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Lessons learned from the test-to-test variability of different types of wear data

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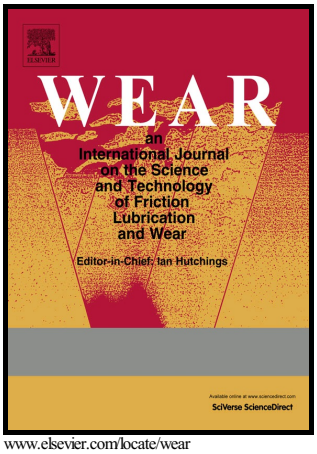

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PII: S0043-1648(16)30661-5
DOI: http://dx.doi.org/10.1016/j.wear.2016.11.012
Reference: WEA101825

To appear in: *Wear*

Received date: 8 September 2016
Revised date: 15 November 2016
Accepted date: 16 November 2016

Cite this article as: P.J. Blau, Lessons learned from the test-to-test variability o different types of wear data, *Wear,* http://dx.doi.org/10.1016/j.wear.2016.11.012

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Lessons learned from the test-to-test variability of different types of wear data

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Abstract

Contrary to the established principles of the scientific method, a surprising number of experimentally-based papers submitted to tribology journals and conferences report only one test result for each material pair or set of applied conditions. However, like hardness, yield strength, fatigue life, and other material properties, wear data exhibit varying degrees of repeatability and reproducibility (R/R). Repeatability concerns the replication of experiments within the same laboratory using the same equipment and materials. Reproducibility concerns testing on different equipment, usually at a different location, but using the same lot of specimens and procedures. An important question is: How many replicate measurements are needed to validate trends in wear behavior or to relatively rank materials, surface treatments, or lubricants? Without repeatability information, it is virtually impossible to establish whether reported material rankings or the effects of variables are real or fall within normal data scatter. The purpose of this paper is to characterize and analyze the R/R of wear data that result from a variety of sources, including material homogeneity, choice of units of measure, and choice of experimental variables. Case studies compare R/R for different forms of wear and their test methods, including ASTM standards. Lessons learned are presented for five forms of wear: (1) cavitation erosion, (2) three-body abrasion, (3) solid particle erosion, (4) dry sliding wear, and (5) fuel lubricity using the ball-on-cylinder (BOCLE) test. Wear transitions can also affect R/R. These examples provide insights for validating wear models, deciding how many repeated tests to make, and when ranking wear-resistance.

Keywords: wear, wear testing, repeatability, BOCLE, ASTM wear tests

Accepted manuscript

1.0 Introduction

In 2016, a survey of the biggest problems facing science was conducted of 270 international scientists in biomedical and social sciences [1]. Results indicated that the third in a list of the top seven problems was: “Replicating results is crucial and rare.” The study’s authors, Belluz, et al., further state:

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