Beyer Blinder Belle

Fan Favorite

BY KEVIN C. POULIN, PH.D., P.E., AND FILIPPO MASETTI

Thanks to a structural renovation in lower Manhattan, a new sports museum comes to life and an historic edifice lives on.

COLLEGE FOOTBALL'S 2008 SEASON ended last month with its traditional plethora of bowl games, culminating in the national championship game in which Heisman Trophy winner Sam Bradford, quarterback for the University of Oklahoma, fell short of victory against the University of Florida and last year's Heisman winner, Tim Tebow.

In America, as soon as one season ends, another begins—or is already in progress. In recognition of this love affair with athletic pursuits, the Sports Museum of America last May opened its doors in lower Manhattan as the nation's first museum dedicated to all sports—and as the new home of the Heisman Trophy.

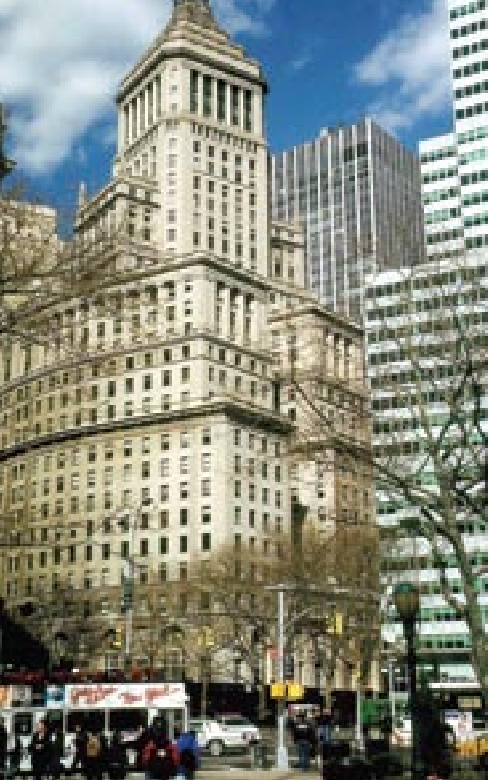
The museum occupies 80,000 sq. ft on the bottom three floors of 26 Broadway, a site with a rich history. It was in this building that John D. Rockefeller made his millions at the helm of Standard Oil, the powerful firm that monopolized America's oil markets and set prices for petroleum for decades. Rockefeller constructed the building in several phases. In 1885, he started with a ten-story building designed by Ebeneezer Roberts. In 1895, he expanded the building through the construction of six additional stories and an addition to the northern section, design by Kimball and Thompson. Finally, in five phases over six years in the 1920s, he built the 32-story tower, designed by Thomas Hasting of Carrere and Hastings, the firm renowned for its design of the New York Public Library.

Worthy of a Museum

Decades later, in May 2006, the building began a structural renovation project to prepare the bottom three floors for their new role as a museum; the rest of the building is used as office space, and another portion of the building has been renovated to house a new public high school. The structural scope of this most recent project included an increase of the live load capacity of the bottom three floors to 100 psf, for museum occupancy, and the addition of both a new elevator and a new stair.

After conferring with the architect, Beyer Blinder Belle (BBB), we knew that the older portions of the building had no original structural drawings, but that the drawings for the Carrere and

The Sports Museum of America (housed in the above building) pays tribute to the nation's sporting history and is also the new home of college football's Heisman Trophy.



Simpson Gumpertz and Heger

Manhattan's 26 Broadway began as a 10-story office building in 1885. It was expanded by six stories and also received a northern addition in 1895. A 32-story tower was added in several phases during the 1920s. A structural renovation to the building was just completed last year.

Hastings portion of the building were available, and we started our structural work with a field investigation program. We systematically probed the older portions of the building for which we had no drawings and we spot-checked the Carrere and Hastings portion to determine whether the structure adhered to the drawings in our possession.

In most of our probes into the 1885 portion of the building, we observed wood sleepers and wood flooring bearing on the top of wrought-iron beams. Between the beams, cinder fill rested on 10-in., terra-cotta tiles that span 4 ft as a flat arch between the beams. The bottom flanges of the beams support the tiles. Thus, the bottom flanges of all the beams are aligned while the top flange elevations vary by the depth of the section. The wrought-iron beams are either supported on 4-ft-thick exterior bearing walls or frame into girders that are supported by cast-iron columns.

When we investigated the 1895 portion of the building, we found similar construction with wrought-iron beams, cast-iron columns, and thick bearing walls. We made extensive site visits to document the steel framing exposed at probe openings, used ground-penetrating radar (GPR) to locate steel framing between probes, and obtained steel coupons for analysis in our Boston lab. We analyzed the live load capacity of the floor system and found that, in general, it was not sufficient for museum occupancy.

To strengthen the beams, we chose to weld WT sections to the top flanges because we were concerned that reinforcing them from below would potentially damage or collapse the brittle terra-cotta tiles. We removed the 4-in. topping slab, which helped to reduce the dead-load stresses in the beams prior to welding the WTs and creating composite action. The contractor, Structure Tone, cast new concrete against the WTs, replaced the topping slab, and coated the WTs with intumescent paint to achieve the required three-hour fire rating.

