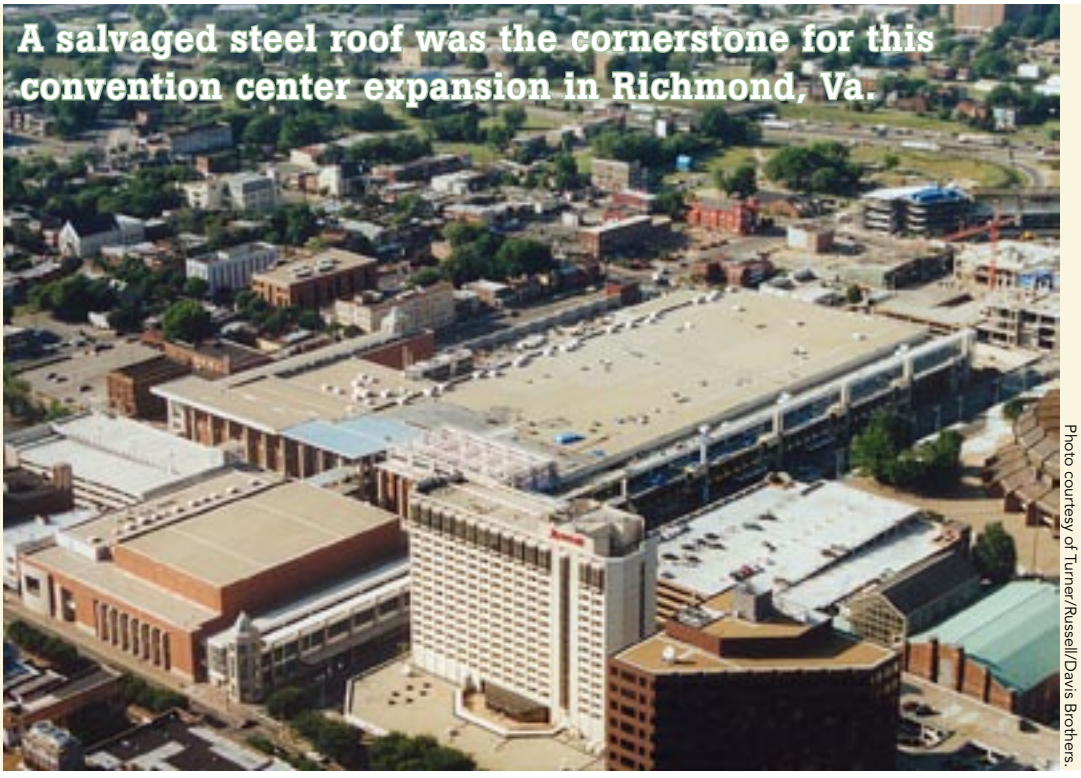
Salvaged Steel

BY JOHN C. LYONS, P.E.



A salvaged steel roof was the cornerstone for this convention center expansion in Richmond, Va.

Photo courtesy of Turner/Russell/Davis Brothers.

JUST OVER A DECADE AFTER THE GREATER RICHMOND CONVENTION CENTER'S DOORS FIRST OPENED, THE FACILITY'S OPERATORS PUT INTO MOTION A PLAN FOR EXPANSION. The original center featured a 60,000 sq. ft exhibit hall and 20,000 sq. ft of meeting space. Its location in downtown Richmond, Va. was attractive to event organizers, and the center had been successful in attracting many regional conventions to the city. Operators hoped that the expansion, however, would make the center an even stronger competitor among the region's convention venues in attracting national events.

Design of the convention center's expansion began in 1997 with a goal to dramatically enlarge the facility. The $128 million expansion would provide a total of 700,000 sq. ft of enclosed space, including 180,000 sq. ft of exhibit hall space; 80,000 sq. ft of meeting rooms; and a separate building featuring a 30,500-sq. ft ballroom. The project also included a 600-car, six-story parking deck.

The design team expected to demolish and rebuild much of the existing building: the existing pre-function areas and building exterior had to be replaced to accommodate the expansion. They even considered, at one point, demolishing the entire building, including the existing exhibit hall roof.

