Bill Andrews

Winter Winner

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A new addition to Colorado's Crested Butte resort braves the weather, as well as building height restrictions.

CRESTED BUTTE IS A BIT OFF THE BEATEN PATH compared to many of Colorado's other ski towns. But that hasn't stopped it from becoming one of the most revered and dramatic. At 9,375 ft, it is home to more than 3,000 ft of vertical drop and some of America's top extreme and elite winter athletes.

That said, the town maintains a less-developed feel than most other skiing destinations. And one of the goals of the newly constructed Mountaineer Square Lodge and Conference Center was to maintain this feel, expanding and upgrading the facilities at Mt. Crested Butte without harming the pristine natural environment or ruining the casual, small-town atmosphere.

The building is located a mere 100 yards from the ski lifts at the base of Crested Butte Mountain. The new complex incorporates regional architecture with 210,000 sq. ft of occupied space, and is composed of a "podium" structure and a superstructure consisting of two multi-story buildings sprouting up from the podium.

This overall desire to blend in with the natural surroundings and rustic atmosphere led to multiple specific structural framing challenges:

- Framing within tight floor-to-floor height limitations common for residential construction
- Framing complex, steeply-pitched roofs
- Providing a long-span, column-free ballroom space while supporting three stories above
- Staggering steel fabrication and erection to accommodate a fast-track construction schedule driven by harsh winter weather conditions.

Podium Structure

The podium consists of a large single-level underground parking basement that measures approximately 72,000 sq. ft, with parking for about 100 cars. Also housed in the basement level are the mechanical systems serving the superstructure via shafts extending vertically through the buildings.

Steel framing sloped to varying pitches supports heavy snow drift loads while also providing usable attic space.

Opposite page:

Above: The "podium" steel framing attaches to precast concrete columns in the basement level and supports a 3-in. by 16-gage steel deck and composite slab.

Below: Framed in steel, the complex gabled roofs of the Mountaineer Square Lodge and Conference Center were designed to blend in with the dramatic mountain setting.

The podium structure includes perimeter basement walls constructed with precast concrete panels, and interior precast concrete columns supported on spread footings with a floating concrete slab on grade. The outdoor plaza over the parking is subjected to heavy loads, including a robust floor deck "sandwich" of non-structural fill, waterproofing membrane, sand bed, radiant snow-melt heating tubes and pavers, as well as a 100 psf ground snow load and fire truck loads. Podium steel framing consists of 3½-in. concrete over 3-in. by 16-gage composite steel deck on W21×44 beams, spaced at 7 ft 6 in. on center, and W24×117 girders. Supplemental reinforcing steel is provided in the concrete deck to support fire truck loads. Drainage slopes are provided through a combination of sloped structural steel framing and tapered fill over the deck.

The irregular podium column layout beyond the superstructure footprint created many skewed framing conditions and some excessive end reaction loads. A number of different connection types were developed for the steel girder-to-precast column connections for the varying conditions, including single-plate bolted shear tabs welded to steel embedment plates in the precast columns, a seated connection on top of the columns, and a column haunch connection.

Superstructure

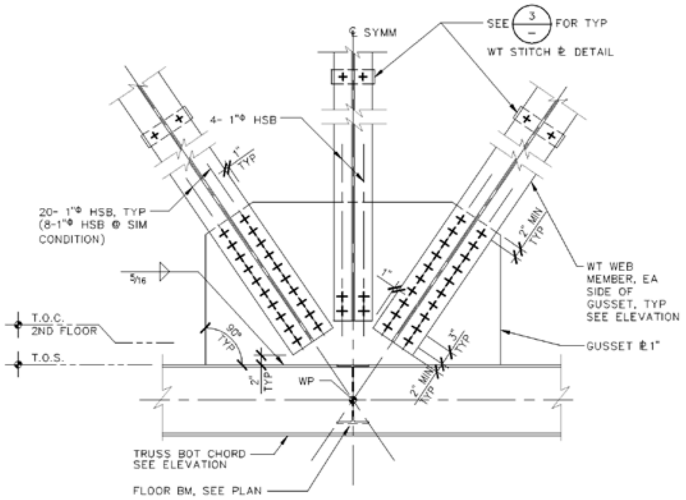
A six-story "boomerang"-shaped building and a five-story rectangular building housing the conference center comprise the superstructure. Each building features high-end condominium units (with price tags reaching upwards of $2 million), and the plaza level space features transit, retail, a fitness center, and skier services.

Due to the constraint of Crested Butte's mandated maximum 75-ft height limit, story heights were squeezed to 11 ft 6 in., leaving only 2 ft 6 in. above the ceiling available for framing and mechanical duct space. The superstructure floors are framed on a typical 30-sq.-ft grid consisting of 2½-in. normal-weight concrete fill over 2-in. composite metal deck supported on W12 beams and W16 girders, which frame to W10 columns. The 30-ft square column grid integrates well with the standard parking layout, thereby avoiding costly transfer girders. Floor vibration was mitigated by optimizing the combination of concrete floor deck and steel framing, slightly upsizing beyond service load requirements to minimize foot-fall perceptibility.

Story-height transfer trusses are enclosed in residential unit partition walls. Including a Vierendeel panel at midspan allows a corridor to pass through the truss.

