Time-variant reliability analysis of RC bridge girders subjected to corrosion – shear limit state

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Abstract

Chloride induced corrosion of reinforced concrete (RC) bridge girders has led to huge loss of national resources. One of the important concerns of RC bridge girders is corrosion of stirrups, because of which, failure mechanism can even change from a ductile flexural mode to a brittle shear mode. Hence, analysis of reduction of shear capacity with time is essential in their reliability assessment, which is the topic of the paper. This paper proposes a stochastic modeling approach for estimation of time-variant shear capacity and reliability within the framework of Monte Carlo simulation, which assists in sustainability-based service-life design of bridge girders. Such modern concepts of design require methodologies for estimating whole life cost at the design stage itself. Development of such methodologies would provide the designer various options to arrive at optimum design having desired performance level during the service life. The proposed approach takes into account: 1) randomness in basic variables, 2) effect of micro-environment and spatial variation of corrosion, 3) number of stirrups resisting web shear failure, and 4) ductile to brittle transition of stirrup steel with corrosion propagation. Incorporation of this transition is found to have significant influence in the time-variant reliability of the girder. Though PFA concrete is known to have better durability characteristics than OPC concrete, this paper gives a framework for its quantification in terms of time variant reliability.

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