Simplifying a Complex Roof Form

Innovation Lowers Building Height and Reduces Costs

By David A. Platten, P.E. and Lee W. Slade, P.E.

American Airlines Center in Dallas, Texas, is a multi-purpose arena that seats 19,200 for NBA basketball, 18,500 for NHL hockey and 20,000 for center-staged events. The roof structure is an innovative and surprisingly economical response to the classic but complex cross-vault architectural roof shape.

Walter P. Moore added an external post-tensioned concrete tension tie embedded in the upper concourse floor framing to economically provide the lateral resistance usually provided by buttresses in traditional barrel vault construction. This unique mix of structural steel and post-tensioned concrete results in a design that takes maximum advantage of the structural depth created by the arch shapes of the cross-vault form. Though internally tied structural systems have been utilized on many recently completed NBA/NHL arenas, these systems have commonly required significant increases in the building height to provide unobstructed fan sightlines below the cross ties. By using the external tension tie, the building was effectively shortened by 15 feet, resulting in structural frame cost savings of an estimated $2 million and additional savings in building façade and MEP systems. The design also provided a long-span roof steel erection method that was simple and safe.

"…unique mix of structural steel and post-tensioned concrete…"

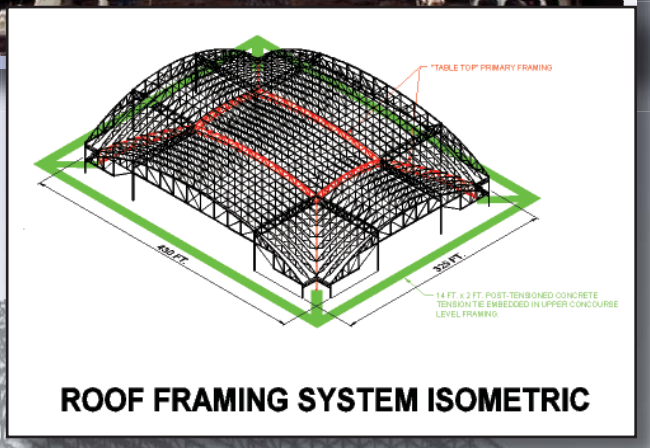
An innovative show rigging support system is integrated into the roof-truss design to improve economy, safety, aesthetics, and to streamline building operations. By establishing a truss spacing of approximately 11 feet and designing the truss bottom chords to resist rigging loads along their length, the engineers eliminated the need for a separate rigging grid. In addition to saving steel tonnage, this integrated solution provides riggers with safe and easy access from the catwalk system, which in turn enables the Center to attract and quickly prepare for a variety of show events.

Collaboration between the architects and engineers resulted in simplification of the building geometry without compromising the desired roof form. In the original architectural design, the cross-vault intersection occurred at a common elevation at the center of the building. At the structural engineer's suggestion, this geometry was greatly simplified by the architect without compromising the desired roof form. To standardize truss shapes and simplify truss connections, cross-vault intersections were established at 45 degrees with matching vault radii in the corners of the building. This created framing in the corners that was symmetric about the valleys, as well as identical in all four corners, greatly improving economy and construction simplicity. The long-side vault radius was flattened between the corners, and its apex was raised slightly

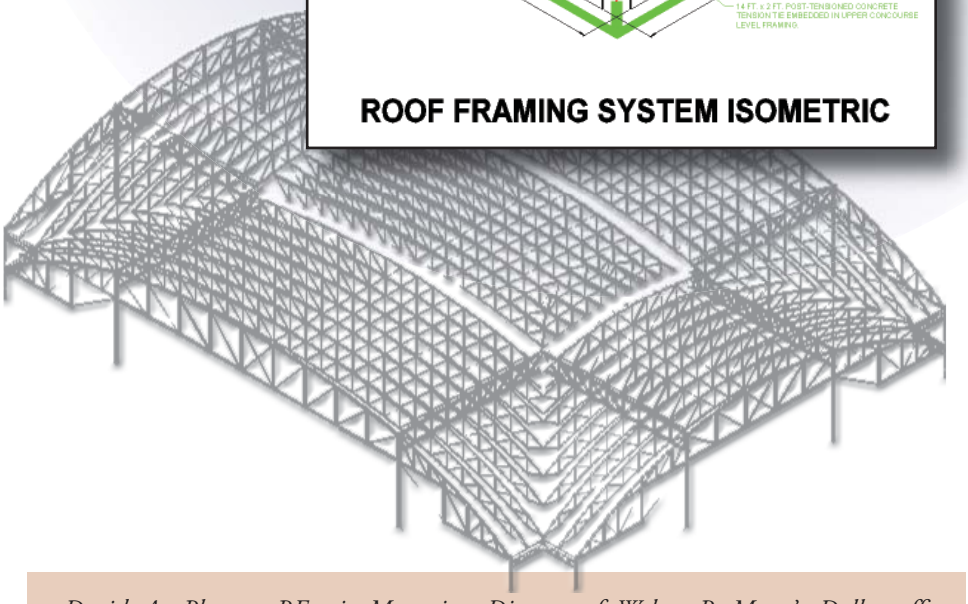
relative to the short-side vault, resulting in the definition of a central framing rectangle 110 feet by 210 feet. The primary load-carrying structure, then, is a "table-top" system where four primary trusses occur at the perimeter of the central rectangle, or "table," with four "leg" trusses extending from the corners of the rectangle, at the valleys, to the tension tie elevation at the upper concourse level.

"…cross-vault intersections were established at 45 degrees…"

Use of the externally tied roof framing system allowed a clear span area of 330 feet by 430 feet to be framed with trusses having depths of only 13 feet. This shallow depth allowed for shop-welded fabrication of the trusses and shipping of complete truss sections in lengths of up to 60 feet, saving both time and money.■



ROOF FRAMING SYSTEM ISOMETRIC



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