Statistical Deterioration Prediction Model for Individual Infrastructure Considering its Heterogeneity

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Summary

The deterioration processes of civil infrastructures are heterogeneous due to unobservable factors even under the same structural and environmental conditions. In this paper, a Markov hazard model is formulated to characterize the average hazard rates, and is extended to a mixed Markov hazard model by incorporating the heterogeneity in hazard rates. By doing so, the benchmarking model to express the average deterioration processes and the statistical methodology for comparative assessment of the hazard rates of the individual facilities is also presented. The applicability of the methodology presented in this paper is examined against the actual visual inspection data concerning the bridge members.

Keywords: Relative evaluation; asset management; mixed Markov hazard model; bench marking

1. Introduction

Recently, the studies regarding the statistical deterioration prediction method based on visual inspection data have been accumulated (Kobayashi and Ueda). The statistical deterioration prediction method is to model regularity existing behind the deterioration process from an enormous amount of information on deterioration. Especially, through the development of a Markov deterioration hazard model (Tsuda et al.) (hereinafter abbreviated as “Markov deterioration model”), the precision of estimating Markov transition probability and the applicability into actual data have been improved. Furthermore, an asset management system mounted with the Markov deterioration model was established (Aoki et al.), and it was verified that it is possible to provide useful information for strategic decision making for asset management.

In general, the deterioration process of civil structures varies broadly according to the environmental conditions and the quality of construction work, even if the structural and material characteristics and usage conditions are the same. In some cases, technological innovation triggered the extension of lifespan of civil structures, and led to the reduction of lifecycle costs. In such circumstances, there is a growing demand for management technology for improving the quality of civil structures and reducing lifecycle costs continuously. In order to achieve such managerial goals, it is necessary to specify a bench marking deterioration curve that represents the average lifespan of civil structures and standard deterioration processes when structural and material characteristics are given, and conduct the relative evaluation of the lifespan and deterioration speed of target civil structures. If it is found from the result of the relative evaluation that deterioration speed is significantly high, it will become indispensable to seek the cause of deterioration.

The Markov deterioration model can collect an enormous amount of deterioration information and use the structural characteristics and environmental conditions unique to structures as explanatory variables, and so it is possible to carry out deterioration prediction for individual structures. However, when the heterogeneity of the deterioration process of civil structures is represented by explanatory variables, the number of explanatory variables increases inevitably and the explanatory

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