HARBOURSIDE
Engineering Consultants

Canadian Consulting Engineering Awards 2024

Transportation Category

Champlain Bridge

Deconstruction Engineering

Project Overview

The original Champlain Bridge, a 3.4 km long, six-lane structure connecting Brossard to Montréal, Quebec, served as one of Canada's busiest vehicular bridges from 1962 to 2019. Situated over the Saint Lawrence Seaway, it faced ongoing structural deterioration, rendering maintenance economically unfeasible. Consequently, Jacques Cartier and Champlain Bridges Incorporated (JCCBI) opted for its replacement by the cable-stayed Samuel De Champlain Bridge.

Nouvel Horizon Saint-Laurent (NHSL) - a partnership between Pomerleau and Delsan AIM - undertook the deconstruction project, engaging Harbourside Engineering Consultants as the Deconstruction Engineer.

The project was divided into three zones for deconstruction activities that began in July 2020 and continued into 2023.

The Zones

Section 5 *included the concrete approach spans west of the steel structure to the abutment on Nun's Island;*

Section 6 *comprised the steel superstructure (trusses) located near/above the Saint Lawrence Seaway;*

Section 7 i*ncluded the concrete approach spans east of the steel structure to the abutment on the Brossard side of the river.*

Quick Facts

- Total Concrete Structure Length = 2678 m
- Total # of Concrete Spans = 49 spans
- Average Weight of a Concrete Span = 1835 Tonnes
- Total Steel Structure Length = 763 m
- Total # of Steel Spans = 7
- Total Weight of Suspended Span = 1950 Tonnes
- The St. Lawrence Seaway Navigation Channel maintained operations throughout the project.

The Project Team

General Contractor: Nouvel Horizon Saint-Laurent (NHSL) - Pomerleau/Delsan AIM Partnership

Bridge Owner: Jacques Cartier and Champlain Bridges Incorporated (JCCBI)

Deconstruction Engineering: Harbourside Engineering Consultants

Deconstruction Engineering Sub Consultant: gbi

Jacking Specialist: Mammoet Canada

Structural Engineer for the Existing Structure: TYLin/SNC Lavalin Joint Venture

Independent Verification Engineer: Arup

Bridge Demolition Specialist: American Bridge

Naval Architect: Concept Naval

The first of the four controlled descents of the three girders in the centre of the span.

Innovation

As the Deconstruction Engineer, Harbourside was responsible for developing sequencing/phasing, means and methods, and designing temporary works for the deconstruction, which required meticulous planning and adherence to environmental, site, and community constraints.

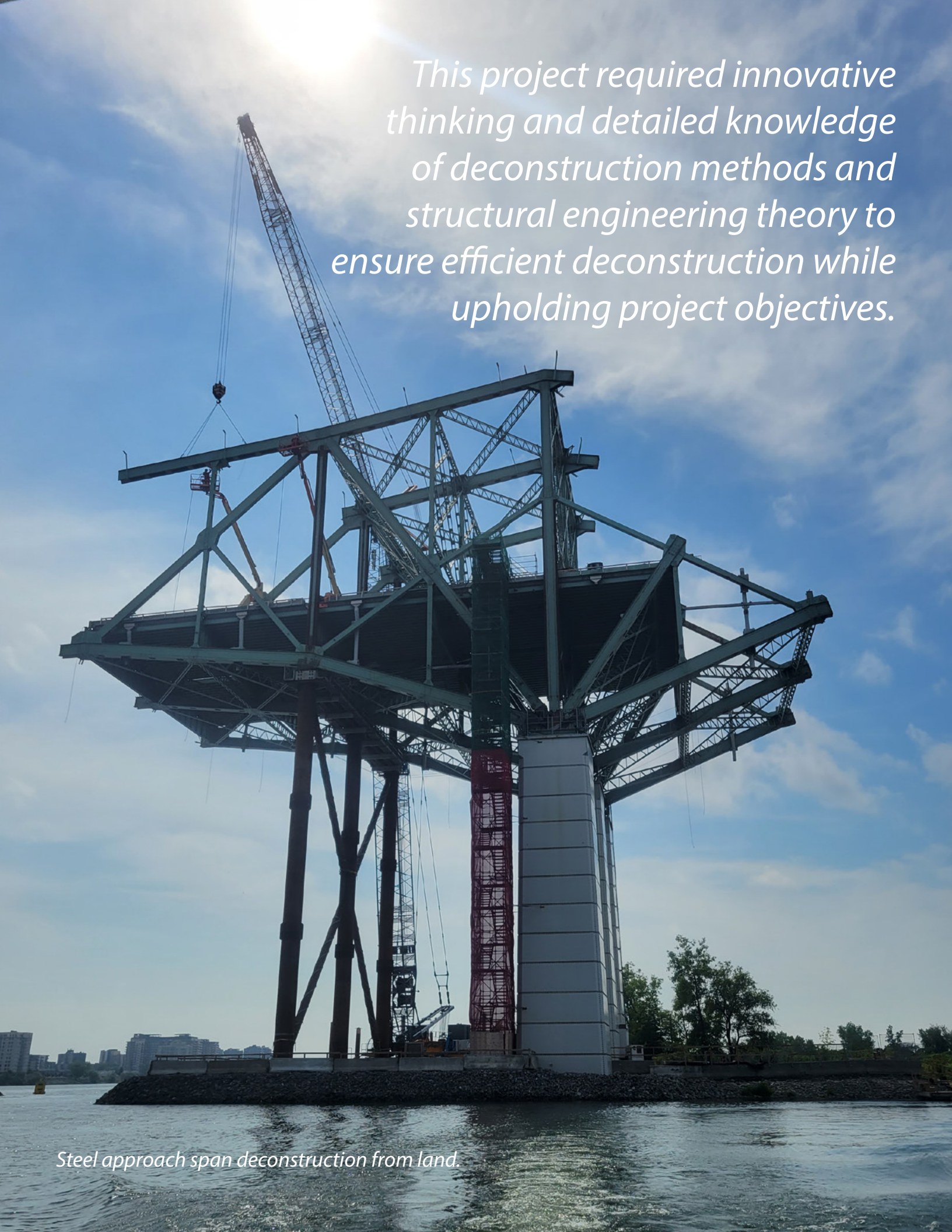
This project required innovative thinking and detailed knowledge of deconstruction methods and structural engineering theory to ensure efficient deconstruction while upholding project objectives.

