Reviving Boardwalk Hall

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When the Atlantic City Convention Hall when opened in 1929, it was an engineering triumph. Re-christened Boardwalk Hall, it recently experienced a comprehensive architectural and structural renovation and rehabilitation.

In its day, the Atlantic City Convention Hall, now known as Boardwalk Hall, was considered a feat of structural engineering. When it opened in 1929, it claimed the world's largest clear span space (456′ long and 310′ wide) under a 137′ high barrel vault ceiling. The form and configuration of the building was developed to serve its primary function: namely, a large column-free space suitable for exhibitions and conventions. The Hall also boasted technical advances in lighting, acoustics and performance design.

Novel approaches to the theatrical lighting were incorporated into the structure. The nearly 200,000 sq. ft. barrel vaulted ceiling of aluminum painted acoustic tiles became the "reflector" for a dazzling show of lighting technology, anticipating the future of laser technology and using artificial light to enhance and define exterior and interior space. The hallmark of the design brought an "electric sun" inside the auditorium, washing atmospheres across the vaulted ceiling.

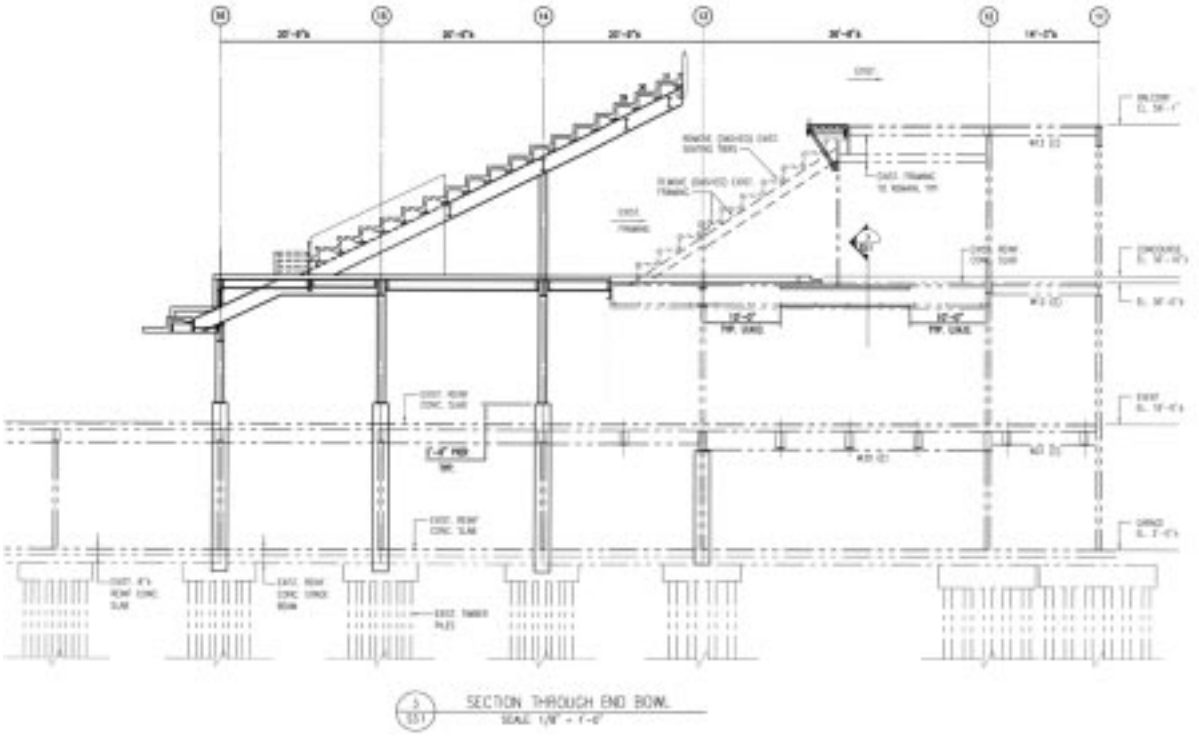
Construction of Atlantic City's new Convention Center in 1997 rendered Boardwalk Hall practically obsolete for exhibitions and conferences. Further, its outdated configuration as a sports arena prevented it from remaining competitive in terms of attracting sports events. Finally, though still home to the annual Miss America Pageant, it was not in any sense a modern entertainment center.

