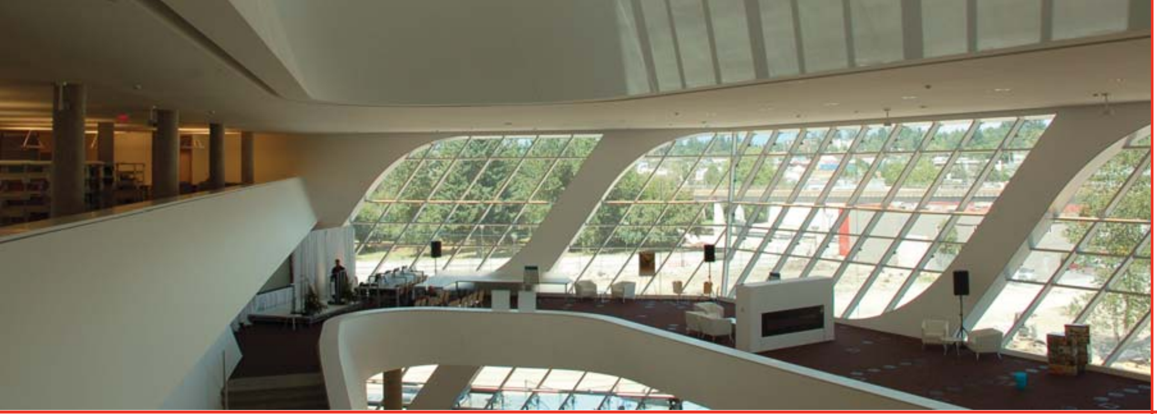
Fast + Epp

ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA
ASSOCIATION DES FIRMES D'INGÉNIEURS-CONSEILS | CANADA

CANADIAN CONSULTING engineer

SURREY CITY CENTRE LIBRARY

Surrey, Canada



Fast + Epp
201 - 1672 West 1st Avenue
Vancouver, BC V6J 1G1
T: 604.731.7412
F: 604.731.7620
mail@fastepp.com
ATTN : Rebekah Funk

SURREY CITY CENTRE LIBRARY
Surrey, British Columbia, Canada

ASSOCIATION OF CONSULTING ENGINEERING COMPANIES: Awards 2013 Competition

Year Completed: 2011

Category A: Buildings

Entering Firm: Fast + Epp — Structural Engineering

Project Leaders: Gerald Epp, Julien Fagnan

Project Owner: City of Surrey
(contact: Scott Groves, Manager of Civic Facilities Division)

Project Architect: Bing Thom Architects
(contact: Michael Heeney, Principal and Executive Director)

SURREY CITY CENTRE LIBRARY – Fast + Epp

75-Word Summary:

Surrey City Centre Library is a contemporary and dynamic new public building in the city's downtown core. The iconic building serves to revitalize the area and facilitates community interaction. With its complex geometrical form and dramatically tilted concrete walls, the four-storey concrete and steel structure required engineers at Fast + Epp to develop innovative solutions under a tight project schedule, together with Bing Thom Architects. Large expanses of high-performance glazing maximize daylight and reduce energy demand. Other sustainable features include a green roof, LED lighting and locally-sourced materials.

Project Highlights:

Innovation

Fast + Epp was the structural engineering firm for this four-storey, 85,000 sq. ft. concrete and steel facility with a dynamic, contemporary design. Complex sculptural shapes are formed by cast-in-place concrete exterior cladding walls at the perimeter, which are tilted at 10 degrees out-of-plane and 35 degrees in-plane. These walls are tied back to the internal steel and concrete structure for out-of-plane loads. Furthermore, the west concrete-cladding wall curves dramatically to follow University Drive. The sloped, tilted and curved exterior walls created challenges for the cladding system. Detailed pricing and construction schedule assessments were undertaken with a number of subtrades. Metal, glazing, precast, tilt-up, shotcrete and cast-in-place systems were evaluated with the latter being chosen. In addition, great care in detailing was required to minimize cracking in these feature walls. Engineers developed ductile seismic connectors to carry significant out-of-plane forces arising from gravity and seismic forces. The unusual form of the exposed exterior walls demanded special consideration of concrete placement, rebar detailing and placement of control joints to minimize cracking in this relatively thin (250 mm) element.

