GLACIER SKYWALK

2014 Annual Canadian Consulting Engineering Awards

OFFICIAL SUBMISSION | APRIL 30, 2014

rjc
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Consulting Engineers

Submitted by:

Read Jones Christoffersen Ltd.
Calgary, AB

This project was completed in cooperation with:

Brewster Travel Canada
Owner

PCL Construction Management
Project Lead, Construction and Quality Management

Read Jones Christoffersen Ltd.
Prime Consultant and Structural Engineer

Sturgess Architecture
Architect

Thurber Engineering
Geotechnical Engineer

Golder Associates Ltd.
Environmental Consultant

RWDI Group of Companies
Consulting Engineers & Scientists
Wind Engineering

SMP Engineering
Electrical Engineer

Urban Systems Ltd.
Civil Engineer

An Engineering Marvel

Destined to become one the most exciting and unique attractions in North America, you only need to look at Glacier Skywalk to know that it is an impressive work of structural engineering. Cantilevering 35m from a steep cliff face, it is anything but a typical structure. It is a dream come true for many members of our design team, a dream that has come true thanks to their innovation, hard work and passion.

The story of Glacier Skywalk began with Brewster Travel Canada's (Brewster) request for design build proposals. They wanted to create an experience that would connect guests with the natural environment and provide them with the opportunity to view the dramatic Sunwapta Falls below. They wanted something that would attract visitors from around the world to enjoy the beauty of Jasper National Park. They believed that any design would likely require cables to cross over the adjacent Highway 93 to support the structure.

They did not expect a design like Glacier Skywalk.

Our design build team, led by PCL Construction (Project Manager) with Read Jones Christoffersen Ltd. (RJC) (Prime Consultant and Structural Engineer) and Sturgess Architecture (Architect), gave them a design they were wowed by; but, they were unsure if it could really be built! After several meetings, they were convinced, and the real work began!

What is Glacier Skywalk?

Flat. Out. Awesome. At least, that's what Brewster's promotion for the attraction says. And it is flat out awesome. Even when the project design was just beginning, Glacier Skywalk attracted worldwide attention winning a World Architecture Future Projects Award in Barcelona, Spain, in 2011.

The Glacier Skywalk experience begins with a receiving area and kiosk, from there people follow an interpretive pathway, with interpretive stations along the way, leading to the dramatic Discovery Vista. Our team maximized the inherent drama and exposure of this area with a cantilevered viewing platform that extends 35m from the face of the cliff. The platform features at its apex 30m of glass walkway suspended 280m above the valley floor. The glass floor and railings of the walkway will give guests the impression of floating in air, providing an exhilarating and intense experience.

To make this landmark attraction a reality, our engineers and the project team worked closely together and thought 'outside the box', because nothing about this project was 'normal'!

Why This Design?

Visiting the Site

Prior to considering what structural form was most appropriate, RJC and PCL traveled to the ice fields to get a feel for the area surrounding the site. Before reaching the site, the Icefield Parkway passes next to the Athabasca Glacier. Since this is where guests visiting the Glacier Skywalk will start their journey, this is where we started our own exploration, experiencing the adventure through a guest's eyes.

Our immediate impression was of a stunning sense of scale and space to the Icefield. Everything around us was immeasurable. All the manmade objects at the Interpretive Centre, and, in particular the snow coaches inching across the Athabasca Glacier, were made to appear insignificant. We also felt a strong sense of remoteness, this despite the fact that we were standing together outside the Visitor Centre and close to the highway.

