FULLFILLING FRANK LLOYD WRIGHT'S VISION

A renewed interest in Wright's legacy and a desire to spur convention-related business led Madison to finally build Monona Center

By Howard Hinterthuer

NEARLY SIX DECADES AGO, THE RENOWNED AMERICAN ARCHITECT FRANK LLOYD WRIGHT designed a new civic center on Lake Monona in Madison, WI. Three times, from 1938 until his death in 1959, Wright redesigned the center, but to no avail. He couldn't gain the necessary public support from city officials to have his vision realized.

However, nearly 40 years after Wright's death, his vision has been reborn as a convention center. Spurred by a desire to stimulate convention-related revenues and a renewed public interest in Wright's legacy, the city secured a combination of city, county, state and private funding to construct the Monona Terrace Convention Center.

Despite the change in function, the appearance of the 250,000-sq.-ft. center admirably matches Wright's vision. However, one major change was a move from a concrete frame to a combination steel and concrete frame by the design team, which includes Arnold & O'Sheridan

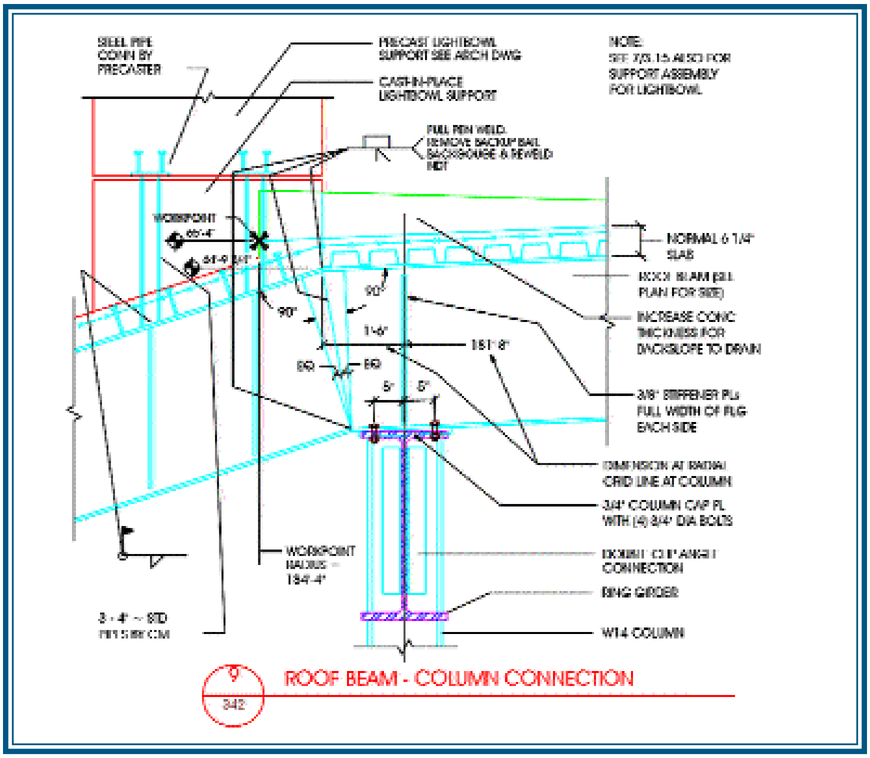
Consulting Engineers, Taliesin Architects and Potter Lawson Architects.

At 580' long, Monona Terrace extends fanwise from an entirely land-filled site 90' into Lake Monona. The biggest change in the original design was switching to a combination concrete and steel frame.

Switching From Concrete To Steel

Steel framing was used in the main exhibition halls as well as the curved promenade, while cast-in-place concrete was used in the east and west portions of the building. "Mr. Wright originally designed a totally concrete building," explained Michael L. Schmidt, a principal with Arnold & O'Sheridan. "But there were several key reasons why we elected to use steel, including the desire to run the ductwork unobtrusively. It also was more cost effective and allowed us greater flexibility in sequencing the construction." The most complicated portion of the project was the three-level exhibition hall, which

Wright's design for Monona Terrace beautifully complements the state capitol and other surrounding buildings. Photo top and opposite by Skot Weidemann Photography, Middleton, WI.



Shown on the opposite page is the roof beam to column connection. Pictured above is the steel joist connection at column and plate girder at column.

features 101'-long clearspan floors. Different truss systems were used on the two framed levels to minimize vibration transmission. The roof truss system, which also supports a rooftop garden over the ballroom and assembly hall, is 7'-8" to 10' deep with trusses spaced 15' on center.

