Resilience Quantification Based on Monitoring & Prediction Data Using Artificial Intelligence (AI)

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Abstract

Lately, there is an increasing demand for resilient infrastructure assets. To support the documentation of resilience, Structural Health Monitoring (SHM) data is a necessity, as well as traffic loads. Those diagnosis and function data can be the basis for the prognosis of future prediction for the performance of the assets. Towards this direction, this paper develops a new methodology that uses real monitoring data and Artificial Intelligence (AI) algorithms to quantify the resilience based on future traffic load predictions of functionality. It includes the case study of the "Hollandse Brug" bridge in the Netherlands considering strains and traffic load predictions and other external. Resilience is derived as a function of both functional and structural parameters throughout the lifecycle. The quantification is supported by sustainability indices and key performance indicators representing the traffic flow, the structural integrity and the sustainability level of the asset.

Keywords: resilience; bridges; artificial intelligence; machine learning; structural health monitoring; traffic.

1 Introduction

Critical Transport Infrastructures (CTIs) such as highway Reinforced Concrete bridges (RC) have a crucial socio-economic impact [1],[2]. The ageing RC bridges are deteriorated by diverse stressors, e.g. increased traffic load, corrosion and multiple hazards, e.g. extreme temperatures, seismic events, floods [1],[2]. Therefore, maintenance and retrofitting measures are necessary to ensure the asset's safety [3]. Though, according to the European Union (EU) Road Federation, the maintenance of damaged CTIs due to natural hazards is significantly expensive and reaches approximately €20 billion per year [4], accompanied with bridges' disruption and further economic losses [2],[4].

The adaptation of the decaying highway RC bridges to the ever-changing environment and increased traffic demands are incorporated into the concept of the forthcoming EU Adaptation Strategies [5]. In particular, the main goal of the new strategies is to guarantee the resilience of CTIs, especially to climate change [5],[6].

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