Development of a Road Maintenance Optimization Model Through A Continuous-Time Semi-Markov Process

Hui Gao

Department of Civil and Environmental Engineering, The Hong Kong University of Science and Technology, Hong Kong, China. E-mail: kohii@ust.hk.

Keywords: *Road maintenance; Optimization; Semi-Markov process.*

Abstract

Optimization models are necessary for efficient and cost-effective maintenance of a road network. In this regard, road deterioration is commonly modeled as a discrete-time Markov process such that an optimal maintenance policy can be obtained based on the Markov decision process, or as a renewal process such that an optimal maintenance policy can be obtained based on the renewal theory.

However, the discrete-time Markov process cannot capture the real time at which the state transits while the renewal process considers only one state and one maintenance action. Moreover, the downtimes of maintenance usually are neglected in current optimization models, which may be not practical in the actual maintenance practices.

In this paper, the deterioration of a road segment is modeled as a continuous-time semi-Markov process in which the state transition holds a Markov property and the holding time in each state is assumed to follow a continuous triangular distribution. Based on this semi-Markov process, both the duration of a road segment deteriorating from one state to a lower state and the downtimes of maintenance actions can be modeled such that the real time points of state transitions can be captured. That is to say, the maintenance model can predict the real time points of various maintenance actions for individual road segments.

In order to derive optimal maintenance policies to minimize the life-cycle cost of a road network, the optimization models are formulated in terms of the linear programming, which is practical for the maintenance of a road network having a large number of road segments and that they are convenient to incorporate various constraints on the decision process, for example, performance requirements and available budgets.

References

Zhang, X. Q. & Gao, H. (2010), Optimal performance-based building facility management, *Computer-Aided Civil and Infrastructure Engineering*, 25(4), 269–84.

Zhang, X. Q. & Gao, H. (2011), Determining an Optimal Maintenance Period for Infrastructure Systems, *Computer-Aided Civil and Infrastructure Engineering*, Accepted.

Zhang, X., and Gao, H. “Road maintenance optimization through a discrete-time semi-Markov decision process.” *Reliability Engineering and System Safety*, review in progress.