Harbourside incorporated the use of sophisticated jacks in the lifting/lowering of concrete spans and the lowering of the suspended span combined with the use of real-time monitoring of load distribution, barge deflection, barge movement, and barge rotations using a variety of sensors that allowed for a high level of control throughout these critical operations.

The detailed jacking procedures and piece-by-piece dismantling procedures for the truss cantilever and anchor arm spans facilitated the safe and efficient deconstruction of the steel superstructure.

Harbourside's contribution to this project enabled the deconstruction to be completed safely and effectively. The controlled, meticulous nature by which the deconstruction was completed helped to advance the image of the engineering profession in the eyes of the public. The successful execution of the deconstruction methods developed on this project will allow for similar methods to be considered for future projects.

The suspended span deconstruction, being located over the economically vital Saint Lawrence Seaway where disruptions were not permissible, required exceptional planning. Work was completed in January, in the most difficult environmental conditions during the yearly Seaway closure. The span was lowered as a single segment with six strand jacks to a pair of barges.



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Steel approach span deconstruction from land.

Complexity

This was a unique engineering project with many inherent challenges. High risk in nature due to the structure's degraded condition, Harbourside's design also had to ensure the safety of the public and workers, protect the environment, and mitigate site constraints.

One of the main challenges was practically and economically removing elements of the bridge without compromising the structural integrity of the remaining structure. For example, the suspended span lowering process and the anchor arm deconstruction needed to provide the ability to control the load between trusses to prevent elements in the system from becoming overloaded and to ensure the remaining truss members remained stable.

Other specific challenges:

- Protection of the new, adjacent Samuel de Champlain Bridge.
- Saint Lawrence Seaway vessel traffic could not be disrupted requiring contingency plans to mitigate risks such as mechanical equipment failure. Major operations had to be timed to occur during the Seaway's winter closure.
- Deconstruction sequencing had to allow for the safe and complete removal of specific elements of the bridge that were designated for research and development or re-use.
- Spans removed via barge needed to account for and accommodate differential barge deflections and rotations.
- Access to the Section 6 steel spans from below used the existing land or jetties built out into the river, however, the relatively narrow jetties restricted equipment mobility.

Harbourside's methods of deconstruction of the bridge significantly reduced costs and schedule, mitigated impacts on the public and surrounding environment, and minimized the risk for the contractors tasked with deconstructing the complex structure.

Concrete span deconstruction over water using a jackup on a barge.

Social & Economic Benefits

This deconstruction project not only provided a rare opportunity for residents and passersby to witness an engineering mega-project but also brought substantial social and economic benefits to the region.

With an estimated value of $400 million, the project generated employment opportunities for local contractors, suppliers, and tradespeople, including equipment operators and ironworkers. This infusion of employment not only supported the local economy but also provided livelihoods for many individuals and families.

Moreover, the involvement of Harbourside engineers and drafters from Prince Edward Island and Nova Scotia underscores the project's broader regional impact, demonstrating the collaborative nature of large-scale engineering endeavors and the opportunities they create across provincial boundaries.

The project's emphasis on research and development contributes to advancing knowledge in structural behavior and deterioration. By leveraging insights gained from the deconstruction process, engineers and researchers can refine methodologies and practices, ultimately enhancing the resilience and longevity of infrastructure systems.

Furthermore, recognizing the rich history and significance of the existing Champlain Bridge to the local community, one of the concrete bridge piers that supported the main steel spans was preserved and will remain to commemorate the historic structure providing significant social benefit.

