The Star of Symphony Park

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Creative cantilevers bring the audience as close to the stage as possible in the brand-new Smith Center for the Performing Arts.

CASINOS. NIGHTLIFE. Hotels bigger than you could possibly imagine.

You're probably thinking about Las Vegas right now, correct?

Symphony orchestra. Ballet. Opera.

Still thinking about Vegas?

If not, the town's new performing arts center may change your perception.

Set less than a mile from the glittering lights of downtown Las Vegas, the Smith Center for the Performing Arts is the center of the city's Symphony Park development. Clad with white Indiana limestone, the building—which opened in March—evokes images of nearby Hoover Dam, a technical achievement which brought new life to the Las Vegas area in the same way that Symphony Park intends to bring new life to the city's cultural scene.

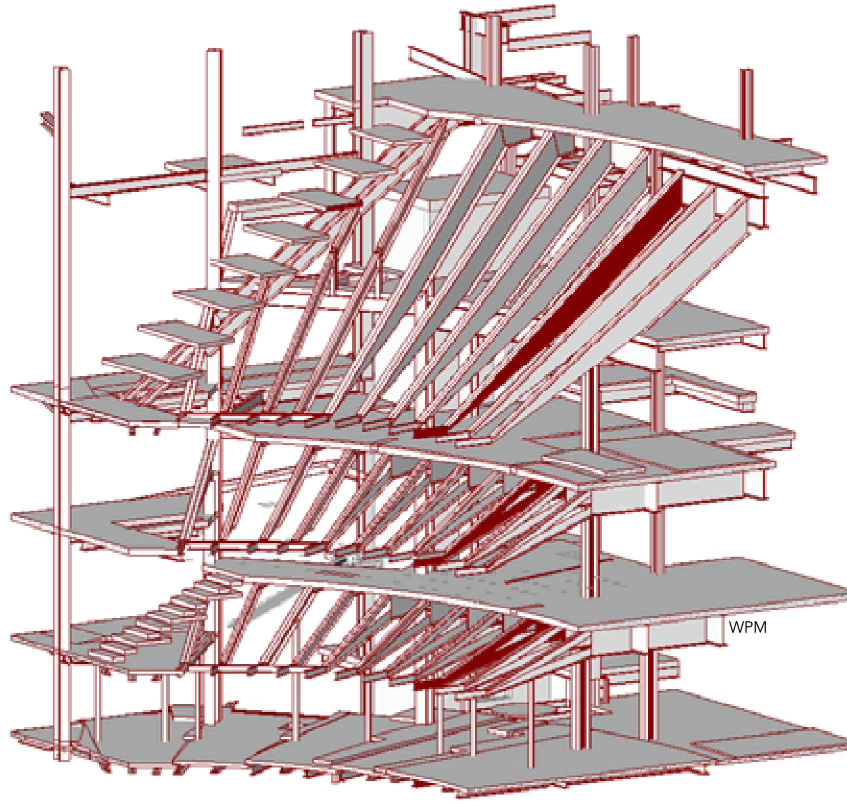
The anchor of the four-building, 505,000-sq.-ft Smith Center—which also includes an education building with a cabaret theater, a children's museum and a parking garage—is the 2,052-seat Reynolds Hall, a world-class performing arts center designed to be the permanent home of the Las Vegas Symphony, the Las Vegas Opera and the Las Vegas Ballet, as well as host touring productions.

Built with nearly 3,000 tons of structural steel, the main performance hall includes a sloped orchestra seating area and four horseshoe-shaped balconies that wrap the hall and allow patrons to sit as close to the stage as possible. The auditorium includes four balconies, cantilevering up to 22 ft—three of which are sloped and stepped along the sides of the auditorium and one that slopes in two directions—a unique aspect even for performing arts centers. The design team determined that composite steel beams and girders with a concrete slab on metal deck to be the most economic floor system for the cantilevers, as this approach allowed flexibility in framing as well as speed of construction; coordinating concrete formwork for such complicated geometry would have been cost-prohibitive and a challenge to execute in the field, and would also have resulted in increased construction time.

Great Seats

The design team took a BIM-based approach, using Revit to create the model, early in the project to aid in coordination during the design phase, and 3D isometric views were included as part of the structural construction documents to help the contractor understand the spatial relationships between the balconies. As a result of close coordination with the fabricator, steel erection was completed in just over four months.

