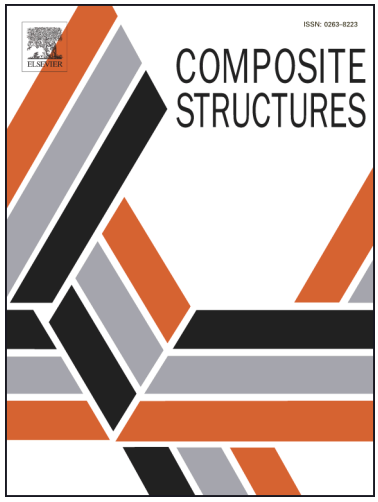

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Geometry optimization of a thin-walled element for an airstructure using hybrid system integrating Artificial Neural Network and Finite Element Method

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Abstract:

One of the fundamental criteria in the design of air structures is to achieve required strength at the highest possible reduction of structure weight *w*. However, it is necessary to keep the second design parameter i.e. stiffness of the air structural element on the proper level in order to satisfy durability and reliability of aircrafts.

This paper presents the application of an integrated system based on artificial neural networks and calculations by the finite element method (FEM) for the optimization of geometry of a thin-walled element of an air structure. The main criterion of optimization was to reduce the structure's weight *w* at the lowest possible deformation (high stress level) of the tested object. The objective of the analyses - using artificial neural networks (ANN) - was to investigate the effect of 4 individual variables defining geometry of the model (including: system of ribs and their inclination, system of holes in ribs and side walls) on its deformation and final value of the reduced weight *w*. Numerical analysis showed that the most important variable is the diameter of holes in the side walls of the model.

Keywords: Neural Network, Finite Element Method, Optimization, Thin-walled element

1. Introduction

Artificial neural networks (ANN) are an effective method for classifying and predicting variables. There are numerous publications on different applications of the so-called artificial intelligence methods, also in technical sciences, for the purpose of prediction [1-13]. These networks are biology-inspired and based on the structure of neurons, synapses and natural nervous systems, particularly those in the brain. Neural networks are in fact mathematical structures enabling the processing of signals by other elements due to the use of certain models which perform input operations.

Neural systems are sometimes called as a type of "black boxes" due to the fact that they only receive information on network output based on input signals. Naturally, this is a generalization, as in fact we can at any moment determine an error function or check e.g. weight of the structural element. A disadvantage of the neural network and, at the same time, its great advantage is the fact that we can access the required results without the application of a complex mathematical apparatus.

As far as composite materials are concerned, several years ago one could observe a significant increase in the interest in the application of ANN for detection of failure modes, e.g. delamination [14-16]. Nowadays we can observe a significant role played by artificial