After further reflection, however, the designers decided to incorporate the exhibit hall's steel roof structure into the new design. The existing steel structure was in good condition. It consisted of a 1.5"-deep, 22-gage metal steel deck on 72"-deep joists, which spanned 145' across the exhibit hall at 5' on center. The lateral system consisted of built-up truss-column moment frames that spanned the hall and were typically spaced at intervals of 40' on center.

Reusing the existing exhibit hall roof provided two significant advantages: saving money and saving time. Salvaging the roof structure would save $3 million in demolition, materials, and erection costs. Additionally, the project team could better meet the facility owner's timeline targets if the roof was salvaged. The existing exhibit hall had to remain operational as long as possible, and the expanded exhibit hall needed to be occupied as soon as possible.

Beyond its advantages, the reuse strategy also posed the project's greatest structural challenges: adding rigging load capacity, unifying the roof slope, and maximizing column-free space.

Rigging Load Capacity

The new building program required the exhibit hall roof to accommodate 4,000-lb rigging points at

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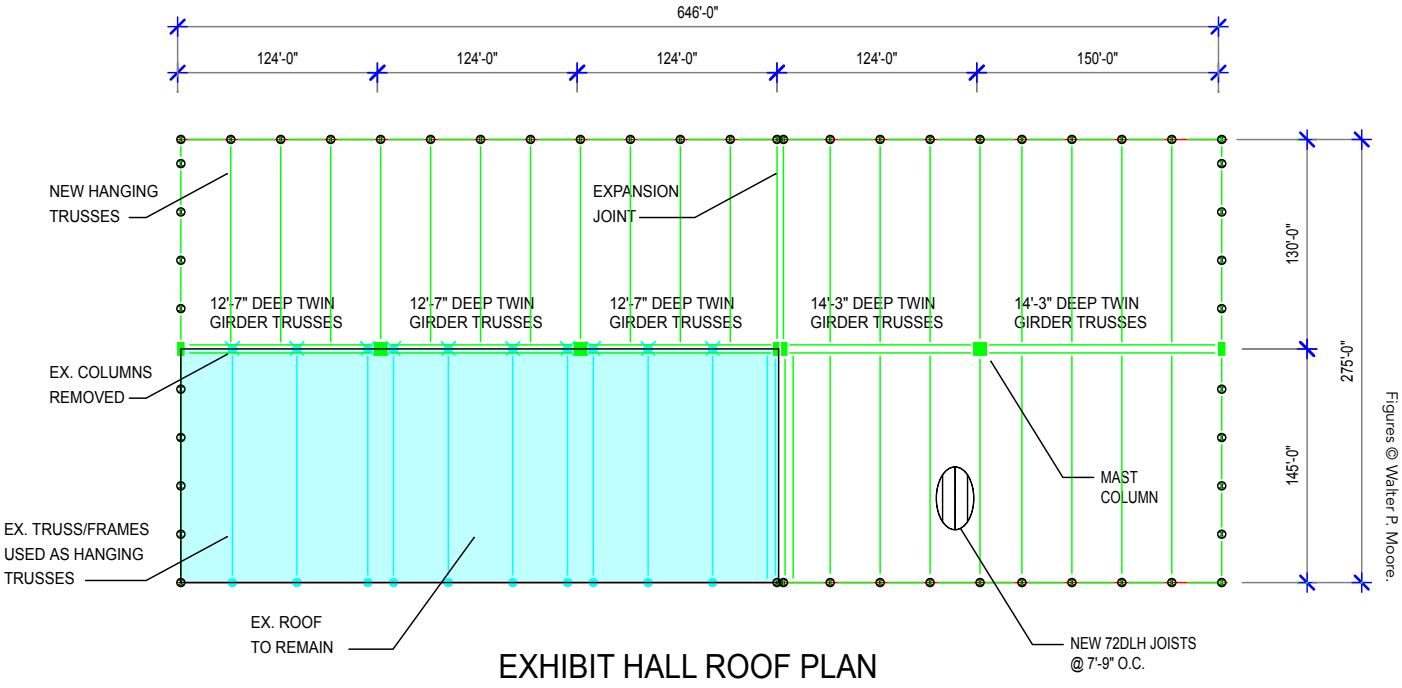


