


**Offering you**

Structural integrity monitoring

Detect, locate and quantify structural damage

Increase service life, decrease rehabilitation cost

# Technology-based Structural Integrity Monitoring

*Making bridges **safer** and **smarter** by combining sensors, A.I., and advanced data analysis to provide **accurate structural health monitoring**.*

**Sensequake** technologies alleviate the shortcomings of traditional SHM by coupling high-sensitivity vibration sensors with advanced data-driven structural analysis. This combination allows for **actionable insight** on overall bridge integrity.

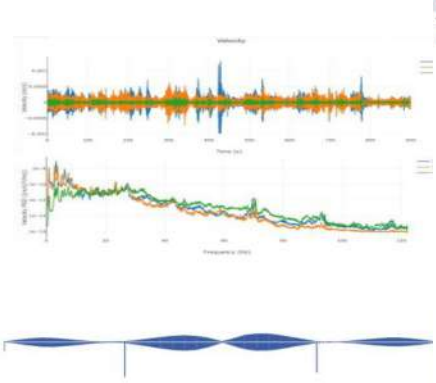
Detailed analysis is done on measured data to extract the dynamic properties of a bridge; its stiffness baseline. Changes in bridge integrity can be detected thanks to Sensequake's proprietary database of healthy and unhealthy bridge baselines – allowing damage to be **detected, located, and quantified**. The technological approach can be used for **damage caused both by aging or natural hazards.**

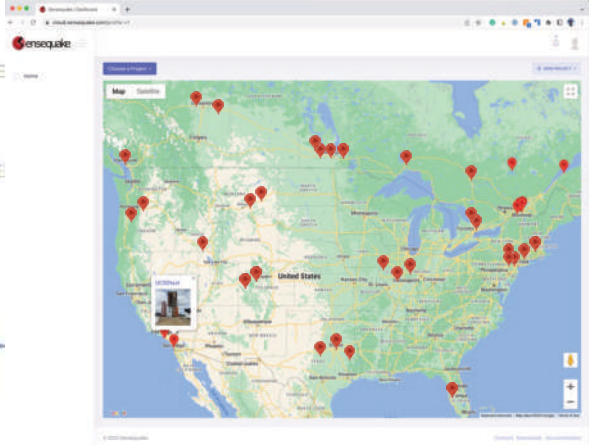
- Bridge integrity assessments based only on measured data from Sensequake's wireless sensors – **no drawings, material properties or finite-element models needed**
- Ambient vibration tests using wireless sensors deployed **only for a few hours during regular bridge traffic**
- Accurate as-is resonance frequencies, 3D-mode shapes and damping ratios (digital twin)
- **Detect, locate, and quantify anomalies or damage** in the foundation, piers, superstructure, and scouring ... from sensors **only** at the deck-level and Sensequake's proprietary database of bridges
- Mapping anomalies in the identified dynamic properties to the physical structure
- Periodic monitoring to determine the **rate of deterioration**

## SENSEQUAKE TECHNOLOGIES



SENSEQUAKE LARZE SENSORS



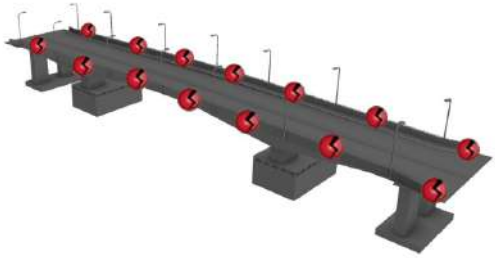


SENSEQUAKE WEB-BASED SOFTWARE

Wide range of technological solutions to monitor the structural integrity of bridges and increase their service life

# Technology-based Structural Integrity Monitoring

## STEPS FOR BASELINE INTEGRITY EVALUATIONS



Design of sensor locations



Rapid, on-site test



Data-driven structural analysis



Global bridge integrity evaluation

- If necessary, Sensequake ShakeLog permanent sensors can be installed:
  - Real-time tracking of bridge dynamic properties to follow structural integrity
  - Dual technology allows for fewer permanent sensors thanks to the initial temporary test
  - Send periodic and event-based reports automatically to a pre-defined list of recipients

Sensequake testing is being used worldwide by many Departments of Transportation and other bridge owners. Sensequake technologies and the combination of baseline tests and optimized health monitoring programs provide state-of-the-art SHM solutions to increase the service of bridges and reduce maintenance and rehabilitation costs.

