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# Launching one

Canadian crew executes largest operation in N. America

In early 2008, KWH Constructors of Burnaby, British Columbia, Canada, partnered with SNC-Lavalin Constructors Pacific (SLCP) of Vancouver, British Columbia, and with their consultant design engineers, International Bridge Technologies (IBT) of San Diego, embarked on a challenging incremental launching scheme for the Coast Meridian Overpass (CMO) design-build project.

After less than one year of accelerated planning, design and fabrication of the steel components, the assembly and launching of the superstructure was started in January 2009 and completed in August 2009. The bridge was publicly opened on March 6, 2010.

It is believed that within North America

this structure is both the longest one-direction, free-cantilever span length launched and the first use of a temporary stay-cable system for incremental launching.

The CMO is a 1,900-ft-long, six-span cable-stay bridge located in the city of Port Coquitlam (a suburb about 12 miles east of downtown Vancouver) in the province of British Columbia. The bridge has four steel pylons supporting a single line of cable stays down the middle and carries four lanes of traffic, two bicycle lanes and one pedestrian lane with a deck width of just over 80 ft. The maximum spans between piers are 410 ft. The project was procured as a design-build contract by the city of Port Coquitlam.

The bridge crosses a large rail yard owned by Canadian Pacific Railway with over 50 parallel sets of tracks at the location of the bridge crossing. Prior to the completion of this project, the rail yard divided much of the city in half and

made local north-south travel difficult. Because of the rail-yard density and congestion, the locations available to place piers were limited and, therefore, long spans were required. Due to rail-yard activity, temporary supports for construction were not permitted and construction activity within the rail yard was severely restricted. Due to these challenges, the city envisioned in the tendering documents a construction method base concept of a launched structure.

A steel superstructure was determined as the most feasible option, due to its relative lightweight in comparison to concrete. The vertical pier capacity was limited as only a single row of piles per pier were allowed within the rail yard.

The steel superstructure option chosen by the design engineer was box girders, but they were constrained to be not more than 10 ft deep for the required profile of the bridge. The only way to free cantilever spans of over 400 ft with these box girders was to use temporary stay cables from the leading permanent pylon and a 120-ft-long temporary launching nose.

The structural system is a hybrid between conventional box girder and cable-stay bridges, which in combination provided an optimal solution for the CMO. Working with input from KWH Constructors and SLCP, IBT created several specialized design details for the superstructure.

## Launching padding

The superstructure was structurally adequate for both the permanent demands and the launching demands. As previously stated, during launching the leading cantilever span required supplemental temporary stay-cable supports. Trailing behind the leading span, the back spans (two-thirds of the superstructure) had smaller demands. The 10-ft-deep box-girder sections alone were adequate for the trailing spans during launching.

The transverse width of the deck has three primarily lines of support; the twin box girders and the single line of stay cables. The stay cables effectively replace a line of girders in the middle to carry the load and also assist in reducing deflections. This is effective for

CMO because the required span would be most efficient with a variable-depth structure, but it is not practical with a launched structure that requires constant depth. The stay cables help replicate the effect of a deeper structure at the piers.

The framing system between the box girders was developed so that the stay forces would distribute as axial loads and not concentrate in any location. Diagonal bracing at each stay drags some load into the box girders. The parallel twin spine beams running the length of the bridge down the middle carry most of the stay force.

The remaining secondary framing members were selected to optimize the span and thickness for the concrete deck panels. This was selected as 16.4 ft typical spacing for the transverse floor beams with a stay support every 49.2 ft. A stay bracing frame was developed for the stay reaction and the subsequent distribution of forces to the box girders.



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The pylons were assembled onto the superstructure prior to launching because heavy-crane access within the rail yard at the piers was not possible. This led away from conventional reinforced concrete pylons and the implementation of all-steel pylons. This also allowed the pylons to be fabricated and erected in segments in the same order

of magnitude of the typical box-girder sections. Pylon sections were fabricated at the same shop and were divided into three segments. The same lifting equipment at the launch site was used for both box-girder and pylon assembly.

