Northern Lights

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Edmonton pays hommage to its northern locale with a shining new addition to the Art Gallery of Alberta.

Randall Stout Architects

Steel forms a “snowcone” at the Art Gallery of Alberta.

EDMONTON, ALBERTA has for several decades centered on the arts—literally; the Art Gallery of Alberta (AGA) is located in Sir Winston Churchill Square, the city’s main civic and public arts square.

However, the museum, a Brutalist concrete structure, has not been taking full aesthetic advantage of its high-profile location. But that’s about to change. The new Gallery, which opens next year, includes an addition/renovation component that upgrades the existing below-standard facilities and adds new celebratory public event areas that will bring a new architectural vitality to Edmonton’s urban core. The project, 84,000 sq. ft in total, will add 27,000 sq. ft of new public spaces and galleries and will include approximately 24,000 sq. ft of interior exhibition space.

In the new building, designed by Randall Stout Architects, Inc. (RSA), the museum’s public spaces are reinvented in a language of sinuous stainless steel surfaces, peeling off of one another, creating opportunities for generous views and natural light within the building. The design was inspired in part by the aurora borealis, the night sky phenomenon that is most readily observed in the northern region that is home to Edmonton and its new Art Gallery.

The overall project is comprised of a renovation of the existing concrete building, a two-story vertical addition above the existing building to contain additional gallery space and administrative office space, and the addition of the atrium space, including the borealis elements.

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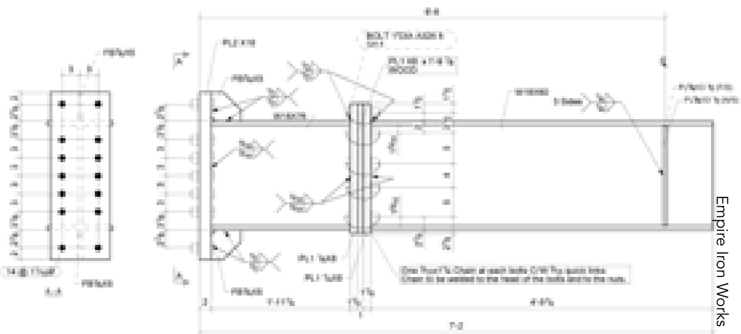
The form of the building evokes the northern lights.

Vertical Expansion

Structural steel was the obvious choice for the new vertical addition, as it was imperative to minimize the impact on the existing structure below, minimize loads at the foundation level, and provide a column-free interior within the new gallery. The entire addition, comprising 10,000 sq. ft at each level, is supported by only six columns located on the north and south perimeter of the volume. These columns each thread down through the existing structure and bear on pile caps supported by 40-ton screw piles, which were installed inside the existing basement. One-story-deep trusses span between and cantilever past the columns to provide support for W33 and W36 beams that span across the space. The resulting gallery addition is completely unimpeded with structure in order to maximize curatorial flexibility for both large and small exhibitions.

Empire Iron Works



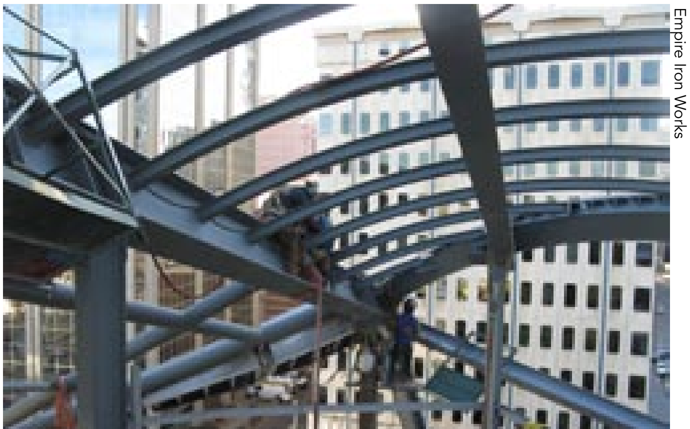
A detail drawing for the thermal break test.

Atrium and Borealis Elements

The angular, transparent glazing planes forming the building envelope of the atrium, and the curving, reflective metal-clad borealis surfaces that penetrate it at multiple locations, work together to animate the building, expose the activities within, and engage people and art at multiple levels on both the interior and exterior. Due to the complex geometries, steel was again the clear choice for structural support, as it could be bent and curved into the required forms.

Wide-flange members as large as W14×370, hollow structural sections up to HSS16×16×0.500, and custom box shapes (18 in. by 18 in.) comprised of 1.5-in. plates create the unique forms. These uncommon shapes were chosen due to strict geometric limitations to define the surfaces of the borealis. Careful consideration was given to connections of these elements, including the transfer of large torsion forces at critical locations.

Empire Iron Works



Steel members of all types and sizes bring the unique structure together.

Thermal Breaks

The design team recognized very early that thermal affects

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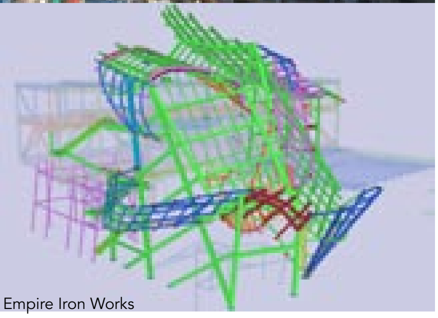

Empire Iron Works

The atrium and borealis element were modeled with Tekla Structures.

would play a significant role in this project. Winters in Edmonton frequently bring lows approaching -50 °F, while interior temperatures are maintained at roughly 70 °F. Of paramount concern were the multiple locations where the curving borealis elements penetrated the building envelope of the atrium.