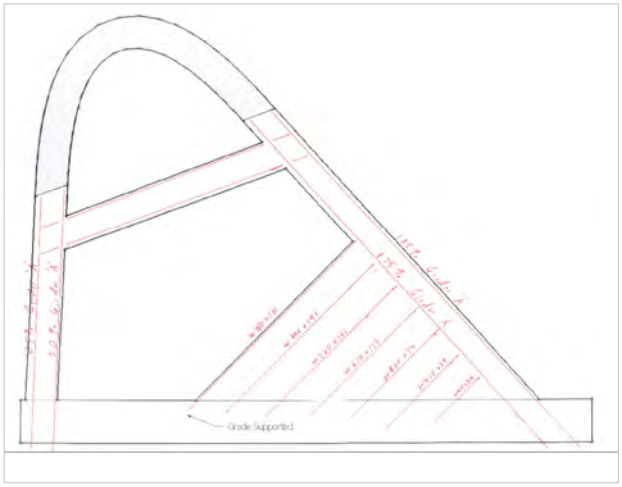
As we continued onto the Glacier Skywalk site, the highway climbed in elevation and the valley became much narrower. With evergreen forest present on either side of the road, this site has a completely different feeling from that of the Visitor Centre. Once we were out of our vehicle at the parking area, we were able to fully appreciate the spectacular vantage point offered by the surrounding steep cliffs. The views are truly breathtaking, even at the roadside. The sound of the falls below is so incredibly loud that it masks any noise coming from the roadway.

The unique and exhilarating perspective offered by the steepness of the cliff face and the relative narrowness of the valley allows for spectacular views of Sunwapta Falls from a very high angle, leaving a strong sense of exposure. This is the 'wow' factor we wanted to maximize and use to define this project.

Planning the Right Structure

Back at the office, we sat down to discuss what sort of structure would maximize the impact of the site for visitors while respecting the environment. We wanted to push the limits of the sense of exposure and quickly decided that the best way to approach this would be to construct a glass floored walk area. By curving the glass walkway in plan we could further emphasize the sense of exposure as it reaches out from the supporting structure. We wanted people to feel as if they were suspended in the air over the Sunwapta Valley floor. The curved plan also allowed us to minimize the visible structure supporting the glass walk, thus enhancing the sense of excitement as you walk along it.

When considering the structural system to use, we felt it was critical that it responded to the surrounding environment. As we had observed onsite, when there is no traffic, there is nothing that does not fit perfectly into the environment. We felt it was important that the new structure also blend into the environment. For this reason, we opted not to go with a high-tech cable stayed system. We felt there should be nothing above the viewing area to compete with the natural scenery, or interfere with guests views.



Since visitors have just left the stunning views of the massive Athabasca Glacier and surrounding peaks, we felt it was equally important that the structure should not attempt to compete with that scale of grandeur. Unlike in a city, where structures are designed to be architectural statements that attract visitors, this structure must not compete with the natural beauty of the area, but be a catalyst and gateway where guests experience the untouched environment in a way they never have before. The structure must not be the attraction, but rather facilitate the experience and journey.

In lieu of supporting the structure from above, we needed to either support it from below, or cantilever it from the face of the cliff. We opted for the cantilevered option. This offers the advantage of not having to perform work down the face of the cliff. It also minimized the amount of visible structure, thus helping to blend it into the surrounding area.

Choosing the Right Materials and Aesthetic Form

When contemplating what materials and construction methods would be most appropriate, we took into consideration the local site restrictions, the importance of blending the structure into the natural surroundings, long term durability and ongoing maintenance requirements, budgetary considerations, as well as the expressed desire for a rapid construction time. In order to meet the quick construction schedule, we felt the bulk of the structure should be substantially fabricated off-site so that it could be assembled on site in the shortest amount of time. The best two material options for this were pre-cast concrete and structural steel. Structural steel offered the more economical solution but would require additional consideration with regard to durability and ongoing maintenance. Precast offered long term durability with minimal maintenance, but was more expensive, much heavier, and more difficult to anchor into the existing bedrock.

Structural steel was identified as the best option, provided we could address the durability and maintenance concerns. Three options were considered. The first was a high end paint system; this provides excellent long term durability but is expensive and requires periodic maintenance. Since the steel would be difficult to access after completion, we felt this was not the appropriate option. The second option investigated was to hot-dip-galvanize the entire structure: this offers better long term durability and, although it is still an expensive process, its maintenance requirements are greatly improved over paint. The disadvantages of galvanizing are that it is not overly attractive and would appear out of place in the context of the site. Additional measures would have to be taken to hide the structural members from view. In addition, the practicality of galvanizing such large pieces of steel would have to be investigated. The third, and ultimately selected option, was to use weathering steel.

