TROUT LAKE ARENA

Fast + Epp

TROUT LAKE ARENA

Vancouver, BC

CANADIAN CONSULTING ENGINEERING AWARDS 2011

Category A: Buildings

Project Owner: City of Vancouver and Vancouver Board of Parks & Recreation

Project Client: Walter Francl Architecture Inc.

Other Consultants: Mechanical: J.M. Bean & Co. Ltd.
Electrical: Acumen Engineering

Contractors: Bird Construction

Community ice arena used as a practice facility prior to the Vancouver 2010 Winter Olympics.

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Cover and title page interior view photos by Hector Lo,

Courtesy of Walter Francl Architecture Inc.

TROUT LAKE ARENA: HIGHLIGHTS

Trout Lake Arena, which served as an Olympic practice venue during the 2010 Winter Games, smoothly sidesteps the design elements of a typical ice rink. Instead of plain and industrial it opts for open, airy, and dynamic, incorporating the aesthetic and environmental advantages of wood and natural lighting into an innovative structural solution.

Significant use of wood as a sustainable material in the design was desired; however, the initial architectural concept of a flat roof with a longitudinal clerestory window at midspan did not lend itself to traditional steel roof trusses, due to the step in the roof plane at the window, nor the use of wood beams, due to the long span.

Fast + Epp proposed a major departure from conventional arena roof design. Instead of supporting the roof on traditional steel trusses spanning the width of the building, a single steel Vierendeel type arch was installed running the length of the arena, effectively splitting the building in two halves. This resulted in shorter spans which facilitated using glue-laminated beams as primary support elements, and allowed natural daylight to stream into the building through the open panels in the steel truss.

The resulting dynamic aesthetic expression accomplished a visual and unusual structural hybrid – concrete, steel, and wood combine and interplay to create rhythmic patterns which interact with the shifting natural light. The final result is an arena structure that showcases wood and design innovation to Olympic skaters and provides an economical and aesthetically striking long-term legacy venue for the community.

NEW APPLICATION OF EXISTING TECHNIQUES: ORIGINALITY AND INNOVATION

The structural design of Trout Lake Arena forgoes typical concrete-and-steel-box ice rink design in favour of an attractive and efficient vierendeel arch and glulam beam roof assembly supported on concrete buttresses. The result was an aesthetically interesting community arena which also served as an Olympic practice venue during the Vancouver 2010 Winter Olympic Games.

Trout Lake Arena has 3,175 sq. m. of floor area and contains an Olympic sized ice rink. It served as the first stage in a revitalization of Trout Lake Park; an adjacent community centre is currently being constructed.

The initial architectural concept called for a flat roof with a longitudinal clerestory window at midspan; however, traditional steel roof trusses could not efficiently accommodate the step in the roof plane at the window, while the long span prevented the use of wood beams as an attractive solution. The structural engineer proposed the following solution:

A 67 metre longitudinal steel Vierendeel type arch (no diagonal members in truss (See Figure 1)) was installed, supported by cast-in-place concrete buttresses at the north and south ends of the building. The arch was constructed using standard steel wide flange sections. The top chord of the arch supports the high roof glulam beams spanning 26 metres to the west perimeter concrete columns while the bottom chord supports the low roof glulam beams which span 14 metres to the east side perimeter columns (See Figure 2). The glulam beams support curved metal decking.

Taking the unconventional step of incorporating a longitudinal Vierendeel arch into the roof structure, rather than spanning conventional steel trusses in the short direction of the building accomplished the following purposes:

1. It splits the 40 meter wide roof structure into two halves, thereby creating secondary spans of 14 and 26 meters. This facilitated the extensive use of wood, a highly sustainable local resource which typically becomes uneconomical at spans exceeding roughly 25 metres due transportation challenges. (See Figure 2)

2. The depth of the truss serves as a crescent shaped clerestory window space allowing ample daylight to penetrate the arena and create interesting light patterns. The use of a Vierendeel type arch eliminates the diagonal members and clutter of a conventional arch and results in cleaner aesthetic expression. (See Figure 1)

3. It results in an economical structure notwithstanding the curved form of the roof which would typically be associated with higher costs. The higher cost of the curved form is more than compensated for by a reduction in the height of the perimeter walls that are associated with a deeper truss conventional solution.

