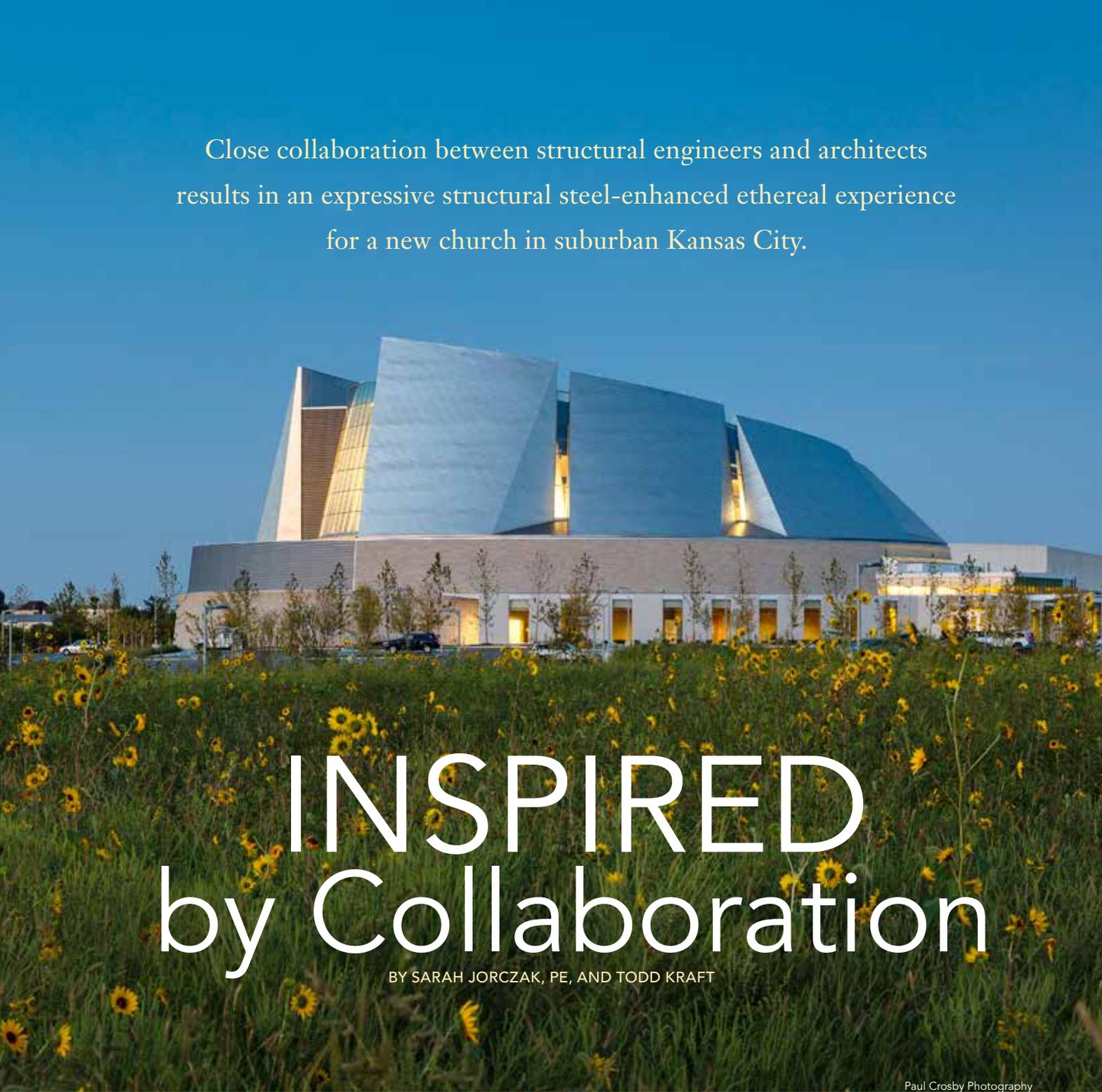


Close collaboration between structural engineers and architects results in an expressive structural steel-enhanced ethereal experience for a new church in suburban Kansas City.