For the Carrere and Hastings addition—again, from the 1920s—we reviewed the existing structural drawings and made site visits to confirm and update as-built structural information. Here, extracted concrete cores revealed that the floor system consisted of 5 in. of cinder fill above a 5-in. cinder-concrete slab, with a draped mesh spanning 6 ft between concrete-encased steel beams. Analysis proved that the cinder-concrete slab was insufficient for the new load but that most of the steel beams were adequate. The solution was to remove the cinder fill and pour a new structural slab in its place, using the cinder-concrete slab as formwork. Removing the cinder fill and replacing it with structural concrete of a similar density allowed us to strengthen the floor slab without increasing the load to the beams.

Another task was to install a new elevator between the basement and the third floor. Since there are two sub-basements below the basement level, it was not possible to use the typical soil-supported pit. Instead, we designed an elevator pit that hangs from the ground floor steel from a series of five hangers and one building column. At the ground floor, we reinforced most of the existing beams with either WTs that stop short of the columns or with new beams below the existing ones, that span to the columns. We were also challenged with designing reinforcement for the existing beams and hanging the pit in this location while threading between a tangle of the building's utilities and infrastructure.

Façade

By the summer of 2007, when construction was underway and the floor-framing strengthening had been substantially completed, the architect asked us to assist with the remodeling of the building's storefront along Beaver Street and New Street. The existing storefront had hosted a series of restaurants, banks, and shops, which had modified the façade over time with limited architectural coordination. The museum wanted to reestablish the appearance of the structure by removing the existing storefront and replacing it with smaller windows surrounded by limestone piers that matched the original stone above. The Landmarks Preservation Commission was deeply involved in the restoration of the façade and held the team to strict standards.

Although a new concrete masonry unit (CMU) back-up wall could be built to the underside of the spandrel beams, the limestone would have to bypass the spandrel beams to create a typical joint with the existing stone above. Thus, we had to make the new stone cladding fit into the existing framing. When the new stone was selected, limited exploratory openings were made to expose the existing spandrel beams, and it was difficult to determine if interference was an issue. Upon interior demolition, we observed spandrel beams installed at an elevation lower than the original floor framing. These beams appeared to be of the same vintage as the storefront modifications. We also found that brick masonry was placed in the gap between the top flange of these spandrel beams and the underside of the existing limestone blocks above.

The renovation included structural probes into the older parts of the building, including the steel—still holding up—in the section built in the 1920s.

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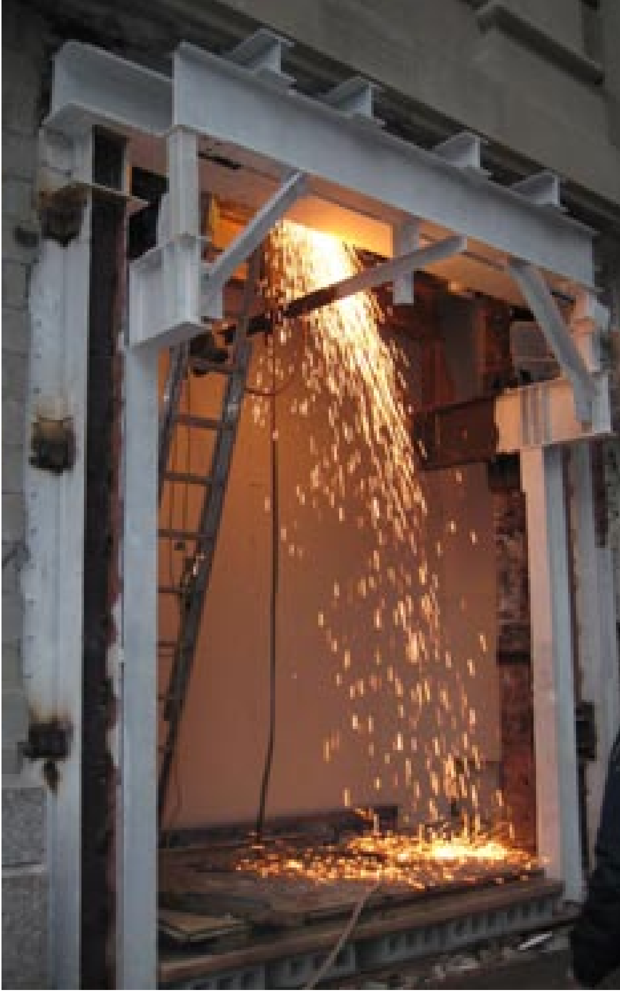

