of the slab was rust staining on the concrete. After the contractor installed temporary shoring, SGH visually surveyed the underside of the cellar slab, looking for spalled or cracked concrete, and requested that the contractor sound these areas to locate additional delamination within the slab. SGH also identified steel beams with cracked concrete encasements that indicated expansive pressure from corrosion. SGH directed the contractor to remove the encasements and grind the corrosion to bare metal at these beams. SGH then measured and documented the remaining cross-sections and determined whether strengthening was necessary. This survey led to the removal and replacement of approximately half of the cellar slab and framing, in addition to some local strengthening of corroded steel columns.

Seven perimeter columns relied on the deteriorated portion of the cellar floor structure for bracing. For temporary bracing prior to slab removal, SGH designed a new grid of horizontal, inclined, and skewed steel braces, just above the existing cellar floor (*Figure 3*), which connected the affected columns to the remaining floor diaphragm, avoiding obstacles such as slab steps and floor openings. In addition, SGH designed replacement beams and slabs and worked closely with the contractor to sequence piecewise beam and slab demolition and replacement to ensure that the existing columns were continually braced during reconstruction.

As part of the architectural transformation, HLW designed two large floor openings, the larger of which was 55 feet long by 35 feet wide in the second-floor slab, to create a spacious double-height lobby for the hotel (*Figure 4*). Several floor beams needed to be removed to create this space, resulting in seven columns becoming unbraced in one or both directions. SGH designed plate reinforcing for these columns to strengthen them for their newly doubled unbraced lengths. SGH sequenced the installation of the strengthening plates to avoid temporary shoring of the columns; the contractor locally cut the flanges of the existing beams at the connections to the columns and installed slotted strengthening plates around the beam webs. The contractor demolished the slab and floor beams only after installing all column strengthening.

In addition to strengthening the columns, SGH redirected the lateral loads around the new large openings in the second-floor diaphragm. The original lateral-load-resisting system consisted of semi-rigid moment connections and masonry shear walls. SGH designed WTs to be installed below the existing slabs to redirect the lateral loads around the openings and back to a continuous line of columns. At the exterior of the building, where the demolition for the double-height space would disconnect columns from the diaphragm, SGH retrofitted the existing connections to create a new moment frame to resist the redirected lateral loads. At this moment frame, SGH designed single-sided channel strengthening for the existing double-height columns as the exterior faces of the columns were not accessible. The demolished second-floor framing had supported a large, cantilevered marquee over the entryway. SGH strengthened the existing spandrel supporting the marquee with a welded plate between the existing spandrel flanges, creating a closed section that could resist torsion loads from the cantilevered marquee. As this beam was also part of the new moment frame, SGH designed its connections to the columns to resist the torsion loads, in addition to transferring the moments.

This renovation preserved the beauty of the Fraternities Club Building's early years, boasting its restored ornamental brick-and-sandstone facade, Romanesque arches, red tile roofs, and copper-clad octagonal cupolas. At the completion of the structural upgrades and interior overhaul, The NH Collection New York Madison Avenue Hotel opened to guests in May 2021. The upscale hotel features 288 new guest rooms, an onsite gym, a bar, and two spacious lobbies.▪

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Figure 4. New spacious double-height lobby.