# INSPIRED by Collaboration

BY SARAH JORCZAK, PE, AND TODD KRAFT

Paul Crosby Photography

## HOW'S THIS FOR A DESIGN GOAL: Transcendence.

The new 140,000-sq.-ft sanctuary and support space for the United Methodist Church of the Resurrection in Leawood, Kansas—designed by HGA Architects and Engineers—was, like many similar projects, built to inspire. The long-established church's desire for a new 3,500-seat, cathedral-like, naturally lit sanctuary resulted in an expressive steel structure with an elliptical shape. The design met these directives while also wrapping the congregation around a thrust chancel to create an intimate sense of community and deliver a transcendent experience for anyone entering the space.

The singular project, however, is much more than its grander, signature moves and was the result of an unprecedented inter-

disciplinary collaboration between HGA's architects and structural engineers. In fact, the structural design was so married with architectural design that the two disciplines couldn't function separately from one another; throughout the project, they were simultaneously engaged. While an integrated approach to design and engineering is the norm at HGA, this project pushed the team to an even higher level of collaboration, from the micro to the macro levels of design.

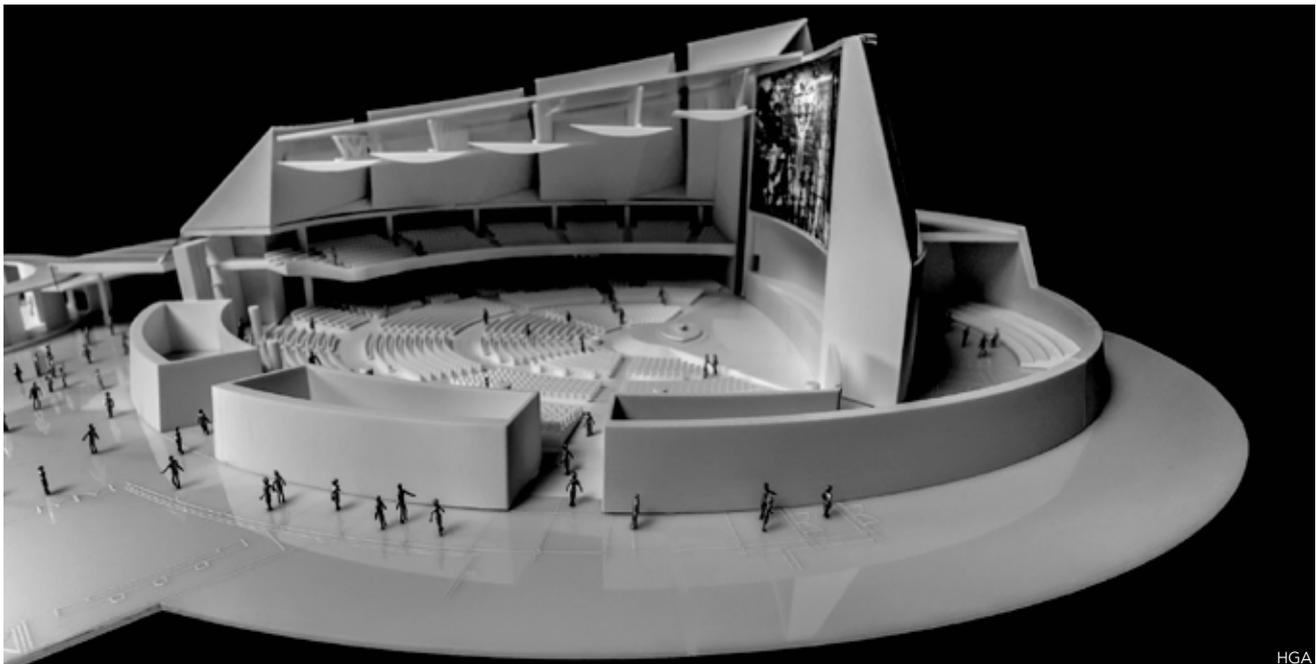
One of the macro aspects was the evolution of the steel structure to support the architecture. Early on in the design process, the team's structural engineers and architects identified truss geometry constraints, such as the panel width (to accommodate catwalks and mechanical systems) and truss depth for the pro-



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◀ The new 140,000-sq.-ft sanctuary and support space for the United Methodist Church of the Resurrection in Leawood, Kansas.

