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Autor: Gallagher, S.B.
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10. Brendan Byrne Arena, East Rutherford (New Jersey, USA)

Owner: New Jersey Sports & Exposition Authority, East Rutherford, NJ
Architect: The Grad Partnership/
DiLullo Clauss Ostroski & Partners
A Joint Venture
Newark, NJ/Scranton, PA
Struct. Eng.: Skilling, Helle, Christiansen,
Robertson, P.C., New York, NY
Gen. Contr.: Terminal Constr. Corp.
Wood Ridge, NJ
Work Duration: 2 years
Service Date: 1981

Brendan Byrne Arena is the newest building in the New Jersey Meadowlands Sports Complex. It joins Giants Football Stadium and Meadowlands Racetrack on a 488-acre site along the Hudson river. The three structures serve the populations of the New York Metropolitan Area and northern New Jersey.

The arena (Fig. 1) is a 22,000 seat facility for indoor concerts and performances, and for sports including basketball, hockey and boxing. With overall dimensions of 145 m by 125 m and an interior height of 40 m, the building encloses 570,000 m³.

Design Considerations

Site constraints were critical in the design process. The marshy ground of the Meadowlands area is unstable; glacial till is 10 m below the surface. High winds and heavy snows can impose severe environmental loads.

Poor ground conditions made sensible a light superstructure on several supports. The high winds required a low-profile building and an aerodynamically stable shape. The expected snow loadings made good roof drainage a necessity.

Programmatic requirements created special demands for the structure. The arena needed a large column-free space, a high ceiling and unobstructed views of the floor from every seat. The scheme had to accommodate large numbers of people and to facilitate their movement in and out of the building and to their seats.

The wide concourse with entrances at grade level and tiers of seating arranged above and below the concourse resulted in an efficient circulation pattern, one that did not depend on long ramps or mechanical transportation. A practical response to the needs for a low profile and a high ceiling located the arena floor below grade level.

Final Structural Design

The design for the arena features a structural steel, folded-plate dome, post-tensioned about the perimeter and shaped by two pairs of intersecting arched box trusses. One pair of box trusses spans the roof in its long direction, the other pair spans the slightly shorter direction (Fig. 2). Eight steel-framed towers, positioned at the edges of the building, rise the full height of the exterior walls to support the trusses; they house also the stairs and elevators. At the interior face of each tower, two box columns are connected by a steel diaphragm shear wall, parallel to the outside walls.

Each of the 5 m deep arched box trusses is composed of three straight segments (Fig. 3). The two outermost segments rise 10 m from the towers before intersecting with the perpendicular trusses. The central box truss section is horizontal. This segment is 40 m above the arena floor. Secondary trusses which vary in depth between 3 and 5 m, bottom chord bracing, and 20 cm acoustic metal decking complete the roof structure.



Fig. 1 Brendan Byrne Arena

- ROOF STRUCTURAL PLAN
1. SUPPORT TOWER
 2. BOX TRUSS
 3. SECONDARY TRUSS
 4. BOTTOM CHORD BRACING
 5. POST-TENSIONED CABLES
 6. CORNER TENSION PLATES
 7. STEEL DIAPHRAGM SHEAR WALL
 8. WALL TRUSS

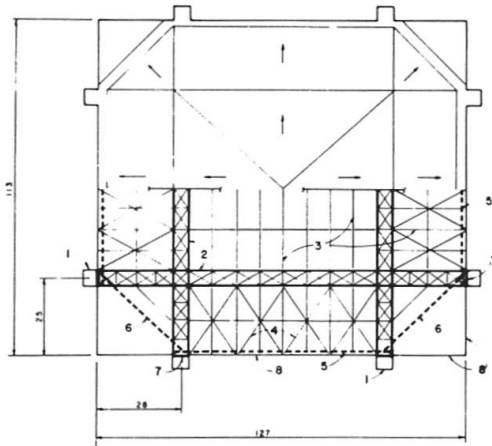


Fig. 2 Roof diagram

Post-tensioned cables in the walls, between the pairs of towers, and steel plate ties, across the diagonal between adjacent corner towers, constitute a tension tie ring which connects the bearing ends of the bottom chords of the box trusses. A force of 5300 N in the cables balances the dead load outward thrust of the arched trusses on the towers and limits lateral deflections at the perimeter.

