An architectural design reminiscent of a welcoming gesture now graces downtown Indianapolis.

Expanding the Indiana Convention Center

BY DAVID MAUSER, P.E. AND SCOTT ROUSE, P.E.

Scott Rouse

▲ Glass entry cube and cantilever structure over capitol street.

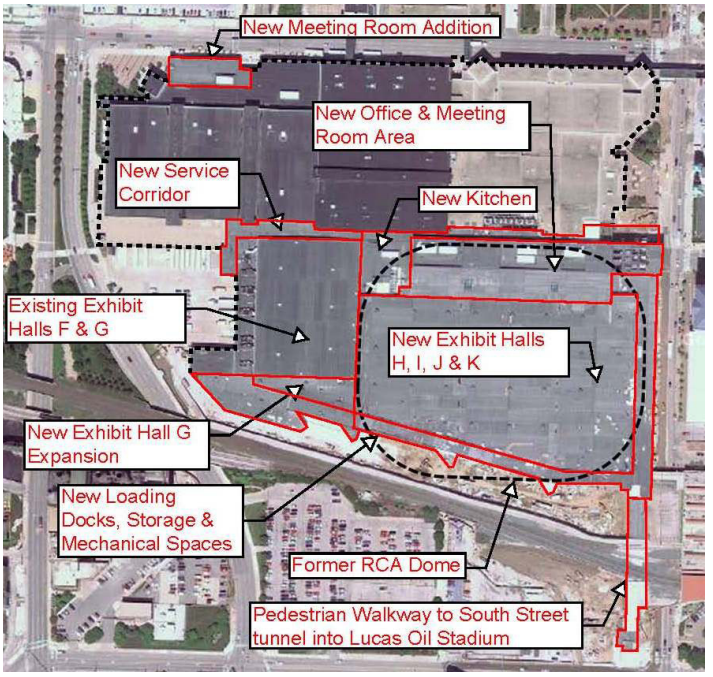
THE MAIN PROGRAM REQUIREMENT for the recent expansion of the Indiana Convention Center in downtown Indianapolis was the addition of approximately 250,000 sq. ft of exhibit space plus additional support spaces, for a total of more than 650,000 sq. ft of new construction. Because of the long-span floor and roof framing requirements and the architectural nature of the convention center project, structural steel was the logical solution.

Structural software employed in the structural analysis of the complex project included RAM Structural System, ETABS, and RISA. W14 wide-flange columns were used through the new expansion because the unbraced lengths were up to 35 ft. A total of approximately 8,500 tons of structural steel was used in the Convention Center expansion.

The new expansion of the Indiana Convention Center presented many design and construction challenges. For example, since 1984 the RCA Dome had been located on the southeast corner of the overall Convention Center site. When originally constructed, it was an integral part of the Convention Center, separated from the rest of the facility only by expansion joints along its north and west sides. Because a major portion of the new expansion was to occupy the site of the Dome, its demolition was a critical first step in the overall expansion process.

In addition to adding a significant amount of open exhibition space on the site of the old Dome, project challenges included executing the architectural plan for an impressive new entrance, and providing a new structural support system at the interface with the existing hall to open up the existing space and fully integrate it with the new space.

David Mauser is a project manager and Scott Rouse is a principal and the project engineer of record with Fink, Roberts & Petrie, Indianapolis. Both are AISC Professional Members.



◀ Indiana Convention Center site plan.

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▲ Suspended pre-function area and tapered girders above that create the welcoming handshake gesture.

▼ View along Capitol Avenue.

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New Office and Meeting Room Block

The new office and meeting room block located on the north side of the main expansion aligns with Georgia Street to the east. The area footprint is approximately 120,000 sq. ft and consists of large first and second level pre-function areas which are open from the ground level to the roof, large first and second level meeting room areas which can be partitioned into as many as 31 individual meeting rooms, and a third level office area. The second level also includes a new kitchen at the west end which serves the entire Convention Center.

