
Photo by Christof Spieler.

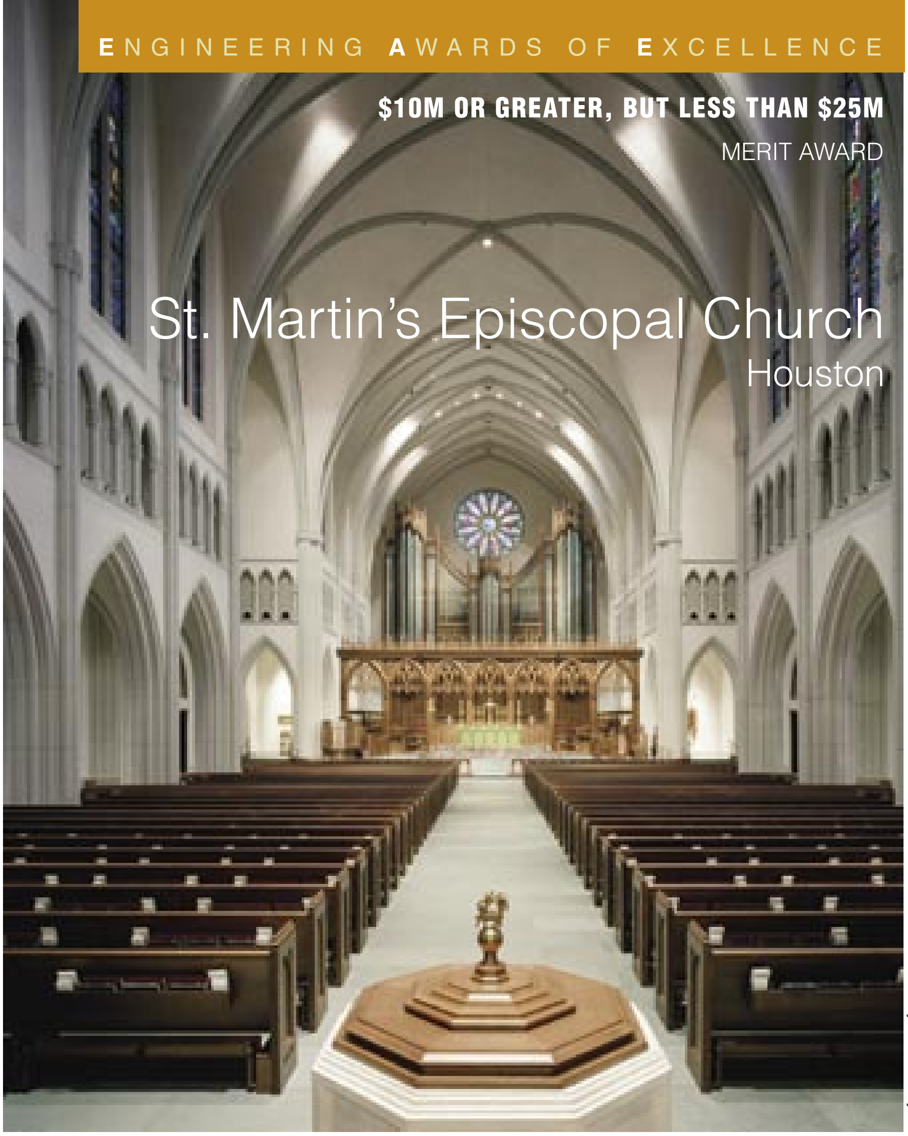
Photo by Mark Scheyer.

$10M OR GREATER, BUT LESS THAN $25M

MERIT AWARD

St. Martin's Episcopal Church

Houston

Structural Engineer
Matrix Structural Engineers, Houston

Engineering Software
RISA-3D
RAM Steel

Owner
St. Martin's Episcopal Church, Houston

Architect
Jackson & Ryan Architects, Houston

Erector
Steel Masters, Inc., Houston, SEAA member

General Contractor
Tellepsen Corporation, Houston

For the new sanctuary of St. Martin's Episcopal Church, the design team worked hard to capture the form and details of a Gothic cathedral. Beneath the structure, however, the buttresses and pointed arches are anything but traditional.

Gothic architecture was the owners' request. The design team's job was to make it work with a $20 million budget and a tight schedule. Work on design development started in December 2000 and the building had to be completed exactly four years later. The challenge was to replicate, in modern materials, the forms of an architecture based on load-bearing masonry.

Several structural systems were considered for this unconventional building. A hybrid system of steel and concrete was considered. But the final choice was what had been sketched in the first design team meeting: a series of steel frames forming the nave, spaced at 16' on center to match the architectural module, and two X-braced steel structures forming the towers.

Each steel frame, 80' wide at the base and 87' tall at the peak, carries the wind loads for a 16' strip of the façade. The main columns are W27×146. Below 32', the main columns are connected with moment connections and angle braces to the beams and columns of the aisle. Above 47', the columns are joined to the gabled roof truss, which is made up of a wide-flange top chord and double angle diagonals. Under wind loads, the main columns bend in an "S" shape due to the fixity from the aisle frames and the roof truss. No column base fixity was counted on for strength calculations. With allowance made for some fixity, lateral deflection under 110 mph winds is less than 1/300th of the height.

As soon as the steel frames were erected, it was obvious that these were the "bones" of a Gothic church. The diagonal braces of the aisle frames form the arches of the aisle ceiling, and the beams above form a classic triforium, used here for air conditioning ducts. The underside of the roof truss forms the shape of the vaulted ceiling.

Between the frames are tall stained glass windows. To meet deflection requirements, these had to be braced to the W27 columns. A steel frame around the window—fabricated to exact dimensions so the windows would fit in without blocking—is attached to steel tubes welded to the sides of the columns. Several different distributions of wind were evaluated to make sure the columns would not twist excessively under this load.

The towers posed their own problems. The steel structure extends to 108', and above this are 80'-tall pre-engineered steeples. Four W14×176 columns form the corners of the tower. Above 47', the columns are connected with double angle X-braces and ring beams. Below that, the opening for the balcony stairs and a large stained glass window eliminate both east-west X-braces in the tower. A series of girts, sloping beams, and diagonal braces concealed in the tower buttresses transfer the wind loads sideways and down to the ground.

Because the tower brick extends 128'

up and steps back often, shelf angles spaced 8' to 15' vertically provide for brick support. A system of tubes wraps around the towers at every shelf angle, following the shape of every buttress, pier, and wall. These are supported on outriggers off the main tower columns or on buttress beams, and are designed to take both the vertical brick load and the horizontal wind loads.

The remainder of the structural system is fairly conventional; roofs are metal deck on steel joists and floors are concrete slab on metal deck on wide-flange beams. The roofs of the aisle and nave are framed with sloping steel bar joists spaced 5'-4" on center. Deep, long-span metal deck was considered early on to eliminate the bar joists, but discussions with the construction team revealed that joists would be useful for supporting the plaster ceiling, lights, and maintenance catwalks. Point loads were specified on the construction documents and the joists were designed to allow these loads to be placed at any point along the joist.

The general contractor and key subcontractors, including the steel fabricator and erector, were brought in early in the design process. Matrix structural engineers worked directly with the steel detailer to answer questions rather than go through a formal RFI process, and shop drawings were submitted in multiple packages to allow fabrication to begin as detailing continued. The result: The building was completed on schedule and in time to install the pipe organ before the first service, Easter 2004. ★

Photo by Christof Spieler.