

Reliability-based condition assessment of a deteriorated concrete bridge

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Abstract. In the existing bridge management systems, assessment of the structural behavior is based on the results of visual inspections in which corresponding condition states are assigned to individual elements. In this process, limited attention is given to the correlation between bridge elements from structural perspective. Also, the uncertainty of parameters which affect the structural capacity is ignored. A system reliability-based assessment model is potentially an appropriate replacement for the existing procedures. The aim of this research is to evaluate the system reliability of existing conventional Steel-Reinforced bridge decks over time. The developed method utilizes the reliability theory and evaluates the structural safety for such bridges based on their failure mechanisms. System reliability analysis has been applied to simply-supported concrete bridge superstructures designed according to the Canadian Highway Bridge Design Code (CHBDC-S6) and the deterioration pattern is achieved based on the reliability estimates. Finally, the bridge condition index of an old existing bridge in Montreal has been estimated using the developed deterioration pattern. The results obtained from the developed reliability-based deterioration model and from the evaluation done by bridge engineers have been found to be in accordance.

Keywords: bridge; reliability; deterioration; conventional steel-reinforced deck

1. Introduction

Civil infrastructures, specifically those in public transportation systems, have been subjected to deteriorating conditions such as aging, fatigue, corrosion, inadequate maintenance and special loading patterns (increasing load spectra). Therefore, they should be inspected and monitored regularly and should be rehabilitated whenever they fail to satisfy appropriate performance levels or required to conform to the latest code or standard (Huffman *et al.* 2006). Inspection, structural health monitoring, damage detection and condition assessment of a bridge constitute a fundamental and critical task in bridge management systems. There has been a significant progress in the areas of structural health monitoring, non-destructive evaluation and automated condition

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BMS	Bridge Management Systems
BCI	Bridge Condition Index
P_f	Probability of Failure
β	Reliability Index
C_s	Surface Chloride Content of Concrete
D_c	Effective Chloride Diffusion Coefficient of Concrete
C_{th}	Chloride Threshold of The Reinforcement
λ	Corrosion Rate of Steel Reinforcement
R	Deck Resistance
Q	Bridge Loading
CI	Condition Index
t_s	Time to Spall
f_y	Yield Strength of Steel reinforcement
E_s	Modulus of Elasticity of Reinforcing Steel
f'_c	Compressive Strength of Concrete
E_c	Modulus of Elasticity for Concrete