In 1997, the New Jersey Sports and Exposition Authority (NJSEA) initiated a project to turn the historic building into an up-to-date sports and special events venue. The project has involved not only a new steel and precast seating bowl, ice sheet, scoreboard, and event lighting and rigging systems, but also recognition of the building's historic significance and incorporation of sound preservation practices and principles into the process.

NJSEA hired architecture/engineering firm Ewing Cole Cherry Brott to lead the modernization and restoration project. Ewing Cole turned to sports design consultant, Rosser International, and preservationist architects and engineers, Watson & Henry, to assist in modernizing and rehabilitating this important historic building.

NEW SEATING BOWL

Since the new multipurpose event center will serve a broad range of events, including minor league hockey, the Miss America Pageant and concerts, it was necessary to determine how to place a new precast concrete seating bowl within the existing structure of the hall. Specialists in sports design at Ewing Cole, along with sports consultant, Rosser International, created a radial "U" shaped seating bowl that could be extended toward the center of the hall to improve sight-lines to the stage and ice sheet. The engineers reviewed the range of additional loads that would be imposed on the existing columns and foundations. With the assistance of geotechnical engineering consultant, Geotech, Inc., Ewing Cole developed an investigative test procedure to evaluate the capacity and condition of the existing piles.

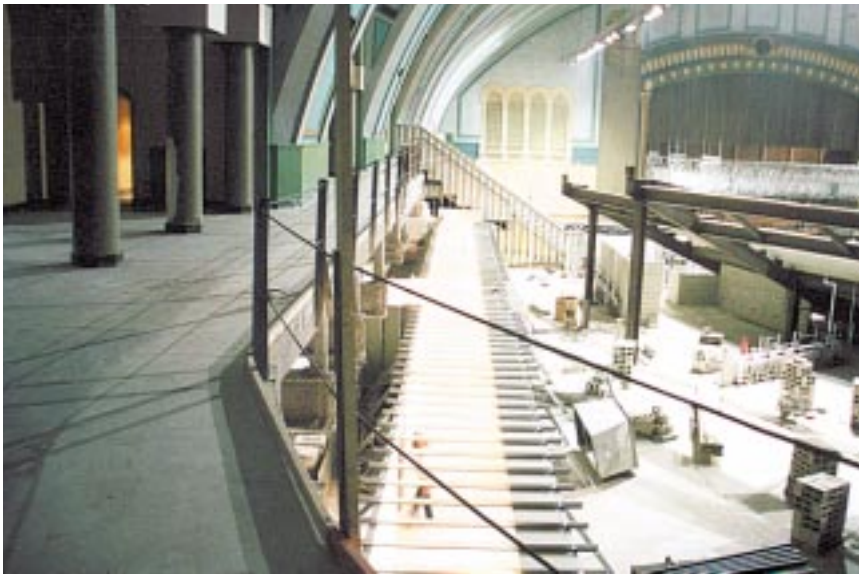


Section view of new seating bowl, showing new framing, as well as existing framing to be removed.

Two test pits were located to represent the most typical of the foundation conditions and excavated down to below the bottom of the existing pile caps, exposing the existing timber piles. Since the garage level floor slab was below the ocean level, de-watering systems of pumps and local well points were provided to draw down the water level locally to below the excavation of the pits. Once each pit was excavated, the existing conditions of each exposed pile was noted and later evaluated. The sizes were measured, and one pile in each pit was dynamically tested to determine more precisely the length of the pile. After the lengths and sizes of the existing timber piles were determined, and the representative conditions of the piles were established, the geotechnical engineer could calculate the load carrying capacity of the existing piles, knowing the soil conditions and the end bearing and friction capacities of the pile. With this investigation, more accurate evaluations of the existing pile and pile cap foundations were established to confirm the existing foundation capacity to support the additional column loads.