Another design condition that essentially dictated the use of structural steel was the shallow member depth required at the cantilevered balconies. In the performance hall, the need for unobstructed sight lines required severe depth restrictions at the balconies. To accomplish this, cantilevered wide-flange steel raker beams were tapered in depth towards the edges of the balconies, allowing sufficient structural depth at the support and accommodating the need for minimal depth at the tip where



▲ The carillon tower rises above Reynolds Hall. At over 140 ft tall, it forms the cap piece of the Symphony Park Development.

◄ Reynolds Hall, the centerpiece of the Smith Center, uses 3,000 tons of structural steel.

► Revit-generated 3D isometric views show the relative positions of the steel rakers at the bi-directional slope of the upper balcony.

the forces are lowest. The size of the performance hall itself is small compared to other facilities with similar capacities, and detailing the balconies in this way allowed for every seat to be as close to the stage as possible. As patron-induced vibration was a concern at the balconies, the sloped rakers were modeled and analyzed for stiffness using SAP 2000 (Version 11).

Besides the geometric and constructability concerns, the chosen system was also advantageous from a seismic perspective. The project is in Seismic Design Category C, and the facility's lightweight framing system reduces the seismic forces that must be resisted, resulting in a more manageable lateral load resisting system, smaller diaphragm forces, and more economic foundations.

A Clear View

When it came to designing the structural members for Reynolds Hall, the design team used ETABS (Version 9), which allowed for a single model to handle both analysis and design of the structural members from the composite beams to the braced frames to the concrete shear walls. Having one design model for all members was beneficial to accurately capture diaphragm forces and interactions between the structural members.

Being a major performance hall, unobstructed sight lines from the audience to the stage, which require a column-free space, are a must. In Reynolds Hall, this is made possible by three 9-ft-deep steel trusses spanning almost 92 ft

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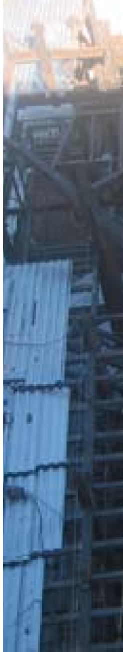


Photos this spread by WPM

A welder makes a connection at the sloped rakers. Tight structural depth restrictions dictated much of the geometry of the horseshoe balconies.

across the width of the hall. The trusses not only offered a lightweight solution to bridge the long span, but also provided relatively open space above the ceiling to accommodate the various lighting catwalks and mechanical systems that traverse the hall.

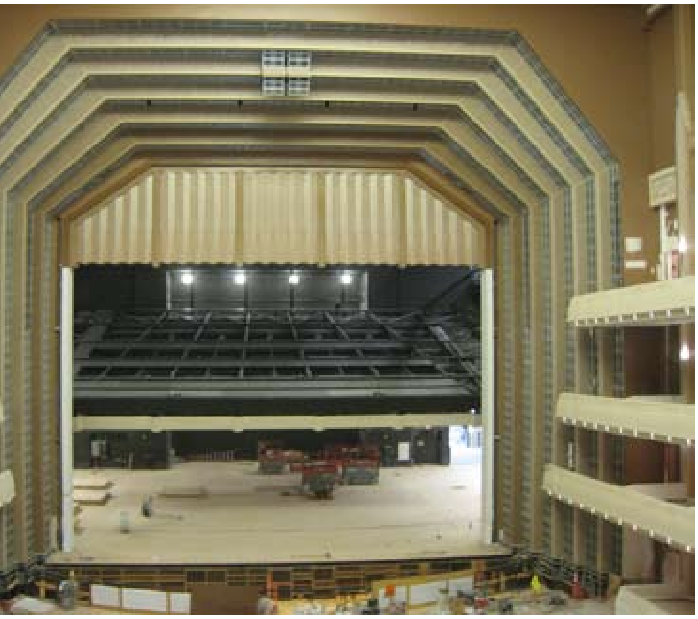
Outside of the auditorium itself, another design consideration was determining how to support the building's carillon bell tower. Towering 140 ft above Symphony Park, the carillon tower is the cap piece of Reynolds Hall. Due to architectural constraints in the main lobby, the innermost columns for the tower had to be transferred at Level 4, approximately 100 ft below the carillon roof. The large gravity forces were supported by plate girders up to 8.5 ft deep, and the seismic forces from the self-bracing tower were transferred to the building's main lateral force resisting elements using a combination of drag strut beams and horizontal diaphragm kickers.

