Rock Solid

The Pierpont Morgan Library and Museum campus features a steel-framed, glass-and-metal clad addition that skillfully relates to the existing structures.

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THE PIERPONT MORGAN LIBRARY AND MUSEUM CONSISTS OF A CAMPUS OF BUILDINGS LOCATED IN MIDTOWN MANHATTAN, ON MADISON AVE., BETWEEN 36TH AND 37TH STREETS. The campus includes three historic buildings and the new addition designed by the Renzo Piano Building Workshop of Paris in collaboration with executive architect Beyer Blinder Belle of New York. The Morgan Residence, a three-story brownstone constructed in the late 19th Century, is located at the corner of 37th St. and Madison Ave. and was home to J.P. Morgan, Jr. The original Morgan library, designed by the New York firm McKim, Mead and White constructed between 1902 and 1906, is a marble-faced Italian Renaissance-style palazzo located on 36th St., approximately mid-block between Madison and Park Avenues. The third historic building is the Annex, constructed in 1928, four years after J.P. Morgan, Jr. transformed the Morgan Library into a public institution, making the Morgan collection of manuscripts, prints, works on paper, early children's books and other priceless artifacts, including two Guttenberg Bibles, available to scholars and the public.

The expansion, completed in April 2006, added approximately 75,000 square feet to the library, making it the largest expansion in the institution's history. The expansion includes three distinct steel-clad volumes surrounding a central, glass-enclosed atrium, which Piano referred to as "the Piazza," as well as an enormous underground expansion that includes archive and storage space for the Morgan collection and a 280-seat auditorium. Throughout the design process, Piano used the analogy of a spacecraft docking into the site and delicately touching the existing buildings to describe the expansion.

Construction Challenges

In order to minimize the visual impact on the historic buildings surrounding the expansion, Piano elected to bury the majority of the expansion below the sidewalk level. There are four basement levels extending a total of 50 ft below grade. Soil borings and test pits indicated that 15 ft below grade bedrock would be encountered. As a result, approximately 35 ft of Manhattan schist would have to be excavated from the site below the entire footprint of the expansion. Piano's design called for the excavation to extend adjacent to all three existing buildings. One of the fundamental construction challenges with the project was to excavate this rock without disturbing the three his-

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Far Left: Rock excavation below street level.

Left: View of the outside of the vault, below-grade floor framing, and columns for the Madison Ave. volume.

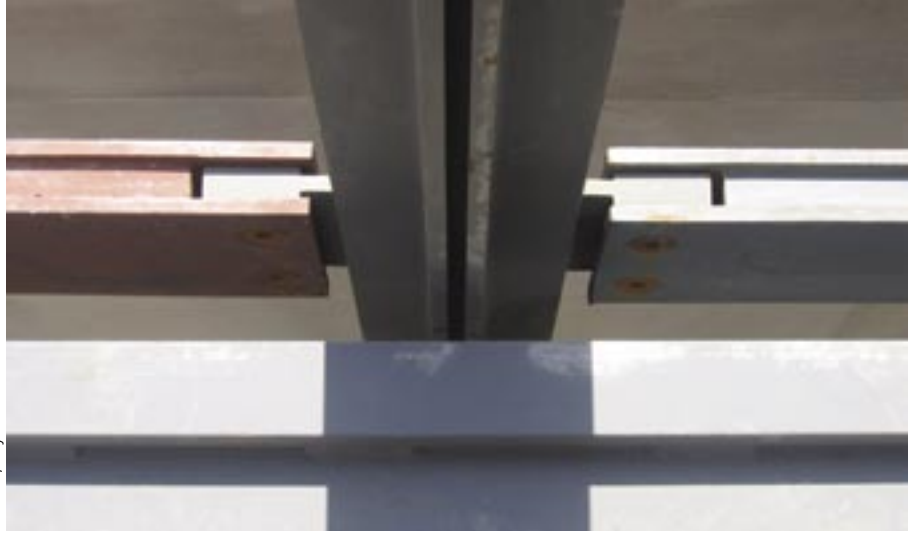
toric structures above. Foundation contractor Civetta Cousins, in conjunction with Construction Manager F.J. Sciame and geotechnical engineers URS, was able to complete the excavation on schedule with minimal impact on the existing buildings by employing a common method for rock excavation along sheer vertical faces known as line drilling. The contractor drilled 1 in. to 2 in. diameter holes along the line of excavation at periodic intervals (approximately six to 12 in. apart) creating a fracture plane. Once the rock was excavated an 18-in.-thick foundation wall was poured, creating a "bathtub" in which the lower portions of the expansion were constructed.

In order to reduce the lateral pressures on the foundation walls, a perimeter drainage system was installed to allow water to flow down the face of the "bathtub" without building up pressure behind it. At the base of the "bathtub," the water is collected by means of a drainage system that extends under the basement slab of the entire expansion. The water is directed to a large pit where it is temporarily stored until it is pumped into the storm water system. Thanks to this system, in conjunction with stainless steel, corrosion-protected rock anchors, the foundation wall adjacent to the auditorium, which is un-braced for a height of almost 50 ft, was kept to a thickness of 18 in.

