Damage Initiation and Propagation Model for Bridge Members

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Abstract

In this paper, in order to statistically analysis damage to bridge members and to forecast the initiation and the propagation of damage, a statistical damage initiation and propagation model is proposed. Specifically, the model is a composite model that the initiation process of damage and the propagation process of damage are expressed by different two types of model. When composing such a composite model, it is necessary that the time point of the transition from the initiation process to the propagation process. The time point is certain that the time point of the damage occurrence, however, the damage occurrence is not observed in general inspection works. Therefore, it is also proposed that the estimation method of the time point of damage occurrence, using the temporal discontinuity inspection data to bridges. Lastly, in order to confirm the validity of this study, an empirical analysis is carried out by applying actual inspection data.

Keywords: statistical model; deterioration model; hazard model; Bayesian estimation; Markov chain Monte Carlo method; Metropolis-Hastings algorithm; steel bridges; big data analytics; risk assessment; asset management;

1 Introduction

In order to forecast damage initiation and propagation (DIAP) to bridge members some methodologies have been established in existing studies. One kind of them is an analyzing method of inspection data that is acquired in inspection works to bridges. Among them, Madanat et al. have proposed a statistical model for forecasting crack initiation and propagation on pavement on expressway bridges [1]. In that model, each of the process of crack initiation and the process of crack propagation is expressed by different two types of model. Besides, the transition time point (TTP) from initiation process to propagation process is set as the time point that crack is first observed in spite of the fact that the true transition time point (TTTP) is the time point of the crack occurrence. As a reason for that, TTTP is not generally observed in inspection works because of the nature that most of inspection works carry out temporally discontinuously. Hence, Madanat et al. have substituted the apparent transition time point (ATTP) for TTTP to estimate the model.

On the other hand, this study takes the point of view that there is underestimation risk of damage initiation rate and damage propagation rate by using the settings by Madanat et al. Thus, in this study, a DIAP model that is explicitly taken into account TTTP is developed. Specifically, unobservable TTTP is regarded as a probability variable that exists between the time points of the inspection works.

In order to distinguish from the model developed in this study from one developed in the existing study, the former is hereinafter referred to as DIAP-TTTP model (damage initiation and

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