The structural engineer’s solution served architectural design and Client objectives by incorporating significant architecturally exposed structural timber in an elegant, efficient, cost-effective, and sustainable manner while also introducing significant natural light through the natural openings in the structural components.

COMPLEXITY

Technical challenges that were encountered include the following:

1. The longitudinal arch had to be carefully analyzed, and steel member sizes optimized, to ensure stability against buckling and economy of design.

2. Large thrust forces had to be accommodated within the concrete buttress walls supporting the arch. This required deep shear keys to be incorporated below the foundations to prevent sliding of the footings.

3. Initial consultations with the metal deck supplier indicated that they did not think it was feasible to bend the steel deck on such a tight radius of curvature. F+E performed calculations to prove it was, in our opinion, possible and the project was tendered as such. Construction proceeded without any of the anticipated difficulties, admirably demonstrating that persistence pays off!

4. The roof diaphragm was subject to high forces due to the 67 meter long building length, and due to the step in the roof. Concrete columns were designed to cantilever from the basement structure at the west side of the building to mitigate against this effect.

ENVIRONMENTAL IMPACT AND SOCIAL AND ECONOMIC BENEFITS

The arch-clerestory provides ample natural light penetrating at an indirect angle into a traditionally artificially-lit space. This avoids negatively impacting ice quality and reduces glare while providing a visually brighter, healthier, and more positive user experience.

The curved roof shape cut costs by reducing roof depth at both ends and both sides of the building. Significant use of wood and architecturally exposed materials reduces costs and environmental impact of materials by eliminating redundancies. The single vierendeel arch enabled shorter lengths of environmentally sustainable glulam beams to be used to span the width of the arena instead of multiple long steel trusses.

Additionally, it created construction and cost efficiencies since the glulam beams were now short enough to be easily transported and installed. The use of wood and the dynamically curved roof form also improves the interior aesthetic and user experience, adding warmth and visual interest through dynamic patterning and juxtaposition of materials and textures.

The Trout Lake Arena has been awarded LEED® Silver.

MEETING AND EXCEEDING OWNER'S/CLIENT'S NEEDS

The design team set out to meet the following objectives for the design of the arena:

- Showcase Vancouver to international audiences and create a lasting impression of innovation and excellence while serving as an Olympic practice venue for the 2010 Vancouver Winter Games.
- Superior aesthetic and functional legacy community facility.
- Natural light access to rink area.
- Significant structural and aesthetic use of wood.
- Maintain fairly tight budget despite rising pre-Olympic construction costs.

The attached photographs attest to success of the arena's aesthetic expression, due in a large part to the effects of significant exposed wood and abundant natural light.

Client and user responses have been positive through the Olympics and beyond.

The final structural solution introduced significant use of exposed wood to the design at a slightly lower costs than the initial steel design was priced at.

The Client has since commissioned an adjacent community center which draws heavily from the design of the arena.

Vierendeel Truss Arch – Construction.

Interior view south.

Photo by Hector Lo, Courtesy of Walter Francl Architecture

Interior view east. Photo by Hector Lo, Courtesy of Walter Francl Architecture

Exterior view north-west – clerestory detail.

Interior clerestory detail.

Photo by Jim Taggart

Interior view south – clerestory overhang.

Exterior view north – colonnaded viewing gallery.

Exterior view of east side.

