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Structural Optimization Methods and Techniques to Efficiently Design Lightweight Composite Structures

Juan Pablo Leiva[1], Brian C. Watson and Shrinivas Lankalapalli

[1] Vanderplaats Research and Development, Inc., 41700 Gardenbrook, Ste. 115, Novi, MI 48375, USA, jp@vrand.com

1. Abstract

The use of composite materials in the development of airplanes, race vehicles, passenger vehicles and other structures has grown very fast in the last few decades. This growth has been propelled by the need to design lighter and yet more durable and stiffer structures. The proper use of composite material can yield structures with stiffness to weight ratios and strength to weight ratios that are very high when compared with structures built using traditional materials such as steel and aluminum. The design of laminated composite structures requires defining material type, thickness and angle of individual layers. Because the number of design parameters can be great, designers can be overwhelmed by the task of choosing appropriate dimensions, orientations and/or materials. Structural optimization methods and techniques can be used to solve this problem. We will discuss the implementation and the usage of structural optimization methods such as sizing and topometry. Engineers and designers need to get results quickly, as the time from design to production has shortened dramatically in the last few years. Therefore, techniques to speed up the optimization process itself are needed. We will also cover speed improvements that include traditional approximation concepts and more recent techniques, such as automatic reduction of design variables using coarsening techniques. This presentation will show several examples that illustrate what is used in the industry and what is possible today. The methods and techniques that will be described are already implemented or are being implemented in the structural optimization software GENESIS.

2. Keywords: Composite Optimization, Structural Optimization, Sizing Optimization, Topometry Optimization