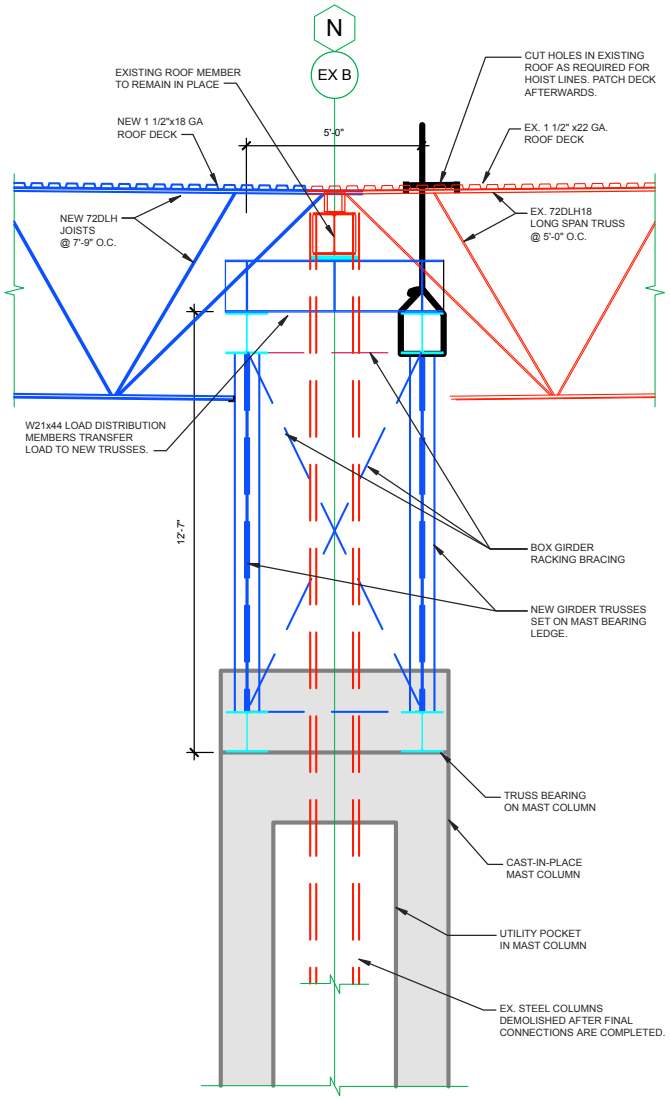
EXHIBIT HALL ROOF PLAN

Above: The existing exhibit hall roof was re-used in the expanded convention center. To match the new roof slope, the existing roof was stripped and topped with tapered insulation.

Right: At the interface between the new space and the existing exhibit hall, a line of existing columns was demolished. New mast columns support twin girder trusses, which in turn support the roof structure, creating large, column-free spaces.

30' on center, as well as 1,000-lb hang points at other truss panel points. The renovated exhibit hall roof would consist of 6'-deep 72 DLH-series long-span joists at 7'-9" on center to provide clear spans of 130' and 145'. Built-up trusses 17'-6" deep were used at 31' on center and were placed parallel to the long-span joists to carry rigging loads. These "hanging trusses" were made from WT8 top and bottom chords and double angle webs. Rigging hardware was installed at panel points to discourage potentially damaging irregular loading of truss members. Each 1,000-lb rigging point consisted of a ¾"-diameter closed eyebolt with a 2"-diameter hole. Each 4,000-lb rigging point consisted of a ½"-thick plate with a rounded 2"-diameter hole. Every plate was stamped with its rigging capacity using powder-actuated lettering tools to prevent over-rigging.