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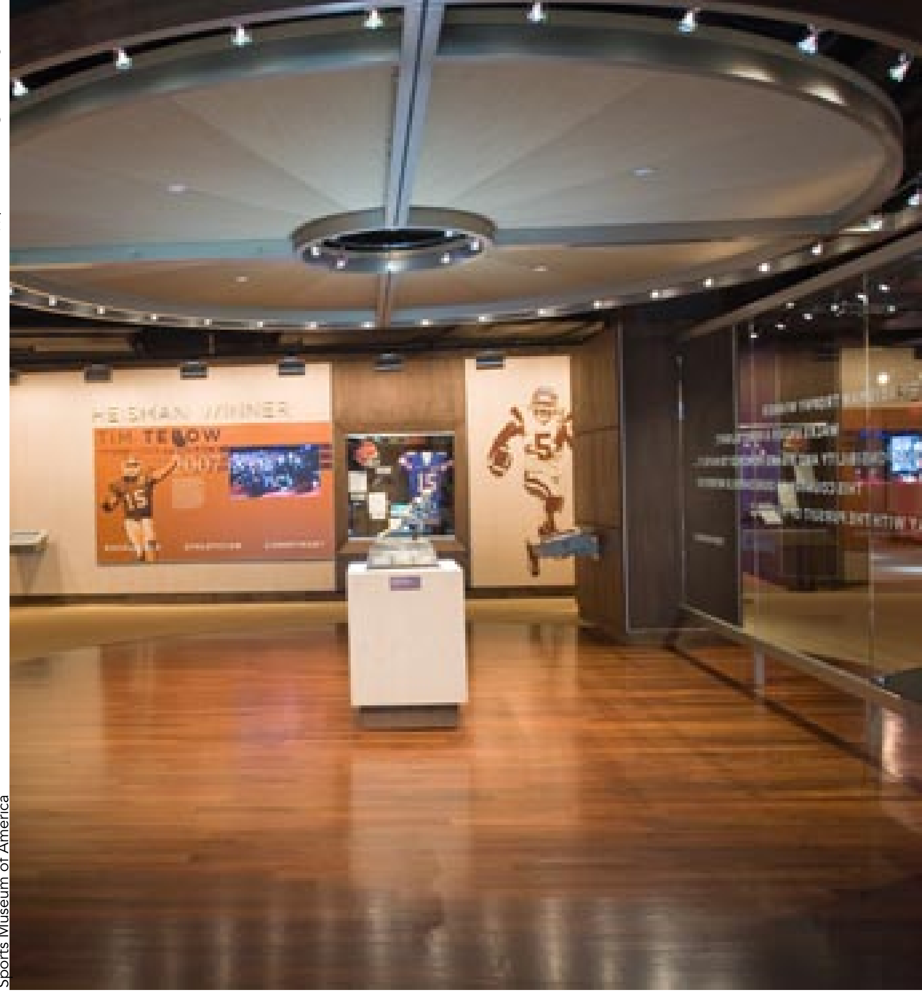
At some of the exterior bays, which were highlighted with limestone blocks, a temporary shoring system was used to support the limestone.



Sports Museum of America

The Heisman Trophy in its new home at the Sports Museum of America. Besides displaying sporting paraphernalia and artifacts, the museum also features several interactive exhibits.

During several site visits, we used a laser level to determine the interference between the back of the new stone with the spandrel beams and/or with the brick masonry, depending on the location. One of the possible solutions was to notch or cut the back of the new limestone blocks, but the stone subcontractor opposed this as it would have affected the integrity of the stone.

The team decided to locally remove the existing brick and/or cut the part of the bottom flange of the existing lower spandrel beams. The removal of part of the existing brick was a very risky operation, since we were not sure whether the load path for the support of the original stone above had been altered during the prior renovations at the storefront. The enigma was solved when we found valuable information in the original architectural drawings, which showed two beams located side by side at the second floor. The interior beam supports the second-floor slab and the exterior one supports the façade. In all but three bays, the contractor confirmed the existence of the upper spandrel beam through exploratory probes. At these locations we were able to temporarily support the original limestone, reinforce the existing steel to provide a new load path, and cut the steel and/or brick interference.

Three Bays

At the three remaining bays, establishing a new load path required a Herculean effort. We had to devise a temporary shoring system to support the limestone, but because of building infrastructure on the floors below grade, we could not place shores to the footings. At one bay, we cantilevered a shoring system from the spandrel beam. At the façade end we installed a post up from the cantilever beam to the underside of the stone, and at the backspan end we installed a post from the shoring beam to the underside of the floor framing. Once the load was redirected, we removed the brick masonry, installed a series of posts to the underside of the stone, and reinforced the spandrel beam.

At the second bay, the lower spandrel beam was below the elevations of the new windows and had to be removed. To temporarily support the 30-ft limestone piers at this location, we bracketed off the columns and installed an outrigger system. We designed needle beams that penetrated the masonry above the existing spandrel beam and redirected the load to the temporary shoring system. Once the contractor installed the shoring with needle beams, they removed the existing spandrel beam and installed a new spandrel below the needles. At the third bay, the lower spandrel beam was only slightly below the elevation of the new windows, and we were able to strengthen the beam and cut the bottom end that interfered with the window line.

The Sports Museum of America reinforces and preserves this country's history with sports—and by renovating the building that houses it, a piece of American architectural history has been reinforced and preserved as well. MSC

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