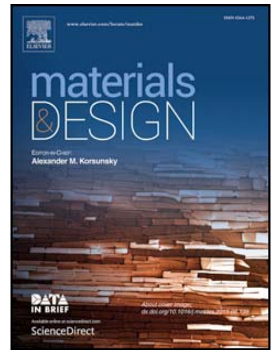

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Design of Composite Systems for Rotary Wear Applications

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Abstract

Due to the prevalence of sliding interfaces in mechanical assemblies, fast and reliable wear prediction capabilities are imperative for system design and analysis. This study investigates the rotary wear of multi-material composite systems that have thrust washer geometries. An analytical rotary wear model is developed to predict the rotary wear performance based on Archard's wear law and a Pasternak elastic foundation model. Numerical methods are used to track the evolution of key wear parameters including surface profile, contact pressure distribution, volume loss and composite wear rate during both run-in and steady-state wear regimes. A direct method is also developed to determine the steady-state characteristics from just the initial conditions and configurations of a given composite system. Optimal designs and design guidelines for several wear objectives are identified. Initial optimal material distributions for target steady-state surface profiles are determined. In addition, the steady-state composite wear rate is minimized to reduce material loss for bi-material systems with prescribed volume fractions. It is found that the optimal material configuration for this objective is counterintuitive. Wear tests are conducted to evaluate the proposed models and optimal design solutions. Results obtained from the wear models agree well with the experimental measurements.

Keywords: rotary wear, thrust washer, composite material, wear model, steady-state, surface profile, wear rate, optimization

1. Introduction

Wear is a facet of tribological study that refers to the gradual removal of material from surfaces of solids subject to contact and relative sliding. Wear is an interdisciplinary phenomena involving mechanics, materials, and chemistry. Wear is often a critical factor that influences the service life of components and the efficient prediction and optimization of wear are important parts of most mechanical design processes. In particular, predictions for the material loss during wear or the topographical evolution of a wearing surface are of great interest