Accepted Manuscript

Nonlinear finite element post-flutter analysis of multibay composite panels in supersonic regime

D.R.Q. Pacheco, F.D. Marques, S. Natarajan, A.J.M. Ferreira

PII: S0263-8223(17)32617-X
DOI: http://dx.doi.org/10.1016/j.compstruct.2017.08.058
Reference: COST 8816

To appear in: *Composite Structures*

Please cite this article as: Pacheco, D.R.Q., Marques, F.D., Natarajan, S., Ferreira, A.J.M., Nonlinear finite element post-flutter analysis of multibay composite panels in supersonic regime, *Composite Structures* (2017), doi: http://dx.doi.org/10.1016/j.compstruct.2017.08.058

Nonlinear finite element post-flutter analysis of multibay composite panels in supersonic regime

D. R. Q. Pacheco [1], **F. D. Marques** [2], **S. Natarajan** [3] and **A. J. M. Ferreira** [4]

[1,2] São Carlos School of Engineering, University of São Paulo, São Carlos, Brazil
[3] Indian Institute of Technology - Madras, India
[4] Faculty of Engineering, University of Porto, Porto, Portugal

Abstract

This study consists of a numerical investigation on the nonlinear flutter oscillations of composite panels on multiple supports (multibay panels) in high supersonic flow. In contrast to what is done in the majority of studies, direct time-domain integration is used here instead of linearized updated mode approximations or modal decomposition techniques. The main goal is to study the interaction between adjacent bays in the nonlinear regime in order to identify aeroelastic phenomena that are not predicted by the usual single-panel approach. Multiple lamination schemes and multibay arrangements are considered, and new important results have been found. In nearly all cases simulated, severe jump discontinuities have been detected in the limit cycle oscillation amplitudes when the dynamic pressure reaches certain values. Such jumps, observed here for the first time, occur due to the nonlinear coupling between neighboring bays and consist of very abrupt amplitude elevations that happen when there are inversions in the motion phase of one or more bays. Furthermore, this study has been able to show that single-panel analysis may be unsafe for structural design as it drastically underestimates the maximum displacements of the bays located in rear (downwind) positions.

1. Introduction.

Supersonic panel flutter is an aeroelastic instability of plates and shells that has regained the attention of researchers during middle 90's, particularly with the expansion of advanced composites applications [1]. The use of such advanced materials in airplanes may lead to improvements in the control of static and dynamic deformations, thereby allowing optimizations in the aeroelasticity-driven structural design of aircraft components.

Real aerospace structures operating in external flows are typically made of thin-walled panels restrained to spars and stringers that act as stiffeners [2]. These stringers are usually distributed along the panels' inner surfaces so as to provide structural stabiliy, especially against shell buckling. Various approaches exist for idealizing the kinematic

[1]Graduate student, EESC/USP (douglas.pacheco@usp.br), corresponding author
[2]Associate Professor, EESC/USP (fmarques@sc.usp.br)
[3]Assistant Professor, IIT-Madras (sundararajan.natarajan@gmail.com)
[4]Professor, FEUP (ferreira@fe.up.pt)