Reliability of bridges considering the effect of local scour

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Abstract

Aging infrastructure is becoming a major concern in the engineering practice, thus, there is a need for the development of a suitable reliability-based analysis of aging bridges subjected to scour hazard. This paper proposes such analysis based in a time dependent stationary deterioration process for the scour demand and a random independent variable for the bridge foundation capacity. Reliability is computed using direct integration for discrete times. Based on the results, an exponential function is proposed to estimate the decrease in reliability due to the accumulation of scour around a bridge pier through time.

Keywords: reliability; scour; bridge engineering; stochastic analysis

1 Introduction

Scour is the most frequent and leading cause of bridge failures in Mexico [1-2]. Bridges of shallow foundation are very common and often ignored after major scouring events; it is unlikely that this trend will change in the near future. Thus, an effort must be made to update the decision-making aspects and prioritize the scarce funds invested in bridge maintenance. In this paper we present a case study aimed to develop a stochastic reliability analysis of bridges in Mexico.

To better understand the scour accumulation problem, we use a state-of-the-art analysis of stochastic reliability and compare it with the state of the current practice in bridge scour analysis. Previous research proposed a stochastic formulation for time dependent scour [3-4]. However, because the large dispersion observed since the dispersion in the results obtained is large, more research is needed to calibrate such formulations

Reliability can be obtained if the probability distribution functions that characterize the demand and capacity of a structure, are available [5]. Time-dependent reliability is aimed to verify that the demand will not exceed the capacity through the designed life time of the structure [5]. The probability distribution function that characterizes scour is hard to obtain and is often based on incomplete or imprecise information [6]; previous research addressed this issue [1] as well as other common uncertainties in the derivation of the probability distribution function of the demand.

Foundation depths for small bridges are usually designed to withstand the maximum scour for a given return period. In Mexico, a 100-year return period flood is used for the scour estimation of non-essential bridges; since there is not a local code that stablishes a methodology for the scour estimation, HEC 18 equations [7] are often used. However, this methodology is based on the premise that a high return period flood is sufficient to cause the maximum probable scour depth during the bridge service life [8]; this approach considers a single scouring event. As mentioned, in Mexico, bridges are not promptly repaired after scouring events, even though some small bridges are left without proper maintenance for several years. This paper investigates bridges as a deteriorating structure subjected to multiple events of scour without any maintenance. Point

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