Shaping Up

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Two fire-damaged brick buildings in Brookline, MA, were re-purposed and rebuilt from the inside out with structural steel.

Changing the function of a structure is not always an easy task, even in the best of circumstances. However, the owners of two water- and fire-damaged structures in Brookline, MA were determined to revive the buildings for new uses while preserving their exteriors.

The main two-story brick building had a footprint of 65′ by 44′, with 12″-thick exterior brick bearing walls, and wood floors and bearing walls on the interior. The fire had burned the roof completely and the building had been condemned. The fire also damaged some of the interior structure on the second floor and the ceiling.

The adjoining two-story building had a footprint of 50′ by 30′. Although not affected directly by the fire, this building suffered water damage as a result of exposure to the elements. Termites also damaged the wood floor and joists.

Making Space

The new design called for a gymnasium inside the main building and a recreational space in a smaller adjoining building. Since this required an open space inside the main building, the structural engineers initially planned to cover the roof with steel or wood trusses spanning 30′ between the exterior walls and to distribute gravity roof loads and lateral wind and earthquake loads to the exterior brick bearing walls.

Investigation of the exterior brick walls revealed that the main materials used to construct the walls were terra cotta blocks covered by brick. The walls were not capable of resisting lateral loads. Further, removing the existing floor to create the large-span gymnasium doubled the unsupported height of the walls, reducing their load-carrying capacity.

Many options were considered to reinforce, repair, or strengthen the walls for gravity and lateral load resistance. Shotcreting the exterior walls from the inside was ruled out due to space limitations and cost constraints. The application of externally bonded Fiber Reinforced Polymer (FRP) systems also was ruled out because of cost implications and difficulty in execution.

The remaining option was to tie the exterior walls to steel frames, which would resist the roof and lateral loads. The steel frames, like a steel cage, would be inserted and erected inside the building while the existing floors were in place. The steel columns could be inserted from small openings at the roof and floors, and the beams could be erected from the inside, completing the steel cage.

No changes would be made to the existing façade of the building: Interior renovations could be done while keeping the exterior brick walls and the roof shape intact.

New Steel

Steel moment frames attached to the exterior walls were designed to resist the lateral loads. The exterior walls were tied to the frames at mid-height and at the top, acting like a curtain wall. The walls were tied at mid-height below the existing wood frame to enable installation of the steel prior to removal of the floors.

W8×24 steel columns were inserted from the roof down to the basement story. They rested on newly poured concrete piers and enlarged footings, which were tied to the existing foundation walls by drilled-in anchors.

Fortunately, geotechnical investigations performed at the site indicated that the existing foundations were resting on glacial till capable of resisting two tons per-sq.-ft load in an undisturbed state.

Steel beams then were installed, tying the steel columns below the wood floor and roof elevation. They were tied to the exterior masonry walls with epoxy anchors and clip angles prior to the removal of the wood structure within.

Steel roof trusses framed the roof and tied the new steel columns at the roof. Double C8×11.5 channels were the main members, and double L3×3×$^1/_4$ angles were auxiliary members. This created a column-free space for the gymnasium. Wood 2×10 rafters spanned between trusses at the top and bottom chord elevation. Plywood ¾″ thick provided a diaphragm to transfer the loads to moment frames attached to the exterior walls.

Steel framing was inserted into the existing structure prior to the demolition of the existing wood framing.

Steel floor framing for the new gymnasium before installation of the non-composite metal deck and concrete floor.

Gymnasium Floor

Since the first floor of the main building would be used for a gymnasium floor, steel frame, metal deck and concrete with welded wire mesh were used for the floor system, but it was not a composite floor. New steel columns and footings were installed to replace the rusted original columns, which had supported the existing steel girders that carried the wood bearing walls and floors above. New girders were W14x61 at the gymnasium floor.

Chimney Supports

The chimney flues at two end walls had to be removed on the inside of the building to open space in the gymnasium area. The top portion of the chimneys, however, had to remain as part of the existing façade of the building. A new support system was designed by using a steel frame tied to newly installed roof trusses to support the upper brickwork of the chimneys.

Wall Openings

The design also called for a 16′-long opening in the 40′-high wall between the main building and the adjacent building, while maintaining the upper 20′ of wall above and the roof structure on one side.

Two MC12×37 channels sandwiched the wall prior to creating the new opening. The channels were bolted with thru bolts and tied at the bottom flange with ¼″ steel plates at every 16″.

The channels were supported by new steel columns inserted inside a separation wall between the two buildings, which ran down to the first floor

Second Building

For the adjacent smaller building, new steel bents created a cathedral ceiling to tie the exterior walls. The building roof was a hipped roof with a flat portion at the top. Exterior masonry walls extended up from the second floor to about 4′, and the sloped roof rafters formed the sloped part of the roof. The slope rafters then were supported with two rows of bearing walls at the middle of the building, used also to support the flat middle portion of the roof.

HSS8×6×$^1/_2$ members create a steel bent. They rise to the second floor, where they are spliced. At the eave, they bend

New roof trusses (*above*) made of C8s and L3×3s created the column-free interior spaces required for the gymnasium (*below*).

with the slope of the roof, running up to the roof's flat portion. There, W8 and W10 (horizontal/flat) beams support the roof wood joists. The bents are tied to the brick walls with steel angles and epoxy anchors.

W8×24 and W8×28 members were used for the girders to reinforce the existing wood roof structure. The girders enabled removal of the bearing walls and the creation of smaller spans for wood joists, which would carry a new loading of 100 lb per sq. ft. Also, a new 2,500-lb-capacity commercial elevator was installed to enable transfer of heavy equipment

Using steel frames for reinforcing and rehabilitation of the building helped achieve a well-coordinated project. The project was completed according to the required schedule, bypassing the hassle of cold weather concreting and lengthy operational procedures. ★

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