Overall, the deconstruction project of the Champlain Bridge not only showcased engineering prowess but also delivered tangible social and economic benefits to the local community, fostered regional collaboration, advanced knowledge in structural engineering, and promoted environmental sustainability.

Deconstruction of the anchor arm from land.

Environmental Benefits

The deconstruction of the Champlain Bridge prioritized environmental sustainability through various measures aimed at minimizing its ecological footprint and mitigating potential environmental impacts.

Recycling: The Champlain Bridge contained 250,000 tonnes of concrete, 25,000 tonnes of steel and 12,000 tonnes of asphalt that could be reused. A key target was to recover at least 90% of all deconstructed materials for recycling, demonstrating a commitment to resource conservation and waste reduction. This repurposing minimized landfill-bound materials, promoting environmental stewardship and the circular economy.

R&D and Re-use: Specific bridge elements were designated for research and re-use, showcasing the project's commitment to innovation. The deconstruction sequence ensured safe removal of these elements, facilitating the extraction of valuable materials for future projects and contributing to ongoing efforts in sustainable infrastructure practices.

As part of its intent to recognize the significant historic importance of the original Champlain Bridge, at special public events in September 2023, JCCBI distributed nearly 4,000 rivets salvaged from the bridge's steel structure. More than 400 steel components from this structure were repurposed when JCCBI launched its pan-Canadian competition to reuse materials from the original Champlain Bridge.

Protecting Air and Water Quality: To address air and water quality concerns, proactive measures were implemented. A dust management system with water misters on the main barge minimized dust during demolition. Captured water was treated before release, ensuring water quality remained uncompromised.

Efficiency Optimization: Through collaboration with contractors and jacking specialists, efficiency optimization of procedures cut the turnaround time for positioning, lifting, re-positioning, lowering, and deconstructing individual spans from 3 to 4 weeks per span to about 1 week, thus minimizing disruptive activities and their associated environmental impacts.

This project demonstrated a multifaceted approach to environmental sustainability, encompassing waste reduction, pollution prevention, efficiency optimization, and innovation. By integrating these principles into its operations, the project minimized its environmental impact while paving the way for more sustainable infrastructure practices in the future.

Above: mechanically deconstructing the spans, girders and piers piece by piece.
Below: Some of the more than 4,000 salvaged rivets.

Meeting Client Needs

JCCBI's project goals for the deconstruction of the Champlain Bridge were multifaceted, encompassing factors such as cost-effectiveness, schedule adherence, public safety, minimizing disruption to the surrounding community, and environmental sustainability. Harbourside, working collaboratively with NHSL, successfully met these objectives through a combination of innovative methods, meticulous planning, and effective collaboration with stakeholders.

Harbourside's innovative methods significantly reduced costs and streamlined the deconstruction process, optimizing efficiency without compromising safety or quality. By minimizing downtime and accelerating the timeline for each deconstruction phase, the project was completed within the allocated budget and timeframe.

Proactive measures to mitigate potential risks and minimize impacts on the navigational channel and infrastructure were implemented. Through meticulous planning and real-time monitoring of operations, potential hazards were effectively managed, and disruptions were kept to a minimum, enhancing safety and community satisfaction.

The client aimed to prioritize environmental sustainability by setting a target to recycle at least 90% of deconstructed materials, minimizing landfill-bound waste, and promoting resource conservation. Implementing careful deconstruction techniques ensured that materials were repurposed for future projects, thus contributing to the circular economy and environmental stewardship.

Through collaborative efforts and strategic planning, the deconstruction of the Champlain Bridge was executed efficiently, responsibly, and with care for both the client's priorities and the surrounding environment and community. In meeting JCCBI's project goals of cost-effectiveness, schedule adherence, public safety, minimizing disruption, and environmental sustainability Harbourside Engineering Consultants in collaboration with NHSL demonstrated commitment to excellence and innovation in engineering.

As part of JCCBI's research and development program, assorted components of the bridge, such as concrete panels, bearings and girders, were given to Canadian research entities. The 12 R&D projects will significantly advance industry knowledge about infrastructure performance and sustainability.

Below: The steel span anchor arm being deconstructed. Parts of the steel section of the bridge are being used by National Research Council Canada to complete investigation of the painting system used on the Champlain Bridge to assess its performance in corrosion prevention under different climatic conditions. This study will provide recommendations to increase the service life of the paint and prevent its premature failure.

All photos courtesy JCCBI.

Achievements

The Champlain Bridge deconstruction engineering project is an example of what can be achieved when sound knowledge of deconstruction engineering is paired with innovative design.

Harbourside worked in concert with NHSL to ensure JCCBI achieved its goal to successfully deconstruct the historic former Champlain Bridge through in-depth planning to minimize the impact on the environment and the public and to reuse the structure's leftover materials. Overall, 56 spans, 53 piers and 53 pier footings were deconstructed.

This project was completed two months ahead of schedule and within the initial budget of $225.7 million.

Post project view from Montreal looking at Brossard.

Pier 2W will be kept in the original alignment of the original Champlain Bridge on the St. Lawrence Seaway Dike.