At such locations, it is crucial to provide a complete thermal break between steel elements that are on opposing sides of the building enclosure. Failure to do so allows the warm interior steel to lose heat to the much colder exterior steel. As the interior steel cools, moisture can begin to condense. On exposed steel shapes such as those in the atrium, this can result in noticeable condensation and even dripping water inside the building. On steel shapes that are enclosed by cladding materials, this moisture can cause problems with coatings, and can lead to mildew and other undesirable non-structural issues.

The laws of physics, however, demand that a cantilevering structure be provided with a backspan in order to remain stable. When the cantilever extends through the building envelope, some amount of continuity must be maintained. The team chose to solve this problem by developing a special moment connection comprised of two steel face plates separated by a single 1-in.-thick block of wood. Wood, in this case oak, was selected as it has a very low coefficient of thermal conductivity, while also having a relatively high compressive strength. All resulting tension forces through this connection are transmitted by high-strength 1-in.-diameter A325 bolts. While the bolts bridge the thermal envelope, it is estimated that this connection prohibits 90% of the heat that would be transferred with a typical moment connection. A testing program conducted at the University of Alberta concluded that the connection is capable of transmitting the required forces so long as the bolts are pretensioned per the standard requirements of CSA-S16-01, the Canadian steel design code.

BIM Workarounds

The curving borealis forms and angular atrium geometries necessitated the use of a 3D modeling program in order to accurately convey the required member work points, both among the design team and ultimately to the construction team. DeSimone and RSA had extensive experience using Rhinoceros (Rhino) NURBS software by McNeel for this purpose (see "A Model Museum," 09/08, available at **www.modernsteel.com**) and continued to use this tool throughout the design phase.

With the steel design work progressing in Rhino, a detailed Revit model was created of the existing concrete structure. As design development began, the team incorporated the new steel structure into the Revit model in order to take advantage of the software's parametric capabilities. The then-current version of Revit Structure, Version 3, however, was unable to accommodate the curving shapes of the borealis, as well as the leaning steel shapes of the atrium. It also did not provide the geometric precision that was required by the architect. As the team still wanted to take advantage of Revit where possible, a decision was made to keep all rectilinear elements in Revit, including the new vertical addition, and use Rhino for the geometries that could not be accommodated in Revit. In order to produce a complete set of 2D plans using Revit, 2D cuts were made in Rhino and referenced into the Revit model at proper elevations to insure they would display properly. This workaround was cumbersome, but necessary in order to complete the documentation, due to limitations in the selected BIM platform.

Ultimately, the Revit model was not used during the construction portion of the project. Instead, a structural Rhino model with wire and solid modeling of each steel member was provided to the construction team along with conventional 2D structural drawings.

Construction

The steel detailer, Empire Iron Works (EIW), created shop models using Tekla Structures Version 13.0. In addition to the primary steel, which was modeled by referencing the structural Rhino models, EIW also modeled the borealis cladding panels and support clips, which were obtained from A. Zahner Company (AZCO), the cladding subcontractor. EIW also used reference models from AZCO to ensure that connection plates and other miscellaneous pieces of steel did not "daylight" through the enclosure surfaces. Shop models and shop drawings were then submitted simultaneously to the design team for review.

The borealis members were fabricated using hollow structural sections (HSS) that were rolled to the geometry generated by the Tekla model. Individual pieces were joined by fitting laser cut ends and fillet welding the joints. EIW created tight joints by exporting information from the Tekla model to the laser cutter's software in IGES format to cut 4-axis bevels.

The alignment of the support clips for the architectural panels that formed the nosing of the borealis components was critical to the final shape of the structure. The Tekla model was used to develop jigs that could be rotated to rectilinear coordinates, allowing the shop to use traditional fitting methods to fabricate the borealis truss components. The support clips were positioned in the shop using data points that were downloaded into a Spectra Precision Optical TS415 Total Station directly from the Tekla model. The data was referenced to an origin relative the global model position to ensure that all structural components aligned in the final structure.

Once the structure was erected the support clips were surveyed by using the site benchmark and model coordinates to verify alignment. The site data points were plotted in the Tekla model and a reference model was issued to AZCO to confirm that their cladding panels could be installed properly. Except for minor deflection issues, all support clips were within the specified tolerances. MSC

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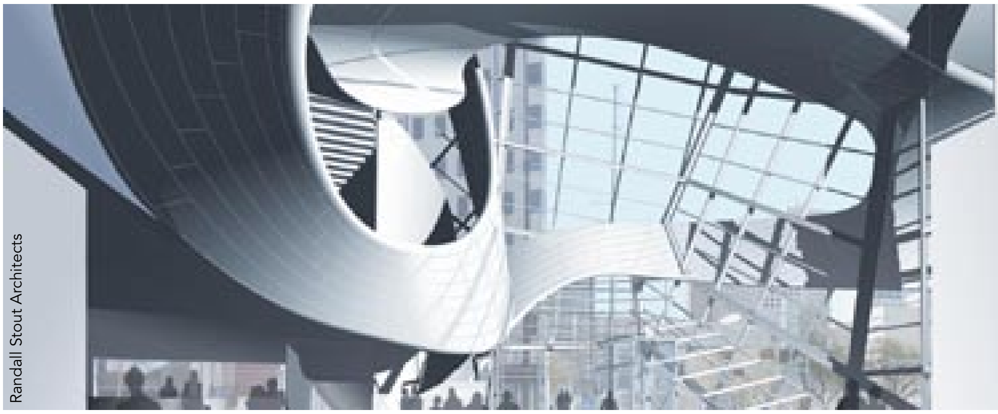

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