Standard hardware components for pylon stay anchorages are usually detailed for concrete sections. IBT developed a detail for the stay anchorages that could accept the highly concentrated forces from the anchorages and transfer the forces to the rectangular steel-box section.

The stay cables used conventional hardware and were supplied by Freyssinet Inc. The stays were composed of 0.6-in.-diam., seven-wire strand. The number of strands per stay cable ranged from 37 for the shortest stay cable to 73 for the longest. A unique feature to the stay-cable arrangement is the quantity of stay cables per pylon. Pylons 1 and 4 have four stay cables per side, while

pylons 2 and 3 have three stay cables per side, a symmetric layout. As noted earlier, the span arrangement was dictated by agreement with the railway for available locations of piers, which led to an awkward pier arrangement. To overcome this and to maintain the general stay-cable spacing, an uneven layout of stay cables was implemented.





For the fifth and final launching phase, the entire 1,800-ft-long portion of the superstructure, weighing 5,000 tons, was pushed into its final longitudinal position. The leading end of the superstructure slowly crept over a major four-lane highway.

## Moving up

Several pieces of specialized equipment were designed and fabricated

by KWH for the CMO. KWH and IBT worked closely to ensure that the launching equipment did not foul with

the permanent superstructure, and IBT made several detail alterations to allow the superstructure to be launched over the piers with the equipment developed by KWH.

The superstructure was assembled in a 450-ft-long temporary assembly bed, which was located directly south of the south abutment. The assembly bed contained four temporary supports for each of the two box-girder lines. Each support was a steel framework on an isolated temporary concrete footing supplied by SLCP specifically for launching and then demolished after completion of the launching.

Launching of the superstructure was divided into several phases. There were five alternating assembly and launching phases until the superstructure had been fully assembled and launched into final position. The next phase was jacking of the superstructure onto the permanent bearings. The last phase was the crane erection of the north abutment box girders and infill steel.

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After the necessary length of the superstructure to achieve the upstation pier had been assembled, the field crews launched the superstructure upstation to the next pier. A launch was complete when the span was traversed and the launch nose was fully past the upstation pier.

A custom-designed launch system was attached to the south abutment to push the superstructure. The typical cycle of the launch system was as follows: apply flange clamps, release wedge brakes, extend launch cylinders, apply wedge brakes, release flange clamps and retract launch cylinders. During a cycle the launch system traveled about 5 ft and took about five minutes.

Between launch phases, the superstructure was "parked" and considered as a static structure. The launch system was locked down at the south abutment, with the wedge brakes applied to ensure that the superstructure would not move longitudinally, other than temperature-induced movement, while more of the superstructure was

added to the back (south) end.

During the launch, the superstructure was continuously monitored and tracked by survey. This information, and other pertinent data, was recorded and checked against theoretical values. SLCP installed strain gauges in several locations in the box girders. These gauges confirmed that the stress levels remained within tolerable limits for the launching.

The rate of the launch system was about 45 ft per hour. Contingency time (clearing splices past rollers, rolling off temporary supports, nose transition, crew rotation) and temporary stay-cable stressing time had to be added to the launch duration, which reduced the overall launch rate.

For the fifth and final launching phase, the entire 1,800-ft-long portion of the superstructure, weighing 5,000 tons, was pushed into its final longitudinal position. The leading end of the superstructure slowly crept over a major four-lane highway during the afternoon rush hour.

## Moving forward

The successful launching of this superstructure has advanced the technology of incremental launching in North America. Previously assumed barriers of span and superstructure type have been overcome. This construction method was necessary to overcome many obstacles that were holding back this needed structure and allowed a city, separated in half for nearly a century, to come together.

Although suitable conditions and forethought are needed to allow launching to be successfully employed, advantages of incremental launching such as assembling a superstructure in a controlled zone away from the public, construction schemes that limit interaction with the public and creating a limited construction footprint in potentially sensitive regions, have been showcased by this unique project. **R&B**

Hall is with International Bridge Technologies Inc.  
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