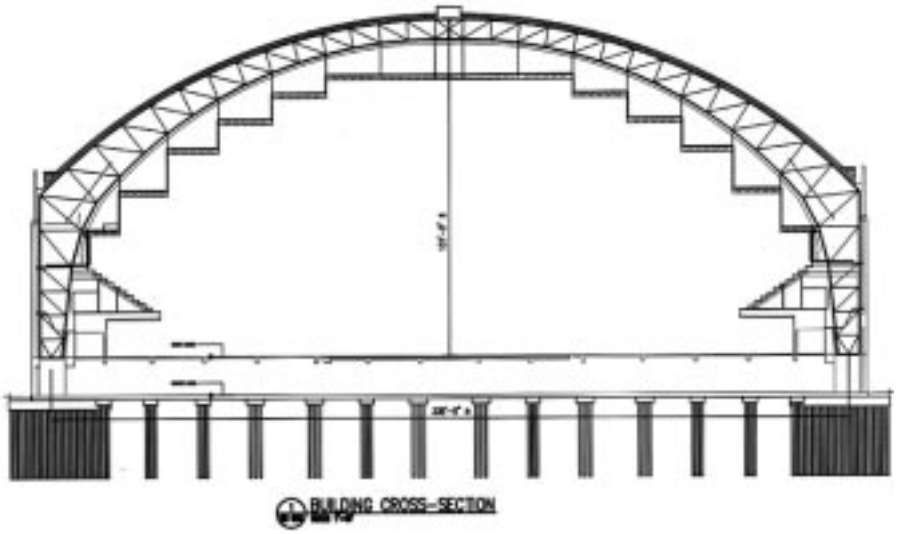
Once it was confirmed that the additional loads would not exceed the capacity of the existing timber piles, the engineering team began developing a system of close spaced columns, transfer girders and beams to distribute the new loads evenly to the existing foundations. Since the existing column grid did not match the spacing required for the support of the new seating bowl, especially at the radial sections of the bowl, engineers used steel transfer girders to support the more economical column spacing above the concourse level. The existing steel wide flange columns at garage level then required reinforcing to support the additional loads of the seating bowl. These were reinforced by encasing them in structural concrete to create "composite" columns.

The new seating bowl of structural steel framing supporting precast concrete seating was selected to create the lightest seating bowl framing system possible to minimize the loads to the existing foundations and have a system that could be erected to fit the construction schedule before Miss America 2001. The steel framing was designed to balance the seating loads to the ex-



Courtesy of Ewing Cole Cherry Brott.

Newly installed steel framing for the new precast seating bowl.



Cross-section of Boardwalk Hall, showing the three-hinged arch configuration. The stepped platforms are the "hanging scaffolding," designed to be moved during major events (such as the Miss America pageant) during the rehabilitation.

Courtesy of Ewing Cole Cherry Brott.

View of the center hinge connection for a typical roof truss.

isting foundations from the unequal column locations from the concourse level above. The concourse level framing was a combination of new and existing steel framing modified to be at the lower elevation of the new steel framing. Several of the existing concourse level girders were left in place because they supported the balcony level framing above. The existing girders were reinforced by field bolting new steel angles to the webs of the existing girders at the lower steel elevation, and steel WT sections welded to the bottom of the existing girders. The top flanges were then cut off at the lower steel elevation. The new steel framing connections to the existing framing were made with new connection angles field welded to the existing framing, but in many cases the connection angles were oversized with holes located to clear the existing connection rivets. Many of the field connections had to be field modified by cutting or rotating to accommodate the existing rivets and other connection plates and built-up angles.

The structural design was performed using computer software such as STAAD and RAM Steel.

