Adapting Traditional Plans to Fit a Tight Site

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Numerous detail modifications —like using steel framing instead of wood— enable designers to maintain the spirit of the standard design.

THE CHURCH OF Jesus Christ of Latter-day Saints (LDS) is building a new Ward and Stake Meeting House in East Cambridge, Mass., just north of downtown Boston. Normally, a wood-framed structure, the current construction incorporates steel in order to support several significant design modifications.

As an international organization, the Church of Jesus Christ of Latter-Day Saints uses a prototypical program and appearance for its Meeting Houses. The building program includes a large chapel, a small chapel, a multi-purpose recreation hall, classrooms, and offices. The typical Meeting House is a single-story structure with a gable roof, large steeple, and usually is constructed in rural and suburban settings where parking is provided on-site adjacent to the building. The new Meeting House for East Cambridge is located on a tight site (150 ft by 200 ft) in an urban, light industrial area of greater Boston, and is required to provide the program and parking within the site footprint. To achieve this, the typical Meeting House layout required significant modification.

The solution, developed by architect Burt Hill's Boston office in conjunction with LDS, turns the typical, single-story Meeting House layout into a two-story building over two levels of below-grade parking. This new design revised the roof from gable to flat (low slope), added two rooftop mechanical penthouses, and two stories of below-grade parking under the building. The design maintained the traditional aspects of the Meeting House including the exterior brick veneer and steeple.

Due to the unique nature of a two-story Meeting House, several design and detailing solutions were required to accommodate the changes. These included the long-span, low-slope roof above

Opposite page: Photo of an offset column in the parking garage. Deep, cantilevered, steel girders are used for the transfer; the steel columns from the superstructure are supported at the ends of the steel transfer girders which cantilevered over and are supported on the concrete columns below.

the chapel and recreation hall, the column offsets between the garage and building superstructure, and the veneer structural supports at the two-story chapel walls.

Relatively long roof spans of between 40 ft and 50 ft were required above both the chapel and the adjacent recreation hall to maintain column-free spaces for large gatherings that require the combined area of both spaces. Further complicating the roof structural design, drainage was specified in the middle of the 40 ft beam span. The drainage was achieved by sloping the primary steel beams and using slices of hollow structural sections (HSS) to develop back-pitch to the drains. The design uses W21 and W24 beams spanning between supporting girders with a constant slope to achieve an elevation change of 7 in. over their length.

To achieve the required back-pitch to the drain located at beam mid-span, a hollow structural section (HSS8×4×3/8) was cut diagonally along its length (7 in. deep at one end tapering to 0 in. deep at the other end) and welded over half the beam length. The welding was detailed to allow the built-up shape (beam and cut hollow structural section) to work compositely with the roof slab. The design using the built-up shape created the required drainage in the middle of the beam span, reduced the roof weight by eliminating the need for tapered concrete, and simplified the roofing installation by reducing the need for tapered insulation. The use of the HSS allowed both sections of the cut shape to be used, simplified welding access to a web that might be hidden by a tapering WT flange, and reduced tripping hazards that might be caused by a flanged shape.

The lateral load resisting system for the superstructure is steel concentrically braced frames in two orthogonal directions interconnected by rigid floor diaphragms of reinforced concrete cast on composite steel deck. Transferring the forces to the garage foundation walls through the first floor diaphragm allowed the garage levels to be free from interior-braced frames or shear walls. Preferably, the steel superstructure columns, both columns which are part of the lateral load resisting system and gravity columns, would align with the

Burt Hill, Project Architect

Front elevation of the new Ward and Stake Meeting House, East Cambridge, Mass. Modifications to the standard plan enabled construction of a fully functional facility on a compact site.

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Photo of the front elevation during construction showing the exposed secondary steel girt structure which supports the veneer. The steel columns closely match the depth of the steps and the steel beams frame to either the inner or outer flange.

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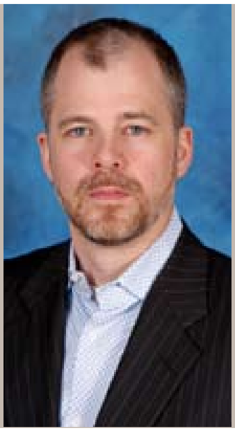

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The garage entrance at the rear of the new Meeting House in East Cambridge, Mass., leads to two levels of underground parking.

concrete columns in the garage structure below. However, as the design progressed, it became evident that in several locations the driving lane and turning radius in the parking substructure were too tight to allow reasonable traffic flow.

To address the congestion in the drive lanes, two concrete columns needed to be offset by several feet from the two steel columns above. The steel columns are located along the dividing line between the chapel and multi-purpose recreation hall and support a substantial portion of the second floor and roof. The offset necessitated a load transfer from the steel columns. Large, doubly cantilevered steel girders were used for the transfer. The steel columns from the superstructure are supported at opposite ends of a W33, doubly cantilevered steel transfer girders. By adjusting the first floor framing layout, we were able to use a single girder. The single girder, with two short, opposite-end cantilevers allowed a relatively shallow shape to be used for large magnitude loads by "picking up" the midspan. This helped maintain the necessary height in the garage below and reduced the need for a deeper excavation.

For brick veneer supported by steel studs, good design and detailing practice necessitates a stiff back up. This is typically *L*/600 for wind loading. In typical framing situations, steel studs spanning between floor framing provide the necessary support. However, steel studs become less efficient in common depths as the required spans increase. In the case of the Meeting House, where the chapel exterior wall is unsupported for nearly 30 ft, the support for the veneer at the face of the two-story chapel required the development of a sec-

A secondary steel girt structure was developed to support the brick veneer being installed on the new Meeting House.


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ondary steel girt structure to work in combination with the support from the primary building superstructure.

The brick veneer steps out from the primary vertical plane of the façade several times and culminates in a perceived pedestal at the front of the chapel sitting directly below the steeple. To provide for the steps, the supporting superstructure columns are centered between the steps and sized such that their depth closely matches the depth of the steps. The primary plan veneer-stop is just over 1 ft. At each side of this step, are two W16×36 columns. The W16s allow the beams and girts at the inner vertical plane to frame to the interior-side flange of the column while the beams and girts in the outer vertical plane are framed to the exterior-side flange of the column. The W16 depth also provides the necessary depth to maintain the stiffness required for a brick veneer façade.

The building construction started in February 2008 and is ongoing. The main structure is completed. The steel topped out in July 2009. At the time of publication, the interior fit-out work is progressing and the last sections of the exterior brick veneer are being placed. The steeple is expected to be installed in April 2010 and the building is expected to be completed and turned over to the church in June 2010. MSC

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Software
SAFE v8, RAM Structural System v12, RISA 3D