PCL Constructors

Sparkling Asymmetry

BY DOUG CAPLAN

A larger-than-life diamond relies on carefully detailed structural steel.

LOCATED 12 MILES FROM VERNON, BRITISH COLUMBIA, approximately halfway between Calgary, Alberta, and Vancouver, British Columbia, the new Sparkling Hill Resort is scheduled to open in March 2010. Perched atop a spectacular granite ridge this stunning four-story, 152-room hotel overlooks the Okanagan Valley to the north and Okanagan Lake to the south.

Promising to be no less dazzling than the surrounding countryside, the resort features the best that can be found in comfort and rejuvenation: spa, yoga, massage, and more, as the first true European-style wellness hotel in North America.

In that spirit, a glass-encased crystal atrium, a compelling symbol for Sparkling Hill Resort, welcomes guests as the main architectural feature at its front entrance. The atrium's glass arrangement was inspired by a Swarovski Crystal and is built on a structural steel frame. It is a non-symmetrical assembly of 15 large glass triangles, all having different dimensions and sloping in many different directions and planes. The crystal structure spans 13 m wide and stands 17 m above the second floor. Its top edge is more than four stories high.

The crystal is visible from a great distance. Air travelers as far as 20 km away will recognize the sun's reflections emanating from the crystal, and those on the ground will marvel at the crystal's reflections and refractions as they drive by.

Building the Jewel of the Okanagan

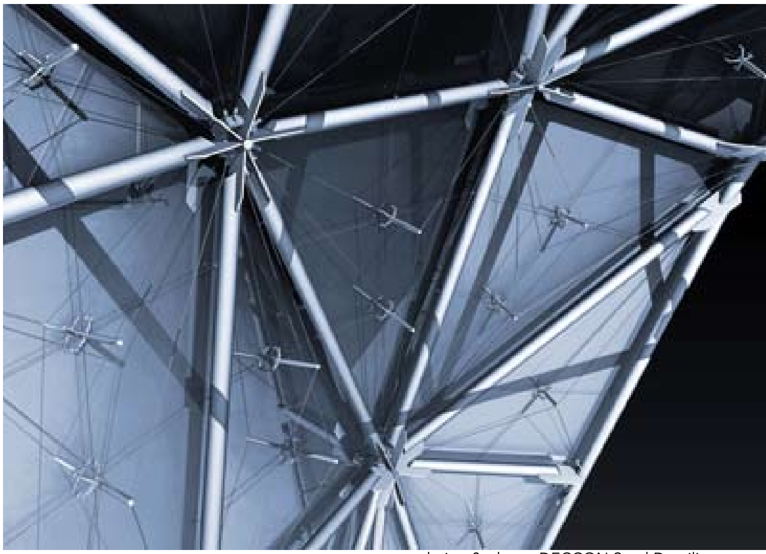
As the main architectural feature of the Sparkling Hill Resort, this avant-garde structure pushed the boundaries of possibilities.

The architects and engineers decided upon a large structural steel pipe frame for supporting the glass panels forming the crystal structure. The crystal frame is made from 8-in. standard pipe positioned 100 mm (slightly less than 4 in.) behind the glass panels, inside the building. The pipes follow all the joining triangular glass panel seams. Brackets attached to the pipe support the glass panels.

The triangles for this crystal are arranged to create three apexes, that is, three different points where the corner of either six or eight triangles would converge. That meant all of the pipes behind the triangular glass panels needed to converge at common work points. This configuration resulted in every pipe having a different trajectory relative to the other pipes. No two panels were even remotely similar, which promised to make the steel fabrication both interesting and challenging.

Because of the site's mountain-top location, the schedule was very tight. The crystal needed to be completed before winter arrived. The design of the steel pipe frame, however, was still a work in progress when the project went out for tender. The general contractor, PCL Constructors, knew that the lowest bidder would not be the deciding factor in awarding this type of work. The first priority was finding trades with a reputation for quality workmanship. For the crystal structure, in particular, there were no second chances. It had to be done right the first time. The general

Opposite page: A steel pipe framework supports the four-story glass crystal at the hotel entrance, setting a tone of elegance for visitors to the Sparkling Hill Resort in Vernon, British Columbia.



rendering & photo: DECCON Steel Detailing

Rendering and photo, above: At some points as many eight glass panels come together just inches above the steel framework, making precision detailing and fabrication imperative.

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Warnaar Steel-Tech.

After the frame had been pinned and its geometry adjusted, the connections were welded. Then crews installed the attachment hardware that would hold the glass panels. Photo courtesy of Warnaar Steel-Tech, Kelowna, British Columbia, Canada.

contractor chose a steel fabricator and steel detailer based on their experience and past history of success, collaboration and integrity.

The architect provided two sets of 3D coordinates, which consisted of 21 individual coordinates for the pipe frame and 14 individual coordinates defining the corners of the triangular glass panels. The 3D model was constructed using these two sets of coordinates. The datum for all coordinates was to originate from a common point for the entire project so that all trades would be working to and from the same point.

