Proceedings of the 10th International Conference on Civil Structural and Transportation Engineering (ICCSTE 2025)
July, 2025 - Imperial College London Conference Center, London, United Kingdom
DOI: 10.11159/iccste25.003

Climate Change Adaptation for Resilient Highway Bridges against Extreme Climate Events

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Abstract

Climate change poses a formidable challenge to global public infrastructure, particularly impacting the structural integrity and resilience of highway bridges. With anticipated increases in temperature, precipitation, and shifts in wind patterns, alongside more frequent and severe extreme weather events like heatwaves, storms, and floods, these infrastructures face risks for which they were not originally designed. The combined effects of climate change, including increased temperatures, wind, and scour, are expected to significantly affect the safety, serviceability, and lifespan of highway bridges, especially as existing structures continue to age and deteriorate. In Canada, corrosion has been identified as the most pervasive and costly issue affecting both reinforced concrete (RC) and steel bridges over the past fifty years.

The interaction of corrosion, traffic loads, and elevated climate loads due to climate change can severely diminish the stiffness and load-bearing capacity of bridge components, potentially leading to catastrophic brittle failures with little warning. The surrounding environment, influenced by factors such as de-icing chemicals, seawater CO2 concentration, and increased precipitation, can further accelerate corrosion-induced damage, leading to cracking, spalling, and delamination. These conditions necessitate more frequent inspections, maintenance, repairs, and the implementation of strengthening strategies as part of comprehensive rehabilitation and climate adaptation efforts.

This keynote presentation highlights findings from a major research initiative led by the NRC Canada in collaboration with three Canadian universities. The project investigates the impact of climate change on existing bridges and informs the design of new infrastructure. It is structured into three main thrusts: Thrust I examines the structural performance and resilience of existing bridges under changing climate loads, utilizing numerical and simplified analytical models validated by experimental data. Thrust II explores the implications of climate change and extreme weather events on bridge design, with a focus on the most prevalent bridge types, and, Thrust III extends the research from Thrust I, focusing on rehabilitation and retrofit strategies for existing bridges to better withstand relevant climate loads.

By addressing these critical areas, the project aimed to equip researchers and structural engineers with insights and tools necessary for designing and adapting infrastructure in the face of climate change, ensuring safety and sustainability for future generations.

Keywords: aged box-girder bridge, extreme loads, corrosion damage, and structural performance evaluation of aging bridge elements

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