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# Ready For MORE

A historic San Francisco building constructed after the Big One in 1906 is modernized and reinforced for the next chapter in its life—and better equipped for future seismic events.

Images: BCCI

**THE SAN FRANCISCO EARTHQUAKE** of 1906 and its subsequent fires leveled more than 80% of the city.

As such, most of the oldest buildings in San Francisco date to just after the quake. One of these is the Musto Building. Built in 1907 to replace a marble workshop that was destroyed, the three-story 58,000-sq.-ft brick masonry edifice at 717 Battery Street in San Francisco originally served as a retail and warehouse space, then as an office building. Its next life is as one of the city's premiere private clubs, The Battery.

Built by general contractor BCCI, with structural engineering performed by Holmes Culley, the highly complex project was part new structure, part full-scale renovation to create a new space that includes guest suites, a fitness center, a Jacuzzi pool, saunas, a spa, massage rooms, a private access courtyard plaza, a card room, a wine bar and cellar, a restaurant, a library and a conference center. Some of the facilities are available to the public—the ground-floor lounge, second-floor conference center rooms and library—whereas select second-floor rooms, such as the bar, card room, library and plaza, will be limited to members and overnight guests.

The project consisted of a seismic upgrade of the unreinforced masonry building, restoration work, basement expansion, a new service building and the addition of a fourth floor for the penthouse suite.

The number-one goal for the entire team was to maintain the building's original turn-of-the-century design aesthetic, while incorporating the required modern day techniques and applications to ensure its seismic stability. Holmes Culley introduced a performance-based engineering approach to achieve the Basic Safety Objective (BSO) of ASCE 41. A non-linear dynamic analysis model of the strengthened building was also created, which allowed for the existing brick masonry to remain exposed, minimized the need for additional building materials, maximized the amount of interior floor area and maintained the building's original exterior character.

## Mandatory Seismic Upgrade

To achieve the mandatory unreinforced masonry seismic upgrade, BCCI incorporated a seismic strengthening system that was sensitive to the building's historic fabric by bracing it with three new steel moment frames (consisting of W18×97 beams and W24×176 columns) that extend through each floor. This technique allowed the interior brick surfaces to remain exposed. In addition, a new foundation system comprised of steel micro-piles (8 in. to 10 in. in diameter) to support the grade beams was introduced, while concrete pile caps were designed to encapsulate the original Douglas fir piles. Meanwhile, the new building, located at the courtyard basement, features grade beams over cast concrete piles and shot-crete perimeter walls.

The building has a dual lateral system in place, consisting of unreinforced masonry walls and the new steel moment resisting frames. Holmes Culley worked closely with core and shell architect, FME Architects, to figure out proper proportioning for the frame so they could achieve expectations for how the brick would adhere to the building. Crucial to the project was the construction phase, particularly bringing the steel moment frames into the existing building while maintaining the stability of the brick walls. The moment frames were delivered in shop-fabricated