**RAPID, NON-INTRUSIVE TESTING**

**DETECT, LOCATE AND QUANTIFY IMPORTANT DAMAGE**

**OPTIMIZED MAINTENANCE**

# SR46 over Whitewater River Bridge

## St. Leon, Indiana U.S.A.





## Project Specifications

**Client**

Indiana Department of Transportation

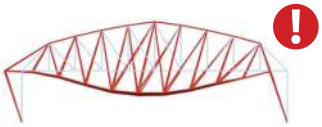
**Bridge Type**

Simply-supported Truss

**Configuration**

5 spans







Sensequake conducted a sensing-based integrity evaluation of a 90 year old, 5-span truss bridge in St. Leon, Indiana. The truss bridge is a fracture critical structure, with many instances of visible corrosion on various trussing members Through the baseline test of the bridge, Sensequake:

- Extracted the dynamic properties of each of the 5 spans (resonance frequencies, mode shapes, damping ratios).
- By taking advantage of Sensequake's database, the bearings, scouring, and corrosion impact on truss members' integrity were evaluated in detail.
- The results obtained helped INDOT in the next steps in the management and rehabilitation of the bridge.

## I65 Gateway Bridge
### Columbus, Indiana U.S.A.

Successful triage of hanger health & evaluation of rehabilitation performance



## Robert Stewart Bridge
### Columbus, Indiana U.S.A.

Successful triage of cable condition which could not be done visually



# Indiana Department of Transportation (INDOT)



*"INDOT has successfully implemented Sensequake's technologies on several bridges across the state. Their bridge rapid testing was done using wireless, synchronized sensors placed while traffic was maintained on the bridges. Sensequake's analysis did not require detailed structural drawings, destructive tests, or finite-element models.*

*Using their large database of healthy and unhealthy bridges, Sensequake conducted an advanced analysis on the overall structural integrity of the bridges. This allowed them to detect potential structural damage in different components such as the superstructure, bearings, and foundations and the effect of scour. A triage across each bridge was provided based on the relative levels of degradation observed through their test results.*

*The insight provided by Sensequake helped fill the information gap left by more widely used bridge management tools such as visual inspection and NDT practices and helped inform the next steps in the management of the assets."*