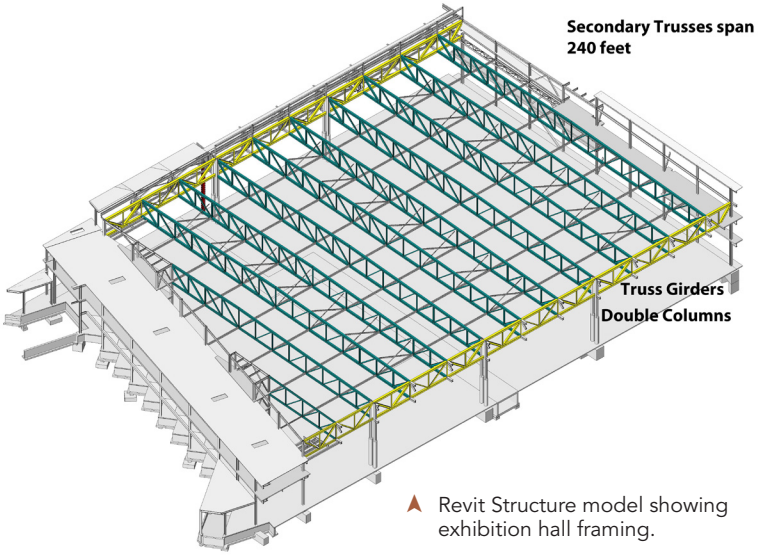
At the east end of this area, the main roof cantilevers 55 ft beyond the exposed, built-up cruciform columns which stand at the center of a 40-ft-tall glass cube, providing an impressive new main entrance for the Convention Center as well as providing outstanding views from the inside down Georgia Street to Conseco Fieldhouse. The entrance and pre-function corridor serve as a physical extension of Georgia Street, which will act as the main hub of activity during the 2012 Super Bowl. The structural framing supporting the glass cube was carefully coordinated with a specialized glazing engineer prior to being issued for bids. Special tolerance and deflection diagrams for the supporting structural steel were issued with the bid documents to eliminate potential handoff issues between the structural steel contractor and the glazing contractor.

The kitchen, office and meeting room floors are typically 4½-in. concrete on 3-in. composite steel deck, for a 7½ in. total slab thickness. Column layout in this area was determined by the meeting room dimensions, so the area is typically framed with 36-in.-deep composite steel beams spanning 60 ft to 70 ft, and composite steel girders spanning 30 ft. The additional thickness of the slab eliminated the need for spray-on fireproofing while also helping to mitigate vibrations in the long span floors due to walking excitation.

Above the clerestory pre-function area between the new meeting rooms and exhibition halls, 8-ft-deep built-up exposed steel box girders are used to support the roof and to support the exposed steel pipe hangers that carry the framing for the second floor pre-function area below. The girders' form helps to express the welcoming handshake gesture conceived by the design architect. The pre-function area wraps around the east side of the exhibit halls, and with its tapered roof cantilever, forms an impressive view of the Convention Center from Capitol Avenue.

New Exhibit Halls

The program requirements for the new exhibit halls required approximately 250,000 sq. ft of new exhibit space, with columns spaced no closer than 90 ft on center. This 90-ft column spacing was used in the north-south direction, along the partition walls, which divide the exhibit hall area into the individual Halls H, I and J/K. Columns were designed as double columns, connected by a gusset plate at the top for the north-south girder truss support, which allows for the partition walls to run continuous across the entire north-south dimension of the halls, between the double columns.



Revit Structure model showing exhibition hall framing.

Halls H and I are 240 ft in the east-west direction. The required clear height of 35 ft inside the exhibit halls, combined with the architectural design which limited the roof height, resulted in a maximum allowable truss depth of approximately 22 ft. However, after considerable consultation with potential steel fabricators for the project, the final truss geometry was selected to limit the maximum depth to only 16 ft out-to-out. This allowed the trusses to be completely shop fabricated and shipped to the site in sections and field spliced with bolted connections at the chords, which proved to be the most economical design. The savings in shipping and field erection, as well as the reduced cladding surface area that resulted from limiting the truss depth, was much greater than the cost of the small resulting steel tonnage increase.

The exhibit hall roof consists of 2-in. acoustic steel decking, supported on 14-in. wide-flange beams. The beams are supported by secondary trusses, typically spanning 240 ft and spaced 30 ft on center. The secondary trusses are simply supported at each end, and typically composed of W14 web-vertical chords and double-angle web members. Primary truss girders, which support the secondary trusses, typically span 90 ft, are simply supported at each end, and are composed of W14 chords and W14 tension and compression web members, all web-vertical, ranging from 211 to 550 lb per ft.

Limiting the deflection for the supported partition walls was a critical design consideration for the truss girders. The secondary trusses in Hall H cantilever over the double columns or through the truss girders along the west side, by approximately 7 ft to allow for the re-support of the existing Hall G roof framing, as described below.