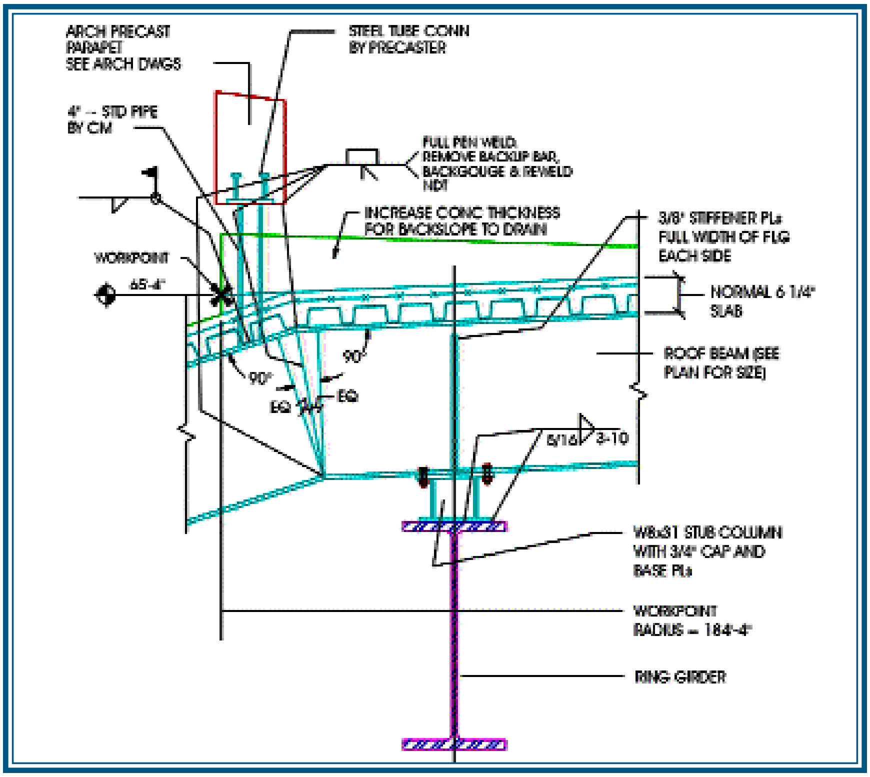
The larger truss members are located in the center, with the depth of the trusses stepping down towards the perimeter of the building to create drainage. The top chords range from W14x120 to W14x159, the bottom chords are W14x120 to W14x257, and the diagonals are 6" angles. Spanning between the trusses are W14x22 wide flange members, which support 6-1/4" lightweight concrete fill on 3" composite metal deck from Vulcraft. The roof trusses were left exposed to facilitate hanging fixtures and other exhibit materials.

The floor trusses, which form the ceiling of the exhibit hall below, are 7'4" deep and spaced 5' on center. The top chords are WT12x58.5, the bottom chords are WT9x71.5 and the diagonals are 4" angles. Again, 6-1/4" lightweight concrete fill on 3" composite metal deck was utilized. Arnold & O'Sheridan used STAAD-III from Research Engineers to design the trusses. Fire protection was provided by a combination of Cafco Blaze Shield II from Isolatek International along with lightweight concrete fill.

"The two different truss spaceings are to accommodate a different natural frequency," explained Dennis McMillen, a senior structural project engineer at Arnold & O'Sheridan. "Also, 15' centers on the roof truss allowed us to create a series of ridges and valleys to facilitate drainage. There is approximately 6" of variation. We also incorporated three separation lines to prevent the transfer of vibration through the floor system to adjacent rooms." The separations, created via double

Pictured, from top to bottom:

- *framing on all sides of central area complete; long span truss framing half complete*
- *framing for level two of the mezzanine;*
- *roof beam-girder connection*



trusses and a small gap in the floor slab, are placed at the west end of the ballroom, between the main corridor and the east wall of the assembly hall and at the west wall of the assembly hall.

The trusses, which are supported on plate girders spanning 30' between W14 columns, were delivered to the site in two sections and then bolted together on-site prior to erection. In the shop, the web members of the trusses were welded to the chords. Each truss has a welded or bolted bearing connection and the bottom chords are tied to the columns for additional lateral bracing to resist wind forces. In addition to their structural role, the trusses serve as a handy and flexible hanging point for exhibits.

Serviceability Concerns

Serviceability was a key concern for the long-span members. "Steel allowed us to do some things we couldn't do with concrete—vibration control for long spans, for example. We designed for serviceability first—to minimize vibration—then we looked at structural capacity."

Another structural challenge was presented in the design of the steel framing over the semicircular promenade. "The toughest part was creating the shop drawings for the compound cuts on the roof beams," explained Jeff Owen of R.D. Sepper Co., the steel detailer on the project. "Not only did they splay out like spokes, but they also had to be pitched to facilitate run-off. We built a mock-up using a compound mitre saw. It allowed us to visualize what we had to do." Beams, which range in size from W12x14 up to W40x324, are joined via single plate or double angle shear connections. The project used a total of 2,400 tons of structural steel.

To avoid expansion and contraction problems during construction, the cast-in-place concrete and steel portions were not connected until after the building was enclosed. "Now that the envelope is complete and the temperature is stabilized, expansion and contraction are no longer a problem. The building didn't require any expansion joints," Schmidt said.

Areas flanking the main exhibit hall are cast-in-place two-way flat slab construction, which allowed the construction of six floors while matching the total height of the three-story exhibition space and ballroom floors.

The entire structure is supported on 1,735 pilings driven 45' to 95' into the landfill and lake bed, with special provisions to accommodate the freezing and thawing of the lake surface. The cast-in-place piles are topped with a precast concrete deck 5' above the water line that is designed to resist ice and wave forces.

An atmosphere of cooperation pervaded all phases of project delivery, notes George Austin, director of Madison's Department of Planning & Development and project manager for Monona Terrace. "By combining construction management and partnering approaches, we were able to achieve an 'all one team' attitude toward project execution. We were thereby able to surmount the problems common to large, competitively bid civic building projects—cost overruns, schedule delays and marginal workmanship."

Because the $67.1 million budget was inviolable, the design team and construction manager employed a system of periodic rigorous cost assessments, including third party engineering review, to make certain the project remained on target.

Howard Hinterthuer is a freelance writer based in Cedarburg, WI, and specializing in design and construction related topics.