Qwest for Excellence

By Thomas Scarangello, P.E., Erleen Hatfield, P.E., and Len Joseph, P.E., S.E.

Photograph courtesy DLR Group.

Omaha's new Qwest Center successfully combines the functions of a convention center and an arena in a carefully planned multi-purpose venue.

Attracting major events, encouraging riverfront redevelopment, boosting the local economy, and raising the city's profile were all goals in the minds of Omaha's city leaders when they proposed the Qwest Center Omaha complex.

The site, a former Union Pacific rail shop, was separated from the city's downtown by an elevated highway. Providing the necessary visibility required a grand gesture, but on the tight budget of a public works project and a demanding fast-track schedule. In the end, a flexible, innovative structural steel framing system was developed through design team collaboration.

The first challenge was deciding the primary purpose of the facility. "One faction in Omaha wanted a convention center, and another equally strong faction wanted a sports arena," says Roger Dixon, president and CEO of the facility's owner and operator, the Metropolitan Entertainment and Convention Authority (MECA).

The solution was an ingenious melding of arena and convention center that allowed some spaces to be shared. The arena and convention center can simultaneously accommodate different events, or the arena's concourses and main floor can be used as an extension of the convention space. The facility thus provides a compromise—one of the first contiguous convention centers/arenas in the country. Among medium sized metropolitan areas, Omaha is a trendsetter with this approach.

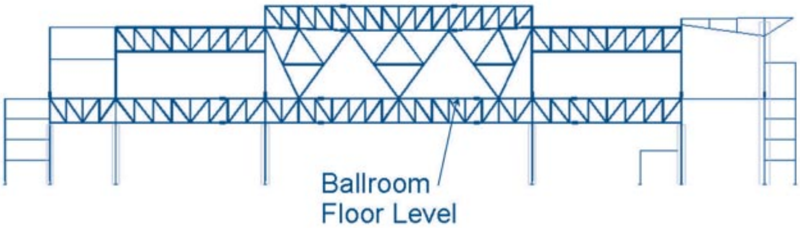
"Events are attracted [to a site] by what you can do with your facility," says Dixon, who notes that flexibility was a prime consideration. Completed in fall of 2003, the \$200 million, one million-plus square foot facility features a 190,000 sq. ft exhibition hall in its convention center. The exhibit hall is linked to a 17,000-seat arena designed for entertainment and sporting events.

"A major focus became how to best take advantage of the physical proximity of the two facilities and how best to share resources, equipment, and space for various events," says architect DLR Group's project leader Ken West. What resulted was an arena attached to a long-span, nearly column-free convention center via a 30,000 sq. ft "swing space." The swing space can be used in conjunction with either facility, or opened up entirely, to create 244,000 sq. ft of continuous flat floor area.

The convention center design concept called for clear spans of 90′ and 150′, a column-free second floor ballroom, and an arena roof spanning a 420′ by 570′ area. Such long spans made steel framing the obvious choice. The completed convention center used approximately 10,000 tons of structural steel to support its two levels. The arena roof weighed in at just over 3,000 tons.

Arena Roof

To give the facility the commanding presence required for a signature entertainment complex, large-scale elements were incorporated into the architecture. A striking element is a dramatic 160′ cantilevered overhang, extending beyond the 350′ main spans of the curved arena roof. The silhouette forms an artful addition to Omaha's skyline and a new city landmark for travelers en route to downtown from the nearby airport.



Left: The innovative double-truss system that supports the ballroom's roof and floor also forms part of the structure's lateral force resisting system.

Photograph courtesy DLR Group.

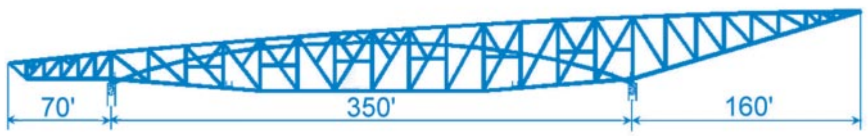
Above: The Qwest Center is one of the first contiguous convention centers/arenas in the country.