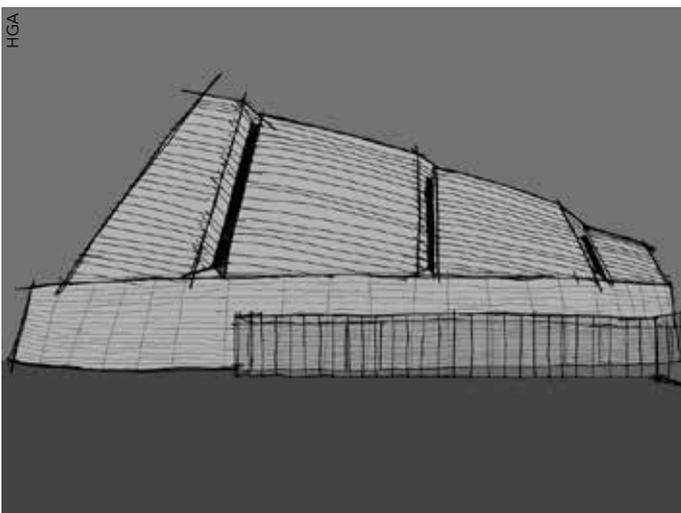
▲ The sanctuary can accommodate 3,500 guests.



HGA

▲ A model of the sanctuary.

▼ A sketch of the exterior sails.



HGA

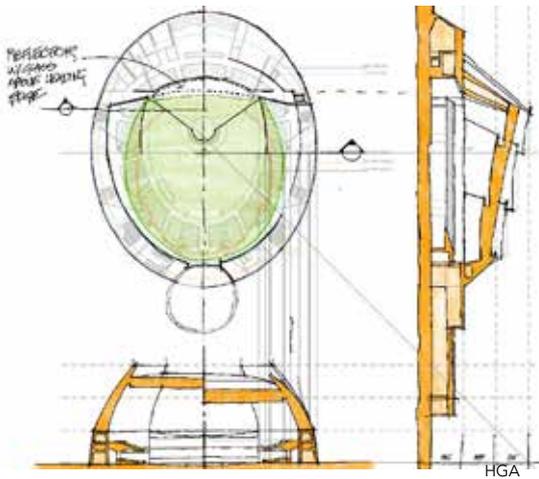


**Sarah Jorcak** ([sjorcak@hga.com](mailto:sjorcak@hga.com)) is a structural engineer and **Todd Kraft** ([tkraft@hga.com](mailto:tkraft@hga.com)) is a senior project coordinator, both with HGA.

