Stochastic degradation model analysis for prestressed concrete bridges

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Abstract

Bridges in the road infrastructure represent a critical and strategic asset, due to their functionality, is vital for the economic and social development of the countries. Currently, approximately 50% of construction industry expenditures in most developed countries are associated with repairs, maintenance, and rehabilitation of existing structures, and are expected to increase in the future. In this sense, it is necessary to monitor the behaviour of bridges and obtain indicators that represent the evolution of the state of service over time.

Therefore, degradation models play a crucial role in determining asset performance that will define cost-effective and efficient planned maintenance solutions to ensure continuous and correct operation. Of these models, Markov chains stand out for being stochastic models that consider the uncertainty of complex phenomena and are the most used for structures in general due to their practicality, easy implementation, and compatibility. In this context, this research develops degradation models of a database of 414 prestressed concrete bridges continuously monitored from 2000 to 2016 in the state of Indiana, USA. Degradation models were developed from a rating system of the state of the deck, the superstructure, and the substructure. Finally, the database is identified and divided from cluster analysis, into classes that share similar deterioration trends to obtain a more accurate prediction that can facilitate the decision processes of bridge management systems.

Keywords: Degradation models; Markov chain models; Prestressed concrete bridges; Cluster analysis.

1 Introduction

Bridges represent an important role in the economy of any nation and conform a pilar to support the transportation of goods and services enhancing the efficiency of the transportation system. According to the 2017 Infrastructure Report Card, the United States has 614,387 bridges, of which 9.1% are classified as structurally deficient [1]. To maintain the nation's bridges at reasonable health, the report estimated that an amount of $123 billion is required, where close to 40% of the bridges are over 50 years old, more of the average design-life of that kind of structures [1].