Accelerated Destructive Degradation Test Planning

Luis A. Escobar*
Dept. of Experimental Statistics
Louisiana State University
Baton Rouge, LA 70803
luis@lsu.edu

Abstract

Accelerated Destructive Degradation Tests (ADDTs) are used to obtain reliability information quickly. For example, an ADDT can be used to estimate the time at which a given percentage of a product population will have a strength less than a specified critical degradation level. An ADDT plan specifies a set of factor level combinations of accelerating variables (e.g., temperature) and evaluation time and the test units' allocations to each of these combinations. This paper describes methods to find good ADDT plans for an important class of linear degradation models. First, different optimum plans are derived in the sense that they all provide the same minimum large sample approximate variance for the maximum likelihood (ML) estimate of a time quantile. The General Equivalence Theorem (GET) is used to verify the optimality of an optimum plan. Because an optimum plan is not robust to the model specification and the planning information used in deriving the plan, a more robust and useful compromise plan is proposed. Sensitive analyses show the effects on the precision of the quantile estimate by changes on sample size, time duration of the experiment, and levels of the accelerating variable. Monte Carlo simulations are used to evaluate the statistical characteristics of the ADDT plans. The methods are illustrated with an application for an adhesive bond.

KEY WORDS: reliability, large sample approximate variance, optimum ADDT plan, general equivalence theorem, compromise ADDT plan, Monte Carlo simulation.

* This is jointly work with Ying Shi and William Q. Meeker, from the Dept. of Statistics, Iowa State University.

Luis A. Escobar is a Professor in the Department of Experimental Statistics, Louisiana State University. His research and consulting interests include statistical analysis of reliability data, accelerated testing, survival analysis, linear and non-linear models. His publications have appeared in the engineering and statistical literature.