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Woody debris trapping phenomena evaluation in bridge piers: a Bayesian perspective

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Abstract

A flood occurs when water and other materials such as woody debris overflow dry areas. If there is infrastructure present, woody fragments could be transported downstream and eventually trapped, leading to increments in the hydrodynamic forces over, say, a bridge. Moreover, local scour can be developed in the structure piers. The purpose of this research is to investigate the bridge pier scour phenomena induced by woody debris from a probabilistic point of view. A Non Parametric Bayesian Belief Network comprising seven nodes has consequently been developed. They are: water level, Froude number, blockage amount, drag force, scour depth, damage and overturning. Through both Monte Carlo Simulation and data from a real structure, the nodes' non parametric probability distributions have been established, an area that has, to date, received very little attention in the literature. By combining the variables under study, it was possible to determine their interaction and dependencies, showing that the depth of the approaching flow is correlated with two nodes: damage and overturning. The results are useful for bridge managers willing to rank investments in maintenance actions within the industry, and to develop optimal risk based strategies for efficiently employing the scarce resources used to that end.

Keywords: Bayesian Net; bridge; damage; pier; scour; model; non-parametric; overturning**.**

Introduction

Bridge piers placed in rivers are exposed to hazards that can result in fatalities and serious material damages. One of these exposures is related to impeding the water to flow naturally below the infrastructure, leading to increments in the hydrodynamic forces. The resultant hydraulic interactions with the bed river in turn, result in the scour deterioration process.

During flood events, sediments and woody fragments transported in rivers could be trapped. This accumulation of debris at piers can adversely affect the functionality of the structural elements. More specifically, there are two effects: (a) an increase in the hydrodynamic forces due to the change of the effective area of the respective component (Parola 2000), and (b) a reduction of the flow area which enlarges the flow velocity and bed shear stresses, developing scour (Lagasse 2010).

Bridge failures, such as the collapse of a structure over the Great Miami River in Ohio in 1989 (Parola 2000), have occurred as a consequence of drift storage. A comprehensive investigation

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