CANADIAN CONSULTING ENGINEERING AWARDS 2022

CROWCHILD TRAIL BOW RIVER BRIDGE INTERCHANGE REHABILITATION AND WIDENING

LOCATION: CALGARY, AB
CLIENT/OWNER: THE CITY OF CALGARY
LEAD CONSULTANT: ASSOCIATED ENGINEERING
SUBCONSULTANT: THURBER ENGINEERING:

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Associated Engineering

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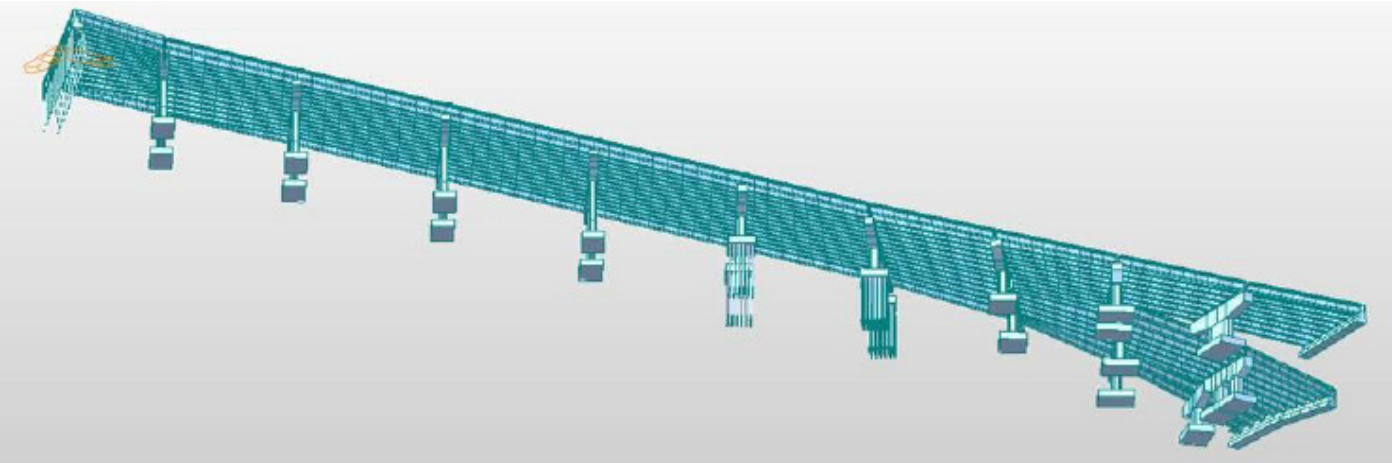
PROJECT SUMMARY

Associated Engineering's innovative design for rehabilitating and widening Calgary's Crowchild Trail Bow River Bridge Interchange improves functionality and safety, and extends the life of the 50-year-old structure. The cost-effective, sustainable solution reused the existing structure, reducing demolition, limiting waste, and protecting the river. The complex traffic staging plan mitigated interruption to commuters, railways, and businesses. Widening the bridge and realigning access ramps eliminates congestion, decreases emissions, and improves the experience for over 100,000 daily commuters.



INNOVATION

Calgary's Crowchild Trail Bow River Bridge Interchange is one of its busiest roadways. After 50 years of service, the bridge was severely deteriorated. The City considered numerous options for bridge replacement, some projected at over $1 billion.

The City engaged Associated Engineering to rehabilitate the bridge, based on our value-for-money concept. Our solution envisioned a wider, safer bridge by adding a full traffic lane in each direction using a unique bridge widening strategy, ramp reconfigurations, and functional traffic accommodations.

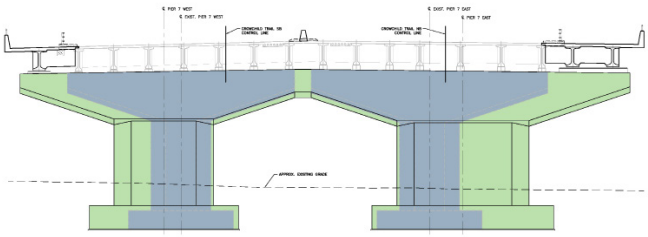
This innovation would simultaneously restore the structural integrity of the substructure, increase lane capacity, and improve the functionality of the interchange. We suggested construction could be completed without interrupting traffic service or the nearby CP Rail tracks, eliminating the need for a temporary structure and additional investment over the two-year construction period.

To accommodate the increase in rolling surface and an extra girder-line on each side of the bridge, our team explored ways to increase the deck, strengthen the piers, and modify load path transfer to the existing piers and abutments, in an effort to rearticulate the entire structure. We recommended tying piers together horizontally using an encapsulation approach – an innovative alternative that redistributes load using existing infrastructure, thus avoiding demolition of the existing bridge.

The river piers were supported by a spread footing on bedrock. The foundations were in good condition, sufficient to sustain added weight. The pier caps, however, needed to be longer, wider, and deeper to accommodate the additional girder-lines. To accomplish this, the pier caps were tied-in using reinforced concrete, and the original pier caps were encapsulated into the new widened pier cap. This provided the pier caps with enough strength and horizontal stability to accommodate Interface Shear – wherein the load from the pier caps is redistributed vertically down the pier shaft before arriving on the foundations.

South of the river, two piers were piled into bedrock and four piers were founded on spread footings. All land-based piers were encapsulated from the pile foundation to the underside of the deck at the pier caps. The spread footing was dug out and piles were added before encapsulating the foundation. Pile caps were also encapsulated. The encapsulated shell provides sufficient strength to support the full load generated by the widened structure. While each pier was unique, the same methodology was applied to each.