**Anne Rearick**

**Director of Bridge Management**

# Whitewater Cutoff Bridge

## Riverside, California U.S.A.





## Project Specifications

**Client**

County of Riverside / Caltrans

**Build year**

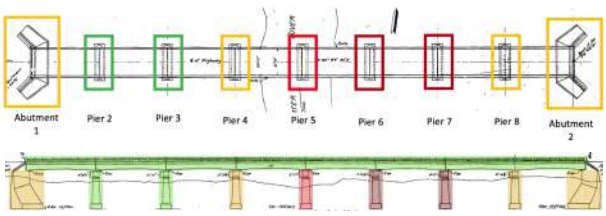
1923

**Length**

130 m - 430 ft

**Bridge type**

Concrete Girder Simply-supported Spans



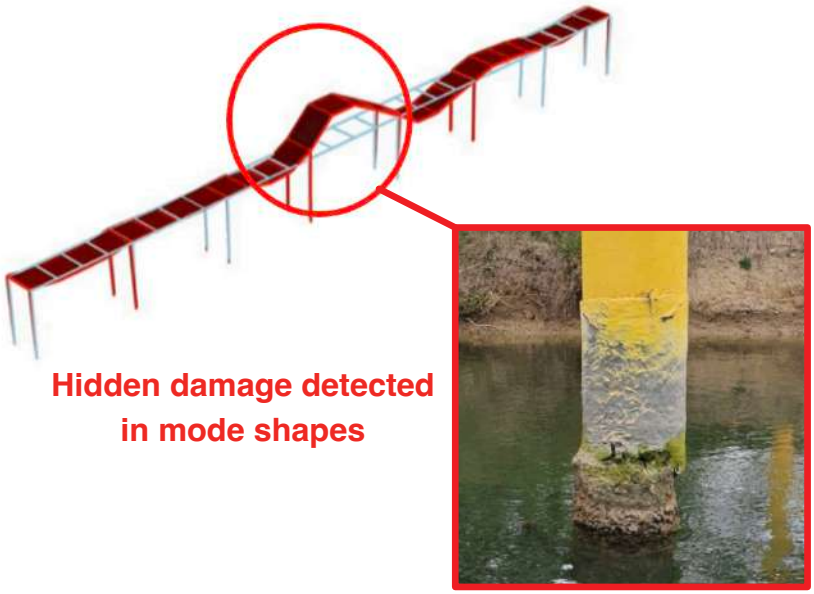

The Whitewater Cutoff Bridge is an over one-hundred-year-old historic bridge that crosses the Whitewater River. This river varies in flow depending on the season. Being the oldest bridge operated by the county, Sensequake was to test the bridge to:

- Determine the impact of scour on integrity by extracting bridge properties from a test done only at the deck-level and using Sensequake's proprietary database of scour-afflicted bridges.
- Conduct a comparative analysis across all 8 spans of the bridge.
- Color-code the structure based on the level of severity of scour across the structure, enabling the owner to prioritized and optimized the rehabilitation of the bridge.

# Frijolillo Bridge Damage Evaluation

## Tuxpan, Mexico





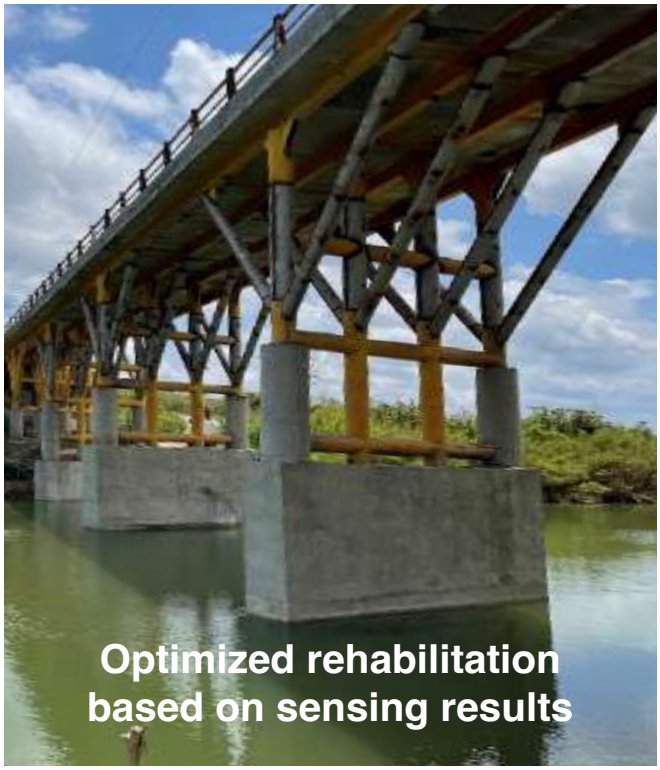
**Hidden damage detected in mode shapes**

*"The results provided by Sensequake's analysis were of great use. Through an in-depth comparative analysis with the results from the bridge and the Sensequake database of healthy bridge baselines, a lack of stiffness was identified.*

*By using Sensequake technology, damage was identified in the bridge supports entirely through the baseline analysis and deploying Larzé sensors on the deck-level. The bridge was recently reinforced with the objective of increasing the load capacity and mitigating the damage found"*