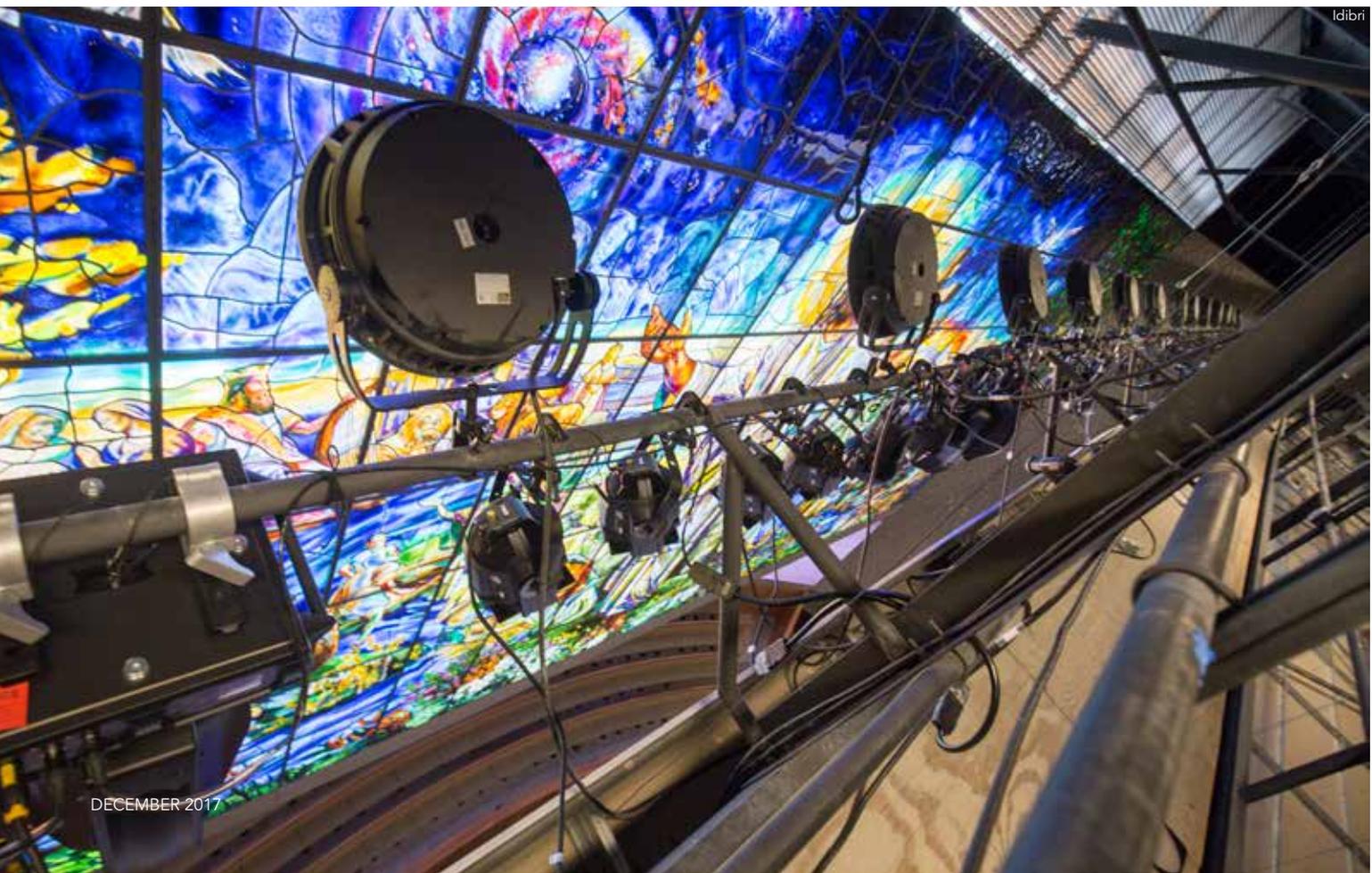
posed ceiling structures. Using SCIA Engineer, the engineers downloaded and parameterized the roof truss depths to show the architects various design iterations and determine the most efficient design solution within those constraints.

Because existing analysis and modeling software has difficulty accommodating non-rectilinear and non-circular grid systems,

HGA's engineers broke down each ellipse on the project into a set of four arcs, each with a unique center, start and end work point, all identified on an orthogonal grid system. A ruling geometry plan communicated the arcs and work points for the design and construction teams to use. This mathematical ellipse layout option permitted the consistent creation of the



- ▲ Early sketches of the facility.
- ▶ Outside the church.
- ▼ Catwalks in front of the stained-glass window.



project ellipses in multiple software platforms, and more than 40 work points were used to establish the multiple ellipses on the project. Similarly, the architects created parametric models with which to communicate the shape and geometry of the church's seven sloped stainless steel exterior "sail" walls. The engineers horizontally offset steel braced frames along the elliptical grids, thereby creating an out-of-plane discontinuity to accommodate these unique sails, which represent the seven days of creation and rise from the perimeter of the sanctuary like hands in prayer. Using the architectural Rhino sail geometry model, the engineers defined planes representing portions of the sails to determine the possible wind-loading vectors. On the church's interior, the architects and engineers collaborated to create structures to support the balconies and enable seating configurations that place a majority of the congregation no more than 100 ft from the chancel.