Exhibit Hall G

Existing Exhibit Hall G is immediately west of new exhibit Halls H-K. The owner's program and architectural design required a column-free expansion of existing Hall G to the south, and a column spacing of at least 90 ft between Halls G and H, so that Hall G could be used as an integral part of the new Hall H-K area. Because exterior walls originally separated Exhibit Hall G from the RCA Dome, a total of 17 columns on the south and east sides of Hall G needed to be removed to create the column-free expansion.

The columns along the south wall of existing Hall G were spaced at 20 ft, 10 in. on center, and supported wide-flange spandrel beams at the roof level and a series of vertical and horizontal wind girts for the wall support. A new truss, spanning the entire 250-ft Hall G dimension was developed along this framing line, so that the 11 interior columns along the wall could be removed. The truss is composed of channel chord and diagonal web members, and was field welded to each side of the existing W24 columns.

Before truss framing was installed, the columns were shored and cut at the base, and jacked by varying dimensions to create a pre-camber position for the roof spandrel beams. The existing column at the west end, which remains in the completed structure, was reinforced with field-welded plates and angles, and the foundation was reinforced with a system of grade beams and auger-cast piles. The new truss, referred to as the "sandwich truss", was designed to extend approximately 4 ft beyond the east corner of Hall G, for support on a slide bearing at the cantilevered end of the new Hall H truss end.

Following the completion of the new reinforcing and new framing along the Hall G south wall, the jacks were removed from the 11 existing interior column bases to activate the new "sandwich truss," and the existing east corner column was cut to activate the end support condition on the Hall H truss cantilever. Finally, the lower portions of all 12 columns, below the sandwich truss bottom chord, were cut off.

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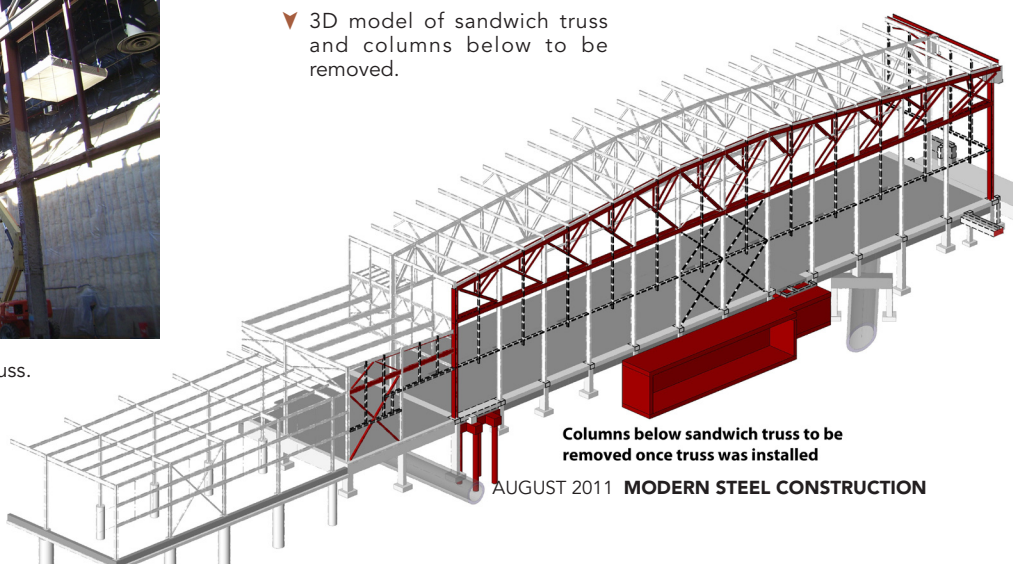
Construction of the sandwich truss.

3D model of sandwich truss and columns below to be removed.



