

Author's Accepted Manuscript

Vibration Analysis of Composite Airfoil Blade
using Orthotropic Thin Shell Bending Theory

Sunil K. Sinha, Richard P. Zylka



PII: S0020-7403(16)31104-3

DOI: <http://dx.doi.org/10.1016/j.ijmecsci.2016.12.012>

Reference: MS3524

To appear in: *International Journal of Mechanical Sciences*

Received date: 20 April 2016

Revised date: 7 December 2016

Accepted date: 15 December 2016

Cite this article as: Sunil K. Sinha and Richard P. Zylka, Vibration Analysis of Composite Airfoil Blade using Orthotropic Thin Shell Bending Theory
International Journal of Mechanical Sciences
<http://dx.doi.org/10.1016/j.ijmecsci.2016.12.012>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting galley proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain

Vibration Analysis of Composite Airfoil Blade using Orthotropic Thin Shell Bending Theory

Sunil K. Sinha^{a*}, Richard P. Zylka^b

^a*Adjunct Assistant Professor, Department of Mechanical and Aerospace Engineering, The Ohio State University, Columbus, 43210-1142, U.S.A.,*

^b*Senior Engineer, Belcan Corporation, Cincinnati, OH. 45242, U.S.A.*

sinha.122@osu.edu

rzyka@belcan.com

**Corresponding Author*

ABSTRACT

In this paper, starting with the thin shell theory, the governing partial differential equation of motion for the transverse deflection of a rotating pre-twisted airfoil is derived. Strain-displacement relationships include the effect of warping of the cross-section due to twist-bend coupling effect introduced as a result of varying stagger angle and camber radius of the blade. The equation of motion, thus derived, is used to formulate the free vibration of a typical turbo-machinery cantilevered airfoil by considering it as an anisotropic shell in full curvilinear coordinates subjected to a centrifugal force field. The analytical derivation considers both the stress-stiffening as well as stress-softening effects of the centrifugal forces on the spinning airfoil. The fourth-order partial differential equation characterizing the flexural motion of the airfoil is transformed into a matrix- eigenvalue form using a Rayleigh-Ritz technique. The blade deformations are represented by a set of “admissible” sinusoidal trial functions, which fully satisfy all the clamped-end constraints as well as the free-edge boundary conditions. The numerical results presented in a non-dimensional parametric form are directly applicable in determining the static and running frequencies of typical composite blades used in the fan module of an aeroengine.

Keywords

Composite fan blade, Airfoil vibration, Centrifugal stiffening, Natural frequency, Eigenvalue solution, Rayleigh-Ritz technique, Orthotropic curved shell theory, Curvilinear coordinates

(Version R1 submitted to *International Journal of Mechanical Sciences*, October 6, 2016)

Download English Version:

<https://daneshyari.com/en/article/5016300>

Download Persian Version:

<https://daneshyari.com/article/5016300>

[Daneshyari.com](https://daneshyari.com)