In order to maintain the sanctuary's openness yet provide sufficient seating, the project required a thin-front balcony with a shallow-depth truss to accommodate high ceilings and unobstructed sight lines from the back row of the tiered parterre seating. The 1,300-seat balcony is supported by cantilevered steel trusses, with chords that extend out from pairs of

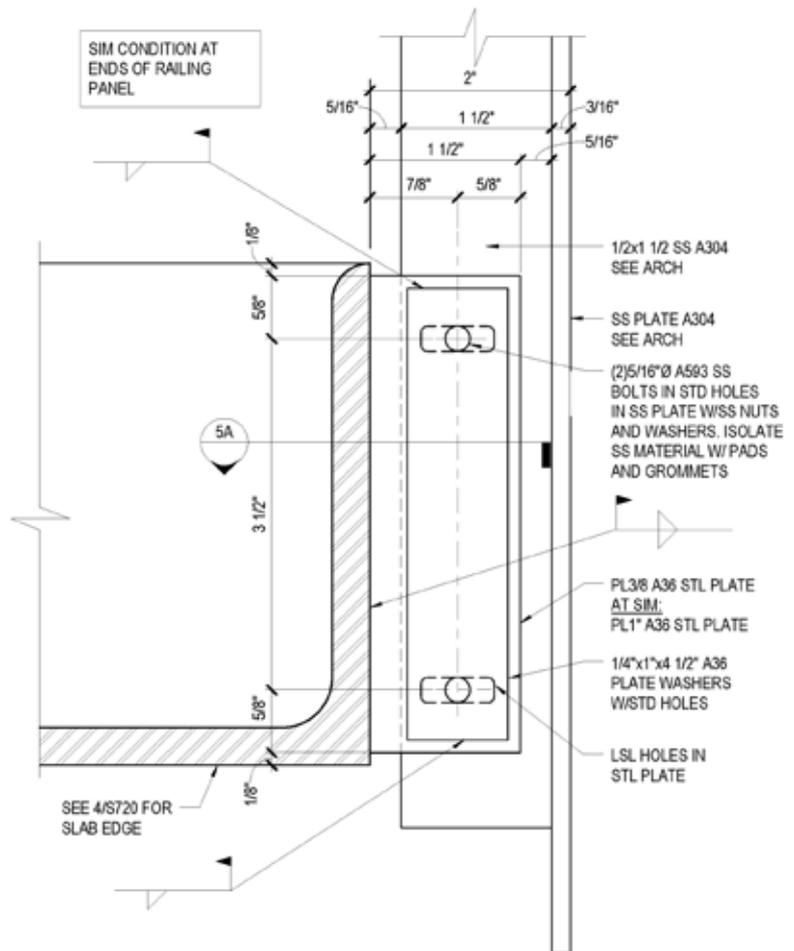
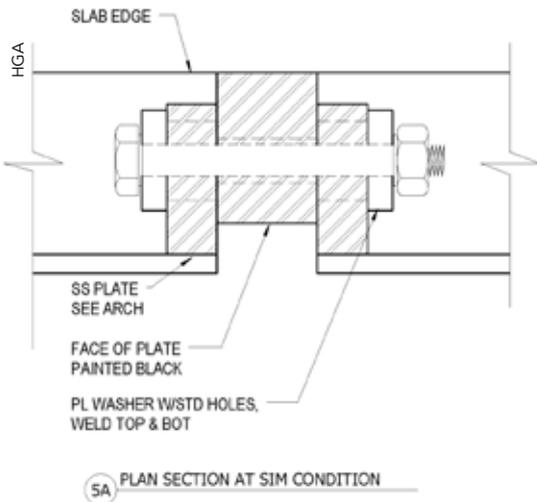
columns spaced on radial grids around most of the elliptical base. The architects and engineers also collaborated on the balcony railing's perforated stainless steel artistic pattern and integrated custom light fixtures, which give the balcony an elegantly fashioned, hand-crafted aesthetic.