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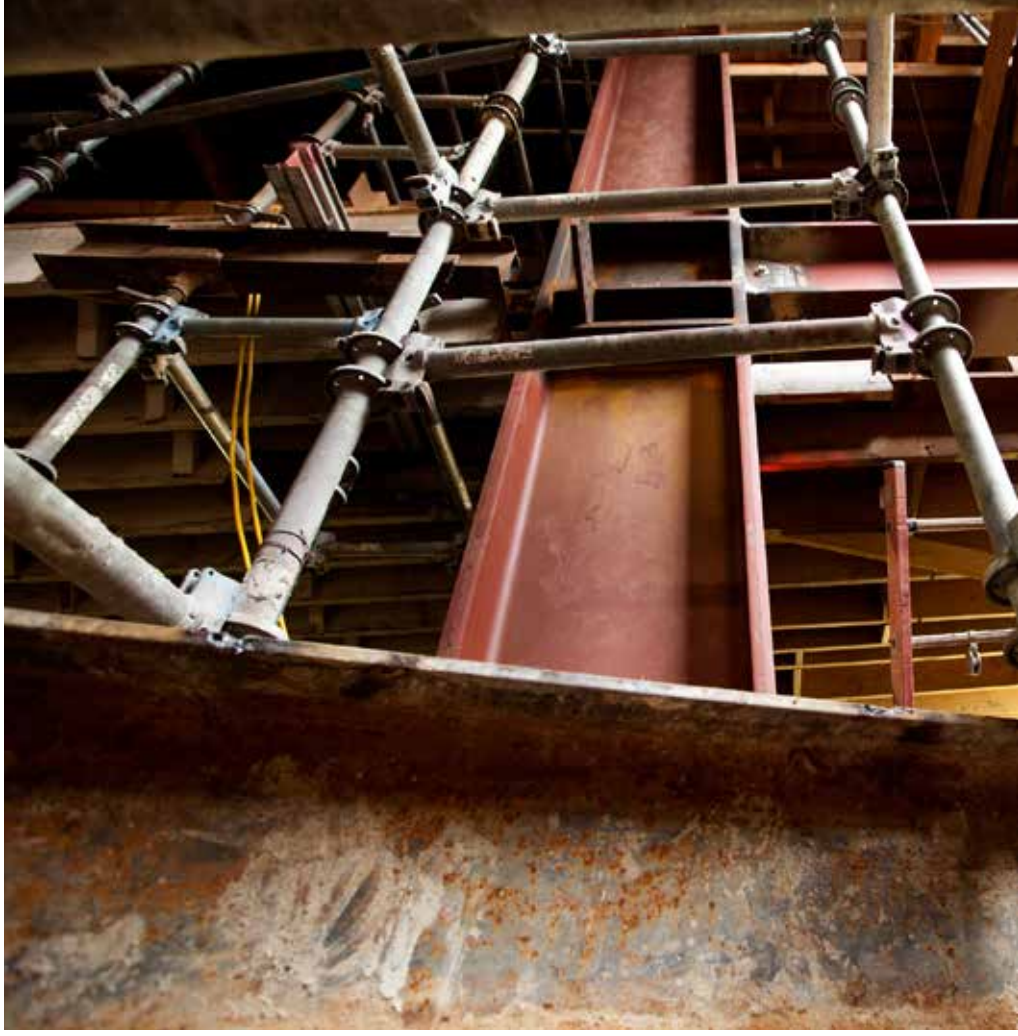

New moment frames were delivered in shop-fabricated cruciform shapes and were craned in through the top of the building.

cruciform shapes and were craned in through the top of the building. From there they were dropped down via slot openings in the floors. Holmes Culley coordinated this aspect of the job carefully with BCCI in order to understand exactly how much room was needed to drop the steel column sections, some as tall as 37 ft and weighing as much as 4 tons each, in place.

## Penthouse and Stairs

Another significant challenge was the addition of a 5,700-sq.-ft fourth-loor penthouse on top of the existing building. BCCI braced the existing walls in preparation for installation of a new roof structure. The existing roof was wood-framed and it was replaced with a new steel frame (using W12×45 and W8×15 shapes), metal decking and a concrete infill roof; floor beams that align with penthouse columns were momentized to create an inverted moment frame to contribute to the penthouse lateral force resisting system. This scheme was implemented both for seismic purposes as well as to upgrade load-bearing capabilities to withstand the new penthouse and the stone roof pavers that now rest upon it. In addition, the new Jacuzzi pool on the penthouse level demanded that significant structural work be done in order to support it.

The ¾-in.-thick steel plate columns that support the penthouse roof are part of a lateral system for the penthouse. The columns have recessed holes in them to allow for light fix-

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Installing new steel.

The Battery, from the street.

tures, and the cantilever columns that support glulam beams at the roof transition to steel HSS8×4×⅝ columns from the penthouse level to third floor via momentized steel splice connections to create the backspan portion of the cantilever. In order to achieve such precision and make sure the execution was flawless, Holmes Culley began doing concept work on the project in early 2009. Through close collaboration with FME Architects and BCCI, and working from an architectural layout standpoint, the team was able to determine where to locate the steel moment frames in parallel with the brick piers.