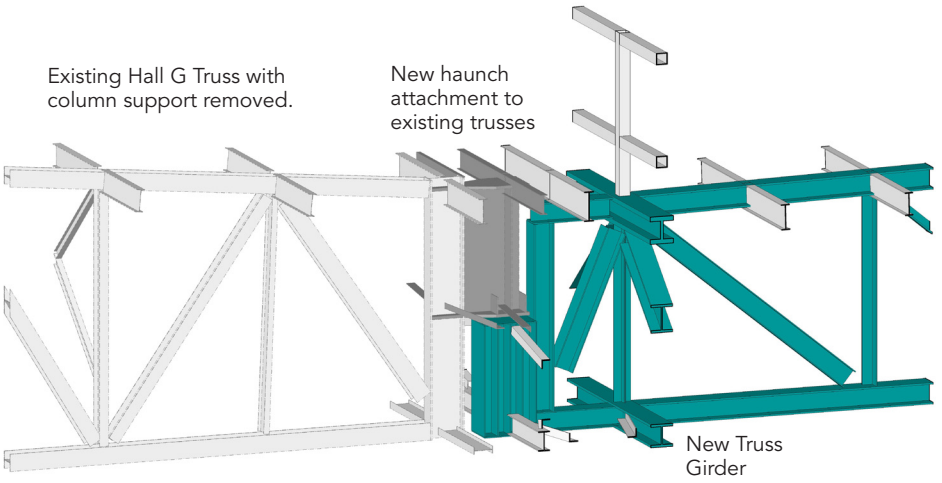


Fig. 1: Revit model showing existing truss bearing on new truss detail.

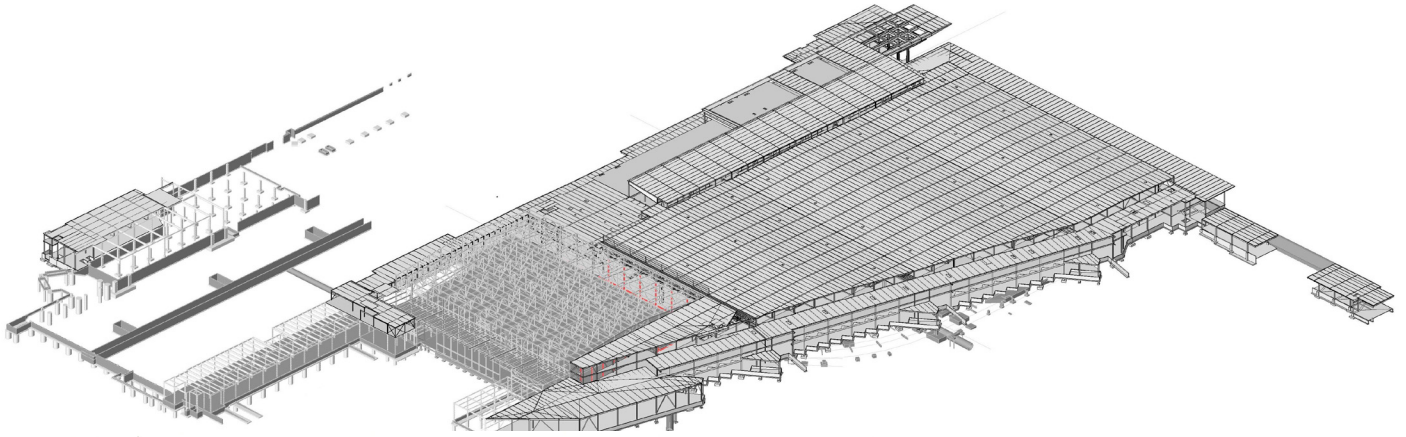
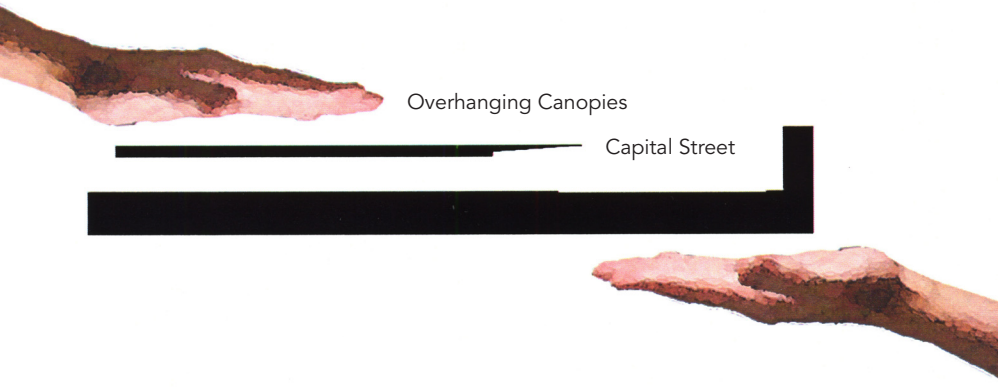


Fig. 2: Revit structural model of the Indiana Convention Center.



To mark its place as a uniquely Indiana facility, the architect conceived of the structural system as a means to provide a narrative from the Hoosier perspective. The overhanging canopies and the exposed framing above the main pre-function hall capture the welcoming gesture of a handshake. Even the shape of the roof was conceived to reflect the glacially altered northern region of the state along with hills of southern Indiana untouched by glaciers.

