STEEL and STONE

By Sarah Buttars and Steven G. Judd, S.E.

Shop-fabricated steel frames with shop-attached granite facing restore an intricate stone façade in Manhattan.

During the events of 9/11, the façade of the 90 West Street building was severely damaged by falling debris and extreme heat. A Cass Gilbert architectural masterpiece designed in 1907, the intricate façade's lower floors boast granite facing while the upper floors are clad in terra cotta. After thoroughly evaluating the building's potential for residential use, the owner decided to restore the façade to its original grandeur.

The initial approach to replacing the damaged stone façade was to duplicate the original installation method—each stone would be attached as a thick cubic block to the primary structure or to adjoining stone pieces. The restoration project proceeded in this manner until the tight rehabilitation and reconstruction schedule and extremely limited site accessibility necessitated a different approach, and so the concept of panelizing the stonework using steel framing was introduced. With panelization, the stone could be assembled piece by piece onto steel-framed panels at an off-site facility. This minimized congestion at the job site, as well as reduced the installation schedule and manpower requirements in the field.

The design and construction team felt that panelization addressed the project's challenges, but they had to gain approval from New York City's Landmark Commission before proceeding. The commission initially expressed skepticism, but when they were presented with the enhancements a fully engineered steel truss system could offer without aesthetic sacrifices, they granted approval.

KEPCO+, a Utah-based architectural cladding contractor with a focus on stone, was selected to design and construct the custom panel system that would incorporate both the new and restored granite onto the steel frames

Coordination on this project began eight months before the first frame was fabricated. This preconstruction coordination ensured that the steel panels were engineered correctly, the building was properly prepared for installation of the panels, and the stone was fabricated to the necessary specifications for installation on the steel trusses.

Detailed engineering was essential to the success of the panel system. One of the major panel design and fabrication challenges was providing framing members where necessary for the individual stones, as well as designing the elements and assemblies to be as repetitive as possible while maintaining the correct finish profile. In order to make these accommodations in the steel frames, panel framing members were placed in a fashion to accommodate variations in the thickness and profile of the stone while maintaining clearance to the structural framing (a pair of spandrel beams spaced about 14″ apart). The panels were designed to occupy as much of the envelope between the back of the stone and the primary structure as possible, for enhanced panel stiffness, while maintaining enough room for the erection and installation tolerances.

Truss panels consisted of 3″ and 4″ HSS members. In some places, there was insufficient room for the panels. In this case, the outside spandrel beam was moved approximately 4″ toward the interior of the building to accommodate them. This was accomplished much easier with structural steel framing than it would have been had the floor plate been framed using cast in place concrete.

When fabricating the arch frame crowning the grand entrance, it was difficult to keep the two radial HSS 4×2×¼ and HSS 5×3×¼ members square with the main section of the frame. The large amount of welds required on this frame introduced extreme heat to the steel members. In order to alleviate warping, additional jigs were used and pattern welding was implemented.

Panel fabrication was completed within three months. Out of the 42 panels fabricated, 33 required unique designs with different shapes, sizes, and connections. This was necessary because there was no pattern to the damage, therefore no pattern to the stone replacement. Each panel was designed to fit a specific place on the building, and blending the new panels with the original stonework was a priority. Furthermore, the panels needed to match the existing bonding and jointing pattern of the building, which called for different breaks in the panels. The custom panels blended new and historic stone, which required a variety of connections.

Once the frames were complete, KEPCO+ crews began attaching the stone. The original façade incorporated large, intricately carved cubic pieces that were the full thickness of the exterior wall. Per the architectural imperatives, these historic stones were used where possible. Those that could not be restored were replicated.

Accurately matching the profile of the façade still intact on the building and blending the panels seamlessly with the remaining veneer presented a huge challenge. Three-dimensional electronic images of the complex stone profiles were exchanged between KEPCO+ and the stone fabricators in order to investigate clearance and avoid interference between the stone and panel framing. Templates were made of the stone profiles remaining on the building, after which the templates were sent to KEPCO+'s Salt Lake City fabrication facility where they were used to align the stones on the panels to ensure proper field alignment when the panels arrived on site in New York. It

The damaged grand arch at the main entrance (shown on previous page) was reconstructed using original and new stones attached to steel truss panels. Note that the center of the arch is part of the unfinished section.

The restored center panel of the grand arch is lowered into place above the main entrance. This panel weighed over 20,000 lb.

A washer, lock washer, and nut secure the stainless steel anchors to the clip angles. Shims accommodate frame tolerances and ensure the face of the stone is in the correct finished plane. Silicone in and around the anchor holes and in the steel connection slots keeps the crevices from being filled with debris and damaging moisture.