The architect demanded a four-storey column-free atrium space and shallow floor structures. Due to the large spans involved at the atrium roof and the third floor reading area ("living room") a challenge was created there that could only be met by choosing steel as the structural system. These areas were required to be supported on tilted and sloped columns to closely match the exterior facade and by a tilted upstand steel truss to be hidden within the curving balustrade at the atrium. In order to erect this floor the steel structure required temporary shoring until it could be fully connected to the concrete lateral elements of the base structure. Constructability was achieved by erecting this complex steel structure after the concrete cladding, with temporary bracing holding the cladding in place until it could be attached to the internal steel structure. This required the steel subtrade contractor to work to tight erection tolerances. Input was required from the steel subtrade for erection issues created by the sloping and tilted structure and the tight tolerances. Consideration of the lateral displacement and stresses caused by the tilting structure was an important design and erection consideration. The permanent lateral forces that resulted were resolved within the concrete shearwalls of the building. Beams, girders and steel deck and topping were all flush framed to further minimize the structural depth. Steel played a crucial role in the success of this structure. Without the help of steel as an integral yet hidden support structure, the overall concept could not have been accomplished.

Complexity

The heavy cast-in-place concrete cladding system created large permanent torsional forces due to its 35 degree tilt. It was therefore disconnected from the base building and tied back to the internal four-storey cast-in-place concrete and steel structure for significant out-of-plane loads only arising from both gravity, wind and seismic forces. Ductile seismic connectors were developed to carry these forces while limiting torsion to the base building. The cast-in-pace cladding was designed to resist the internal forces due to the in-plane 35 degree tilt.

The atrium roof structure also posed several challenges. The pop-up central area is an important feature which includes aesthetic, ventilation, daylighting, smoke exhaust and other design and coordination issues. Due to the complex nature of this element and the tight design and construction schedule, it was tendered after the main steel structure was in shop drawing stage. The design of the main section of the atrium roof had to anticipate the final geometry and structure of the pop-up portion. The irregular plan shape of the roof area and the location of the pop-up in plan required the design of several large custom trusses to ensure an economic and efficient design. Parapet details around the perimeter required close coordination between design team members.

At the third floor of the atrium the long span structure was supported by the design of a tilted (35 degree) upstand truss to span 24 meters and support a significant part of the floor. This truss was required to fit within the warping drywall-clad guardrail, which is a feature of the interior space. As a result, its top compression chord is laterally unbraced. The tilted columns and truss were unstable during erection and had to be shored temporarily. Deflection of this structure after removal of the shoring had to be carefully calculated to ensure that resulting lateral displacement of the steel structure did not exceed the tight dimensional tolerance to the cast-in-place cladding.

Social & Economic Benefits

The first public building and a key revitalization element of Surrey's new downtown core, Surrey City Centre Library was conceived as a building with a true community role and ample space for social interaction or opportunities for neighbourhood connection. Fast + Epp was the structural engineering firm for this four-storey, 85,000 sq. ft. concrete and steel facility, which features a dynamic, contemporary design.

The dynamic shape of the building's exterior parallels the interior function of this library; the institution has embraced its new role in a digitized world as a place for socialization and connection, in addition to reading.

The revitalization of Surrey's downtown core has gained momentum as a result of the construction of this bold landmark. Surrey's Mayor, Dianne Watts called the building "absolutely iconic" in Building and Construction magazine.

Future phases of Surrey's revitalization project involve the construction of a new City Hall building and plaza, underground parking, a performing arts centre and an iconic 52-storey mixed-use tower. The Surrey City Centre Library project offers a stunning new gathering space for BC's fastest growing city.

Environmental Impact

The large expanse of high-performance glazing provides an interior space that maximizes daylight to reduce energy demand. Other features, including a green roof, LED lighting and locally-sourced materials, contribute to a building that meets Surrey's Sustainability Charter for social, economic and environmental sustainability.

Meeting the Client's Needs

The design mandate for Surrey City Centre Library was for the building to be an iconic structure and key public element of the revitalization of Surrey's new downtown core. The client desired the building to be dynamic and emphasize its community role. In addition to the project's considerable technical challenges, a fast-track schedule meant the building had to be solely designed and constructed in only 15 months, in order to meet a Federal stimulus funding program. Diligent project management, communication and coordination between team members was crucial, as construction of foundations started before the building design was complete.

