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Kingsway Pedestrian Bridge

This award-winning project in Burnaby, B.C. displays a rare — and technically challenging — use of wood in a bridge structure.

The Kingsway Pedestrian Bridge is a 44-metre (145-ft.) clear span structure spanning the busy intersection of Kingsway and McMurray Avenue in Burnaby, a city in Metro-Vancouver, B.C. The bridge's signature design creates an aesthetically striking portal for traffic entering Burnaby along the Kingsway corridor.

The structure consists of an extremely thin edge concrete walkway which is suspended from a gracefully curving arch structure that incorporates three different materials: wood, steel, and concrete. The covered wood portion of the arch features a series of bi-axially curved glue-laminated beams that are anchored by custom shaped steel haunches at both ends.

The composite arch construction using steel haunches and a timber drop-in span is thought to be a "world first." Bending and warping glue-laminated wood to achieve the desired dynamic aesthetic expression in a pedestrian bridge has rarely if ever been done. Supporting glass guards on tension rods in a bridge structure is also very unusual.

The timber components exude warmth, enhance the dynamic multi-material expression of the bridge, and demonstrate the viability of using a rapidly renewable resource in a construction sector that is dominated by steel and concrete.

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The 44-m arch with "pinched" glu-lam beams.

Underlying Complexity

The apparent simplicity of the final design belies its underlying complexity. In fact the bridge is one of the most difficult designs Fast + Epp had undertaken. The design was complex in the following respects.

The glue-laminated arch's double curvature results in biaxial stresses that required careful analysis with a 3-D SAP program. The two edge beams actually had to be split into two halves in order to make them more flexible and achieve the large horizontal bend to create the desired "pinched" shape of the arch. The result was probably some of the longest and thinnest wood components ever manufactured — spaghetti-like 100-ft. long and 3-in. thick pieces! Extreme caution was required to avoid damaging the pieces when shipping them to the job site.

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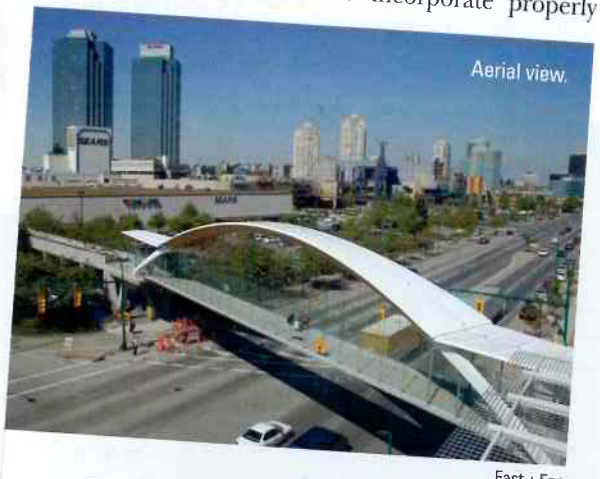
AWARD

The stainless steel rods supporting the concrete bridge deck tend to overstress the edge of the glulam beams by virtue of their support points being immediately adjacent to the edge of the arch. In order to create a more desirable uniform stress distribution in all the wood members, care was taken to incorporate properly detailed blocking pieces to transfer load from the edge of the arch to the more interior wood members. The design also included on-site tensioning of the individual glulam elements with steel rods that were glued into the cross holes to ensure a tight fit.


Aerial view.

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Because a hybrid wood-steel arch has, to the best of the designers' knowledge, never been constructed before, they had to do careful analysis of the joints and custom details to ensure the successful transfer of bending, axial, and shear forces. Keeping in mind construction tolerances and the potential differential shrinkage between the wood arch and steel haunch, it was necessary to ensure tight fitting connections to avoid potentially "soft" structural behaviour and undesirable sagging and vibration in the bridge.

The bridge deck was originally envisioned to be a stiffened steel plate with concrete infill. However, to minimize long-term maintenance, and also in order to provide additional mass to mitigate against vibrations, it was decided to construct the bridge using precast concrete planks post-tensioned together. This approach required more attention to the erection procedure, but the extra effort was worth it, and a thin concrete bridge edge aesthetic was achieved.

The architect chose to incorporate tall 2.4-m high glass guards. Rather than add chunky guardrail posts that would have compromised the bridge aesthetics, the glass guards were structurally fastened to the stainless steel tension rods that support the bridge deck. This is a very uncommon method of supporting glass guards which results in large horizontal wind forces being imparted to the tension rods, and required detailed analysis.

Since the concrete platform acts as a tension tie to resist the arch thrust forces, it required careful detailing for the steel haunch-to-concrete platform connections, including a sliding connection to avoid large thrust forces on the south concrete support structure. The engineers also had to determine a seismic resistance strategy.

The wood arch component was fabricated in a nearby department store parking lot in a short time frame, and erection required only a single day of traffic closure. The structure successfully met its budget and schedule constraints, although the budget was increased from $1.7 to $2.7 million during design in view of the rapidly escalating construction costs during the pre-Olympic building frenzy.

CCE

Project name: Kingsway Pedestrian Bridge
Award-winning firm: (structural engineer) Fast + Epp, Vancouver (Paul Fast, P.Eng., John Miller, P.Eng.)
Owner: City of Burnaby
Architect: Busby Perkins + Will
Other key players: RFA Consulting (electrical); Dominion Fairmile (contractor); Solid Rock (steel fabricator).