**Dr. Joel Martinez**
**Director General**
**MM Engineers SC**



**Optimized rehabilitation based on sensing results**

# The Jacques Cartier Bridge

## Montreal, Canada







## Project Specifications

**Client**
JCCBI (owner)

**Build year**
1930

**Length**
2.7 km - 1.7 mi

**Bridge type**
Cantilever

Sensequake monitored the Jacques Cartier Bridge during heavy construction near one of its critical piers. Three technologies were used to ensure integrity:

- Sensequake Larzé sensors were used to determine the stiffness properties of the pier pre-construction. The properties were extracted again after the construction, confirming that the integrity had been maintained.
- Sensequake sensors used to monitor the vibration amplitudes in real-time and notify the client via SMS and email if they passed any thresholds.
- Sensequake ShakeLog technology to track resonance frequencies and mode shapes in real-time to identify any anomalies rapidly during the monitoring period.

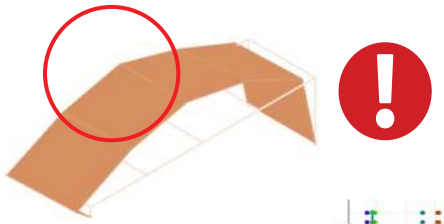
# Champlain Ice Control Bridge

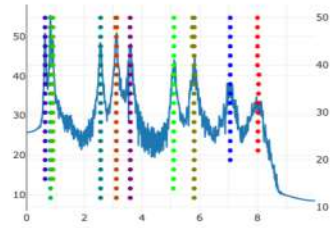
## Montreal, Canada



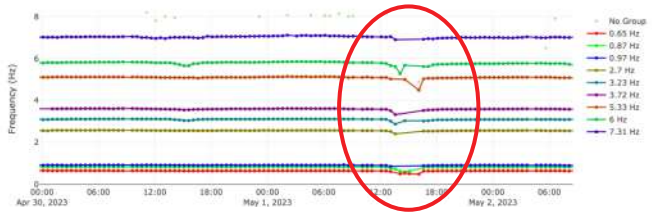
*"Sensequake's unique technology was able to provide the following added values:*

- *24/7 real-time monitoring*
- *AI-based analysis on the cloud to track stiffness properties*
- *Automated damage detection using Sensequake proprietary methodology*
- *Automated report generation "*





