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Bridge scour monitoring: challenges and opportunities

Mohammed Farooq, Nemkumar Banthia

The University of British Columbia, Vancouver, BC, Canada

Faezeh Azhari

University of Toronto, Toronto, ON, Canada

Contact: farooq@alumni.ubc.ca

Abstract

Scour and related hydraulic causes have been identified as the reason for almost 60% of over-water bridge failures in the United States. Hundreds of millions of dollars have been spent in direct repair costs. With increased frequency of flooding due to erratic rainfall patterns, scour-related damage to bridges is expected to increase. In the last few decades, several periodic and real-time scour monitoring systems have been developed. This state-of-the-art review introduces various contact and non-contact methods of bridge scour monitoring along with their strengths and limitations. Next, the challenges in installation and performance of some of the scour monitoring techniques in field applications are discussed. Indirect methods of monitoring bridge scour based on ambient and forced vibration analysis of the structure are also reviewed. Finally, the paper also provides some thoughts on novel methods of conditions assessment hitherto not tried for scour monitoring.

Keywords: Structural health monitoring, sensors, bridge Scour, hydraulic, condition assessment

1 Introduction

The average age of America's 607,380 bridges is 42 years, out of which 11% are structurally deficient and another 14% are functionally obsolete (1). The scenario in Canada is not different. As of 2006, Canada's infrastructure deficit was C$125 billion (2), of which about C$22 billion was in the area of deteriorating transportation assets (3). About 59% of Canada's infrastructure is over 40 years old (3). Technology Roadmap also reported in 2003 that Canada's public infrastructure has used up 79% of its service life (3). The ageing infrastructure not only is a huge economic burden, but also poses major risk to a catastrophic failure that could lead to human casualties. One of the recent examples is the partial collapse of the 116 year old Bonnybrook Bridge in Calgary in 2013 due to floods. In spite of periodic monitoring numerous times a day since flooding began, the dismal state of the bridge foundations was not recognized (4). Erosion of the river bed around the foundations caused by unprecedented flooding was recognized as the reason for the collapse. Scour is the engineering term for the removal of bed-material around an obstruction such as a bridge foundation, pipeline, or an offshore structure. Local scour around bridge piers is a result of horseshoe and wake vortices caused by changes in flow pattern.

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