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SE 160A: Project 4 Write Up

1. Using your MATLAB program and the four provided EXCEL files calculate the section properties (A, Xc, Yc, Ixx, Iyy, Ixy) for the four different beam sections: I-, L-, C-, and Box. Fill in the following table, where the centroid is measured from the bottom-left corner of the beam, and the inertia properties are calculated about the centroid. Calculate (EIxx/□A) for each section and comment which of the four beams provides the greatest bending stiffness per pound of weight (maximum EIxx/□A). Explain

	I-Section (A)	L-Section (B)	C-Section (C)	Box (D)
A (in^2)	1.8	1.2	1.8	2.4
pA (lb/in)	0.1764	0.1176	0.1764	0.2352
Xc (in)	1.5	0.75	1	1.5
Yc (in)	1.5	0.75	1.5	1.5
Ixx (in^4)	3.15	1.2	3.15	3.6
Iyy (in^4)	0.9	1.2	1.8	3.6
Ixy (in^4	3.33067E-16	1.2	4.21885E-16	8.88178E-16
EIxx/pA	178.5714285714286	95.663265306122454	178.5714285714286	153.0612244897959

The I section and C section have the greatest bending stiffness per pound of weight because it has the highest EIxx/pA ratio. This makes sense because the I and C section maximize the vertical distance of its mass placement from the centroid, increasing it EIxx. Likewise, the Box design does the same task but also in the horizontal area distribution, however, its pA is too large to be as efficient as the I and C sections.

NACA ANALYSES

1. Calculate the section properties for three different airfoil thicknesses; thin (NACA-0008), nominal (NACA-0014), and thick (NACA-0018). Also calculate the section properties for a highly cambered airfoil (NACA-4414). Calculate (EIxx/pA) for each wing about the modulus-weighted centroid. Which airfoil provides the greatest wing bending stiffness per pound of wing weight?

	NACA-0008	NACA-0014	NACA-0018	NACA-4414
EIxx/pA	84.476326073538942	247.9634905709147	405.5422852678070	272.3014561048863

The NACA-0018 has the greatest bending stiffness per pound of weight (EIxx/pA)

2. Calculate the NACA-0014 section properties for regular skin and internal spar thickness, and compare to an airfoil with double skin and internal spar thickness. Fill in the following table with the wing bending stiffness (EIxx) and wing bending stiffness per wing weight (EIxx/pA) for each. Comment on the effectiveness of increasing the wing skin thickness in order to increase the wing bending stiffness (EIxx). Is the added weight (pA) worth it?

	NACA-0014 (regular thickness)	NACA-0014 (double thickness
Ixx	48.2099694239935	73.5367704279871
EIxx/pA	247.9634905709147	216.3170103325614

By doubling the skin thickness, the NACA 0014 airoil essentially gains ~1.5 times more Ixx (75/50) for the cross section. However, this is met with a cost of ~2 times the weight. Thus, the effective bending stiffness per pound of weight is less efficient. Because airspace prioritizes weight, the added weight is not worth it, unless a higher Ixx value is required for performance, they will pay a greater cost in weight.