A large portion of the below-grade volume is occupied by the vault space, which houses many of the Morgan's priceless relics. The vault is a three-story structure surrounded by a 12 in. thick concrete wall, and rests directly below the Madison Ave. volume. In it are high-density storage units, similar to those used in the stack sections of other libraries. Because many of the Morgan's artifacts are irreplaceable, the vault had to be designed for some unique contingencies. One such contingency included a hypothetical broken water main (not an unheard-of event in Manhattan), possibly resulting in the flooding of the entire Morgan basement. The outside of the vault was waterproofed, and the entire volume of the vault was anchored down using high-strength steel rods that were drilled and epoxied into the bedrock below. In addition, the doors into the vault are similar to those used in ship bulkheads, to help ensure a water-tight enclosure of the vault, thus protecting its contents.

Steel Matters

Above ground the expansion is a collection of steel and glass volumes, distinct from the existing stone and brick structures, but superbly integrated into the historic campus. All three structures are framed in steel with concrete-on-metal deck slabs. The first space encountered by visitors is the Madison Avenue structure. Except for the ground-level glass entry, the Madison Ave. building's façade is entirely clad in painted steel panels that are hung from the perimeter of the roof. The panels, designed and fabricated by façade contractor Josef Gartner GmbH of Germany, are each hung from the panel immediately above, creating a vertically unitized system. Each panel is braced back to the building frame by means of steel tees and clips that allow the panels to move vertically while bracing the panels against lateral loads. Identical steel panels cover the side (east and west) facades of the office structure—a four-story volume on 37th St., at the northeast corner of the site. Likewise, the same steel panels enclose a smaller unit on 36th St., between the McKim, Mead and White-designed palazzo and the Annex. The small volume is a 24 ft by 24 ft by 24 ft cube containing a single gallery space (aptly named "the Cube" by Piano's office during design). According to Piano, the steel-panel clad-



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Example of cruciform column at egress stairs on either side of the Madison volume.

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Portion of completed skylight at the Piazza.

ding is intended to convey security, much like the door of a bank safe.

With the exception of the middle portion of the office structure roof, the roofs of all three structures, as well as that of the Piazza, are glass. The glass is supported by steel purlins spaced at 3 ft on center. Piano's original intent was to create the purlins from three separate pieces of ¾-in.-thick steel plate with the outer plates slighter deeper than the middle plate, creating a ¾-in.-deep reveal along the bottom of the purlins. However, Josef Gartner proposed to create the purlins out of a single, 2¼-in.-thick piece of steel, with the reveal "routed" out of the center, similar to how a carpenter would work with a piece of wood. The purlins are 9 in. deep and span approximately 33 ft over the Piazza and at the roof of the Madison Ave. structure. These purlins also cantilever (slightly) over the spandrel beams at the roof of the Madison Ave. structure and the Piazza to support the steel façade panels (at the Madison building) and the steel curtain wall mullions (at the Piazza).

Creating built-up shapes from smaller, more delicate pieces of steel became a common theme for Piano. The six columns supporting the roof of the Piazza are cruciform in shape, and are created from four angles, with steel plates inserted between them to create reveals similar to those seen in the roof purlins. In the end, the columns are 13 in. square and extend approximately 50 ft in the air to support the glass roof. Likewise, the columns in the two, glass-enclosed egress stairs on either side of the Madison Ave. structure, as well as at the stair to the west of the 37th St. office structure, are all smaller versions of the cruciform columns supporting the Piazza roof. A line of similar cruciform columns extends along the north edge of the Cube and supports a lower roof, just south of the Piazza. This variation on a theme carries through to the stringers at these stairs as well, which mimic the roof purlins' triple-plate appearance.

The glass roof didn't permit the use of a traditional diaphragm at the roofs of the Piazza, the Madison Ave. office structure, or the 37th St. office structure. As a result, the frequently spaced purlins along with 2-in.-square steel bars perpendicular to the purlins were used to create a horizontal Vierendeel frame that performed as a diaphragm. This diaphragm provided lateral stability for the Piazza, which had no lateral load-resisting system of its own. It was desired to keep the Piazza cruciform columns as slender as possible, but they were unable to be incorporated into moment-resisting frames. Therefore the Piazza roof had to rely on the Madison Ave. and 37th St. office structures, as well as the Cube structure to some extent, for lateral stability. The horizontal frame created by the roof purlins spans horizontally between the three "solid" volumes, each with its corresponding lateral system. The Madison Ave. and 37th St. office structures feature steel moment resisting frames, while the cube features a steel concentrically braced frame.

With its 2-in.-square steel bars spanning between the 2¼ in. by 9 in. purlins, which in turn span between larger, rolled

wide-flange beams along the north and south edges, the Piazza roof appears to have a hierarchy of structure, similar to what one might see in a wood trellis. This was an effect Piano sought from early on in the design. He frequently said that he wanted to create primary, secondary and even tertiary layers of structure so that the roof of the Pizza remained light and airy, like a "flying carpet."

The upper two stories of the Madison Ave. structure cantilever approximately 24 ft to the east, over the glass entrance. Diagonal bracing behind the steel façade panels make the cantilever possible. Also, in order to create a column-free space for the auditorium below, the entire 37th St. office building is transferred on 40-in.-deep wide flange beams below the first floor. Both challenges required the high strength-to-weight ratio of steel in order to keep member sizes within a reasonable range.

Conclusion

While the materials used by Piano for the addition to the Morgan Library and Museum set it apart from the adjacent existing, historic buildings, the proportions (certainly those visible above ground) and elegance of the new buildings are in keeping with those of their neighbors. While it is unlikely that many of the visitors to the new Morgan will confuse the addition with a spaceship, the steel and glass facades and roofs are certainly a leap forward in building design and technology from those employed in the construction of the original buildings. MSC

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Diagonal bracing at the "Cube" during erection. (Photos by Frank Prial, Beyer Blinder Belle)