The buildings' complex gabled roof structures consist of bare 16-gage, 1½-in.-deep metal deck supported on steel framing sloped to varying pitches. Steel proved to be an efficient framing material to support heavy snow drift loads while still allowing for usable attic space, with the flexibility to shape the various rake and eve overhanging conditions. Hollow structural sections (HSS) were used as secondary steel framing applications such as HSS5×5×⅜ partial-height posts and HSS10×8×⅜ tower roof members.

Resistance to wind and seismic lateral forces is provided by concrete shear walls located at building stair and elevator cores, plus other strategic locations as needed. The two buildings are interconnected via a 45-ft long, two-story steel-framed pedestrian bridge. A slip-joint connection is provided at one end of the bridge to accommodate both construction tolerances and the potential relative movement of the two building portions due to wind and seismic loads. Three-dimensional lateral analysis of the buildings was performed with ETABS, using the linear elastic requirements of the 1997 Uniform Building Code.



9 TRUSS CONNECTION DETAIL

¾"=1'-0"

Ballroom and Conference Center

The plaza-level conference center space doubles as a ballroom and required an expansive 5,400-sq.-ft column-free floor space. The open area was achieved using story-height steel transfer trusses, with W14×145 top and bottom chords at the second and third floor levels, which span 60 ft and are integrated within the residential unit partition walls. Web diagonal and vertical members range from double WT4×15½ to double WT5×44 sections except at the mid-span, where an open 6-ft-wide Vierendeel panel allows for a walkway corridor to pass through the truss. The panel is framed with W10×45 vertical members, which are complete joint penetration (CJP) groove welded to the top and bottom chords. These trusses support a 30-ft tributary floor load above the conference center, as well as point loads from columns supporting the tributary loads of the fourth floor, fifth floor, and roof. Despite the resulting high load demands, the W14 top and bottom chords fit within the limited ceiling space, the truss live load design deflection was limited to ¼ in., and no usable floor space was sacrificed. All chord and web member end connections were bolted to minimize field welding and accommodate quicker fit-up.

Scheduling Challenges: Met

Given the fast-track schedule, the steel detailer collaborated with the structural engineer early in the design process. Steel detailing representatives visited DASSE's office to discuss various ways to refine structural steel connection details to suit the fabricator's and erector's preferences, thus making them more economical and erector-friendly. For instance, cantilever beam connections at numerous balcony and roof overhang conditions initially included CJP groove welded top and bottom flanges. However, after shoulder-to-shoulder review with the steel fabricator prior to final issuance of construction documents, this detail was modified to include a fillet-welded lapping plate across the top flanges in lieu of CJP groove welds. This detail change reduced costly field CJP groove welding and field weld inspections. Similarly, column splice connections were modified from partial joint penetration (PJP) groove welded to bolted plate connections.

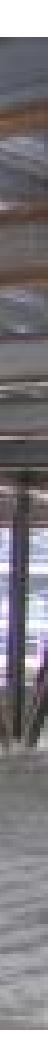
Multiple design submittal packages were issued to allow foundation construction to begin as soon as the snow melted and the ground thawed. This approach also allowed the fabricator to place early steel mill orders, facilitated timely steel delivery to the site, and supported the phased schedule. The podium mill order was issued first, allowing the contractor to order the plaza level steel and begin detailing while the superstructure design was being finalized. The superstructure steel drawing package was submitted next, a mere two months after the first package. Lastly, a final building superstructure package was submitted, which included primary and secondary steel information, in addition to the completed architectural and mechanical/electrical/plumbing drawings.

The compressed construction schedule required continuation of construction through the extremely cold winter and in a relatively difficult-to-access location (Crested Butte is nowhere near an Interstate). Concrete slab pours during the cold winter days were particularly laborious, as heated tents had to be erected to achieve a favorable ambient temperature during placing and curing. Steel, by contrast, was erected relatively quickly despite record low wind chill temperatures dipping below -20 °F at times.

Up and Running

The project weathered the challenges of remote location, extreme winter conditions, low residential floor-to-floor heights, complex roof and plaza framing conditions, and achieving a column-free conference center and ballroom space—all within the overarching goal of adding new visitor space while maintaining the look and feel of a rustic, charming ski town. MSC

David Kirschenbaum is a senior project engineer with DASSE Design, Inc. (now Thornton Tomasetti) in San Francisco. William Andrews, principal-in-charge, formerly of DASSE Design, is now principal with Walter P. Moore, San Francisco. Both are AISC Professional Members.



Owner
Crested Butte Mountain Resort

Architect
BSA Architects, San Francisco

Structural Engineer
DASSE Design, Inc. (since acquired by Thornton Tomasetti), San Francisco

Steel Detailer
Podium structure: W&W Steel, Oklahoma City (AISC Member)
Superstructure: KL & A, Inc., Loveland, Colo. (NISD Member)

Fabricator
Podium structure: W&W Steel, Oklahoma City (AISC Member)
Superstructure: Cives, Roswell, Ga. (AISC Member)

Erector
Podium structure: Pioneer Steel, Inc., New Castle, Colo. (SEAA Member)
Superstructure: LPR Construction, Loveland, Colo. (AISC/SEAA Member)

General Contractor
Haselden Resort Constructors, LLC, Centennial, Colo.