Project SUNBURST

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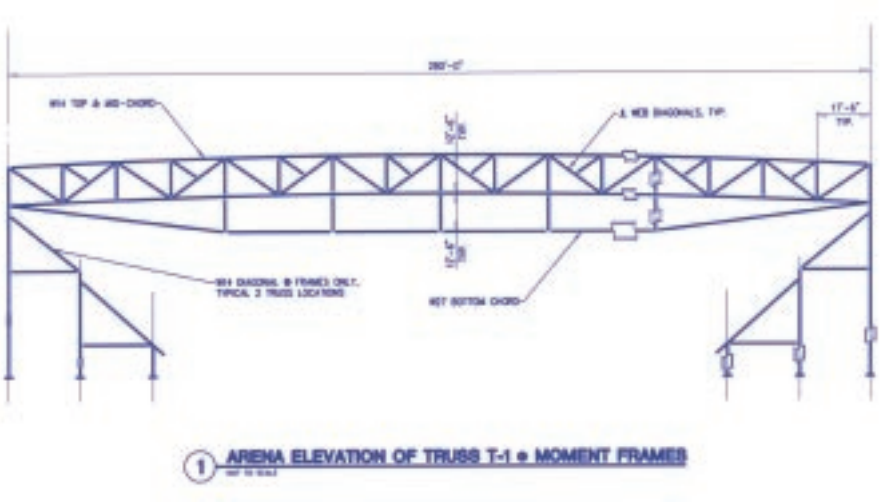
Extensive use of steel framing allowed the ambitious expansion of the Mohegan Sun casino complex in Uncasville, CT to proceed quickly and economically.

The billion-dollar expansion named "Project Sunburst" tripled the size of the Mohegan Sun casino complex. The original facility, opened in 1996, was a casino with minimal support services. The expansion provided a diversity of activities. Besides doubling the gaming area, entertainment, retail and lodging was added. Over 9,000 tons of steel framing helped make this project a reality. Design started in March 1999; the majority of the building opened 31 months later (one week ahead of schedule) in September 2001. The hotel tower has just opened.

The design and construction of the expansion was divided into several distinct segments. The largest portion was called the podium. The project footprint is 675,000 sq. ft. This segment was home to the casino floor, a two-level retail area, a 300-seat cabaret and a large convention center. The 10,000-seat arena is the next largest steel building. Steel was also used to frame the new mechanical central plant and mechanical penthouses on top of the 36-story hotel tower. Once the building was enclosed, steel framing played a vital role in the interior of the building. With the exception of the hotel tower, the building is one to two stories tall with an average roof height of 50′.



Opposite: Night view of casino entry canopy, framed with an exposed space truss. Typical HSS sizes are 16x8 and 8x8.

Opposite, inset: Aerial view looking northwest at Mohegan Sun Casino. Phase II Expansion is stepped white roof in the foreground and 36-story hotel tower.

Left: Framing schematic of typical arena truss. Six of these trusses were located 37' apart.

Below: Typical HSS-to-column connection, east side of arena.

Bottom: Interior view of the 10,000 seat arena.

The podium required 6,500 tons of steel. This was spread out over a footprint of about 1,000′ by 750′. Because of its size and configuration, as well as parking below, the building was divided into nine unequal sections with expansion joints. The sections roughly followed the building functions and determined the building erection sequence. Each section had its own requirements. The basic grid of the podium is based on a 28′ module. This grid was determined as an efficient layout for the two levels of valet parking below the podium. The steel spans vary between 28′ to 168′. With the hotel overlooking the entire roof, the owner required that there be minimal exposed mechanical equipment. As a result, there are five elevated mechanical mezzanines varying in size from 1,500 sq. ft. to 18,000 sq. ft.

The largest podium section is the casino. This section was built first to provide time for the extensive finish work. This structure was 46′ tall and had an open floor plan. At the center is a 168′ wide truncated octagonal pyramid that rises 100′ in the air. The pyramid is approximately the shape of the planetarium dome suspended below. The structure consists of a W40 tension ring on the bottom, a 56′-wide W24 compression ring at the top. The two rings are connected by radial W24 compression struts that rise 20′ in a 56′ run. Rafter beams support 1½″ roof deck. No additional structure is required for balanced loads. Unbalanced loads utilize the adjacent roof diaphragm and chevron braces to stabilize the structure.

With the large opening, high height and 56′ square structural bays, we re-

Connection at planetarium dome compression ring.

lied on a series of frames that used most columns in two directions. To maximize stiffness, large tube steel sections were used with fixed base plates. A mix of moment and knee-brace frames was used. The 22 and 18″ square tubes sections were fabricated in the shop by seam welding a bent plate. The horizontal framing consisted of LH series joists, wide flange sections and several plate girders.