Along the portion of the east side of Hall G, which borders Hall H, bearing haunches were field welded to the exterior face of six of the existing columns. These six existing columns, which support the ends of the 250-ft Hall G trusses, were locally reinforced at the truss ends for the change in force distribution (no truss reinforcing was required), and jacked from the new Hall H truss ends to a pre-defined jacking load. The existing columns were then cut at the base, bearing assemblies and shim plates were inserted between the upper and lower haunches, and the jacks were subsequently removed. Finally, the lower portion of all six columns, below the Hall G truss bottom chord, was cut off (see Fig. 1).

In order to avoid the need for large-scale reinforcing of the lateral systems in the existing facility, expansion joints were provided along the north and west sides of the meeting room/exhibition hall addition, in the same basic locations as were provided along the sides of the former RCA Dome. Because the Hall G truss bearing condition occurs along the north-south expansion joint, however, slide bearings were required on the Hall H lower haunches to allow for differential lateral movement between the Hall H and Hall G trusses. The slide bearing assemblies can be seen between the bearing haunches in Figures 1 and 2.

The original lateral load resisting system for the existing Hall G included moment frames in the east-west direction, and braced frames in the north-south direction. Because of the column removal along the east wall, the Hall G lateral system had to be redesigned and reconfigured. New braced bays were added to replace the existing braced bays that were removed between Halls G and H.

Steel Erection Challenges and Conclusion

The erection of the structural steel presented several significant challenges. A fully engineered erection plan including the consideration of thermal effects was required. Due to the timing of the erection, the entire steel frame was subject to extreme low temperatures. The erector came up with a special sequence for connecting the braces in the lateral system to help mitigate the extreme thermal effects over the winter.

The owner's program for the Convention Center expansion was prepared by Conventional Wisdom Corporation of Ocoee, Fla. Magnusson Klemencic Associates, Seattle, participated in the preparation of the structural design criteria and structural system selection through the design development phase of the project. Structural Alliance, LLC and Kiva Engineers also participated in the structural design as associate structural engineers.

By exercising a high level of cross-discipline coordination during design, and by devising unique solutions to the structural challenges of the expansion, the Indiana Convention Center Expansion has provided increased capacity for meetings and events, a visual and architecturally engaging main entrance to the facility, and the means of meeting the convention and visitor needs of the present and the growth opportunities of the future. MSC

Developer
Indiana Stadium and Convention Building Authority (ISCBA)

Structural Engineer of Record
Fink, Roberts & Petrie, Inc., Indianapolis

Design Architect
Ratio Architects, Indianapolis

Construction Manager
Shiel Sexton/Powers & Sons Joint Venture, Indianapolis

Steel Fabricator
Lenex Steel Company, Indianapolis (AISC Member)

Steel Erector
Ben Hur Construction Co., Indianapolis (IMPACT Member)

Erection Engineer
James Ronning, P.E., Plymouth, Minn. (AISC Member)

Steel Detailer
Louden Steel Detailing Co., Indianapolis (AISC and NISD Member)

Model Helps on a Site With History

Completion of the $275 million Indiana Convention Center Expansion in early 2011 marked an important phase of growth for the city of Indianapolis. Providing increased capacity for the city's vibrant sports, convention and tourism activity, this expansion—the fourth since the original Convention Center was opened in 1972—places Indianapolis in the position of being a "first tier" convention destination, ranking it among the top 20 in the nation for exhibition space and quality of facilities.

One early expansion culminated in the opening of the Hoosier Dome in 1984, which became the home of the Indianapolis Colts football team and was rechristened the RCA Dome in 1994. When the Colts moved to the newly constructed Lucas Oil Stadium in 2008, it cleared the way for demolition of the Dome and construction of the latest Convention Center expansion.

Revit architectural and structural building models created for this project were used not only for producing final construction documents but also for design coordination and construction sequencing presentations. Portions of the existing facility adjacent to the new construction were modeled based on owner-provided existing drawings. These included large underground masonry sewers running diagonally through the entire new expansion area that had to be bridged, below grade, by concrete transfer girders, to support columns that would be located directly above the sewers. The locations and sizes of the existing sewers, which were present when the RCA Dome was originally constructed, were accurately documented on the existing drawings, and confirmed by utility surveys during design. By incorporating these sewers into the Revit Structure model, the locations for new foundations were accurately coordinated around the sewer locations, which resulted in only minor foundation revisions required during construction.