The Kingsway Pedestrian Bridge

By Paul A. Fast, P.Eng, Struct.Eng

In 2005, after years of saving for a much-needed pedestrian bridge in a crowded commercial centre, the City of Burnaby set out to develop a new, signature pedestrian overpass. Fast + Epp, together with Busby Perkins + Will Architects, were brought on to tackle the challenge of the long-anticipated bridge's design, which was required to support a clear span of 145 feet over a busy intersection adjacent to the largest shopping mall in the Province of British Columbia.

The Client desired that the completed bridge act as an iconic and visually striking 'welcome portal' for visitors entering the city along the Kingsway corridor, improving upon the urban aesthetic of the crowded downtown core. Additionally, the City expressed a clear desire to avoid traffic delays or rerouting past the busy intersection during the construction of the bridge.

The design concept resulted in the quiet elegance of a simple tied arch structure that would also provide some rain protection. The primary arch was constructed using wood elements below a covered midspan, which morph into steel haunches at both ends that are exposed to the weather. The concrete bridge deck acts as a tension tie. This combination of materials takes advantage of the strength and durability of concrete and steel, and the visual appeal, warmth, and sustainability of wood.

The wood component of the arch consists of bi-axially curved and slightly warped glue-laminated beams in a rarely attempted manner of construction. This resulted in a complex geometric shape that is difficult to both analyze and construct. The double curvature created by biaxial and torsional stresses required careful analysis with a 3-D SAP program. The two edge components of the arch were split into two halves in order to make them more laterally flexible, and to achieve the horizontal bend required to create the dramatic 'pinched' shape of the arch. The result was perhaps some of the longest and thinnest wood components ever manufactured – spaghetti-like 100 foot long by 3 inch thick pieces which required extreme caution to avoid damage when shipping to the job site, where they were assembled on-site in a department store parking lot. The top of the arch was sheathed with two layers of ¾ inch thick plywood and protected with a ¼ inch thick non-structural steel plate roof cover. The arch in its entirety was then lifted into place and installed in a single day, during the only traffic stoppage in the course of construction.

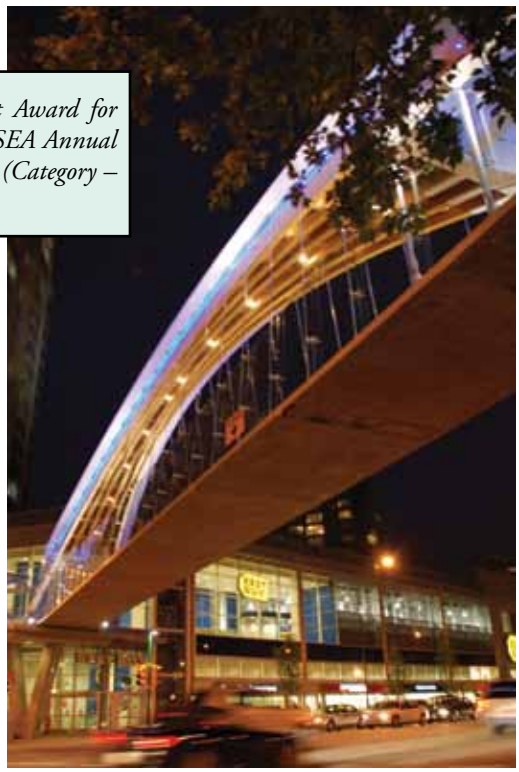
Fast + Epp received an Outstanding Project Award for the Kingsway Bridge project in the 2009 NCSEA Annual Excellence in Structural Engineering program (Category – Bridges and Transportation Structures).

The stainless steel rods supporting the concrete bridge deck tended to overstress the edge glulam beams by virtue of their support points being immediately adjacent to the edge of the arch. However, in order to create more desirable uniform stress distribution in all the wood members, care had to be taken to incorporate properly detailed blocking pieces that would transfer load from the edge of the arch to the more interior wood members. This was accomplished with on-site tensioning of the individual glulam elements with steel rods that were glued into the cross holes to ensure tight fit. Additional stress distribution is provided by full width 4-inch square HSS steel members that are mounted directly above each row of blocking. The ends of the HSS members cantilever beyond the edge glulams to support the tension rods.

Detailing the steel haunch to concrete platform connection (the platform acts as a tension tie to resist arch thrust forces) and creating a sliding connection at the south end to avoid large thrust forces on the south end concrete support structure added to the complexity of the project, as did the determination of a seismic resistance strategy. A significant challenge in mixing three different materials in a complex geometric shape is the coordinating and reviewing of shop drawings from three separate sub-trades (steel fabricator, glulam fabricator, precast concrete fabricator) to ensure that everyone is 'playing to the same tune'. The seamless erection of the arch and deck structure is testimony to the fact that all trades were well coordinated.

Due to the uniqueness of the hybrid wood-steel arch, careful joint analysis was required and custom details were developed to ensure the successful transfer of bending, axial, and shear forces. Extra care and attention was given to ensure that a tight fitting connection was achieved that would avoid potentially 'soft' structural behavior and undesirable bridge sag and vibration.

The bridge deck was originally envisioned to be a stiffened steel plate with concrete infill. However, in order to minimize long-term maintenance and to also provide additional mass to mitigate against bridge vibration, it was decided to construct the bridge using 7-inch thick precast concrete planks post-tensioned together. The edges of the concrete deck units have built-in gutters and are only 4 inches thick, contributing to the distinctive thin edge aesthetic.



Kingsway Pedestrian Bridge Sidewalk View.

Tall 8-foot high glass guards were structurally fastened to the stainless steel tension rods that support the bridge deck, resulting in larger than usual horizontal wind forces being imparted to the tension rods. This required detailed analysis to determine if the relatively large lateral tension rod deformations were within an acceptable range.

The Kingsway Pedestrian Bridge provided a groundbreaking degree of aesthetic appeal for a local public works project, and its innovative design has won a number of national and international awards.▪

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