The exterior walls are supported by 15 m deep wall trusses spanning between and cantilevering from the towers. These same trusses support also the lower ends of the secondary roof trusses as well as the outer ends of the inclined girders which carry the upper-tier seating.

Wind loads are carried to the wall trusses through the roof deck and the bracing in the planes of the box truss bottom chords, and through the diaphragm action of the precast concrete seating in the upper tier. The wall trusses transfer the loads to the steel diaphragm shear walls at the towers. 40 cm thick concrete shear walls below the concourse anchors the steel plate diaphragms and delivers lateral forces to the foundations. The validity of the wind desing was confirmed by wind tunnel investigation.

The uninterrupted volume of the arena is one of the major accomplishments of the design. The arched trusses are able to achieve long spans with relatively short members. As they open up the interior volume they emphasize also the lightness of the roof.

Construction

From start to finish, the construction of the arena took just over two years. Extensive sitework, including surcharging the area with 2.6 million cubic meters of sand, was required. A cofferdam, designed to become part of the building's permanent ground-water control system, was then constructed. The foundations, a network of 2,400 piles, some of them battered to resist lateral loads, were installed over a four-month period. Then eight support towers (1,700 metric tons of steel) were erected. Four falsework steel towers, at the intersection points of the box trusses, were built to carry loads during the assembly of the roof structure. During the tower erection sequence, plane sections of the box trusses were fabricated off-site by the steel subcontractor. The pieces were then brought to the site, where the trusses (1,900 metric tons of steel) were raised and laced together in-place. The falsework towers were removed after the circumferential cables were tensioned. Finally, the building was finished with insulated steel wall panels and with precast concrete seating.

(S. B. Gallagher)

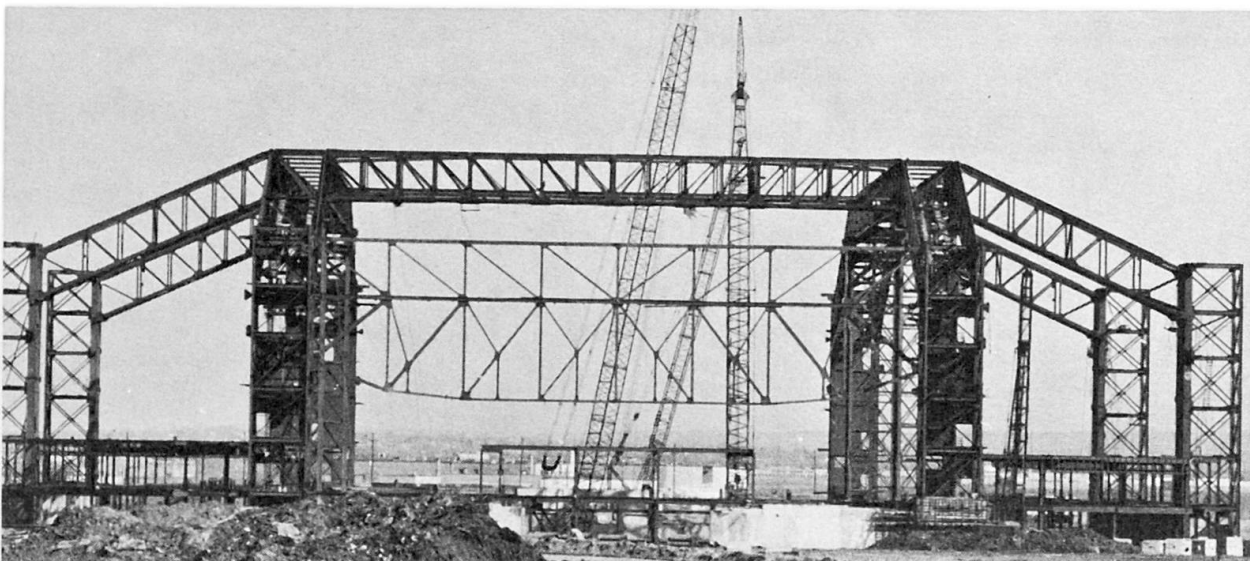


Fig. 3 Construction