The massive stained-glass window is another of the church's signature micro elements. The collaborative design team, along with glass artisans and the construction team, carefully developed structural steel framing for this colorful 93-ft by 37-ft feature, which provides a reverent backdrop rich in visual storytelling. The engineers analyzed multiple iterations of cross sections using solid plate, WT shapes and HSS as possible vertical support members. Each option needed to have adequate strength and stiffness but also be thin enough so as not to cast shadows on the windows; in the end, the architects selected the thinnest and shallowest profile. Each of the 161 stained-glass panels is supported by vertical and horizontal aluminum mullions, which tie back to exposed HSS8x2 that provide lateral support.

Even the limestone and bronze altar itself took advantage of structural steel framing. Curved to resemble the triclinium or U-shaped formal dining tables of Biblical times, the mobile

▼ Steel lighting fixture on the balcony.

▼ Drawing of the steel railing attachment to the balcony slab edge.



5 GUARDRAIL ATTACHMENT DETAIL

altar's framing was engineered so that it could function as a table and also withstand load reversal when it is moved via pallet jack across the chancel floor to make room for special events.

Another architectural-structural feature is the colonnade that wraps the sanctuary and opens into a 15,000-sq.-ft narthex with 20-ft-high ceilings and a continuous ribbon of clerestory windows that divide the narthex from the main structure. To make this architectural vision a reality, the engineers used a thin ceiling plenum that was expertly coordinated and integrated with structural, mechanical and electrical systems; long-span, open-web steel joists were used, enabling mechanical ductwork to run horizontally through the structural elements. Framing member positions were coordinated with lighting locations to further reduce the required depth of the ceiling plenum. The engineers distributed mechanical and fire-protection systems vertically between upper and lower narthex ceilings at column locations to keep them hidden while maintaining the light, elegant look of the narthex. They also designed a back-up structure comprised of HSS to create two massive, custom-designed ceremonial doors leading from the narthex to the sanctuary. Outside the church, thin edges were engineered to be hidden behind metal panels on the entry canopies.

The level of engineering and architectural collaboration throughout the church speaks to the project's complexity and the team's determination to create the transcendent building the client requested. The project challenged both design disciplines to expand their thinking as well as the traditional notion of what a church structure should be. The completed project not only elevates the value of the partnership between architects and structural engineers, but also demonstrates the myriad ways in which structure and architecture were informed by each other in order to develop systems—from the macro to the micro level—that allow the Church of the Resurrection to inspire. ■

**Owner**

United Methodist Church of the Resurrection, Leawood, Kan.

