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Risk and resilience of bridgeworks exposed to hydraulic hazards

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1 Abstract

Transportation infrastructure is a pylon for the society and economy, enabling the services and transportation of goods, under normal and emergency circumstances. Bridgeworks act as bottlenecks within road and rail networks and their failures due to e.g. floods, cause disproportionate losses, which are expected to be exacerbated due to climate change. Thus, pinpointing the vulnerabilities and quantifying the resilience of bridges within transportation networks exposed to hydraulic hazards is of paramount importance. However, reliable quantification of risk and resilience of flood-critical bridges is not yet available, as there is a lot of engineering guesswork for qualitative assessments. This paper describes a new integrated framework for the resilience assessment of bridgeworks and networks subjected to hydraulic hazards such as scour, debris flow and hydraulic actions. An overview of the critical hydraulic hazards, and the evaluation of their intensity measures based on regional and site-specific approaches is provided in the paper. The framework also includes vulnerability models for bridges for the evaluation of direct losses, i.e. physical damage, as a means to deliver the quantitative risk assessment (QRA) of the exposed bridgeworks and networks. The second component of the resilience framework is the restoration and reinstatement models, which are expressed by practical restoration times and tasks. Toward this end, this paper summarises an on-going comprehensive survey, which aims to elicit knowledge from experts, in an effort to develop restoration models for bridges exposed to floods. The framework is a useful tool for allocating the resources reasonably toward efficient management and consequence analysis on a network level.

Keywords: bridges; network; transport; infrastructure; fragility; risk; resilience; flood; scour; assessment

2 Introduction

Flooding is the greatest risk to infrastructure assets and to bridges all over the world. The cause that accounts for the largest percent of recorded bridge failures is of hydraulic nature, and in particular scour (S) that is triggered by floods, debris accumulation (D) and hydraulic forces (F), which may be exacerbated due to climate change [1]. Based on a record of scour-induced bridge failures spanning over 173 years, it is estimated that the annual probability of failure is 27%, i.e. one out of three bridges crossing watercourse might be damaged due to flood [2]. There has been extensive research on hydraulic actions (SDF) to transport infrastructure, including numerical [3][4], experimental [5] and monitoring [6] efforts.

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