Climate Resilience of Long-span Bridges through Early-stage Aerodynamic and Climate Consulting

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Abstract

Critical infrastructure, such as long-span bridges, is important for the sustainable economic development of society. The safety and serviceability of these structures is highly sensitive to wind hazards. Understanding the risks to the bridges from the wind is crucial to ensuring their resilience, particularly with the growing threat of climate change. In this work, the authors will present case studies demonstrating the benefits of early-stage aerodynamic and climate consulting in delivering climate resilience for new and existing long-span bridges. The assessment could enable structural engineers to refine wind loads for the design of new long-span bridges, reducing material usage and embodied carbon. For existing bridges, a better understanding of the current performance could lead to informed decisions on bridge rehabilitation for climate change adaptation, as part of effective asset management, to extend the service life of bridges and reduce user carbon.

Keywords: bridge aerodynamics; bridge rehabilitation; wind effects; carbon footprint; climate resilience.

1 Introduction

Bridges – in particular long-span bridges – are critical access to the transportation network. Under the growing threats of climate change, it is crucial to ensure the safety and serviceability of both new and existing bridge for the development of the economy and society, while reducing their environmental impacts.

Bridges are among the most capital carbon intensive elements of the transport infrastructure [1]. It is often related to investments required to ensure the structures meet usage demands and satisfy durability requirements against severe environment exposure. There is little opportunity to reduce operational carbon as the majority of such activities on bridges are independent of the structure itself. However, well designed and managed bridges could remain open during or could return to full operation shortly after extreme events. This helps reduce user carbon by limiting road traffic emission caused by longer journeys or travel time due to bridge closure. Also, well maintained bridges have prolonged service life and are capable of handling increased usage, without the need of constructing new crossings.

Unlike buildings which are typically designed for 50 or 60 years, bridges have a longer design life, up to a century or more. Bridges are there more likely to experience extreme environmental loads – including wind hazards which are predicted to be progressively more severe due to the impact of climate change.

In recent years and even more in the last three years, it has become apparent that aerodynamic studies targeting wind-related performance goals

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