Steel on Stage

Joe Tebben

The Gerald Ford Amphitheater in Colorado's Vail Valley blends art and function in a unique steel structure.

The Gerald Ford Amphitheater nestled in the beautiful Vail Valley of Colorado is a facility built in 1987 that was in need of expansion and a new roof structure. The existing roof system was an impressive series of exposed square steel HSS trusses that stepped and intersected, however the years of exposure to the extreme elements led to water intrusion and inadequate coverage over the seating areas. So when the owner, Vail Valley Foundation, decided to replace the roof, they had choices to make regarding the size, configuration and aesthetics of the new roof system while preserving the outdoor ambience that makes the the-

Erectors complete the field splices and set the first truss which will serve to support all other trusses with a "spindle post" over the stage area (right side of truss).

atre unique. The construction schedule was also critical, the theatre needed to finish its summer 2000 show circuit and be ready to reopen for the spring 2001 shows, requiring construction through the winter months.

The Foundation selected three outstanding firms to begin the process, Morter Aker Architects as designer, Monroe & Newell as structural engineer, and J.L.Viele Construction as general contractor. J.L. Viele selected Zimkor Industries of Littleton, Colorado early in the process to assist with the budget, schedule and design challenges for the structural steel on the project. One of the key objectives for the project team was to create a roof system with fewer support columns and more clear span framing to allow unobstructed views. Steel was the logical choice over other materials such as wood or concrete because the steel trusses could span the required 118 feet, support roof snow loads of 100 psf plus catwalks loads, while remaining exposed to view. The team explored the

Two cranes are used to hoist the first truss into position in difficult jobsite conditions.

The other trusses are connected to the first truss to form the roof structure.

A view of the finished roof trusses as they intersect at the spindle.

use of square HSS members similar to the existing structure but the spans required such massive HSS sections that they were undesirable architecturally. The solution was to use round heavy wall pipe sections to construct trusses that could cover the spans and still look impressive.

The roof framing is arranged in a series of five trusses that intersect directly over center stage and "fan out" to the perimeter of the theatre. Each truss varies in elevation and length. Truss fabrication utilized pipes ranging in size from 12 in. × 1.625 wall for the chords to 8 in. × .719 wall for the web members, configured in a unique gable shape with diagonal webs. The intersection of the trusses over the stage is served by a large "spindle post" utilizing a pipe 24 inches in diameter with a wall thickness of 1.219 inches and large connections to support the other trusses. The bays between trusses are spanned with open web bar joists, wood decking, and a membrane roof system. Selected areas carry suspended ceilings made of cedar planking to enhance the acoustics and aesthetics of

The roof structure nears completion after application of cedar plank roof deck.

the structure. The roof panels step up and down in elevation to conform to the site and allow natural lighting through the clerestory skylight panels.

The truss fabrication presented many challenges due to the size constraints, complex connections and the fast track design/construction schedule. The connecting of different size pipes at various skews would require special weld procedures and need to be closely coordinated to ensure constructability and insure the integrity of the joints. Zimkor supplemented their shop fabrication efforts by utilizing a partner shop (Western Slope Iron, Grand Junction, CO) to assist in production, and keep the project on schedule and within budget. Monroe & Newel and Zimkor value engineered the design by implementing the use of gusset plates to connect truss web members, which minimized the difficult and costly coped pipe ends. The gussets were cut to a half-moon shape for a more aesthetic appearance and to allow easier fit up and welding. Mike Wray (Zimkor's shop superintendent) says, "Although the job was not large as far as tonnage was concerned—350 tons—it was very labor intensive with more than 11,000 shop man hours. We consumed over 2 tons of welding wire during fabrication and had to perform machined ends and special weld procedures at many of the joints."

The intersection of the five trusses over the stage presented a challenge to the design team as to how they could be supported without the use of columns in the theatre seating area. All five trusses where to be supported on just two columns at the rear of the stage. Through collaborative efforts, the team managed to incorporate an effective "spindle post" to capture all the trusses, remain unobtrusive in the finished theatre and allow a safer erection sequence on the site. The heavy snow loads imposed on the trusses required the pipe wall thickness to vary throughout the length of the truss. Zimkor, in conjunction with their consultant (Welding and Joining Management Group), engineered special weld procedures resulting in machined transition welds. John Gross of Lehigh University also provided valuable experience and advice on pipe truss construction. After fabrication, all exposed steel received SSPC-SP6 sandblasting and an epoxy paint system.

Winter in Vail creates a severe environment of snow, high winds and extreme temperatures that make building construction a difficult proposition. The confined site is within a city park bordered by a river making for limited access, complicated by a short construction schedule window and the fact that many of the existing theatre elements would remain in place. J.L. Viele developed and implemented a plan that allowed all the subcontractors to accomplish their work on time and within budget. The steel erector made special considerations to perform field-welded truss splices and plan an effective and safe erection sequence. Limited lay down area was arranged for steel delivery and preassembly of the trusses. Temporary shelters were constructed to perform the critical field welds and allow testing under controlled conditions. Hoisting was performed by strategically positioning two cranes and erecting the steel in

The completed theater kicks off its first show of the 2001 summer season.

specific sequence. The structure was difficult to plumb because there are no square corners, few level framing members due to the geometry of the building and connections that had limited tolerance.

The collaborative efforts of the project team were a resounding success. The newly renovated amphitheater serves as a focal point for the performing arts in the Vail Valley. The beautiful surroundings of the Gore Mountain Range and Gore Creek provide an inviting back drop for shows of world renowned talent and the facility is also perfect for corporate and community gatherings. In addition, those who visit the theater will appreciate the highly visible, uniquely designed structure that is also an impressive art form.

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OWNER AND OPERATOR
Vail Valley Foundation, Vail, CO

GENERAL CONTRACTOR
J.L. Viele Construction, Vail, CO

STEEL FABRICATOR
Zimkor Industries,
Littleton, CO (AISC member) with
Western Slope Iron,
Grand Junction, CO (AISC member)

STRUCTURAL ENGINEER
Monroe and Newell Engineers,
Denver, CO

ARCHITECT
Morter Aker Architects, Vail, CO

STEEL DETAILERS
Zimkor Industries, Littleton, CO

ENGINEERING SOFTWARE
RISA 2D

DETAILING SOFTWARE
AutoCAD Release 14