Meetings were held with subtrades during the design phase to provide direction to the design team, including several alternate cladding systems. Metal, glazing, precast, tilt-up, shotcrete and cast-in-place systems were evaluated with the latter being chosen. In addition, numerous meetings were held early in the design process to coordinate the location and routing of services, architectural finishes and construction of future adjacent projects. In the original scope of work the library did not include any underground parking because of the future construction of the adjacent below grade City Hall parkade. Later instructions from the City directed the team to add a basement to the structure which would eventually become part of this future parkade which was still in the conceptual stage at the time. The design team worked carefully to anticipate the elevation of this parkade below the adjacent City Hall Plaza and to maximize the parking efficiency while ensuring the most cost effective foundation system for gravity and lateral loads of the Library. This input enabled construction drawings for the ground floor and underground parking of the Library to be issued during the design development phase of the full Library project.

The construction manager engaged subtrades prior to completion of the construction documents phase to provide effective design input and cost and schedule control. The resulting building was completed on time and economically.

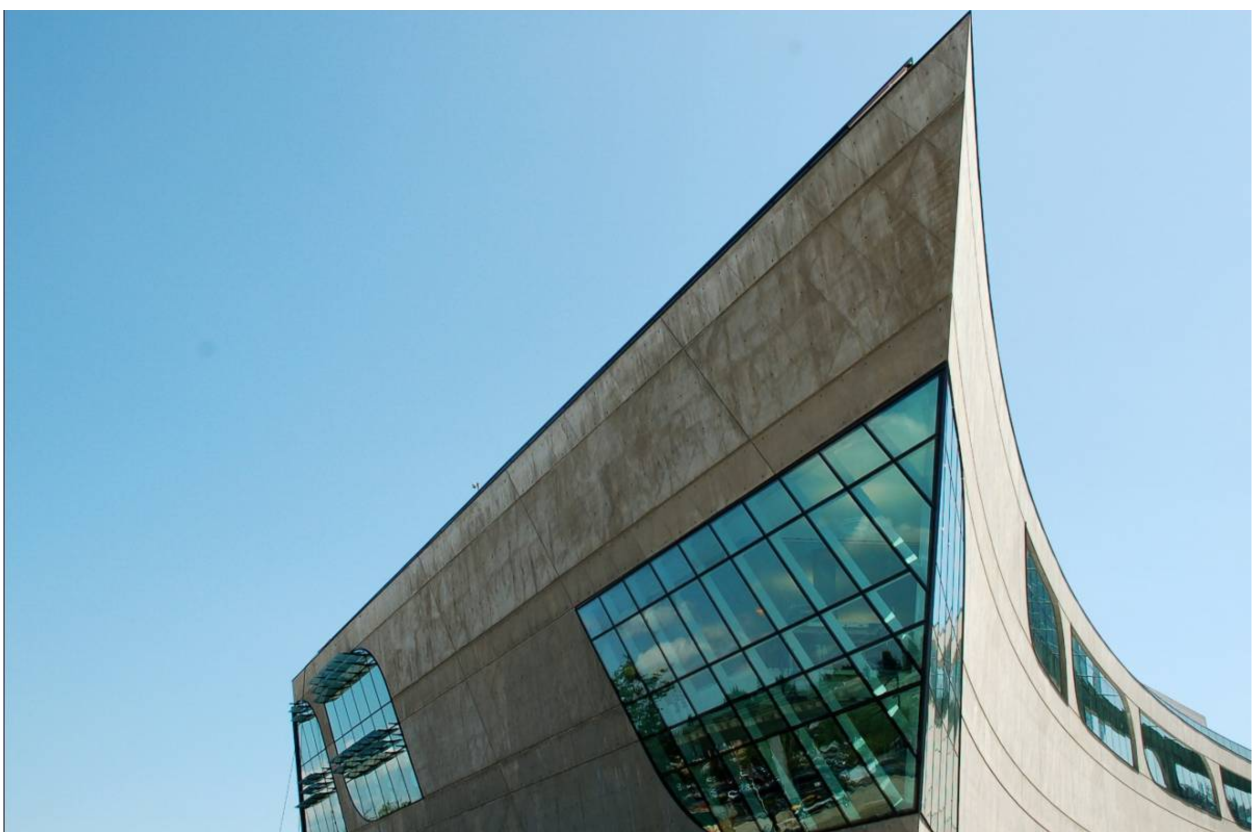


Figure 1: The bold, exposed concrete and glass exterior of Surrey City Centre Library. Photo Credit: Stephan Pasche