The expansion team had to enhance the existing roof's rigging capacity to prevent the older portion from becoming "second class" exhibitor space. This problem was solved by changing the building's lateral system. The new roof was laterally supported by large 6'-6" × 7'-6" cast-in-place mast columns. These mast columns were founded on 30' × 30' spread footings, which enabled them to provide lateral stability for the large exhibit hall roof. With this new lateral system, the truss-column frames within the existing roof no longer needed to resist lateral load moments. Walter P. Moore analyzed these trusses, heavier than needed to resist roofing loading, and found them to be capable of supporting the same rigging loads as the new hanging trusses. Hang-point hardware and lateral braces were welded to the underside of the existing trusses. In this manner, the older portions of the hall were provided with rigging capacity that matched that of the new portions of the hall.



Section A-A through twin girder trusses.

Courtesy Walter P. Moore.

Twin steel girder trusses, consisting of wide-flange chords and double angle webs, span between the mast columns to support long-span joists on each side of the exhibit hall roof.

Roof Slope

The existing roof sloped at ⅛" per foot. This slope was only half the ¼" per foot slope specified for the expansion. The architect wanted the top of the old roof to match the elevation and slope of the adjoining new roof. This would avoid the potential complications associated with differing roof slopes. The existing ballast, roofing membrane, and insulation needed to be replaced due to the age of the existing roofing materials. The architect seized this opportunity and increased the thickness of roofing insulation to build up the elevation and slope of the existing roof to match that of the new roof. Steel plates and kickers were used to connect the new and existing roof structures and to maintain diaphragm stability. In this manner, the new and existing portions of the exhibit hall roof are identical in terms of drainage and maintenance.

Column-Free Space

Column-free space is critical to the exhibit space's functionality. A line of columns supporting one side of the existing exhibit hall roof was demolished so the exhibit hall space could be widened from 145' to 275'. An erection sequence was developed to support the existing roof before and after column removal so the existing roof could stay intact.

The existing roof would serve as the northwest corner of the exhibit hall roof. Six new cast-in-place mast columns were spaced at intervals of 124' or 150' on center along an axis running through the east row of columns supporting the existing exhibit hall roof. Twin steel girder trusses, consisting of wide-flange chords and double angle webs, span between the mast columns to support long-span joists on each side of the exhibit hall roof. In the all-new portion of the exhibit hall roof, the girder trusses were 14'-3" deep and supported joists on top. Girder trusses supporting the existing roof were only 12'-7" deep to avoid interference with existing joist diagonals. This roof-framing scheme resulted in a floor plan that was considerably more open and versatile.

Raising the Roof

The scheme to raise and place the roof required careful coordination between the design team, construction manager, steel fabricator, erector, concrete contractor, and demolition subcontractor to work well. The structural contract documents showed the erection sequencing for the column removal to help facilitate coordination. In addition, all parties met at the job site beforehand to ensure that each understood its role in the process.

One consideration ran constant for all parties through each phase of demolition: the stability of the old roof had to be maintained.

The first step was to stabilize the existing roof structure. The demolition subcontractor designed and installed temporary braces to support the existing roof laterally so that surrounding portions of the building could be removed. Next, the mast columns were cast between existing columns along the axis of the new exhibit hall. The erector cut two holes in the existing roof deck to permit crews to hoist and erect the interior steel girder truss.

Next, the erector placed the outer steel girder truss. The erector then placed W21 load-distribution members, at 7'-3" on center, between the top of the new twin girder trusses and the top chord of the existing truss. Steel plate shims were used to account for irregularities and to ensure a tight fit between the new and old construction. When all permanent bracing was installed, the erector cut the old steel columns, permanently transferring the existing roof's weight to the new twin steel girder trusses and cast-in-place mast columns. Load was transferred from 22 existing steel columns to the four new cast-in-place mast columns, which produced an open and highly functional exhibit hall space below.

With proper planning and coordination, the center's original steel roof structure proved resilient and adaptable. The owner was provided with rigging capacity, lower maintenance roof slopes, and the large column-free space needed for the center to grow into a leading convention venue.

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SMBW Architects, P.C, Richmond, Va.

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Associate Engineer
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Engineering Software
SAP2000
RISA-3D

Fabricator
Cives Steel Company, Mid Atlantic Division, Winchester, Va., AISC member

General Contractor
Turner/Russell/Davis Brothers joint venture