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Modified Weibull Approach for Bridge Deterioration Modelling

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Abstract : State-based Markov deterioration models (SMDM) sometimes fail to find accurate transition probability matrix (TPM) values, and hence lead to invalid future condition prediction or incorrect average deterioration rates mainly due to drawbacks of existing nonlinear optimization-based algorithms and/or subjective function types used for regression analysis. Furthermore, a set of separate functions for each condition state with age cannot be directly derived by using Markov model for a given bridge element group, which however is of interest to industrial partners. This paper presents a new approach for generating Homogeneous SMDM model output, namely, the Modified Weibull approach, which consists of a set of appropriate functions to describe the percentage condition prediction of bridge elements in each state. These functions are combined with Bayesian approach and Metropolis Hasting Algorithm (MHA) based Markov Chain Monte Carlo (MCMC) simulation technique for quantifying the uncertainty in model parameter estimates. In this study, factors contributing to rail bridge deterioration were identified. The inspection data for 1,000 Australian railway bridges over 15 years were reviewed and filtered accordingly based on the real operational experience. Network level deterioration model for a typical bridge element group was developed using the proposed Modified Weibull approach. The condition state predictions obtained from this method were validated using statistical hypothesis tests with a test data set. Results show that the proposed model is able to not only predict the conditions in network-level accurately but also capture the model uncertainties with given confidence interval.

Keywords : bridge deterioration modelling, modified weibull approach, MCMC, metropolis-hasting algorithm, bayesian approach, Markov deterioration models
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