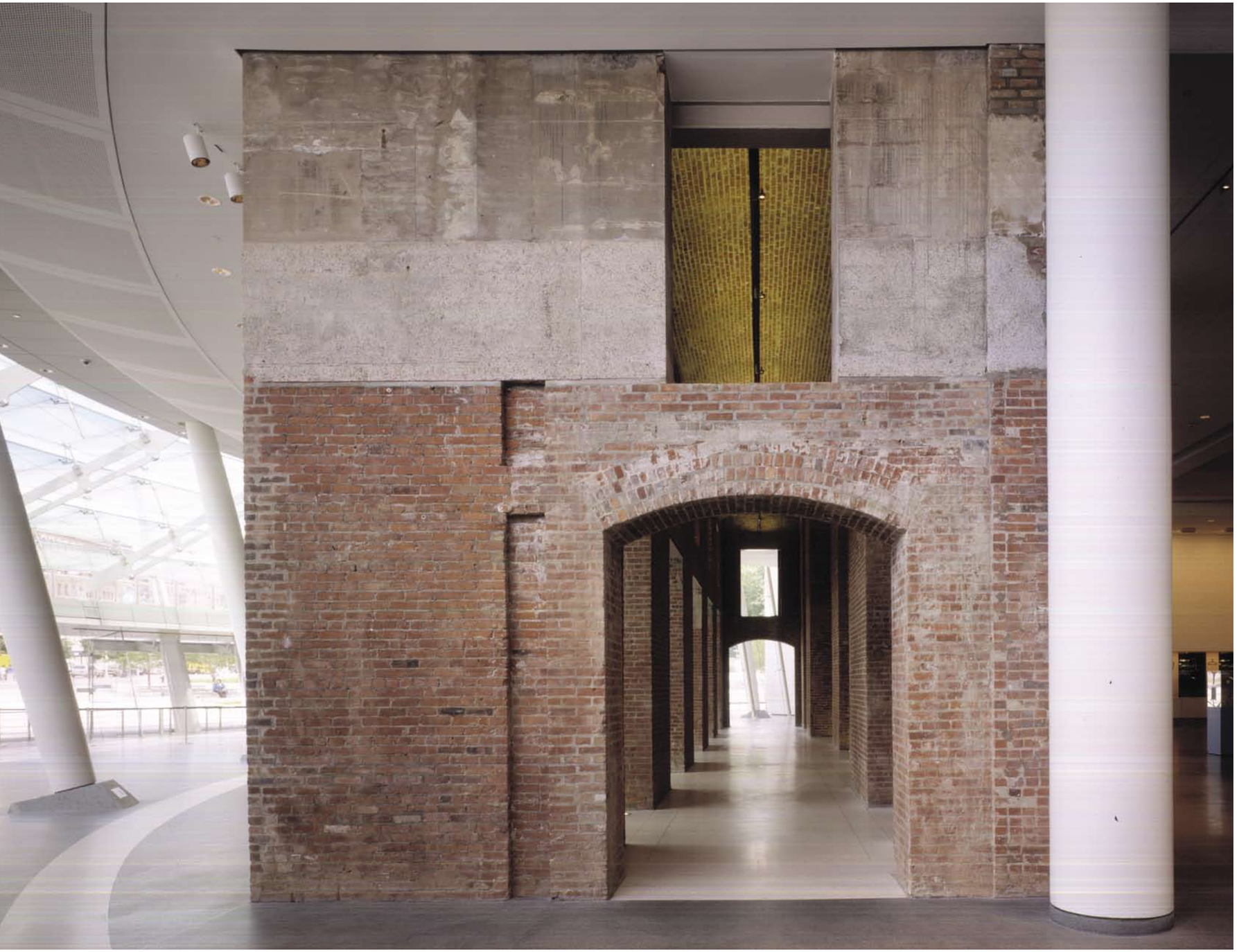

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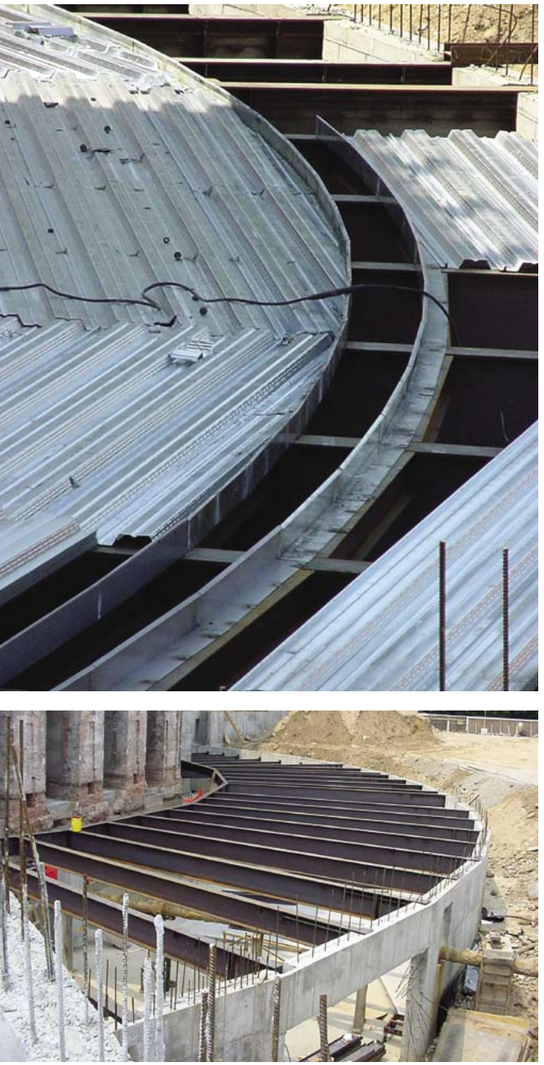
ABOVE The pavilion integrates with the existing museum's structural system without relying on it for any lateral bracing.

