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PROBABILISTIC CHARACTERIZATION OF FATIGUE DAMAGE DATA FOR AEROSPACE MATERIALS

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ABSTRACT

The development of stochastic models for representing the uncertainties present in a problem is a very important component of probabilistic reliability analysis. Stochastic modeling of engineering parameters require the determination of appropriate probability distribution functions and their associated statistical parameters. In cases that of practical interest, there are usually two or more random variables or processes involved, and hence it is further necessary to establish the correlations between the uncertain parameters or functions. The choice of stochastic models often influences the reliability values as well as the probabilistic sensitivity factors computed from analyses. This is especially so for probabilistic fracture mechanics and fatigue reliability calculations which constitute the cornerstone for durability and damage tolerance assessments.

The present paper reports the development of a methodology for probabilistic fatigue data characterization. The characterization utilizes raw fatigue damage (crack initiation or crack growth) data to determine the most appropriate probability distributions, statistical parameters and confidence bounds for the modeling parameters that are involved in fatigue damage initiation and propagation relations used in durability and damage tolerance prediction. Correlations between different parameters are also computed on the basis of well established deterministic models and standards (such as the ASTM E647-93 standard) that have been widely accepted in the industry. Statistical tests are implemented on the basis of Kolmogorov-Smirnov measures of model acceptability. The probabilistic models are determined using both the method of moments (MOM) and maximum likelihood estimators (MLE) and are packaged within the framework of a user-friendly computational tool (PRADAC). Illustrative practical examples are presented to demonstrate the utility of this probabilistic pre-processing computational tool and the important effects on fatigue reliability prediction of aerospace structural components.

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