EAE

Merit Award

Swonder Ice Arena

Evansville, IN

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Juror Comment

"An impressive building for the cost. Simple and elegant steel detailing results in a practical solution meeting the owner's brief."

The Swonder Ice Arena is a simple building form that dynamically defines a massive space. The arena's roof curves across the width of the building along the line of a continuously curved W16 to create a sculptural shape. A cantilevered glass canopy supported from steel pipe columns and HSS beams welcomes visitors to the arena. The facility includes a 1000-seat ice rink, a 400-seat ice rink, indoor and outdoor skateboarding parks, a fitness area, a hanging walking/jogging track, a concession area and offices.

The W16 roof beam that forms the roof line extends from one end of the building to the other, with full-penetration welds at each connection. It also forms the top chord of a king-post truss over the 1000-seat ice rink; spans across the central core of the building; forms the top chord of another king-post truss over the 400-seat ice rink; and cantilevers over a low roof area, allowing clerestory windows between the two roof planes.

The roof beam was braced against twist at each end of the truss and at the centerline of each truss span, and was braced at the top flange by the roof deck. Designers used an LRFD design with the beam stability concepts developed by Joseph A. Yura, Ph. D. at the University of Texas, and determined the C_b value of the beam for the unbraced length of approximately 50′ on each half of the trusses.

Beam analysis was conducted using a three-dimensional model of the building to account for beam continuity and bracing, and the effect of horizontal forces acting simultaneously with the dead and live loads. A P-Δ analysis was used to include the effects of the deflection of the beam, and to satisfy the LRFD design. This was concern where the beam carries large axial forces as the top chord of the two king-post truss spans. The axial forces, together with the dead and live-load deflections, affect the moments in the top-chord beam and vary the C_b factor for each load case.

The roof was designed to support uplift wind forces. The uplift design case used the roof deck to brace the top flange of the beam, providing a conservative C_b value of 2.0 for the uniform-load design calculations, with the ends of the beam braced against twist.

The interior of the rink volumes were opened by establishing a 20′ spacing for

Owner
City of Evansville, IN

Architect/Structural Engineer
Jacobs Facilities, Inc., St. Louis

Architect
Edmund L. Hafer & Associates, P.C., Evansville, IN

General Contractor
Weddle Brothers Construction Company, Inc., Evansville, IN

Detailer
LJB, Inc., Dayton, OH
(AISC member)

Detailing Software
SDS/2

Engineering Software
RISA-3D

the roof trusses, and by keeping the lines of the trusses simple with a minimum number of members. An EPICORE roof-deck ceiling system spanning between trusses provided an appealing ceiling, supported the vertical loads, and provided the required diaphragm strength and stiffness.

The steel columns on one side of the 1000-seat ice rink were designed to lean towards the rink. The leaning columns impose horizontal forces on the building, as the horizontal component of the dead and live forces acting at the roof attempt to push the building to one side. These horizontal forces are resisted by diagonal bracing on each end of the building. The roof diaphragm, acting in concert with a horizontal truss located near the center of the building above the leaning columns, transfers the dead, live, wind, and seismic forces to the diagonal braces at the building sides. The horizontal roof truss can support the horizontal forces, but is too flexible to keep the horizontal deflection of the roof to an acceptable value. Instead, the stiffness and strength of the roof deck was used with the horizontal truss to reduce the deflection of the roof to a reasonable value, to provide some redundancy, and to support the trusses during construction.

The contractor first installed the horizontal truss and then installed the roof trusses from each side, working towards the building center, and completing the roof deck attachments between each set of trusses before placing the next truss. Until the roof deck was completed, it acted only to reduce differential horizontal deflections between trusses and to transfer horizontal forces back to the horizontal truss that spans between the two exterior lines of diagonal bracing. Once the roof deck was completed, the deck diaphragm and the horizontal truss acted together to support the remainder of the horizontal loads.

The walking and jogging track and a spotlight catwalk in the larger rink are hung from the roof structure, freeing the floor plan below. Despite the additional dead and live load demand that they place on the roof structure, they actually reduced net wind uplift near the peak of the roof, where the uplift forces generally would be higher. The continuous nature of the roof framing has the necessary stiffness to reduce vibration on the track to a comfortable level.

The project cost was just under $12 million, and the building was completed in 2002. ★