CEILING CHALLENGE

The Ewing Cole team faced a challenge in determining how to efficiently remove and replace the barrel-vault ceiling. The roof structure is a system of pairs of three hinged arches forming 10′ x 10′ box trusses spanning more than 300′ across the building and nearly 140′ high above the event floor. The condition of the existing trusses was good since members were painted. Saltwater was not a problem as it is an enclosed interior space. The historic ceiling had deteriorated significantly. Removal required special asbestos containment. Further, the process was to occur simultaneously over several years with other construction and with the Miss America Pageant, which opened every September. Clearly, a typical scaffolding system built from the floor to the ceiling would not be feasible given these restraints.

Ewing Cole, working with the construction manager, Tishman Construction, devised an innovative "hung" scaffolding system that was suspended from the existing roof trusses. Support beams were added at strategic locations, and "trolley beams" were suspended to carry traveling scaffolding platforms. This system was used to remove the existing ceiling and install the new ceiling without ever obstructing the event level floor for other construction work or the Miss America Pageant.

The new ceiling was constructed with modern materials, which were able to replicate the look of the 70-year-old ceiling panels while improving the acoustical properties of the hall. A system of GRG (glass reinforced gypsum) panels and perforated metal panels were combined to restore the shape and texture of the historic ceiling.

ADVANCED INFRASTRUCTURE

The new ice sheet has been centered in the new bowl layout and on the existing structural arches. The existing rink moved 20′ towards the stage end, enabling the far end of the bowl to be closer to the stage for better viewing

Photo copyright Tom Crane and Jeffrey Totaro.

The completed Boardwalk Hall Auditorium with new precast seating bowl, new lighting, pulley-operated scoreboard and original stage and proscenium finishes.

during the Pageant and concerts, while creating symmetry of the bowl in the space. The relocation required careful coordination of the floor framing and the depressed rink slab areas in the event floor between the existing roof truss ties running continuously through the width of the floor for 335′. During the removal of the existing ice sheet, it was discovered that the underlying structural slab and reinforcing was deteriorated and corroded, probably by leaks from the original brine ice-making system installed in 1929. During the course of identifying possible remedies, consideration was given to actually increasing the load carrying capacity of the slab as an additional benefit. Replacing the deteriorated and corroded material and thickening the structural slab has bypassed previous restrictions, allowing a broader use of the arena to include "dirt floor" events, such as rodeo or a circus.

OTHER SPECIAL NEEDS

This project provided many additional engineering challenges for the designers, as the existing structure was modified and reinforced to accommodate its new uses. The existing 335′ span trusses were strategically reinforced with steel angles and flat bars, to hang over 130,000 lbs. of lights and speakers for various concert venues and additional loads for rigging points. A complex system of hoist motors and pulleys were coordinated and supported within the ceiling cavity to provide an operable and flexible system for the center hung scoreboard, sound system and rigging grids.

The original architecture at the perimeter of the building provided niches to expand concession and retail for increased revenues for the building operator, SMG. These niches are woven into the existing architecture of the building. Across the concourse, additional concessions are tucked neatly under the new seating bowl. Locating these new concessions and toilet rooms under the new seating bowl presented a challenge because the area, essentially isolated from the existing building, had to be bridged back to the existing building on the two sidelines, limiting the area available to coordinate various engineering requirements. We solved this problem by creating new lintels in the existing terra cotta walls to open up the spaces and reinforcing the steel floor framing where the framing interfered with the architecture.

Creating a modern, multi-purpose special-events and sports center within the historic envelope of this existing building required a number of innovative structural solutions. The result is a 12,000-seat venue and a facility that maintains its historic significance while boasting the latest technologies and conveniences.

John H. Sassmann, AIA, was Senior Project Manager. Richard A. Esslinger, P.E., was Senior Structural Engineer. Jared J. Loos, P.E., is a structural engineer. All are with Ewing Cole Cherry Brott.

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SOFTWARE

STAAD PRO