High-altitude visitor center weathers wind, soil loads with extra connections

The newly opened Pikes Peak Summit Visitor Center features a total–precast concrete system. The precast concrete was provided by Stresscon of Colorado Springs, Colo., and they say that at 14,115 ft (4300 m), the visitor center is the highest total–precast concrete structure in the world.

Extensive coordination between the architect, structural engineer, general contractor, and precaster was necessary to ensure that the rigorous requirements were met for this one-of-a-kind project. Programming and design for the project started in mid-2015. Groundbreaking and construction began in mid-2018, with the first phase of excavation and foundation work. Stresscon's precast concrete erection started the beginning of July 2019, and erection was finished in November 2019.

A total of 462 premanufactured components, including tees, beams, columns, flat slabs, a kinked beam, stairs, spandrels, and insulated retaining walls make up the two structures that replaced the previous visitor center and research laboratory.

The kinked beam posed a particular challenge. It was a 26 ft (8 m) L beam with a 15 ft (5 m) rectangular cantilevered end that projected out of the building footprint to support the overhanging observation deck at the east end of the upper deck. The specific challenge was that the rectangular beam was kinked at 15 degrees to the centerline of the L beam and was thus known as the kinked beam. "Thanks to Chris Rodacy, Stresscon's outside consultant engineer for this project, the final design of this kinked beam was finally achieved," says Don Palmer, retired vice president for Stresscon.

The kinked beam also posed a forming challenge. "The original concept was to cast the L-beam portion of the beam in the L-beam form, then match cast the 15-degree rectangular portion on to the L beam," Palmer says. "A special casting form had to be constructed for this beam. In addition, special rigging and handling for this beam were necessary."

The visitor center is on a foundation of bedrock, and the team had to remove more than 6 ft (2 m) of permafrost and deal with melting ice and pumping in order to keep the foundation site functional. This building is two levels below grade on three sides.

The second building is the U.S. Army's High Altitude Research Laboratory (HARL), a two-level precast concrete structure featuring basement and main levels, designed for use by the U.S. military for high-altitude exercise, endurance training, and testing. Structural precast concrete members for this facility were also designed for extreme soil and wind loads.

The building diaphragm for soil and wind loads is under construction for the Pikes Peak Summit Visitor Center in Manitou Springs, Colo. Four times the normal number of connections were required in the building's wall system to handle the extreme soil loads. Courtesy of EnCon United.

The dormitory building's precast concrete retaining walls range from 19.5 to 21.5 in. (6 to 6.5 m) thick with 8.5 in. (216 mm) of isocyanurate insulation, providing an overall *R*-value of 75. Four times the normal number of connections were required in the building's wall system to handle the extreme soil loads.

Because of the steep grades and numerous hairpin turns, delivery logistics had to be well planned. Delivery logistics were limited by length, width, and weight on trailers no longer than 40 ft (12 m) and were typically half the usual load. This created a huge variable for production and erection because the piece size was limited to 10 ft (3 m) wide, a 45 ft (14 m) long, and 30,000 lb (13,620 kg), with no panel stacking on the trucks.

This restricted the piece size that could be used in the project and led to most loads being one piece per load. The drivers averaged six pieces per day and had to have all trailers down before the mountain opened to visitor traffic. The limited site provided enough room for seven full and seven empty trailers. Drivers followed a daily loop, shuttling precast concrete pieces to the jobsite, then driving back down the mountain with empty trailers that were reloaded for the next day's journey.

"For this project, only seven of our drivers would make this run. Trucks would leave the Pikes Peak toll gate at 4:30 a.m., drop a full load—one piece—pick up an empty trailer, and head down off of the mountain by 7 a.m. so that the gates could open for the day's traffic," Palmer says. "No drivers would make deliveries at night."

The jobsite was very restrictive. The area remained open to tourists during construction. A 250-ton (227-tonne) hydro crane was required for the job based on engine efficiency and performance at more than 14,000 ft (4200 m) in altitude.

Typical work days were six hours or less and based on the altitude and fitness levels of the employees. In many cases, altitude sickness and shortened shifts occurred due to limited oxygen at this elevation. Extremely high winds and lightning also shut down the jobsite on many occasions. The teams still erected an average of four precast concrete pieces per day.
—William Atkinson

Precast concrete unusual choice for cabin in the woods

As a result of the work done by Molin Concrete Products of Lino Lakes, Minn., a design-build custom home was built on the shores of Spirit Lake. The two-story, three-bedroom, two-and-a-half-bath home in Aitkin County, Minn., features insulated architectural precast concrete walls and a prestressed concrete structural beam that supports the prestressed hollow-core upper-level floor.

The interior sides of the exterior walls of the home were furred to facilitate electrical wiring and then covered with a combination of wood and drywall. The interior walls are a combination of precast concrete and wood-framed walls. The main-level ceiling features exposed painted hollow-core precast concrete and a faux wood beam design element. Although the roof framing is a wood engineered parallel truss system with wood deck, the roof covering is a standing seam metal roof.

This two-story, three-bedroom, two-and-a-half-bath home on Spirit Lake in Aitkin County, Minn., features insulated architectural precast concrete walls and a prestressed concrete structural beam that supports the prestressed hollow-core upper-level floor provided by Molin Concrete Products. Courtesy of Molin Concrete Products Co.

There were some challenges with the project, says Mike Wagner, vice president of engineering for Molin. "There were a lot of panels with mitered corners, and a few of these were greater than 10 ft wide," he says. "Normally we require miter panels less than 10 ft wide so that they can be shipped on edge on a normal flatbed trailer and still be below the height limit for shipping." Because of the size, though, these had to be shipped on 45-degree-angle frames with the architectural faces down, requiring special padding on the trailer to avoid scratches.

"Another challenge was that there was no opportunity for repetition," Wagner says. "Each wall panel was like its own project with unusual geometry and lots of angles and openings."

Still, for this project, the precast concrete building component installation was completed in less than five days.

The home is both fire and storm resistant. Precast concrete, is naturally noncombustible. The precast concrete building enclosure coupled with the steel roof also protects the homes from wildfires and sheltering inside a reinforced concrete building is one of the safest places to be during a storm.

The home is also energy efficient. Precast concrete walls act like thermal sponges, absorbing heat during the day and then slowly releasing the heat as temperatures fall at night. Then the night air cools the walls and keeps the building from getting too hot during the day. This thermal mass cycle repeats itself each day, reducing heating and cooling loads on the building's HVAC system, resulting in energy savings.

Precast concrete's durability reduces the home's maintenance and operating costs. Due to long-term energy and maintenance savings, the homeowner expects a 10-year return on investment, not taking into account potential savings in insurance premiums.
—William Atkinson