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Forensic Quantification of Fire on Suspension Bridges

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ABSTRACT

Suspension bridges generate critical transportation and trade links in areas requiring the spanning of large obstacles. Such structures are, by nature of their scale, highly utilized and rarely redundant from a transportation network perspective. As such, the reliable maintenance of long-span bridges is of eminent importance. Various hazards have been well-quantified, namely earthquakes, high wind events, and, more recently, corrosion to critical structural members. However, to date, the hazard of fire on suspension bridges, stemming both from the environment (e.g. wild fires) or vehicles (e.g. car and truck fires), remains poorly understood. Building codes consequently fail to address this hazard, on both the load and resistance sides of the equation. We present here a thorough survey of suspension bridge fire incidents in the United States of America, focusing specifically on parameters such as location, duration, intensity, height of the fire and damage caused thereby. The data integrates often sparse event logs of bridge owners with forensic analyses of the various events using photogrammetry and videogrammetry of professional and social media footage. The incidents are then categorized with respect to the danger posed to the structure. A set of case studies are presented to detail the investigation method. The goal of the final database is to effectively quantify the hazard of fire on suspension bridges such that appropriate actions may be taken by owners and authorities to protect their infrastructure.

Keywords: fire hazard, forensic, main cable, damage, suspension bridge

1 INTRODUCTION

The challenges inherent in the operations and maintenance of long-span bridges are generally well-studied, specifically as they pertain to the safety of major infrastructure against earthquakes, wind, and material degradation (corrosion). The two former hazards have been captured effectively in the prevailing building codes on a global scale. Earthquakes, somewhat surprisingly, present the most predictable hazard as their well-established historical quantification remains accurate to this day. In light of climate change, extreme weather events, well-quantified in past decades, must be reassessed as the hazards due to hurricanes, tornadoes, and other high-wind events are rapidly evolving. The latter, corrosion, has also received considerable attention in the recent past from works by Noyan et al. (2010), Mei at al. (2013), Betti et al. (2016), Karancı at al. (2018), and Brügger at al. (2015, 2017, 2019, 2022).

Beyond the abovementioned hazards, however, remains a largely uncaptured quantity: fire. Unlike structures susceptible to chimney effects (i.e. tunnels and overpasses), fire has been largely

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