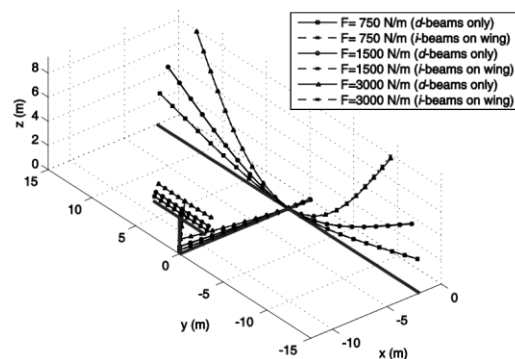
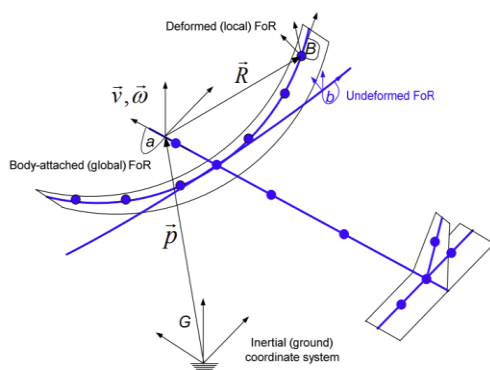


Bachelor's Thesis:

Gradient-based Optimization and Analysis of a Lightweight Cantilever Wing Beam Using Bernoulli and Timoshenko Theory

In aerospace engineering, wings must achieve maximum stiffness with minimal weight. Modeling a wing as a 1D cantilever beam provides a simplified yet effective way to capture its spanwise bending behavior while keeping the analysis analytically tractable. The aim of this thesis is to explore how the airfoil cross-section (t/c ratio) and wing slenderness influence stiffness, deflection, and weight, and to develop a gradient-based optimization framework that minimizes wing weight while meeting structural constraints. Calculations are based on Bernoulli and Timoshenko beam theories and implemented in MATLAB or Python, bridging classical beam theory with practical lightweight aerospace design.



Key Objectives

- Compute deflection, slope, and internal forces for various aerodynamic loading conditions, including point loads, uniform lift, and sinusoidal or elliptical lift distributions (using MATLAB or Python).
- Investigate the influence of slenderness (L/t) and t/c ratio on bending stiffness and shear effects through parametric studies implemented in code.
- Perform gradient-based optimization in MATLAB or Python to minimize wing weight while satisfying deflection constraints.
- Visualize weight vs stiffness trade-offs and identify regions where shear deformation significantly affects structural behavior