Our approach saved the City millions of dollars, while extending the bridge life by 30 years.



COMPLEXITY

The bridge widening enabled the realignment of 10th Avenue and Bow Trail, and relocation of Memorial Drive exit ramps in Calgary. Untangling the ramps and lengthening the weave distance substantially improved safety. Both lanes on the south end of the bridge were reconfigured to accommodate the deck widening and new entry ramps. Our strategy reduced impact on the river, railway traffic, and businesses.

The pier encapsulation approach rehabilitated the bridge and accommodated two additional lanes of traffic. This approach avoided the cost and environmental impact of bridge demolition and new construction.

With the extent of structural deterioration unknown, we involved the contractor early - at the 70% stage of detailed design. With a high priority on safety, we developed a construction sequence that would maintain structural integrity and reasonable productivity levels to ensure timely project completion.

The bridge rehabilitation and widening were further complicated by six power transmission ducts built into the bridge deck. The high voltage power lines inside these ducts accounted for a large portion of southwest Calgary's power supply. Working with ENMAX, we designed a new duct alignment built into the widened section of bridge deck.

To allow for bearing replacement, we determined a bridge jacking strategy that accommodated the traffic loads and the allowable stresses in the ducts due to deflection.

Construction sequencing was planned down to the hour. Services to nearby amenities and businesses remained uninterrupted and heavy traffic was safely accommodated with 3.3 metre wide lanes. Available traffic lanes were never reduced during construction.

SOCIAL AND ECONOMIC BENEFITS

The original infrastructure included unfavourable merge lanes and ramps that created gridlock and increased risk of collisions.

Prior to construction, The City of Calgary conducted extensive public engagement which helped establish a collaborative path forward between the project team and members of the public. Public input and feedback benefit all users of the road today.

Associated designed safety improvements for all modes of transportation. The safety upgrades included new lighting for pedestrians, increased shoulder widths, a new median, and side, single slope barriers. The intermediate diaphragms have been extended and are now architectural features.

The interchange reconfiguration reduces traffic weaving, increased merging distance, improving safety and decreasing risk of accidents.

The 50-year old deck cantilevers and traffic barriers were replaced, and both median and side barriers were upgraded, making for a safer and more comfortable journey for all users.

Our solution resolved the City's traffic issues on Crowchild Trail while avoiding the need for major property acquisition and limiting the impacts on adjacent residential neighbourhoods

The team's careful planning of construction sequencing and traffic management minimized impact on the travelling public throughout the two-year construction period.

The Crowchild Trail Bow River Bridge has been structurally reinstated, extending its service life for another 30 plus years. At $27.5 million, the cost-effective solution saved taxpayers hundreds of millions of dollars compared to initial options. The bridge widening accommodates current and future populations and traffic demand, and the relocated traffic lanes make the journey safer and quicker for the travelling public.

ENVIRONMENTAL BENEFITS

By leveraging and reusing existing infrastructure, our team's approach offered many significant environmental advantages, especially considering the size and scale of this project.

Limited Impact to the Bow River: Instead of building in-stream berms, our team's strategy redistributed load to the existing land piers and abutments, so work was not required on the foundations of the river piers. The tie-in on the river pier caps was completed from above, further reducing the construction impact on the river and aquatic life.

These modifications provided enough additional loading capacity for the bridge, eliminating the need to modify the river piers. As our strategy limited impacts to the Bow River, we were able to avoid additional regulatory permitting, which was critical to a timely completion of the bridge rehabilitation.

Reduced Waste and Materials: Little waste resulted from this project by re-purposing the existing infrastructure. Substantially less concrete and materials were required to complete the bridge rehabilitation, especially when compared to building a new bridge.

Reduced Greenhouse Gas Emissions: By adding two additional lanes and improving the function of the interchange, free-flow traffic was achieved through this once gridlocked route. Our environmentally responsible approach reduces greenhouse gas emission from idling vehicles.

Increased Greenspace and Pathways: By relocating the Memorial Drive exit ramps, our configuration created more usable greenspace and river pathways on the north side of the bridge and river, as well as improved connection to the city's entire pathway system.

MEETING CLIENT'S NEEDS

Calgary's Crowchild Trail is the busiest and one of the city's most important transportation corridors, connecting people, goods, and services from Glenmore Trail to 16th Avenue. The corridor features one of the few crossings over the Bow River. Constructed in 1968, the Bow River Bridge has suffered significant substructure deterioration and posed safety concerns after over 50 years of service. As Calgary's population has more than doubled in the last 50 years, the corridor has struggled to handle the increased traffic demand.

The City had considered numerous options, including demolishing and building a new bridge, to improve the functionality and safety of this corridor. All options were costly and disruptive. Some options were projected to cost over $1 billion and required expropriating several blocks of homes.

Based on Associated Engineering's innovative rehabilitation and widening scheme, the City decided to rehabilitate the bridge. The rehabilitation extends the service life of the bridge, accommodates the growing population, and addresses functional design issues. The solution avoided major expropriation of residences. Our collaborative approach with the contractor, utilities owner, and City staff helped to confirm constructability, safety, and construction sequencing; as a result, construction proceeded efficiently.

The project was the first combined widening and rehabilitation of a major in-service bridge in Alberta's history. With a total cost of $27.5 million, the cost-effective restoration of the Crowchild Trail Bow River Bridge Interchange has improved the quality of life for commuters and established an efficient transportation network that will serve Calgary for generations to come.

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Judge's comment: "The resourcefulness of the engineers was extraordinary. The increase in capacity of the bridge, delivered without need to do in-stream work, and while keeping traffic open throughout construction, was quite impressive. The overall benefit of a safer and wider bridge was delivered impressively.