Below: Four 64'-deep truss systems, two floors in depth, were placed around the perimeter of the ballroom, shown here.

Supporting the dramatic arena roof is an elegant truss system. Structural engineer Thornton-Tomasetti used its broad experience with long-span structures and sports arenas to determine an appropriate system. An array of truss systems used for other sports arenas was studied. Systems studied included tension-tied truss systems that Thornton-Tomasetti had used before to successfully span hundreds of feet in earlier projects, such as the Pepsi Center in Denver, CO.

"Thornton-Tomasetti's experience is impressive," says Dixon, "and that gives them a good understanding of our project."

While tension-tied trussed arches can be very efficient to fabricate and erect, they work best where loads are well-distributed and acting in predictable directions. Snowdrifts and wind uplift forces on the signature cantilever could generate large, unbalanced, and reversible forces, making tied arches less effective. The final design incorporates four main full-depth trusses with bowed top chords to handle the severe load patterns. The main span of these trusses is



Four trusses with bowed top chords support the roof of the arena. The trusses feature a 160' catilever.

350′, with the primary cantilever of 160′ on one end and a smaller 70′ cantilever on the other end. Five bridging trusses run perpendicular to the main trusses and are 13′-6″ deep. The roof infill framing is comprised of W14 steel beams supporting the 3″ metal roof deck.

Convention Center Roof

There is structural drama in the convention center, too. In its pre-function space, the architects designed a dramatic, undulating roof and enclosed the space with a glass curtain wall. The roof runs the entire 720′ length of the pre-function space to create an exceptionally open and grand setting for trade shows and large-scale meetings. Structural columns behind the curtain wall vary in height to support the curving roof. These columns rise up to 97′ above the finished floor and carry gravity loads from roof framing and curtain wall supports, in addition to lateral loads from wind on the facade. However, the architect requested that the columns be slender to maintain the desired bright and open visual impression, though the construction schedule was tight. The solution was composite construction. Tubular steel horizontals run behind facade mullions and frame-to-steel columns that support steel roof framing. For added buckling resistance, lateral stiffness, and fire protection, the columns were encased in reinforced concrete after the roof framing was placed. This two-step process allowed steel erection to proceed without waiting for concrete work to catch up.

Ballroom and Convention Center

The entire 30,000 sq. ft ballroom space, located on the second level, is column-free. This design choice enhanced both the aesthetic appeal of the space and its operational flexibility, but posed a design challenge for the roof framing. The exhibition space on the level below the ballroom also required as few columns as possible, which made the design of the ballroom floor challenging. Program requirements required both the exhibition and ballroom levels have tall story heights, so lateral stability was also a concern. Any solution had to be practical to fabricate and erect, as well.

An innovative double-truss system proved to be the structural workhorse. Four 64′-deep truss systems (two floors in depth) were placed around the perimeter of the ballroom, hidden in walls. The double truss system simultaneously framed the roof, supported, and stiffened the floor, and acted as a part of the lateral-load resisting system. By strategically locating these key trusses, many structural benefits were provided with minimal impact to the architect's design. The double trusses performed the work of several structural elements and provided a cost savings over more traditional structural engineering solutions. The truss bottom chords also provided the stiffest possible support for the floor framing, which was comprised of 12′ by 6″-deep trusses (chosen to maximize shipping depth) and W30 steel floor beams. The top chord of the double trusses supported the roof framing and consisted of 120′ span steel joists provided by Vulcraft.

The structural design for this superstructure was completed in only seven months, with the construction completed in 22 months. This was all part of an intensely coordinated effort to get the project for up and running by fall 2003, and it could not have been possible without the use of structural steel.

"The convention center and arena is a project with very exciting potential to spur further development," West says. "Four or five years out, you won't even recognize Omaha." ★

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