Weathering steel is structural grade steel in which the chemistry has been altered, so that as it rusts, it forms a protective layer over itself. This layer prevents further corrosion of the steel. The result is a steel product that can be left exposed to the elements. It is very durable and has very limited maintenance requirements. Weathering steel has been used since 1964 both architecturally, where its stable rusted appearance becomes a feature of the design, and structurally. The greatest advantage for this project is that the colour of the weathering steel will naturally blend in with the surrounding geology. This makes it the ideal choice for the Glacier Skywalk.

The weathering steel of the main structure is picked up and developed further by the sensitive addition of a weathering steel plate. These plates give an irregular angular appearance to the platform and disguise the more pragmatic-looking structural girders. The weathering sheets serve to further promote the Skywalk as an extension of the existing landscape as opposed to an imposed intervention. This theme is carried along the project length and is incorporated into elements at the Kiosk and Discovery Trail. This creates a uniform language for the entire project that attempts not to stand out, but rather blend in with the natural beauty and drama of the location.

For the Interpretive Pathway, a cast-in-place concrete slab-on-grade was selected. This, combined with carefully controlled maximum grades, ensured barrier-free access requirements are met. The concrete walkway features embedded hardware offering reflections of the natural history of the area. The hardware also identifies points of interest along the trail, specific peaks, geological formations, etc.

The Project – Making it a Reality

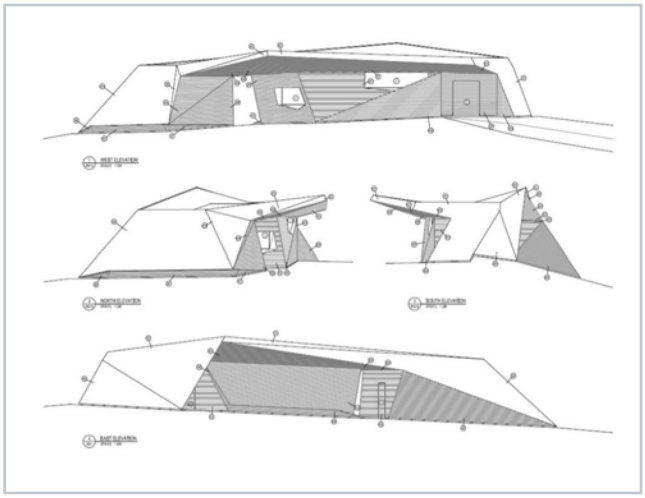
The Site – A Challenge in Itself

Glacier Skywalk is located within Jasper National Park, just minutes away from Brewster's Columbia Icefield Glacier Discovery Centre, on the Icefields Parkway. Highway 93 runs beside the project site. The site itself is the side of a mountain, a steep cliff – not the easiest place to build!

The Receiving Area Kiosk

The kiosk is the first element of Glacier Skywalk. Like the whole project, this building is not your typical gateway to an attraction. The geometry is complicated, there are virtually no 90 degree corners and everything is skewed, tilted, tapered and/or cantilevered.

The kiosk is solar powered as there are no services to the site. It is designed to be self-sustaining for days with no sun.



The Interpretive Pathway and Stations

The interpretive, wheelchair-friendly pathways are cut into the side of the cliff. There are two separate paths over much of the 300m length. The lower path leads people out and the upper pathway brings people back to the receiving area. The two paths are separated by a gabion wall and the height between the two pathways varies and changes along the route. The front of the gabion wall, which will be visible to visitors, was hand stacked one rock at a time, to maximize aesthetics.

Along the pathway are three unique interpretive stations – no two are alike. The first is cantilevered off the path, the second is a cave and the third is a tunnel! Like the kiosk, the pathway and the stations all feature unique and unusual geometry.

An example of how we accommodated this geometry is the construction of the cantilevered station. It was built like an airplane rather than using traditional framing. Each of the structural pieces was laser cut to match 3D files, a weathering steel skin was then welded overtop to create the unique finished shape.

