Accepted Manuscript

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PII: S0142-1123(18)30464-X
DOI: https://doi.org/10.1016/j.ijfatigue.2018.08.037
Reference: JIJF 4833

To appear in: *International Journal of Fatigue*

Received Date: 27 March 2018
Revised Date: 26 August 2018
Accepted Date: 30 August 2018

Please cite this article as: Zhu, J., Zhang, W., Li, X., Fatigue Damage Assessment of Orthotropic Steel Deck Using Dynamic Bayesian Networks, *International Journal of Fatigue* (2018), doi: https://doi.org/10.1016/j.ijfatigue.2018.08.037

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J. Zhu[1], W. Zhang[2], X. Li[3]

Abstract

Current health monitoring of orthotropic steel deck (OSD) subjected to fatigue damage mainly relies on deterministic physical models and the field measurements through inspections and monitoring. Nevertheless, various aleatory (random) and epistemic (lack of knowledge) uncertainties exist due to empirical justifications, model simplifications, inaccurate statistics of model parameter, measurement error, etc. The present study proposes a probabilistic model for fatigue damage diagnosis and prognosis of an OSD through integrating the physical model with field inspections while accounting for the associated uncertainties, using the dynamic Bayesian network (DBN). The DBN is suitable for representation and reasoning under uncertainty in various fields. The proposed framework aims to fulfill two interdependent tasks (1) diagnosis: track the time-dependent variable (i.e., the crack growth) and calibrate the time-independent variables (i.e., the geometric parameters and the multiplier for the crack shape factor); and (2) prognosis: predict the crack growth in the future. The particle filter (PF) is employed as the Bayesian inference algorithm for the established non-Gaussian DBN composed of continuous variables of various distribution types, as well as nonlinear conditional dependence between them. In addition, a Gaussian process (GP) surrogate model is established to relate the output stress response of the physical model (OSD) under the input truck load and model parameters, which is further implemented as the conditional probability distribution (CPD) in the DBN model. Finally, the

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