The glass panels are held in place by a pre-tensioned wire cable system. A total of 150 cables are required to secure 27 glass struts, which are perpendicular to the glass panels. One end of the strut is attached to the glass. The other end, standing 500 mm below the glass, is held and locked in place by four 10-mm-diameter stainless steel cables. Struts and cables were supplied by the glass supplier. The fabricator, however, became responsible for supplying and installing more than 170 connector plates on the steel pipe frame for the cables. The detailer was responsible for the steel detailing of the entire project and for locating all the cable connector plates on the steel pipe frame. Because the cables needed to be pre-tensioned and ordered before the crystal was erected, the detailer provided the glass supplier 3D models so that they could measure accurately the length of the cables.

Each cable has a clevis on the end that attaches to the connector plate on the pipe frame. Erection clearances were so tight that each workpoint needed to be incrementally moved away from the intended workpoint to ensure adequate erection clearance for the cable clevis pin. As each workpoint was re-located, the adjacent workpoint also needed to be re-aligned to satisfy the geometry that engineers had meticulously worked out. This was one of the most time consuming and complex tasks that the detailer had to deal with, for both the 3D modelling of the structure as well as the 2D shop drawings. The pipe junctions just below the glass apex have as many as eight pipes coming to a common workpoint, which required modeling in 16 cable connector plates to a hub for a total of 24 entities all coming in from different angles, at different slopes, to converge at the same vertex.

To find an acceptable location for all the cable connector plates, the detailer added to its 3D model all of the glass panels, the 27 glass support struts and stabilizing cables, and cable clevises. This was essential for finding and eliminating any clash between cable clevis and pipe, between cable and pipe, clevis and gusset plates, etc. It also was critical for verifying bolting clearances for the clevis pins and welding access for the cable connector plates. Every cable connector plate had to be re-entered into the model several times until a suitable location was found by trial and error. Each re-entry shifted the connector plate slightly farther away from the originally intended work point until all clearance criteria were met. This trial and error method was by far the fastest way to finding acceptable location for connector plates.

DECCON Steel Detailing

Overlaying portions of the DECCON 3D model on top of photos from the shop proved to be an effective way to confirm that complicated parts were correctly fabricated. In this photo, the marking on the pipe (A3012) shows through the translucent green model piece. The piece marks on the fins also are on the steel and show through the brown model fins.

Fabrication and Erection

Fabrication began before the crystal model was completed. Due to a very tight construction deadline, shop drawings were intentionally shop issued twice. The main crystal pipe frame was modelled first. Shop drawings were then created while the cable connector plates were still being entered into the model. Once the cable plates were added to the model, the 2D shop drawings were updated.

The erection strategy was also planned very carefully. There was a very narrow tolerance for error in installation of the pipe frame. The entire crystal structure needed to be within a few millimeters of the theoretical 3D coordinates established by the architect. The pre-tensioning of the cables allowed for a maximum error of only 10 mm.

The strategy was to erect the entire frame loosely with erection tabs/bolts that had been placed in the model. Once fully erected but not fully welded, the entire structure was aligned with guy wires. With the help of a surveyor, all 21 coordinates were pinned into the correct position. Once pinned securely into position, the entire crystal was fully welded. During the final welding, coordinates periodically were rechecked to ensure that nothing had moved. The crystal structure was erected rapidly and efficiently, making the final node adjustments minimal.

A vital key to the fabricator's success was the close collaboration they received from the PCL survey team at the job site. Richard Callihan, senior surveyor for PCL Constructors, uses an advanced survey system combining a Nikon DTM-352 total station and MicroSurvey software. That setup allows the surveyor team to solve complex survey calculations and transfer the information directly into the total station for use in the field.

Callihan initially placed his instrument 45 m from the crystal pipe frame to assist the erection crew in placing the frame's workpoint nodes. He could locate any given workpoint on the outside surface of the pipe frame, but not the pipe centerlines. However the node coordinates supplied by the architect were along the centerlines of the pipes. To find the workpoints along the centerlines of the pipe frames and help in moving all 21 nodes on the pipe frame to their exact coordinates, Callihan and his assistant came up with a clever idea: using two total stations located 19 m from one another and leveraging their powerful survey software.

The erection of the crystal structure was smooth and error free. Both the steel detailing and the steel fabrication of the crystal were done successfully and the great care taken to do both labor-intensive jobs right paid off. MSC

Owner
Sparkling Hill Resort, Vernon, British Columbia, Canada

Architect
Cannon Design, Vancouver, British Columbia, Canada

Engineer
Read Jones Christoffersen Consulting Engineers, Victoria, British Columbia, Canada

General Contractor
PCL Constructors, Kelowna, British Columbia, Canada

Steel Detailer
DECCON Steel Detailing Services, Surrey, British Columbia, Canada (AISC Member)

Software
Bentley ProSteel