Maintenance Planning for Deteriorating Bridges Using Preference-based Optimization Method

Sun-Young Lee
Ph.D. Student
Seoul National University
Seoul, Korea
sylee@sel.snu.ac.kr

Hyun-Moo Koh
Professor
Seoul National University
Seoul, Korea
hmkoh@snu.ac.kr

Wonsuk Park
Senior Researcher
Seoul National University
Seoul, Korea
wpark@sel.snu.ac.kr

Sung Woo Lee
Professor
Kookmin University
Seoul, Korea
swlee@kookmin.ac.kr

Hyun-Joong Kim
Master Course Student
Seoul National University
Seoul, Korea
hjkim@sel.snu.ac.kr

Summary

A new method is presented to determine maintenance actions and schedule for deteriorating bridges. The maintenance planning of deteriorating bridges is formulated as multi-objective optimization problem that treats the maintenance cost as well as the condition grade of the bridge deck, girder and pier. To effectively address the multi-objective optimization problem and decision making process for the obtained solution set, we adopt a preference-based optimization model and apply a genetic algorithm as a numerical searching technique. The effectiveness of the proposed method is verified numerically on a typical prestressed concrete girder bridge. The optimal sequence and schedule of maintenance actions such as repair, reinforcement and rebuild are determined by the proposed method. To model the deterioration process of the bridges, actual condition grade data in Korea is used.

Keywords: Bridge maintenance planning; preference-based optimization; genetic algorithm.

1. Introduction

Most of the bridge maintenance planning methods target essentially the minimization of the maintenance cost of deteriorating bridges while imposing constraint on structural performances [1, 2]. However, structural performances are of critical importance in the bridge maintenance planning and the single optimal maintenance solution may not necessarily meet a bridge manager's specific requirements on the lifetime bridge performance. Several researches have shown that both the cost and the bridge performance could be treated simultaneously by the multi-objective or min-max optimization problem formulation. Liu et al. [3] minimized both maintenance cost and a normalized weighted average deterioration measure for maintaining the bridge deck. Miyamoto et al. [4] investigated optimal maintenance of existing bridges by minimizing maintenance cost and maximizing bridge load-carrying capacity as well as durability. Furuta et al. [5] simultaneously considered minimization of life-cycle cost, maximization of service life, and target safety level for maintaining civil infrastructures systems. Liu et al. [6] simultaneously optimized the structure condition, safety and cumulative life cycle maintenance cost. However, due to the nature of the multi-objective optimization problem, a decision making process is always needed to determine an optimal maintenance planning and it is sometimes very hard to choose the optimal one from the solutions set that may be composed of hundreds possibilities.

In this study, we present a new method to determine an optimal maintenance planning of deteriorating bridges. The problem is formulated as the multi-objective optimization problem that treats the maintenance cost as well as the performance of the bridge including condition grade of the bridge deck, girder and pier. To effectively address the multi-objective optimization problem and decision making process for the obtained solution set, we adopt a preference-based optimization model [7, 8] and apply a genetic algorithm as a numerical searching technique. Optimal maintenance solution is derived based on the preference of the bridge manager such as the

https://doi.org/10.2749/222137807796157977