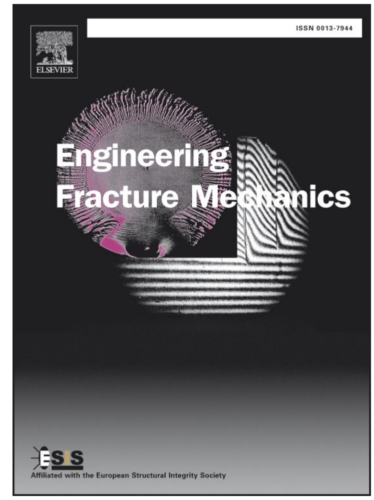
Accepted Manuscript



SDE Models With Exponential Drift And Diffusion For Approximating Fatigue Crack Growth Dynamics

E.J. Allen

PII: S0013-7944(18)30364-3
DOI: https://doi.org/10.1016/j.engfracmech.2018.07.013
Reference: EFM 6079

To appear in: *Engineering Fracture Mechanics*

Received Date: 4 April 2018
Accepted Date: 6 July 2018

Please cite this article as: Allen, E.J., SDE Models With Exponential Drift And Diffusion For Approximating Fatigue Crack Growth Dynamics, *Engineering Fracture Mechanics* (2018), doi: https://doi.org/10.1016/j.engfracmech.2018.07.013

SDE Models With Exponential Drift And Diffusion For Approximating Fatigue Crack Growth Dynamics

E. J. Allen

Department of Mathematics and Statistics, Texas Tech University, Lubbock, Texas 79409-1042

Abstract

A scalar stochastic differential equation (SDE) is studied for modeling fatigue crack growth dynamics. The drift and diffusion coefficients in the SDE model are exponential functions of the number of fatigue cycles. Exponential coefficients are shown to be reasonable based on experimental, physical, and theoretical arguments. The SDE model is examined for two fatigue crack growth datasets. For each dataset, the four parameters in the SDE model are fit using observed crack lengths for two different low values for the number of cycles. Then, using the SDE model with the fitted parameters, probability distributions for several higher values of the number of cycles and several first-passage probability distributions are calculated and compared to the observed distributions. The comparisons indicate that the proposed SDE model provides a good approximation for fatigue crack growth.

Keywords: crack growth, fatigue damage, stochastic differential equation, mathematical model, first-passage time
2010 MSC: 60H10, 74A45, 74R99, 34F05

1. Introduction

Based on comparisons involving a broad selection of data on crack-propagation rates, Paris and Erdogan [1, 2] hypothesized the empirical law for fatigue crack growth:

$$da/dN = C(\Delta K)^m \tag{1}$$

where da/dN is the crack growth rate per cycle, a is the fatigue crack length, N is the number of cycles, ΔK is the range of the stress intensity factor, and C and m are the Paris law parameters that depend, for example, on the