The sections to the east and south of the casino provide casino support services. The framing consists of wide flange columns and braced frames. The roof over the 300-seat cabaret was designed to support theatrical rigging loads and lighting catwalks. To allow maximum flexibility for suspended loads, wide flange beams spanning 28′ framed into 7′ deep built up trusses. The rest of the roof was framed with wide flange girders and LH-series joists. The exterior metal panel wall was braced and supported with vertical wind columns located a maximum of 10′ on center.

The section north of the casino had the most steel framed levels. The second level is used for meeting rooms. The landscaped pool terrace is located above the meeting rooms. The pool is enclosed with a quadrilateral sloped roof. The 28′ column grid extends to the third level to accommodate the large terrace and pool loads.

The pool roof is a trapezoid with the two parallel sides skewed 45° from the building grid. The two long sides are skewed 30° and 20° respectively. In addition, the roof and the outside columns slope 6° to meet at a right angle. The roof framing cantilevers a minimum of 6′ from the columns. A 30′ wide parallelogram skylight is located over the pool. The roof lateral system consists of moment frames in two directions. The sloped columns are square tubes to optimize biaxial stiffness.

At the pool deck, the sloped columns are fixed in a socket to a pair of W24s. The pool deck supports terraced planters. A 13′ diameter hot tub is hung from the pool deck. The concrete lined pool is framed with lower framing including a 94″ plate girder spanning 63′. The pool framing was carefully coordinated with the meeting room mechanical systems as well as pool piping systems. Several beam penetrations were provided to maximize clearances below.

The adjacent main ballroom framing is simple in comparison. The 96 SLH joists span 168′. The actual ballroom is 158′ × 250′. The difference in the width is the depth of the storage pocket for movable partitions. The partitions allow subdividing the ballroom into as many as 10 different rooms. Each potential room was provided with a number of potential rigging points.

The retail section has a two-story area to the north of the curved walkway and a one-story portion to the south. The one-story portion was designed for a future mezzanine. The second level walkway slab edge is a continuous set of linked curves. The curved are achieved with a curved pour stop on multiple cantilevered beams. Along the north-south axis at the center of the retail area is a high column free ceiling that connects the retail area with the second level hotel lobby. The exterior roof profile was a three-section arch. Numerous shaped trusses frame this 112′ wide roof area and allow for various ceiling configurations including a sloped partial cone surface with openings for skylights. The 112′-wide retail walkway required 88 SLH joists.

In the northwest corner, a tall enclosure was to house an IMAX theater. From the outside, it appears to lean west 8′ in its 35′ height. Actually, the columns are plumb with east-west beams cantilevering as much as 20′. Sloped wind columns complete the illusion.

With the entire podium over two basement levels, an innovative system to support the steel erection cranes was required. With the regular building grid, ADF fabricated three crane platforms per crane . The crane platforms placed the large crane loads partially over the columns so as not to load the slabs and beams. The crane would leap frog the platforms along a pre-set route.

The arena is completely surrounded by the podium and self park garage; therefore, all 2,100 tons of steel were erected from the event floor. The 10,000-seat arena has a fixed upper seating bowl and retractable lower seating bowl. With the seating retracted, the event floor is a 164′ × 216′ rectangle with chamfered corners. The arena layout is very compact with a 330′ × 315′ footprint and chamfered corners of the north end. Structural steel supports the precast seating deck, and steel trusses span 280′ over the entire arena.

The arena roof consists of six three-chord trusses that are 25′ deep. The tension chord supports the lighting catwalks. The platform is seismically-braced to the roof diaphragm. The roof has a perimeter plan truss to deliver seismic and bracing loads to the building lateral system.

The arena lateral system consists of two north-south braced frames and two combination braced/moment frames that use one of the roof trusses. During design, particular attention was paid to minimize the quantity of brac-

A major interior theme element, the Wombi Rock is a 60' tall interior mountain clad with translucent and opaque stone panels. A primary steel frame is attached to the building structure, and adjustable brackets are used to attach the panels.

ing members. The speed of erection more than compensated for any additional steel weight.

