

Finite Element Model-based Structural Health Monitoring (SHM) of critical structural components under vibrations

P.J. Antunes, A.Z. Rocha, N.J. Ferreira, J.C. Viana, G.R. Dias

Critical Materials, Lda.
SpinPark-Centro de Incubação Tecnológica
Zona Industrial da Gandra
4806-909 Caldas das Taipas
Guimarães, Portugal

Abstract

SHM systems aim at giving, at every moment during the useful life of a structural component or sub-system, a diagnosis and prognosis of its structural integrity. The behaviour of the structure must remain within the design specifications, although its structural health can be altered by usage aging, environmental and operational conditions and by accidental events (e.g., impacts). The benefits of a coherent approach to structural integrity evaluation through advanced SHM systems are various, mainly: a reduction on inspection & maintenance operations and costs, maximization of craft operability and improved safety. Critical Materials is combining finite-element simulations (ABAQUS®) and real sensor data in order provide improved diagnosis and prognosis capabilities with reduced system complexity.

FEM is a very valuable tool for the prediction of the dynamic behaviour of structures subjected to vibrational loadings, such as advanced composite aerostructures. The intrinsic nature of polymeric materials requires a good characterization of its (viscoelastic) behaviour in order to obtain accurate simulation results. For dynamic FEA, the estimation of material and structural damping (dissipative phenomena) assumes a relevant role.

In this work, several techniques for estimation of material and structural dampings are used (resonant methods - Oberst bar, and forced vibration – DMA, and free vibration methods). Material viscoelastic properties served as input for a set of simulations, in which different dynamic analysis techniques are used (direct integration methods and modal analysis) and compared with experimental results. Finally, computational simulations are used to validate a methodology for localizing damage in a structure, as required by an advanced SHM system.