Figure 2: The interior of Surrey City Centre Library showcases the building's complex geometrical form. The tilted truss is concealed within the drywall guardrail. Photo Credit: Stephan Pasche

Figure 3: Construction crews assemble third floor steel, inside the cast-in-place cladding. Photo Credits: Solid Rock Steel

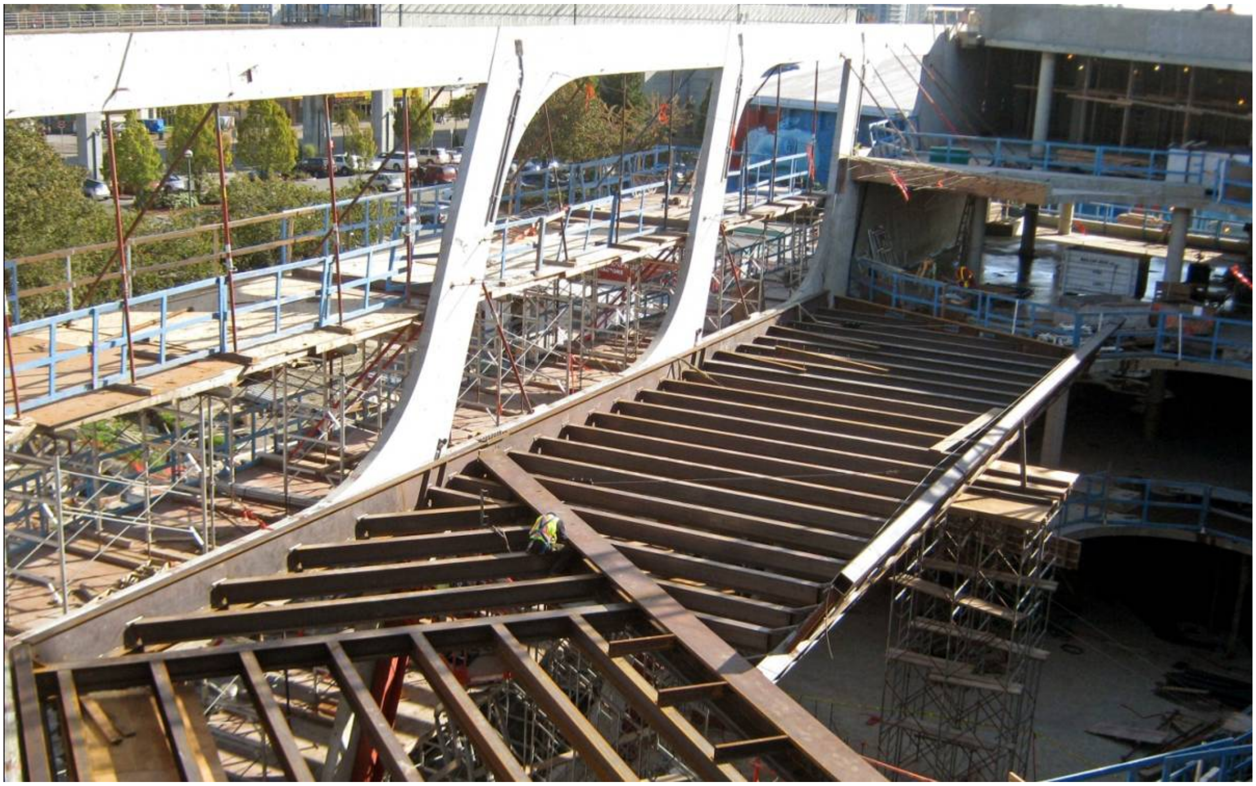


Figure 4: Construction crews assemble third floor steel, inside the cast-in-place cladding. Photo Credit: Fast + Epp

Figure 5: Complex geometry required careful rebar detailing. Photo Credit: Lawrence Chan

Figure 6: Custom seismic connectors, developed to carry the significant gravitational and seismic loads. Photo Credit: Stuart Olson Dominion Construction Ltd.

