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High-fidelity Structural optimization of a tow-steered composite wing

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Abstract

Composite materials are now making their way into the primary structures of large transport aircraft and have contributed to more efficient airframes. However, the composites used so far consist in conventional plies with fixed angles. The introduction of the capability to manufacture tow-steered composites opens the door to more efficient airframes by enabling more tailored structures. This paper will propose a general method for setting up tow-steered composite structural optimization problems. This method also features a method for mapping potentially thousands of discrete ply angles to a complex structure of interest. This mapping is amenable to adjoint gradient computation, which would otherwise be prohibitively expensive for any problem with a high enough fidelity to be of use. While the motivation of this method is to parameterize and optimize composite tow angles, it can handle both spatially varying tow angle and thickness variables separately and together. Several structural problems are proposed and their results presented. From these results we show that this method offers a robust design parameterization while being general enough to be applicable to a large number of structures. While purely structural, the presented methodology can be extended to aerostructural design optimization.

Keywords: structural optimization; tow-steered composites; composites; fuel burn; flexible wing.