**General Contractor**

McCownGordon Construction, Kansas City

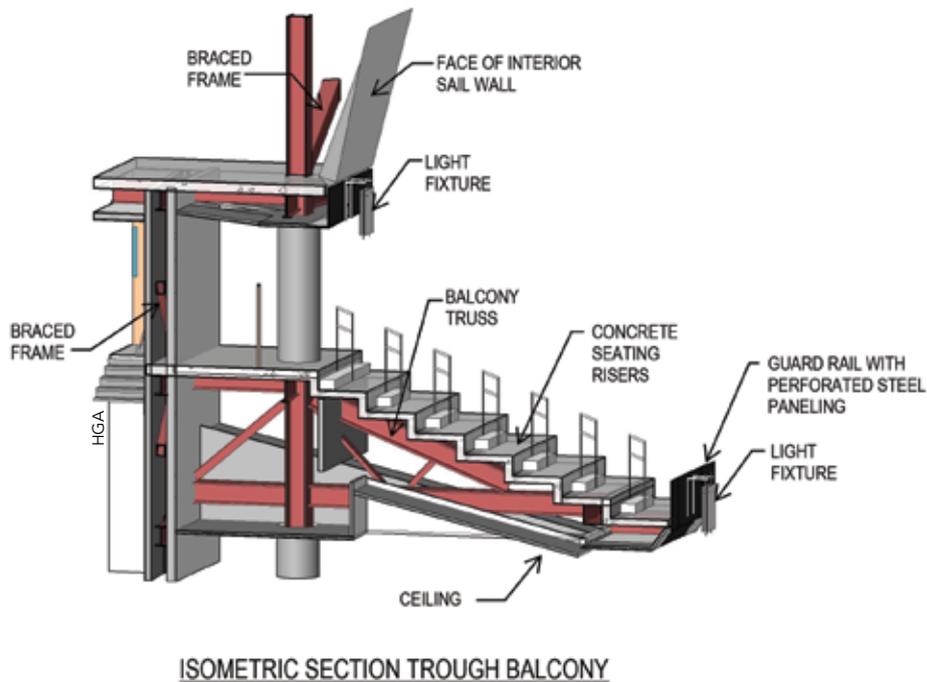
**Architect and Structural Engineer**

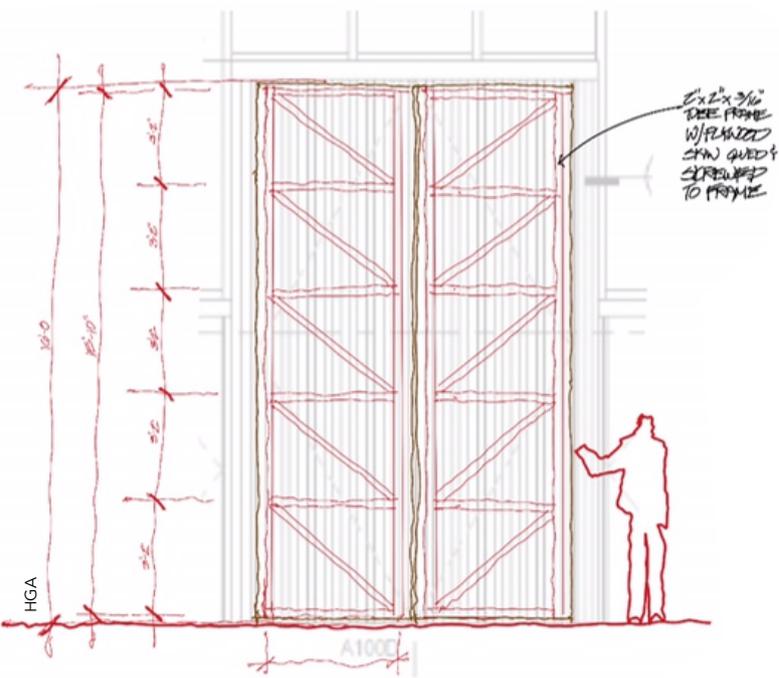
HGA Architects and Engineers, Minneapolis



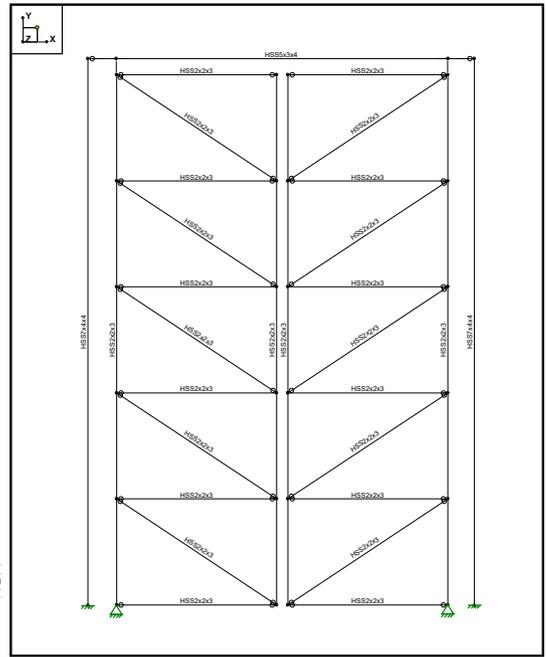
Paul Crosby Photography

- ▲ HSS-framed doors into the sanctuary.
- ▼ A Revit cross section view of the balcony.





ARCHITECTURAL SKETCH



STRUCTURAL ANALYSIS MODEL CONFIGURATION

- ▲ Sketch and framing plan for the double door into the sanctuary.



Paul Crosby Photography



Paul Crosby Photography

- ▲ Inside the lobby.
- ▲ The stainless steel sails of the church.
- ▲ A side entrance to the church.



Aaron Dougherty Photography