Another important element of the project both structurally and aesthetically was the 40-ft-long feature staircase that runs from the basement to the third floor. It was designed to have a folded steel plate effect and is cantilevered on one end to achieve the desired suspended look. Fabricated stepped plate stringers with steel plate treads were designed to create the appearance of a floating continuous folded steel plate stair bisected by a large steel plate landing/balcony to overlook the lounge and bar area. The landing and balcony are supported by cantilever outrigger plates hung from suspended tension rods that sandwich the existing wood columns at the balcony. BCCI and Holmes Culley worked with FME Architects to achieve the desired light and airy aesthetic while ensuring the vibration performance of the stair was within acceptable limits for human comfort via a finite element analysis of the stair.

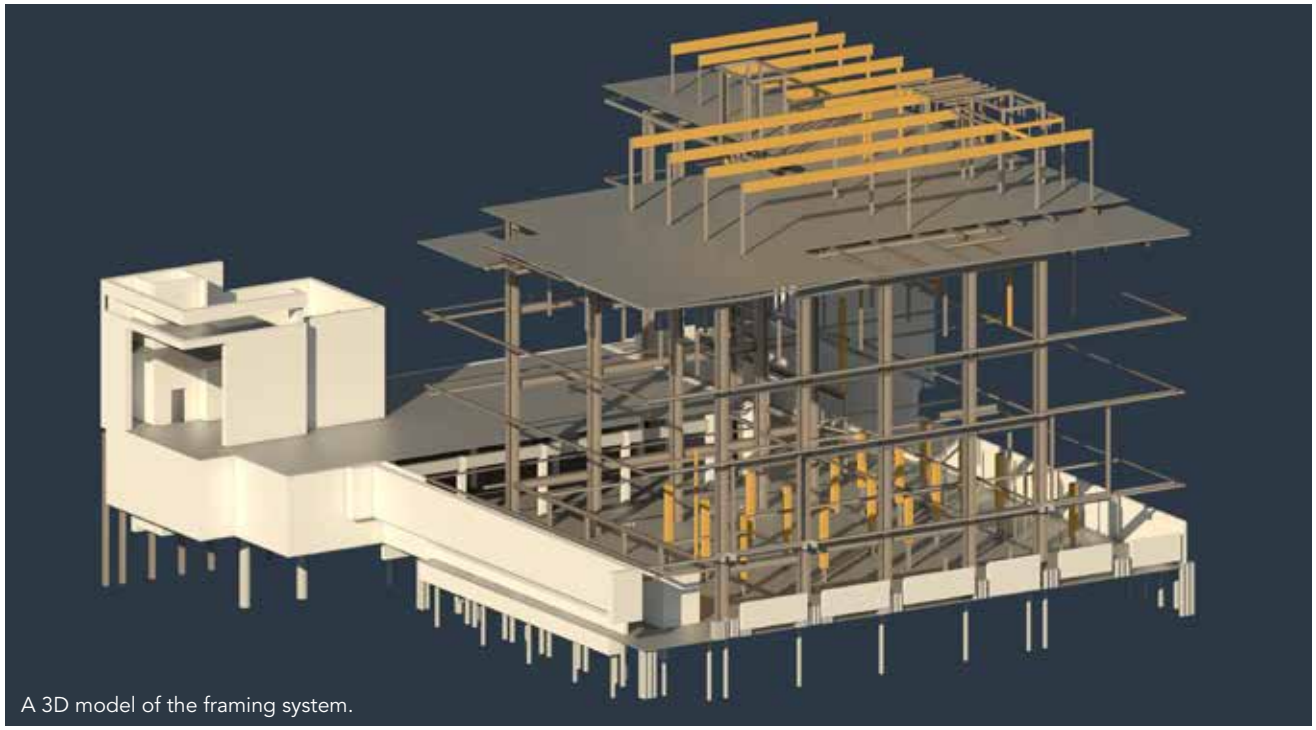
The rehabilitation project was completed this past fall and used approximately 280 tons of new steel. Thanks to the reinforcement and seismic upgrades, this century-old building is poised to last another hundred years. Built after the Big One in the early 20th century, it's now better prepared for the next one, whenever it happens. ■

**Owner**
MXB Battery, LP, San Francisco

**General Contractor**
BCCI, San Francisco

**Architect**
FME Architects, San Francisco

**Structural Engineer**
Holmes Culley, San Francisco



A 3D model of the framing system.