Separating Sound

As with any performing arts center, acoustics was a prominent driving force in the design. One acoustical concern was the potential of noise and vibration transmission from outside the facility. This issue was addressed by adding a second 6-in.-thick slab over the 7½-in.-thick slab on metal deck at the auditorium roof to add mass and insulate noise transmittance through the roof. In addition, the auditorium's plaster architectural ceiling, which hangs from the main roof framing and forms the acoustical barrier for the hall, was attached using a complex system of calibrated springs so that vibration at the roof would not be transferred into the auditorium. The finished surfaces in the auditorium—from the wall treatments to the ceiling and floor coverings—were carefully chosen from a mixture of highly reflective and highly absorbent materials to acoustically direct the sound.

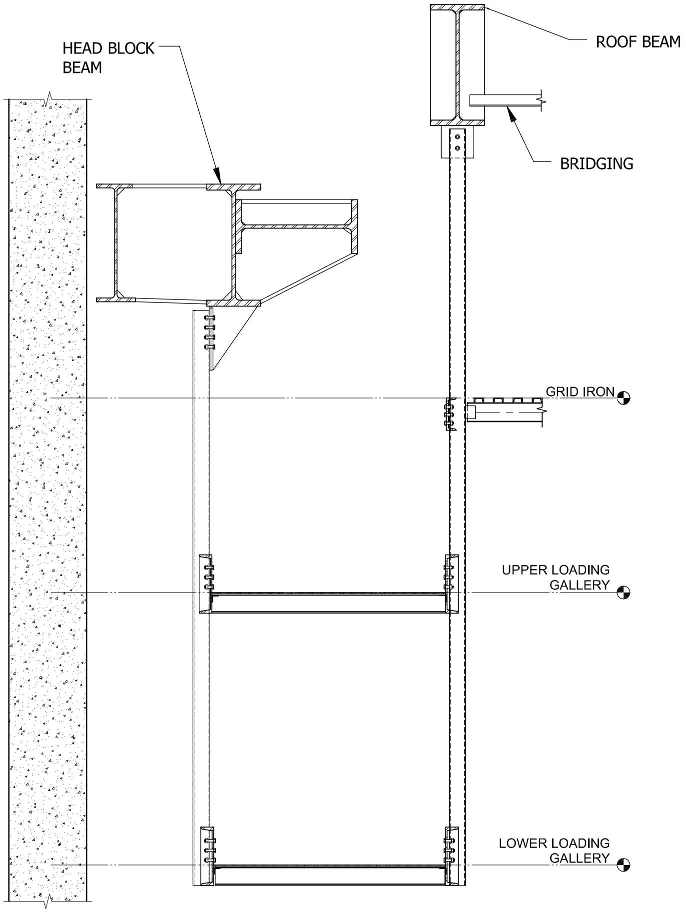
Behind the Scenes

Out of audience sight but integral to making the show go on at any major theater venue is a complex system of catwalks, lighting and stage rigging. At the Smith Center, the main stage is serviced by a steel grid 100 ft above stage level. Comprised of web-



Structural steel horseshoe balconies form a ring around the main orchestra floor. The geometry of sloped balconies allows for all seats in Reynolds Hall to have clear sight lines and close proximity to the stage.

The headblock beam and the gridiron provide support for theater equipment and rigging, supporting loads as high as 4,000 lb per ft.



The orchestra ceiling is deployed. Supported from the grid 100 ft above the stage, it takes less than 20 minutes to deploy the ceiling from its stored, vertical position.

horizontal C3 channels spaced at 6 in. on center and supported by the roof beams at the stage house, this grid is designed for some pretty heavy lifting, as it services a large counterweight rigging system used for theater sets and stage lighting. The rigging involves lightweight truss battens at 6 in. on center, supported by pulleys mounted on the underside of the roof beams. The cables from these pulleys span the width of the stage to vertical counterweights, necessitating a large built-up head block beam consisting of three heavy W36 shapes (two are W36x330 and one is W36x182), spanning the entire depth of the stage and stiffened with 1-in. steel plates between the pulley lines, to resist both the vertical and horizontal components of the rigging loads.

Also supported by the main stage grid and head block beam is a 37.5-ton retractable orchestra shell ceiling for Las Vegas Symphony performances. This ceiling, which hangs in the vertical position at the back of the stage house when not in use, can be deployed using a system of pulleys and winches which are permanently mounted to the grid. During lifting and deployment, this imparts point loads as high as 10 tons to the grid.

In addition to the grid directly above the stage, a second grid platform hangs from the auditorium roof beams in front of the stage house and supports, among several clusters of speakers, a decorative steel frame that surrounds the proscenium. Additionally, a forestage reflector, which acts as an extension of the orchestra ceiling, can be deployed through hydraulic doors located in the proscenium steel. This provides a striking finished look to the stage, as well as a visual and acoustical highlight for the symphony. MSC

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