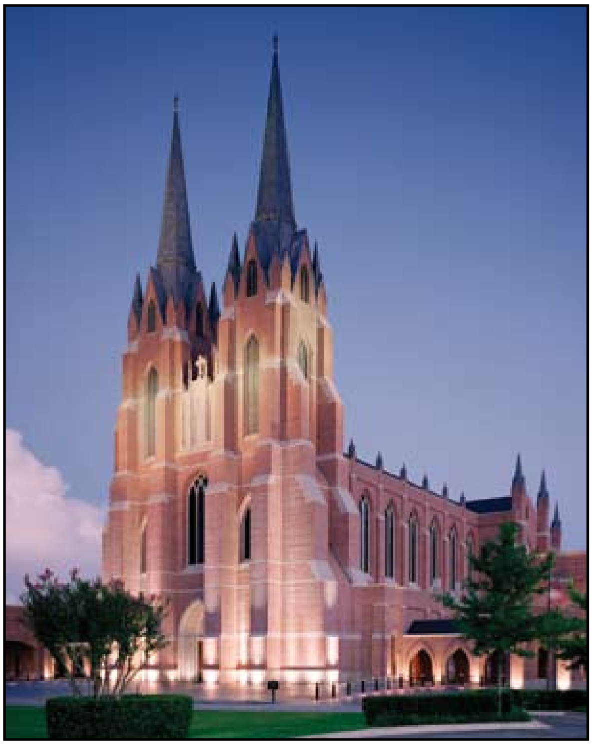
St. Martin's Episcopal Church Houston, TX

By Peter J. "Chip" Hurley III, P.E., Christof Spieler, P.E., and Moyeen Haque, Ph.D., P.E.

The St. Martin's Episcopal Church project was presented an Outstanding Project Award (New Buildings $10 Million to $30 Million category) in the NCSEA 2005 Excellence in Structural Engineering Awards program.



The intricacy of the building's shape, with buttresses, spires, and piers, is true to Gothic precedents. Photo by Mark Scheyer, Inc.

Innovative structural engineering is often associated with the latest trends in Architecture. The most advanced techniques of the structural profession frequently allow the Architect to extend the boundaries of shapes and forms that are possible. The classic Gothic shape of St. Martin's Episcopal Church and large clear spans, combined with brick and stone finishes, presented structural engineers with as great a challenge as any cutting-edge design.

The program was highlighted by several equally important goals. The form of the church had to be appropriate for the liturgical functions, hence the cruciform plan. The seating capacity was to be 1300; this meant that the church would be large. Also, the congregation sought a building that would inspire its members as well as the surrounding community. The Gothic style selected could fulfill all of the requirements if the plan was large enough.

St. Martin's rector, The Rev. Laurence A. Gipson, D.D., worked closely with Architect, John C. Clements, AIA, Principal of Jackson & Ryan Architects. The architects carefully researched precedents and identified prototypes. When the research was complete and examples were presented to the building committee, St. Elizabeth's Cathedral in Marburg Germany (built 1235-1335) was selected as a model for the exterior and Chartes Cathedral in Chartes, France (built 1194-1260) was selected as a model for the interior. European cathedrals are built of load-bearing masonry, and the construction process often took more than a century. The congregation had neither the time nor the money to undertake a load-bearing masonry structure. Modern materials would have to be used. Furthermore, seating for 1300 required that the plan for St. Martin's would be much wider than any original Gothic cathedral. The problem facing the design team was how to use modern materials and techniques to construct a church that appeared Gothic in scale and detail, but was actually larger and included accommodations for modern conveniences.

The proximity of the church to occupied buildings and the tight site presented challenges to the design and construction team. Photo by Christof Spieler, P.E.

Hurricane force winds are a certainty in Houston, Texas. The lateral systems at St. Martin's would have to support significantly larger lateral loads than European counterparts. Overall sway of the building frame was a particular concern, as was the localized wind pressures and suctions on the windows.

The church has a typical Gothic plan which resembles a crucifix. The main body of the structure is the tall nave which extends from the entrance to the choir area, and finally the altar. The nave is intersected by perpendicular wings called the transept(s). They form the arms of the cross and are the same height as the nave. There is an aisle down each side of the nave for circulation. The entrance is flanked by large towers. The space between the towers, from the front doors, to the nave is the narthex. It serves as the entry hall. The balcony is located above the narthex and has room for additional seating.

The structural challenge was obvious from the beginning. The church is a giant hollow vessel. There are no interior partitions except for the short below the balcony separating the nave and the narthex. The columns are widely spaced and the side walls are mostly filled with stained glass windows. Except for the short wall below the balcony, there are no intermediate floor levels. There is no location to conceal diagonal bracing or shear walls. The solution was to use large steel moment frames. Each frame outlines the shape of the nave including the roof (54 feet wide and 87 feet tall) and the 13-foot wide aisles on each side. The steel frames followed the slope of the steel roof above the aisles.The frames follow the same module as the architecture. The vaults and windows repeat at 16 feet on center, as does the structural steel frame. Each frame was designed to carry its own wind loads, thus overcoming the lack of transverse walls to conceal lateral bracing.

The twin towers are simpler than the nave, but they presented some challenges. The basic concept is that of a trussed tube; four corner columns are connected with X-braces to form a rigid structure that measures 16 feet on each side. The corner columns are W14x176, the X-braces are double angles, and the horizontal members are wide-flange beams. These horizontal elements sometimes serve

The Gothic forms, down to the petals of the rose window, are present even in the bare structural steel. The moment frames of the nave are clearly visible in this view. Photo by Christof Spieler, P.E.

to support intermediate floor decks. These structural elements combine to create a stiff structure that supports the gravity loads from the tower and resists the lateral wind loads.

The largest load on the church other than wind is the weight of the masonry. Support of the masonry was particularly critical at the towers because they are 128 feet tall and the brick steps back many times. Shelf angles, 8 to 15 feet apart vertically, were supported by a series of steel tubes that wrap around the towers and along the walls, and are supported off the columns by outriggers. These frames follow the outline of every buttress, pier, and wall. The frames support the horizontal wind loads as well as the vertical masonry loads.

Aside from a few support rooms and attic spaces for ductwork, the interior of the church is one huge space, leaving little room for structural elements. Photo by Mark Scheyer, Inc.

From the beginning, it was clear to all involved that St. Martin's was a special project. We, as structural engineers, had the opportunity to design a structure where every major component and detail was unlike any we had done before. For once the predominant question was not "Is this the most economical way?" or "How soon can we issue?", but rather "Is it possible to do this at all?"▪

Peter J. "Chip" Hurley is Principal and founding partner of Matrix Structural Engineers. Mr. Hurley has more than twenty-eight years of engineering design and management experience. Christof Spieler has seven years of experience in engineering design and is currently a Senior Associate at Matrix Structural Engineers. Christof was the Project Engineer on St. Martin's Episcopal Church. Dr. Moyeen Haque is a partner at Matrix. Dr. Haque's has seventeen plus years of engineering design and management experience and was the Principal in Charge on St. Martin's Episcopal Church.

Project credits:

Owner
St. Martin's Episcopal Church, Houston, TX

Architect
Jackson & Ryan Architects, Houston, TX

Structural Engineer
Matrix Structural Engineers, Inc., Houston, TX

Geotechnical Engineer
Tolunay – Wong Engineering, Inc., Houston, TX

Contractor
Tellepsen Builders LP, Houston, TX