The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Mode Shapes-based Multicriteria Optimization of Thin-Walled Composite Cylinders Using Deep Learning

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Keywords: *Shell, Layered composites, Mode shapes, Optimization, Machine learning*

This paper presents multicriteria optimization of thin-walled composite cylinders. The optimized parameters are the lamination angles of successive composite layers as well as the parameters describing the geometry of the analyzed structure. The main source of data describing the optimized structure are vibration mode shapes identified using a deep learning approach [1].

Identification of mode shapes, i.e., determination of mode shape family (circumferential, bending, torsional or axial), is done using Convolutional Neural Networks. The identification procedure is very efficient, allowing for identification of mode shapes of structures with different parameters describing geometry and/or lamination angles.

The optimized parameters of the structure are quantities concerning dynamic and buckling properties of the tested structures (e.g., the fundamental natural frequency, the width of gaps in the structure' frequency spectrum or the buckling force) as well as the structures' stiffness [2, 3] and topology.

The proposed optimization algorithm is accurate, robust, and fast. The advantages of the proposed approach used are related to the use of neural meta-models replacing time-consuming finite element method and to the application of genetic algorithms [4] as a main optimization algorithm.

REFERENCES

[1] I. Goodfellow, Y. Bengio and A. Courville, *Deep Learning*. MIT Press, 2016.

[2] B. Miller and L. Ziemiański, Optimization of dynamic behavior of thin-walled laminated cylindrical shells by genetic algorithms and deep neural networks supported by modal shape identification. *Advances in Engineering Software*, Vol. **147**, 102830, 2020.

[3] B. Miller and L. Ziemiański, Optimization of Dynamic and Buckling Behavior of Thin-Walled Composite Cylinder, Supported by Nature-Inspired Agorithms, *Materials*, Vol. **13**, 2020.

[4] D.E. Goldberg, *Genetic algorithms in search, optimization and machine learning*, Addison-Wesley Longman Publishing Co., Inc., 1989.