Tracked Mode Frequencies



**Ulysse De Wavrin**

**Former Engineer**
**Jacques Cartier and Champlain Bridges Inc.**

# Champlain Bridge
## Montreal, Canada



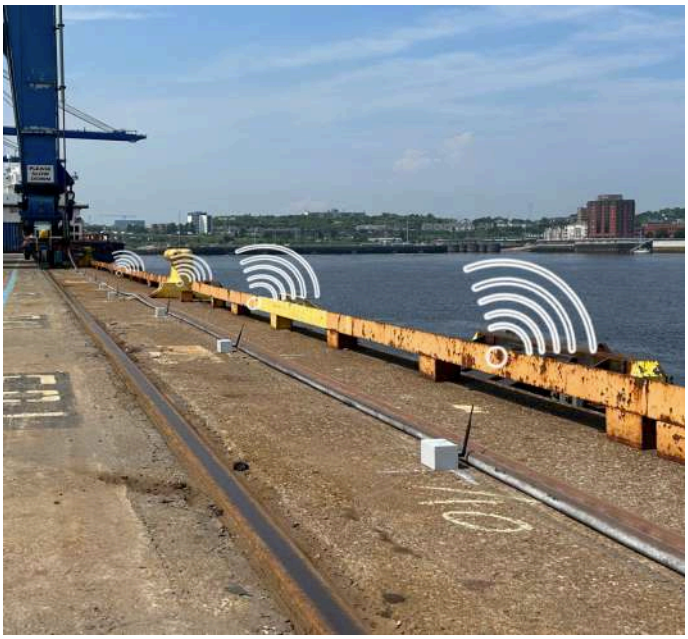
# High Level Bridge
## Edmonton, Canada





# Port of Long Beach
## California, U.S.A.





# Hugh John Flemming Bridge
## New Brunswick, Canada



# Thousand Islands Bridge

## New York, U.S.A.



# Ras Al-Khair Bridges

## Kingdom of Saudi Arabia





# Pointe Ellice Bridge Bridge

## Victoria, Canada



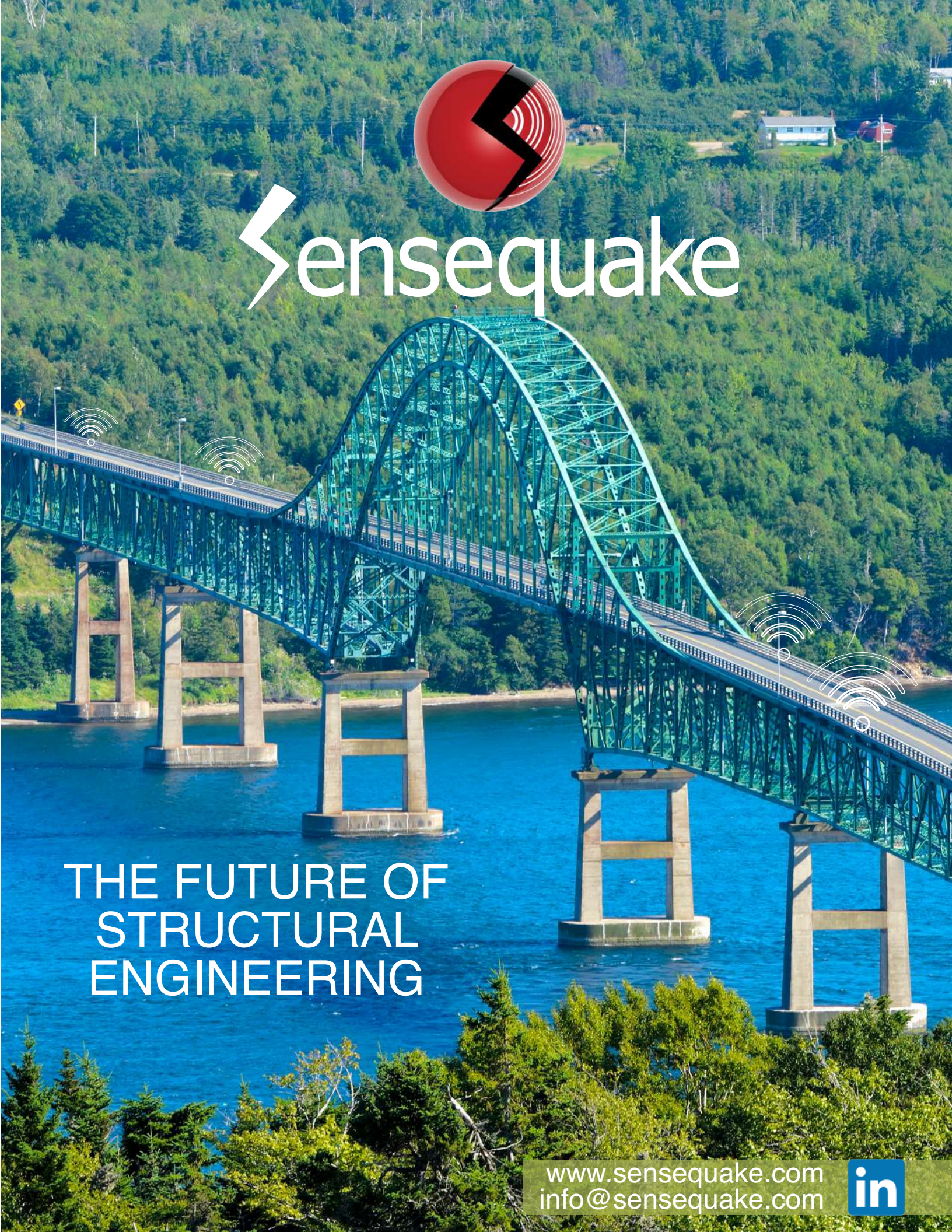
# Reversing Falls Bridge

## Saint John, Canada



# Sensequake Technologies being used Globally




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STRUCTURAL
ENGINEERING
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