11th World Congress on Structural and Multidisciplinary Optimisation
07th -12th, June 2015, Sydney Australia

Application of a Multi-Objective Optimization Approach on Sandwich Structures

Liliane Ngahane Nana[1], Thomas Fieder[1], Anna-Lena Beger[1], Jörg Feldhusen[1]

[1] Chair and Institute for Engineering Design (ikt), RWTH Aachen University, Germany, nana@ikt.rwth-aachen.de

Abstract

Sandwich structures consisting of thin face sheets and lightweight foam core can provide high specific strength, stiffness and bending stiffness while being extremely lightweight. Because of this attributes, these structures are able to decrease the weight of complex structures significantly. Due to their attractive properties sandwich structures have been used in various applications, ranging from transportation vehicles to civil engineering over wind energy applications. In addition to the mentioned advantages, another major gain is the infinite possibility of combining different kinds of materials to achieve custom-designed properties. Given all these benefits it is a big surprise to observe that sandwich structures remain rarely used in the mechanical engineering industry. One reason for this scarcity of use is the lack of a systematic approach to arrange the various parameters of different materials and different thicknesses for skin and core.

For the experiment in this work, a symmetric sandwich panel (the face sheets are identical) specimen was tested. The aim was to find out which combination is the best one to achieve well-defined objective functions, which are defined below. For this purpose three main variables were defined: the material for the face sheets, the material for the core and the thickness of the face sheets. The objectives functions were maximizing the bending stiffness, minimizing the mass and minimizing the cost. In addition to these objective functions constraints such as the length of the sandwich plate, its width and its total thickness were defined. The total thickness is a constant value, while the thickness of the core results from this total thickness and those of the face sheets. In total there were 18 possible combinations.

Due to the fact that the addressed problem deals with more than one objective function a Multi-Objective Optimization (MOO) method was used. Amongst the multitude of possible methods, the Genetic Algorithm (GA) was chosen. The reasons for this choice are the advantages of such algorithms, for instance the facts that they work well on mixed discrete/continuous problems, they are simple to set up and they are very robust.

With a free algorithm, similar to a genetic algorithm, which was developed at the ikt in the context of this work, the non-dominated solutions, the so called Pareto set, could be identified. To verify this method, this Pareto set was compared with the results found with a parallel calculation and the results are similar. Thus it can be concluded that GA is suitable for the MOO of a sandwich panel. But to confirm that our algorithm really works there is a need to apply it on a significant larger study area (e.g. a solution space with at least 100 possible combinations). Notwithstanding other adapted methods such as Particle Swarm Optimization or simulated annealing should be tested in order to evaluate their suitability.