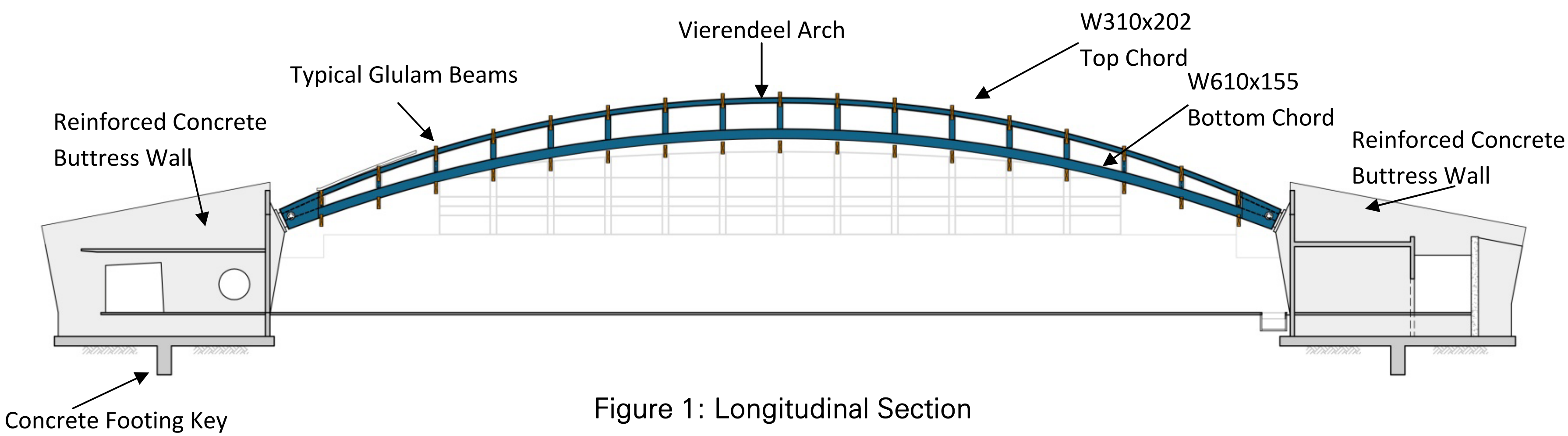

Figure 1: Longitudinal Section

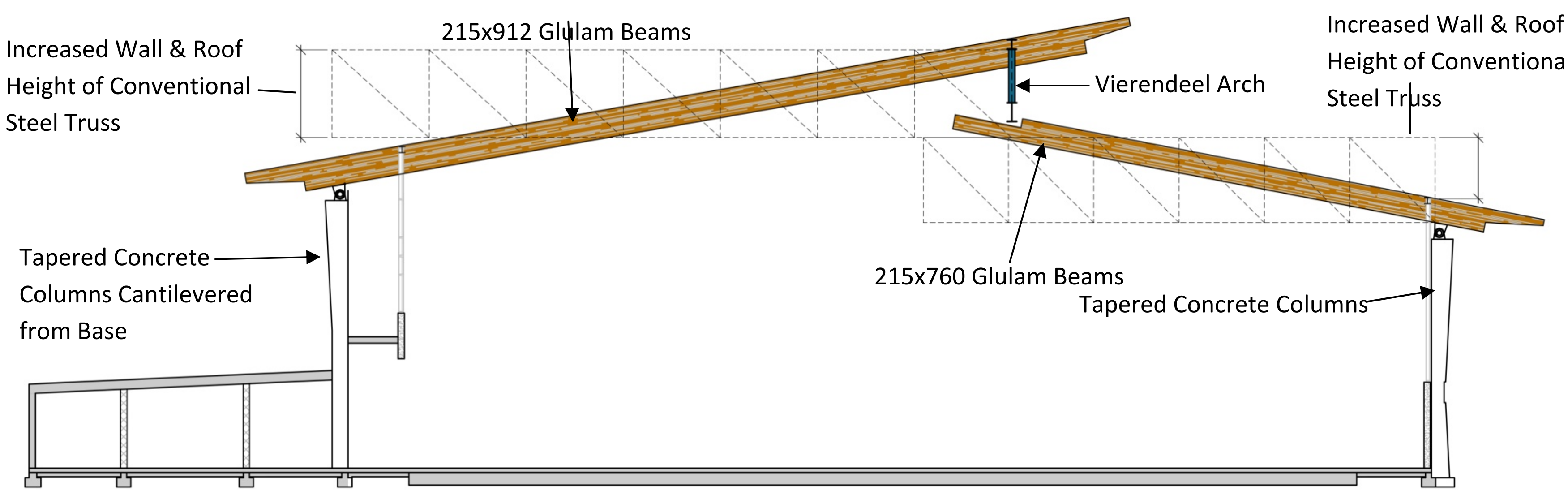

Figure 2: Cross Section