

# RESEARCH AND DEVELOPMENT PROGRAM

## CHAMPLAIN BRIDGE DECONSTRUCTION



The deconstruction of the Champlain Bridge is a unique opportunity to significantly improve our knowledge of infrastructure performance and sustainability. After a competition among Canadian research bodies launched in June 2019, JCCBI selected ten projects that will be carried out during the deconstruction.

### Study of the Compressive Strength of Steel Truss Bridges Made of Assembled Parts

**+ Researchers:** Robert Tremblay (Polytechnique Montréal) / Nicolas Boissonnade (Université Laval)

**+ Research body:** Polytechnique Montréal

Older major steel truss bridges are made of chords consisting of assembled parts. Current standards do not account for the flexibility and strength of these connecting parts. This project aims to develop calculation methods to evaluate the compressive strength of these chords to determine their flexural and shear rigidity.

**+ Goals:** Reduce uncertainty during the evaluation of bearing capacity to better pinpoint rehabilitation strategies.

### Experiments and Design Guidelines for Repair and Strengthening of Steel Bridges Using Externally Bonded Lightweight High Modulus Carbon-FRP Plates

**+ Researchers:** Brahim Benmokrane (Université de Sherbrooke) / Omar Chaallal (École de technologie supérieure)

**+ Research body:** Université de Sherbrooke

Carbon fibre reinforced polymers (CFRP) are increasingly used to rehabilitate concrete infrastructure, but so far this material has not been used on steel structures. However, CFRP offer many advantages because of their high rigidity compared to more conventional methods (bolting and welding), and they are starting to be used to rehabilitate steel structures.

**+ Goals:** Study the feasibility of using CFRP to repair steel structures and develop analytical models to reliably predict the contribution of CFRP to strength, while estimating the service life of this type of reinforced steel components under cyclic fatigue loads.

### Performance Assessment of Painting Systems Applied to Steel Structures

**+ Researcher:** Nafiseh Ebrahimi (NRCC) **+ Research body:** National Research Council of Canada

The painting of steel bridges plays a significant role in preserving these structures against long-term corrosion. For this study, samples of steel components from the Champlain Bridge will be studied in the laboratory, while historical data on surface preparations, different types of paint, as well as climate conditions will be examined to understand long-term deterioration.

**+ Goals:** Assess the impact of complex parameters that have affected the performance of paint applied to the bridge and issue recommendations for improvements that are applicable to JCCBI's other steel structures and to the structures belonging to other managers.

### Advanced Techniques for Condition Assessment of the Champlain Bridge After 57 Years of Service

**+ Researchers:** Leonardo F.M. Sanchez and Beatriz Martin-Perez (University of Ottawa) **+ Research body:** University of Ottawa

To evaluate the performance of concrete structural components over their expected service life, effective and reliable tools are required to correlate reductions in the mechanical properties of used materials with structural consequences. For this project, advanced and non-destructive microscopic and mechanical techniques will be used to correlate the type and extent of damage of the affected material with mechanical and durability losses. Automated tools based on machine learning techniques under development will be applied to bridge components to increase the speed and accuracy of diagnosis of the affected structural components.

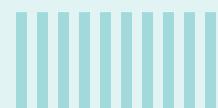
**+ Goal:** Increase the speed and accuracy of diagnosis of the affected structural components.

### Evaluation of the Real Condition and Mechanical Performance and Durability of Concrete Elements of the Bridge

**+ Researchers:** Benoît Fournier and David Conciatori (Université Laval) **+ Research body:** Université Laval

For the managers of civil engineering structures, diagnosing actual condition and future behaviour is a major challenge. This project aims to implement a multidisciplinary analysis of the condition assessment of concrete components of the bridge through destructive and non-destructive methods, with a focus on problems related to corrosion and alkali-aggregate reaction.

**+ Goal:** Better understand the influence of exposure conditions on the causes, magnitude, and mechanisms of degradation on different concrete structural components to better calibrate a predictive damage model.



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### Improvement of Hysteretic Behaviour of Fretted Elastomeric Bearings for Seismic Isolation of Bridges

**+ Researcher:** Lotfi Guizani (École de technologie supérieure) **+ Research body:** École de technologie supérieure

In areas with moderate seismic activity, such as most of Quebec, basic seismic isolation using fretted bearings appears to be an effective solution. However, the absorption rate from fretted bearings remains limited. An evaluation of the hysteretic characteristics of the bridge's fretted bearings under various load and temperature conditions will be carried out to develop avenues for improvement.

**+ Goals:** Efficiently improve the absorption rate of fretted bearings and study the long-term reliability of structures with a collection of behavioural data.

### Critical Analysis and Performance Monitoring of Surface Repairs of Concrete Elements

**+ Researchers:** Richard Gagné (Université de Sherbrooke) / Benoit Bissonnette (Université Laval)

**+ Research body:** Université de Sherbrooke

The different surface repairs of concrete elements applied to the bridge in recent years show varying levels of durability and behaviour. The project components include damage mapping, the sampling of different bridge elements, and laboratory characterization.

**+ Goals:** Evaluate the performance of surface repairs of concrete elements while accounting for repaired damage, the type of surface preparation, materials or products, deployment techniques and climate conditions.

### Evaluation of the Performance of CFRP Reinforcements and Development of a Model for Predicting Their Lifetime

**+ Researcher:** Radhouane Masmoudi (Université de Sherbrooke) **+ Research body:** Université de Sherbrooke

Carbon-fibre-reinforced polymers (CFRP) were widely used on the Champlain Bridge as a reinforcement technique. This project consists of an experimental program and laboratory tests to better understand bonding and fatigue properties while accounting for the phasing of the work performed on the bridge.

**+ Goals:** Assess the residual capacity of concrete components rehabilitated with this technique and study its durability by analyzing the level of degradation using prediction models.

### Assessment of Corrosion and Evaluation of the Degree and Distribution of Corrosion on Response of Girders

**+ Researcher:** Denis Mitchell (Université McGill) **+ Research body:** Université McGill

Evaluating the performance of prestressed girders that have degraded due to corrosion is a major issue. Some innovative exterior repair solutions used on the bridge's prestressed girders will be evaluated to confirm hypotheses.

**+ Goals:** Better understand the degradation process of prestressing cables due to external influences, the redistribution of loads between cables, and their performance in different states of degradation.

### Evaluation of the Residual Bearing Capacity of the Intermediate Slabs and Reinforcement with UHPC

**+ Researchers:** Jean-Philippe Charron and Mahdi Ben Ftima (Polytechnique Montréal) **+ Research body:** Polytechnique Montréal

Conventional tools currently used to assess the residual strength of deck slabs do not take into account the rapid failure of corroded reinforcements. This project will involve new condition assessment techniques and consist of an experimental program using the bridge's intermediate slabs in a realistic context.

**+ Goals:** Provide a complete solution that includes a theoretical and actual evaluation of the residual capacity of deck slabs as well as a sustainable reinforcement method with the use of ultra-high performance fibre-reinforced concrete (UHPC).

Together, we can  
advance innovation



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