All panels were "pre-registered" prior to shipping. Pre-registration is KEPCO+'s process of pre-installing each panel in the shop to ensure the finish materials align with the adjacent panels.

was also necessary to remove a portion of the back of each stone to accommodate the steel frame behind it while maintaining the articulated stone profiles.

Instead of using large cubic pieces for the simple stone elements, a stone veneer was implemented. The typical veneer stone averaged about 3" in thickness, with some as thin as 2", and was attached to the steel panels using a mechanical #31 or T31 anchor. The T31 anchor was inserted into a curved slot routed into the back of the stone using a diamond encrusted rotor bit. Three inch to 4"-long steel angle clips were carefully located and welded to the frame. The angle clips had access holes for the mechanical anchors and were welded in place on the frame prior to setting the stone.

Once all welding was completed, the finished frames were hot-dip galvanized to prevent rust and deterioration. A washer, lock washer, and nut secured the stone anchors to the clip angles. Shims between the angle clips on the back of the stone could be adjusted to accommodate frame tolerances and to ensure the face of the stone was in the correct finished plane. Silicone was inserted into the anchor holes and the mechanical connection anchor slots to keep them from being filled with debris and moisture from condensation—moisture that, if not prevented, would lead to long-term deterioration. Stone assembly was completed in three and a half months.

Upon completion, the panels were shipped to New York City for installation. Once the panels reached the job site, they had to be off-loaded within a four hour time limit. Off-loading 40,000 lb of granite, stone, and steel on a compact job site in Manhattan was not an easy undertaking. However, through detailed scheduling of shipments from KEPCO+'s facility to the job site, everyone involved in the installation knew when the loads would arrive. This ensured that the site was prepared for off-loading and maximized the available time.

All panels were "pre-registered" in KEPCO+'s shop prior to shipping. Pre-registration is KEPCO+'s process of pre-installing each panel in the shop to ensure the finish materials align with the adjacent panels. Then, the building connections that are installed in the panels are adjusted to reduce alignment time in the field. The overall process allows for quicker installation and higher quality control.

KEPCO+ also manufactured custom racks that supported the panels in an upright position for shipping and off-loading. These racks made it possible to unload quickly because they ensured the panels were never stored in a way that would harm the stone on the front or the connections on the back. Once the panels were unloaded, erection had to be coordinated with other ongoing activities, such as terra cotta repair taking place on the upper floors with sky climber units. The sky climber units were suspended in a way that made it necessary to size the crane so as to underpin the overhead operation. This was accomplished through downsizing the crane. Downsizing the crane also reduced congestion, which gave other trades more workspace, provided more room for storing panels prior to installation, and minimized the budget.

The crowning arch provided one of the greatest installation challenges, on top of its fabrication challenges. The complex arch panel weighed over 20,000 lb and integrated numerous highly detailed carvings of both historic and new granite. Due to the importance of this particular panel, and because it had to be erected in between the sky climber mast units, meticulous planning of crane placement was essential. The crane had to effectively reach between mast units carrying a granite-clad steel truss panel with a spreader bar in place, while keeping the boom of the 35 ton crane under the overhead work.

After the panels were in place, they were adjusted and then permanently anchored to the superstructure via field welding. Panel anchorage was comprised of various hot rolled steel shapes including rectangular HSS sections, 1½" round bars, various 6" angles, and 1" plates welded to the superstructure. The connection material projected out past the perimeter framing in order to join with the connections built into the panels, allowing the panels to attach to the building in precise locations.

Erection of panels on the building took less than a month, and was completed with relatively little on-site manpower when compared to the field labor that would have been necessary to handset each individual stone.

The panelization concept, only possible through the use of steel, greatly improved the constructability of the 90 West project by allowing large quantities of stone to be installed on the building in a very short time, improving the schedule, eliminating equipment that would have been necessary for hand setting, and reducing costs. ★

Sarah Buttars is Director of Communications for KEPCO+. Steven G. Judd is Director of Engineering for KEPCO+.

Owner
The Kibel Companies, New York
BD Hotels, New York
Brack Capital Real Estate Group, New York

Architect
Façade Maintenance Design (FMD), New York

Cladding Contractor and Engineer
KEPCO+, Salt Lake City

Engineering Software
RAM Advanse
AutoCAD

General Contractor
Seaboard Weatherproofing & Restoration, Port Chester, NY

Panel Installer
Conventional Stone and Marble, Mineola, NY