POLITECNICO DI TORINO
Repository ISTITUZIONALE

Global/local sensitivity analysis and design optimization of aerospace composite laminates

Original
Global/local sensitivity analysis and design optimization of aerospace composite laminates / Pagani, A.; de Miguel, A. G.; Lionetti, M. P.; Sanchez-Majano, A. R.; Carrera, E.. - ELETTRONICO. - (2019). ((Intervento presentato al convegno Italian Association of Aeronautics and Astronautics - XXV International Conference (AIDAA 2019) tenutosi a Rome, Italy nel 9-12 September, 2019.

Availability:
This version is available at: 11583/2764099 since: 2019-10-29T12:17:25Z

Publisher:
Associazione Italiana di Aeronautica e Astronautica

Published
DOI:

(Article begins on next page)

Italian Association of Aeronautics and Astronautics
XXV International Congress
9-12 September 2019 | Rome, Italy

GLOBAL/LOCAL SENSITIVITY ANALYSIS AND DESIGN OPTIMIZATION OF AEROSPACE COMPOSITE LAMINATES

A. Pagani*, A.G. de Miguel, M.P. Lionetti, A.R. Sanchez-Majano, E. Carrera

Mul[2], Department of Mechanical and Aerospace Engineering
Politecnico di Torino
Corso Duca degli Abruzzi 24, 10129 Torino, Italy

*alfonso.pagani@polito.it

ABSTRACT

Composite structures are known to have high stiffness-to-weight and strength-to-weight ratios, which make them good candidates for advanced applications and substantial weight saving. In contrast, it is undoubtedly clear that the design of composite structures adds new degrees of freedom (design variables and parameters) that were unavailable and, hence, unexplored in the case of metallic components [1]. One of the main challenging aspects is the relatively high computational cost associated to the optimum design of these structures. Thus, equivalent-single-layer structural theories, invariants and lamination parameters are generally used in modern practise along with gradient-based algorithms for the optimization and the sensitivity analysis of composite laminates. This approach, however, severely shrinks the design space and limits the advantages of this class of materials.

This work introduces a new methodology based on multilayer perceptrons artificial neural networks (ANNs) for the sensitivity analysis and the design optimization of composite structures [2]. A back-propagation algorithm is utilized along with Monte Carlo simulations and advanced structural theories for training ANNs to replicate response surfaces and sensitive derivatives of laminated structures versus design parameters (lamination angles, layer thickness, etc.). Dataset and ANN training process is carried out by means of Carrera Unified Formulation (CUF), according to which refined structural theories with layer-wise capabilities can be implemented in a hierarchical and unified manner [3]. Thanks to the scalable nature of CUF, the entire environment is implemented into a global/local analysis framework, which makes it possible to optimize local (critical) regions of complex aerospace structural assemblies of which finite element models from commercial software tools are available.

REFERENCES

[1] X. Liu, D. Furrer, J. Kosters, J. Holmes. *Vision 2040: A Roadmap for Integrated, Multiscale Modeling and Simulation of Materials and Systems*. Hampton, VA: NASA/CR—2018-219771, (2018).

[2] A. Pagani, E. Carrera. Surrogate modelling of aerospace structures for damage detection and classification in "Proceedings of the *First International Conference on Mechanics of Advanced Materials and Structures*", Torino, Italy, (2018).

[3] E. Carrera, M. Cinefra, M. Petrolo, E. Zappino. *Finite Element Analysis of Structures through Unified Formulation*. John Wiley & Sons, (2014).