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Project #2

Analysis-model write-up: due Oct 5, 2021
Report: due Oct 19, 2021

Background

You work for a small aerospace company that manufactures unmanned aerial vehicles (UAVs). You are designing the wing for a new long-endurance aircraft that will be used as a telecommunications platform. Specifically, you are designing the spar that will act as the main structural support for the wing.

The following design parameters and specifications of the wing have been predetermined by the aerodynamics and manufacturing specialist:

wing semi-span: 7.5 m, which is also the length of the spar.

spar cross-section shape: circular annulus.

material: Carbon fiber composite, with density 1600 kg/m^3, Young's modulus 70 GPa, and ultimate tensile/compressive strength 600 MPa.

manufacturing constraints: The inner and outer radii of the annulus cannot be less than 2.5 mm apart, the inner radius cannot be smaller than 1 cm, and the outer radius cannot be larger than 5 cm.

aircraft operational weight: The total mass of the aircraft will be 500 kg, including the spar.

loading: At a 2.5 g maneuver (i.e. a maneuver at which the total force on the spar is 2.5 times the weight of the aircraft), the force distribution in the spanwise direction will have an approximately linear distribution, with maximum load at the root and zero load at the tip.

Your objective is to minimize the weight of the spar without the structure reaching the ultimate strength of the carbon fiber (anywhere over the span) during the maneuver condition.

Analysis Model

Write a concise (less than one page) description of how you will analyze the wing spar. Specifically, discuss

- how you will represent the spar's geometry;
- how you will calculate the weight of the spar, and;
- how you will estimate the normal stresses in the spar at the 2.5 g maneuver.

Project Report

Write a report that **concisely** describes your approach and results. At a minimum, the report should contain

- an executive summary;
- a description of the analysis method, including any assumptions and limitations inherent in the method;
- a description of the geometry parameterization, if any;

- the optimization problem statement and optimization method(s), including the objective and any constraints;
- results, including the final geometry(ies) and convergence history(ies);
- conclusions and/or discussion of the results, and;
- an appendix with the source code.

The length of the report is not to exceed 10 pages (excluding the code appendix). Please refer to the corresponding rubric for how the report will be assessed.

Collaboration

You are permitted and encouraged to discuss the project with each other, provided each of you writes your own code and report. A good policy to follow in order to avoid academic misconduct is to not take project notes or exchange project files with one another; i.e. exchange information verbally and you should be fine.