Deep Learning Based Framework for Long-term Management of Bridges Considering Climate Change Effects

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1 Abstract

Hydraulic-related hazards (e.g., flood and scour) are recognized as the leading stressors that threat the safety of bridges during their service life. In addition, climate change has been recently recognized as a significant factor that can drive changes to the frequency and intensity of hydraulic-related hazards. Consequently, current design, management, and decision-making methodologies should adapt to these changes to ensure the satisfactory performance of bridges under these hazards. This paper presents a multi-hazard probabilistic framework that can help bridge officials and decision makers to establish flood fragility curves with respect to service life and variability of the future floods. In this paper, downscaled climate data, adopted from the global climate models, are employed to predict future flood hazards at a given location. Time-variant scour depth profiles based on the predicted streamflow data are then estimated and used to predict the future condition of the bridge. Deep learning networks and finite element modeling are then employed to quantify the structural performance of the investigated bridge under applicable hazards. The proposed framework is illustrated on an existing bridge in Oklahoma.

Keywords: Deep learning, Scour, Climate Change, Flood Fragility.

2 Introduction

Overtopping, erosion of bridge approaches, failure due to direct water pressure, and debris impacts are failure mechanisms that flooding may cause. In addition, the reduction in buckling capacity and lateral load resistance of bridge footings due to scour can lead to bridges that are more vulnerable against floods or other extreme events such as earthquake and traffic overloads. Accordingly, several studies (e.g., [1] and [2]) have focused on developing methodologies to predict the behavior of bridges under scour. Other studies investigated the combined effects of scour and other extreme events such as earthquake excitations and traffic over loads (e.g., [3] and [4]). However, none of these studies have considered the effects of climate change on future flood and scour hazard occurrence using proper climate modeling, streamflow modeling, and scour analysis.

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