Figure 7: Construction of self-supporting cast-in-place concrete exterior cladding walls. Photo Credit: Stephan Pasche

Figure 8: Underside of steel decking showing flush steel beams to reduce the floor depth. Also shows tilted steel column in tight tolerance to concrete cladding. Photo Credit: Fast + Epp

Figure 9: Close up of tilted steel column that supports third floor and roof atrium structure, which will be concealed behind drywall. Photo Credit: Fast + Epp

Figure 10: Rounded corner of the tilted truss follows geometrical form of Surrey City Centre Library's interior guardrail and supports much of the building's third floor. Photo Credit: Fast + Epp

Figure 11: Steel roof trusses allowed the atrium to remain column free and support the tilted skylight pop-up. Photo Credit: Fast + Epp

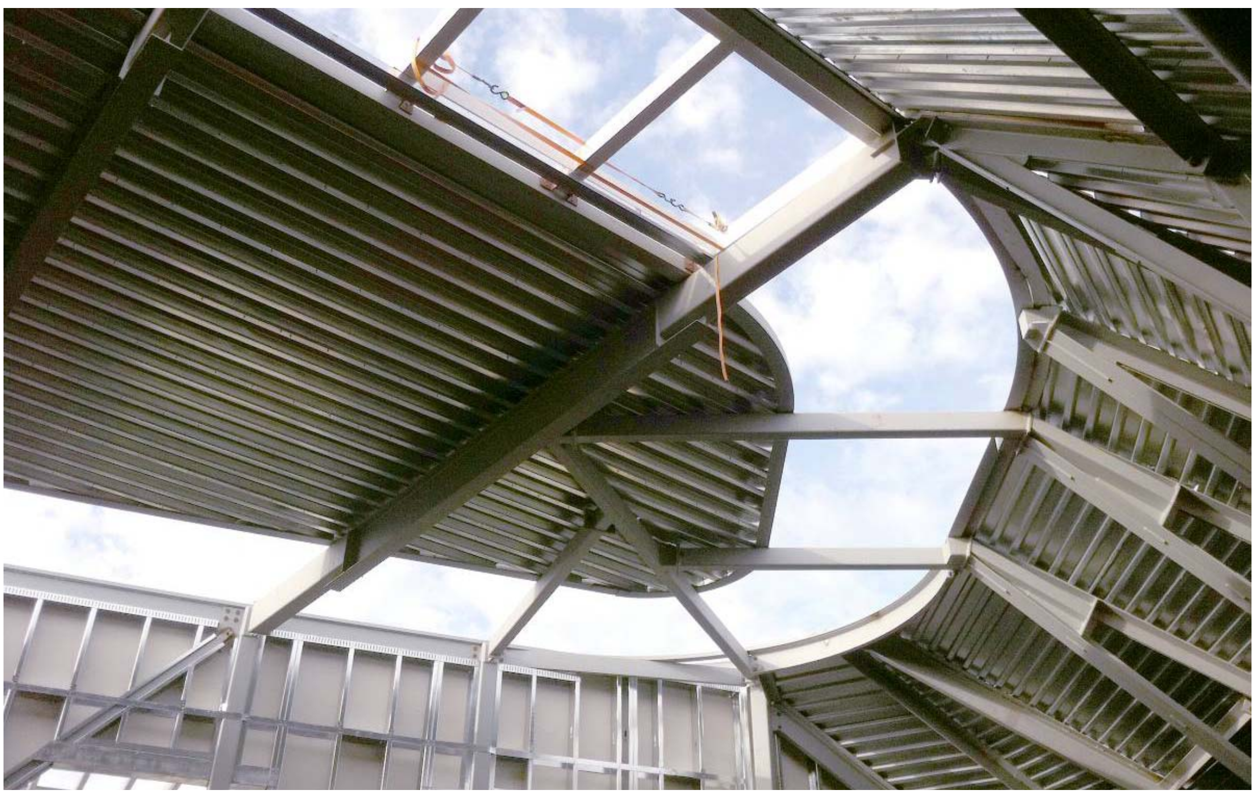


Figure 12: Pop-up central area is an important element which includes aesthetic, ventilation, daylighting and smoke exhaust features. Photo Credit: Fast + Epp

Figure 13: Interior finished shot – steel played a crucial role achieving the column-free, long-span atrium space and shallow floor structure. Photo Credit: Stephan Pasche

Figure 14Full: Exterior finished shot of the library, which has played a key role in the revitalization of Surrey's downtown core. Photo Credit: Stephan Pasche