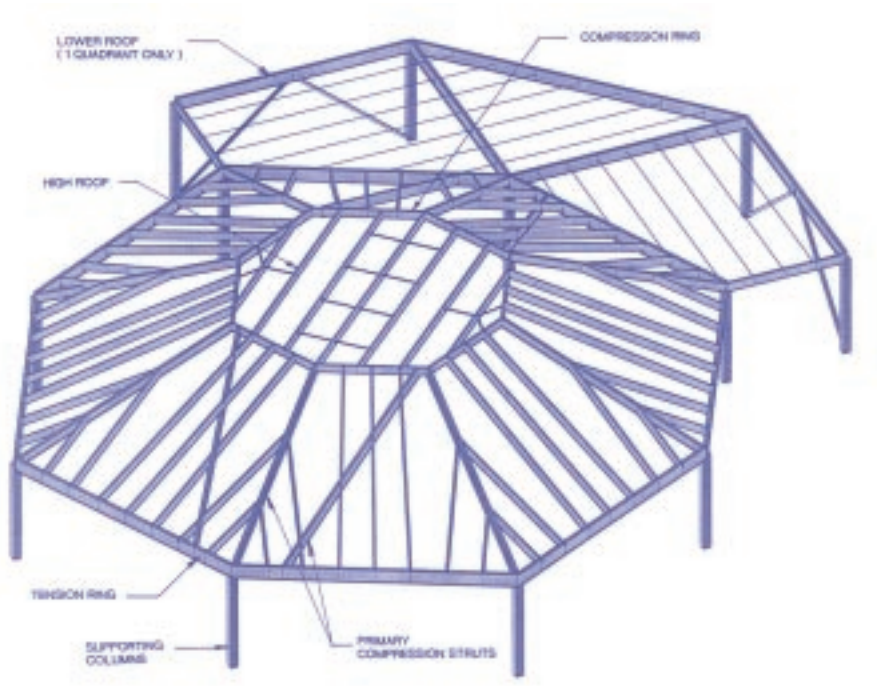
With two large cranes working on the event floor, the steel and precast seating units were erected in eight days, one week faster than scheduled. The roof trusses were built with flying connections and required no shoring towers. To avoid overstress in the truss support columns, the final truss connection was made after dead load deflections had occurred.

The podium and arena represent the bulk of the steel. Several other sections also used steel to efficiently provide framing. To support the mechanical demands of the large expansion, a new 500-ton central plant was built. The roof joists were sized to support smaller piping up to 12″ diameter. Large pipes (up to 30″ diameter) were supported on pipe mezzanines.

The top of the hotel tower features three mechanical rooms with a sloped roof and a tall parapet. This proved the distinctive shape of the top of the tower. The erection of 300 tons of steel was significantly faster than the concrete alternate.

There are two main entries to the expanded facility. The casino and hotel entries each have large porte-cochere canopies that act as gateways to the facility. Both canopies utilize exposed structural tube steel frames and trusses together with metal deck.

The casino canopy covers about 23,000 sq. ft. Fifteen stone-clad columns support the canopy. The center section is a four-legged space truss pyramid that cantilevers forward. The side sections frame into the center section as multiple brackets. Columns are located 35′ on center with the three rows on a 60′ spacing. These frames support HSS 14×6 purlins. The connections are field welded and ground smooth. There is a



Framing schematic for planetarium dome. The framing of the adjacent high roof is omitted for three quadrants for clarity.

continuous skylight at the canopy center.

The hotel canopy is quite different from its counterpart at the casino. It consists of two main sections. The first is the drop-off canopy, and the second is the pick-up canopy. The drop-off canopy has a central tapered trapezoid space truss that support six tapered trusses that cantilever to two sides. The entire canopy is supported on four columns. The center truss is made of HSS 16× shapes. The wing truss is made up of HSS 9×9s. The roof deck spans between the wing trusses.

The pick up canopy cantilevers 40′ form the building columns. To control rotation, braced frames were introduced at two locations. The RISA model predicted a dead load deflection of 0.9″. When erection shores were removed from the tapered cantilever beam, the measured deflection was $^{3}/_{4}$″.

With the large interior spaces, the "theming" elements were structures in their own right. As engineer for several theming contractors, we designed some of the larger elements: Wombi Rock and the Turtle Shell. The Turtle Shell is a domed steel frame with glass infill panels. The frame is made from round and rectangular HSS. The HSS are used to frame the individual shell scales, concealing lighting and sprinkler lines. The geometry was defined in CATIA and analyzed in RISA. Joint geometry was refined in CATIA as well as member curvature. The dome is supported on eight legs. The elongated dome approximates the shape of a bicycle helmet.

Another major theming structure is Wombi Rock. This 60′ tall interior mountain is clad with translucent and opaque stone panels. This structure is similar to that used on the Statue of Liberty. A primary steel frame is attached to the building structure. A series of adjustable brackets are used to attach a series of facet frames. A 3D computer model kept track of the panel locations and configurations.

Steel made the Phase II expansion a success in many different ways. Steel's versatility as both an exposed architectural material and a strong material that could span long distances was used throughout the project. Steel allowed the project to meet its ambitious schedule and provide an efficient and attractive complex of buildings.

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SOFTWARE
ETABS, RISA, RAM Design Toolkit, CATIA