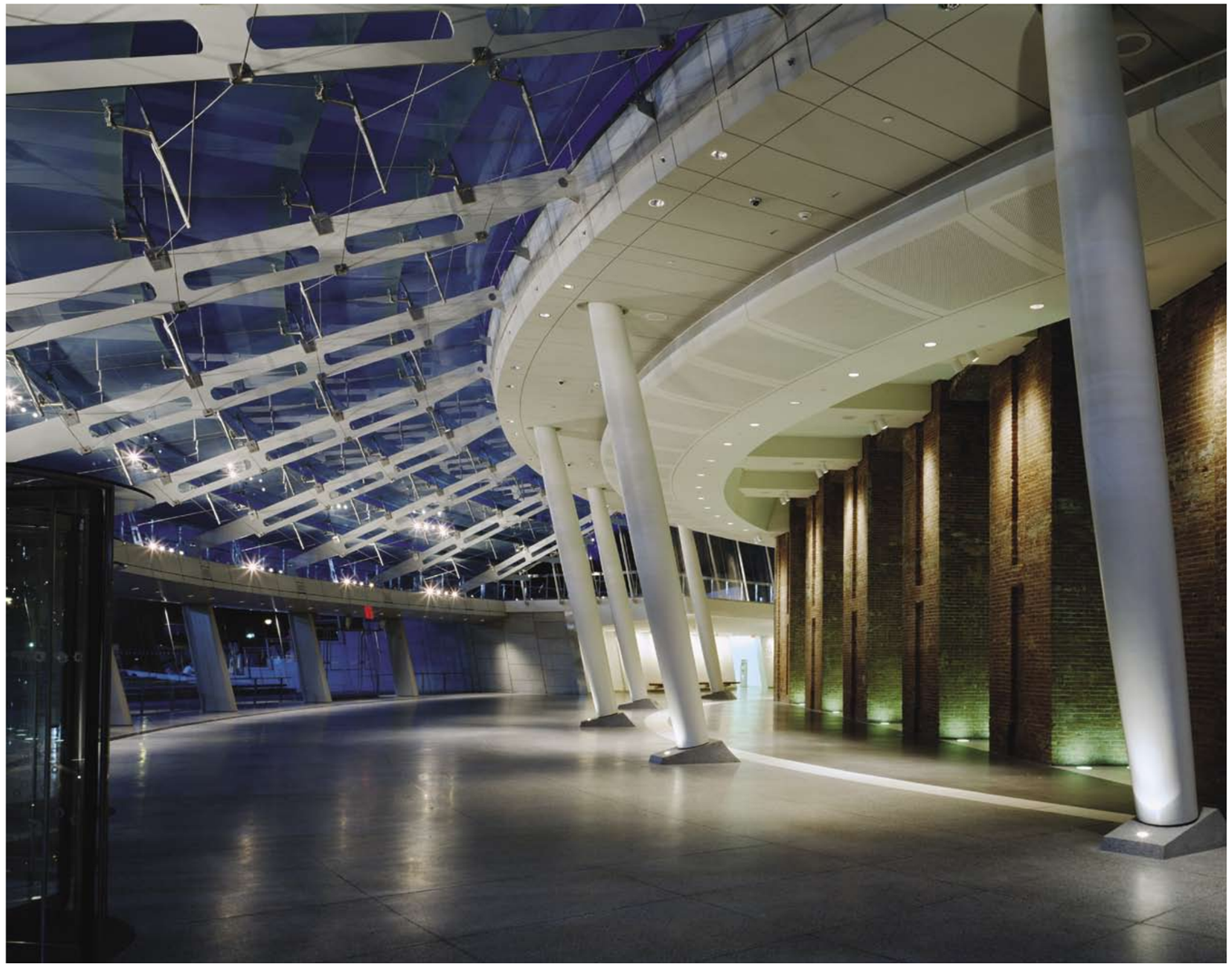
BROOKLYN MUSEUM
ENTRY PAVILION

Steel Spans the Ages

A cutting-edge steel and glass pavilion may not seem like the appro-priate choice for a classic beaux arts building, but when the Brooklyn Museum of Art hired Polshek Partnership to design a new entry sequence and public space for their 1914 McKim, Mead & White edifice, the architects decided that it was the only solution. Their thinking wasn't motivated by any outré sentiments either, but by precedent. In their proposal documents, Polshek drew attention to the existing building's many steel and glass skylights and referenced McKim, Mead & White's legendary Penn Station, which coupled a neoclassical masonry facade with the era's latest steel and glass building system. As David Tepper, Polshek project architect, puts it, "Even back then they were perfectly comfortable mixing the two."

Implementing the pavilion design concept required a high grade of structural steel and exquisite workmanship. To arrive at a complementary massing between old and new, the architects modeled their addition on a hemicycle stair originally intended for an unbuilt portion of the east facade (only one sixth of the original master plan was constructed, due primarily to the topographically difficult site). Rather than the intended stone risers, however, the stair was abstracted into a stepped skylight that ascends two flights from a curving walkway one floor above the ground-floor entrance, leading to another curving walkway that meets the base of the portico at the museum's third floor. To add dynamism to the space, the architects specified that the pavilion cant out 13 degrees, making it not only circular in plan, but like an inverted cone in section. Further complicating matters, the pavilion was designed to be structurally independent from the existing building. "It relies on it somewhat for vertical support, but not at all for lateral forces," says Mike Auren, a structural engineer with Robert Silman Associates. "Usually we specify 36 ksi for this type of project, but in this case we needed the strength of grade 50."





