Invited Paper

Spectrum Shape and RMS Levels for Simulating Road Vehicle Vibrations

Vincent Rouillard * *and* Matthew J. Lamb **

Abstract

Today, there exists a number of standards designed to assist packaging engineers with implementing suitable laboratory testing regimes for road transport. These standards use vibration spectra that have been shown to often vary significantly from those from measured vibrations. Furthermore, for road transport, these standards protocols do not account for the significant variations in vibration root mean square (rms) levels that are clearly evident during transport as well advocate some form of time-compression to reduce testing duration by artificially amplifying the simulated vibrations. Each of these individual approaches combine to render the simulated vibrations commonly in use around the globe unrepresentative of what occurs during transport, thereby making it difficult to optimise packaging systems. This paper proposes a new approach for simulating road vehicle vibrations that includes five representative spectra based on a large collection of published spectra as well as a risk-based method for determining suitable test intensity – also based on all publicly available rms data.

Keywords: Vehicle vibrations, product damage, protective packaging, vibration spectrum, Power Spectral Density, root-mean-square, Weibull distribution.

1. Introduction

The delicate compromise between the costs (both financial and environmental) related to excessive packaging and those associated with product damage is becoming increasingly important. For this to occur, the prediction of damage rates for various packaging scenarios must be accurate and, to date, this can only be achieved if laboratory simulations of distribution environments - particularly vibrations during transport – are sufficiently accurate. Today, a number of test protocols (as prescribed by ASTM, ISTA, ISO, MIL standards) are aimed at simulating vibrations related to road transport (broadly acknowledged as the most common source of damage to products during the distribution phase) in laboratory settings. Although these protocols have evolved over a number of years, their development and formulation have not, however, always been sound and many such laboratory test protocols remain reliant on flawed assumptions and limited understanding of frequency and statistical analysis techniques [1]. The three main ingredient for simulation of random transport vibrations are: 1) their frequency structure – usually presented as the Power Density Spectrum (PDS); 2) the level at which the vibrations are to be generated – usually by defining the overall root-mean-square (rms) level or its distribution and 3) the duration of the simulation. This paper is based upon two recent publications [2,3] by the authors and brings together the conclusions to form a single, practical approach to simulate more realistic road transport vibrations for packaging optimisation.

* Ph.D, M.Eng, FIEAust, Victoria University, Melbourne, Australia, vincent.rouillard@vu.edu.au
** Ph.D,Victoria University, Melbourne, Australia