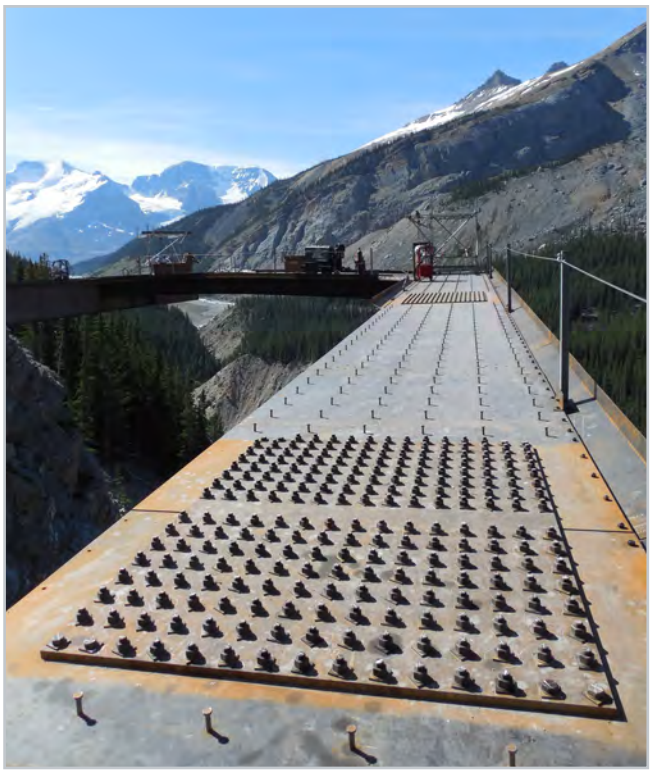
The Discovery Vista

The glass floored Discovery Vista is an observation walkway 280 metres above the Sunwapta Valley. Cantilevering 35m from the cliff face, the Vista features a curved glass walkway to thrill visitors and enhance their feeling of exposure.

Cantilevered trapezoidal steel box girders are an integral part of the structural system, supporting the glass walkway. These provide the very high strength to weight ratio required for the project. In addition, the closed form of the box girders results in superior torsional stiffness.

The girders were fabricated in Eastern Canada, shipped via truck to site and then lifted into place by crane. Because they have a big job to do, they are big! The longer of the two girders is 46.5m long, 3.6m deep and has a mass of close to 200,000kg! The design for the box girders had to ensure that they not only supported the glass walkway, but that they could be shipped to site and hoisted into place. As one piece, each girder is too large to lift into place; so each was designed as separate pieces. The size of each piece was based on the weight limits of the crane required to lift them into place. Bolted splices were used to speed erection and minimize the need for full penetration welding in the field. The largest of these connections contains 980 high strengths bolts. The girders are secured to the cliff with 66 rock anchors that extend 10 to 20 metres into the native bedrock.

Getting these girders right required our engineers to ensure the design had precisely the correct slope and geometry to achieve the right elevation – the ends couldn't sag and the girders had to be placed evenly!



The geometry of the glass walkway was conceptualized specifically for the loads that are applied; it is supported with a self-anchored suspension cable system on one side only. The apparent eccentricity of this system is counterbalanced by horizontal forces created by curving the walkway in plan. The geometry of the walkway has been precisely determined to eliminate torsional stresses under uniform load. A large HSS compression chord, acting with secondary steel framing members, provides torsional resistance under partial loading conditions. This system was selected as it minimizes visible structure below the glass floor, thereby maximizing the sense of exposure. Structurally, it works like a suspension bridge, just twisted! There is only one shape that works for the given loads and configuration, determining a very specific shape.

Like a diving board, the walkway structure is quite 'soft' so tuned mass dampers were utilized to mitigate vibration under dynamic loading to make it more comfortable for users. Wind deflectors were also added to the outer railings to ensure aerodynamic stability.

The Result

The design and construction of this project captured the imaginations of people around the world. Even those outside the design community are able to appreciate the complexity of this structure. The photographs and videos of construction are stunning, and it is almost unbelievable that this is happening right here in Canada.

Pre-sales have already exceeded expectations and international media have declared Glacier Skywalk a 'must see' destination in 2014. We hope to see you there!

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