LEFT TOP AND BOTTOM: © POLSHEK PARTNERSHIP ARCHITECTS; OTHER: © RICHARD BARNES

TOP, ABOVE LEFT Steel floor framing above a new basement level supports the pavilion concourse.

ABOVE RIGHT At night, the low-iron vertical glass elements of the skylight seem to disappear, while the fritted horizontal lites assume a palpable materiality.

Columns built up from 1 3/4-inch plate vertically support the lower walkway, which is framed with 14W99 wide flange beams, cut to fit within a custom 3/16-inch-thick aluminum enclosure manufactured by Pohl America and fabricated in Germany. "The aluminum plate was bent to the correct form and backed up with carrier channels that are recessed from the edge with a shadow joint between panels," says Tepper. "This creates a real crisp, clean finish." The columns, which are covered with the same material (both are treated with an off-white metallic paint meant to match the existing stone facade), are moment connected to the steel structure of a new basement level beneath the pavilion. Due to the cant of the structure, the walkway had to be anchored at its extremities to keep it from falling outward. At its eastern extremity the walkway is bolted into a sloping, stepped structure that serves as bleachers from which to appreciate a water feature by Wet Design and allows public access to the walkway. At the other extremity, however, a curving stair braces the walkway. The stair cantilevers off of the walkway's last column—at this point the 14W99 beams are replaced by a 1 1/4-inch plate girder—curves down over a water feature, and bolts into a stone plinth.

