A methodology for resiliency assessment of existing bridges – a study on a bridge from 1930

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Abstract

This paper introduces the methodology RWDI has developed, tested and consolidated over the years working in close collaboration with bridge designers, owners and operators, for the multi-hazard assessment of existing bridges and the ad hoc development of a structural health monitoring programme leading to enhanced resiliency. The work is highlighted through the presentation of a case study for a 2,725 m long cantilever bridge built in 1930. The dynamics of the structure in its current state were characterised and its capacity to today and future wind loading was assessed fully following the proposed methodology prior to the initiation of a structural rehabilitation program to extend the design life of the bridge beyond its 150th anniversary.

Keywords: bridge engineering; structural rehabilitation; structural health monitoring; wind loading.

1 Introduction

In the context of aging bridge infrastructure, intensification of vehicular traffic and uncertainties associated with climate changes there is a collective desire to hear that the bridges that are in use today are safe and will remain safe for an extended period of time or would need repairs to stay safe. This is the case everywhere in the world.

To respond to this demand, an evidence-based bridge asset evaluation approach was devised. It focuses on providing a nimble decision-making tool for bridge owners on issues related to the structural health of their bridges facing changing multiple hazards and the accumulation of years of dynamic loading. The multi-phase approach is illustrated in this paper and its strengths are highlighted through the presentation of a case study for a long-span cantilever steel bridge, the Jacques Cartier Bridge in Montréal, Québec, Canada.

The bridge has a main span of 334 m, an overall length of 2,725 m, and has provided a fixed link across the harsh climatic environment of the St-Laurent River since 1930. To guide the rehabilitation work to extend the life of the bridge up to its 150th anniversary, studies were carried out i) to understand the current state of the bridge and ii) to determine the risk profile of the structure to multiple hazards. These studies included site inspections, short-term ambient vibrations measurements, establishment of a calibrated finite-element model and a numerical model, wind-tunnel tests on scaled physical models, numerical simulations of the response to storm winds, and thorough evaluation of the remaining capacity of

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