Eight-inch diameter, double strong round columns vertically support the upper walkway. These columns are bolted to a 16-by-16-inch HSS section that forms one continuous arc around the outer rim of the walkway and is in turn bolted to two concrete piers that support allegorical statues of Brooklyn and Manhattan that used to grace either end of the Manhattan Bridge. This HSS section acts as a giant catenary that holds the entire structure back. Along the inside of the arc, a 12-foot-deep horizontal truss, built up from a combination of W16, W14, and W12 flanges, delivers the stiffness needed to handle the lateral forces.

The most heroic element of the pavilion, however, is the skylight, which utilizes a unique rod truss system and castellated steel beams to span the 35 feet between lower and upper walkways. TriPyramid fabricated all of the fittings, rods, and beams for W&W Glass Systems, who supplied the glass and installed the skylight. The 18-inch-deep castellated beams are water jet cut from 1-inch plate, a process that, says Michael Mulhern of TriPyramid, kept the plate straight throughout fabrication and made for easier installation. The beams are laterally braced by the horizontal glass lites and the rod truss system. The museum questioned using glass in a structural capacity because they feared something breaking and then causing a successive collapse. "As a result we designed the plates to support several spans unbraced," says Auren.

"So there's a ton of redundancy. The skylight is actually the most robust system in the whole addition."

The truss system is composed of 3/8-inch-diameter cold drawn stainless steel rods, each drawn to a yield strength of 15,000 pounds. To keep the extremities of the skylight glassy, the pre-stress tensions of the rod truss system were braced by 3-inch diameter, double strong pipe catenaries that pass through 1/2-inch plate and connect to the upper and lower walkways. The rods of the truss feature cold formed heads, which allowed for a thinner rod diameter and a cleaner finish, as they forgo threading and tie buckles. Machined, 316 stainless steel couplers connect the rods to the beams. These couplers also support the unique finger castings that point support the glass. The finger units were investment cast out of 17-4PH high strength stainless steel. Also known as lost wax casting, investment casting employs a single-use ceramic mold for each unit. "This process gives a very fine finish," says Mulhern, an outcome very much desired by the architects. As Craig Mutter, another Polshek project architect, puts it, "We specified two finishes for each finger casting: most of it is a soft brush finish, but there's a bead blasted finish along the inside curve between point supports. It really gave a textural depth to the project."

"We did a similar thing by using two Types of glass in the skylight," continues Mutter. The point supported horizontal lites are 1-inch-thick tempered, laminated, and fritted with a PVB interlayer. Whereas the curved vertical lites—the "risers" of the stair—which are cemented to the horizontal layers with structural silicone, are 1/2-inch tempered, 1/4-inch heat strengthened, laminated, and low iron. The 10-foot-high lites that enclose the ground floor of the pavilion are 3/4-inch, monolithic, tempered, and also low iron. "At night with the lights on," says Mutter, "the vertical glass just disappears, leaving the horizontal lites, which have a real material quality due to the fritting, to seemingly float in mid air."

Polshek worked closely with their team of consultants throughout the design stage. "It was really more on the European model of doing things," says Tepper. "When you think about the big picture, the reason this addition works, aside from the fact that proportionally it's grounded firmly in the beaux arts tradition, is because it has a handcrafted quality that matches what they did in stone on the original." The result is a light and ebullient reinterpretation of a beaux arts theme that introduces an entry sequence more attuned to the 21st Century. ■

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TOP A curving pipe catenary braces the rod truss system at its extremities.

ABOVE A cantilevered, curving stair braces the lower walkway at it's western extremity.

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ABOVE The design of the pavilion was based on a hemicycle stair, detailed in McKim, Mead & White's original master plan.

BROOKLYN MUSEUM ENTRY PAVILION

Owner **Brooklyn Museum of Art** *Brooklyn, NY*
Architect **Polshek Partnership Architects** *New York, NY*
Structural Engineer **Robert Silman Associates, PC** *New York, NY*
Skylight Consultant **Dewhurst, Macfarlane & Partners** *New York, NY*
General Contractor **Bovis Lend Lease** *New York, NY*
Structural Steel Fabricator and Erector **Ment Bros. I.W. Co., Inc.** *New York, NY*
Ornamental and Miscellaneous Metal Fabricator and Erector
Ment Bros. I.W. Co., Inc. *New York, NY*
Skylight Glass Fabricator and Erector **W&W Glass Systems, Inc.** *Nanuet, NY*