



AEE 461 Design of Aircraft Structures

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Task #2

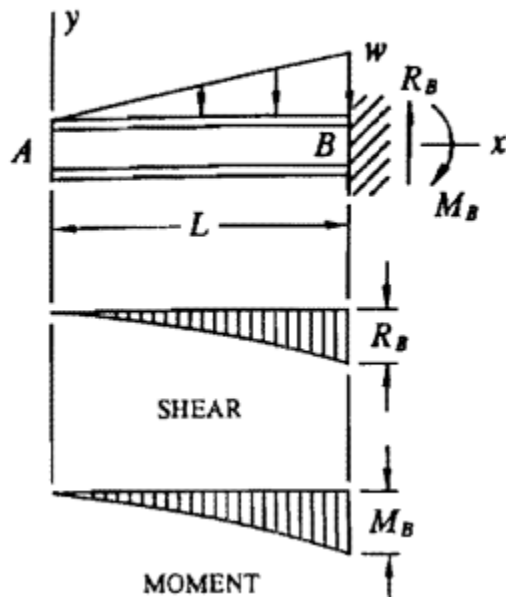
Calculation of Stresses under Bending

Solution:

a) Decide which wing section is the most critical one,

In Appendix D, Table A-1, Case 5 the followings are given:

Case 5 CANTILEVER BEAM—Uniformly varying distributed load.



REACTIONS

$$R_B = \frac{1}{2}wL$$

$$M_B = \frac{1}{6}wL^2$$

SHEARS

$$V = \frac{1}{2} \frac{wx^2}{L}$$

BENDING MOMENTS

$$M = \frac{1}{6} \frac{wx^3}{L}$$



$$R_B = \frac{1}{2} \cdot 0.5 \cdot 6000$$

$$= 1500 \text{ N}$$

$$M_B = \frac{1}{6} \cdot 0.5 \cdot 6000^2$$

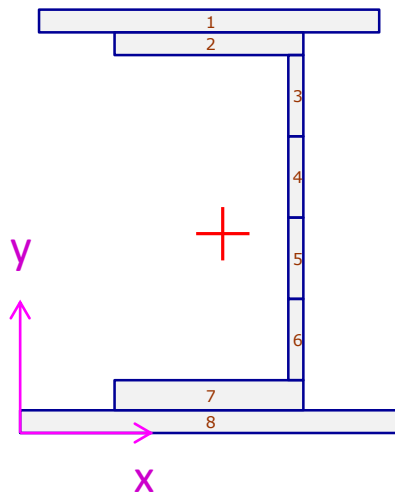
$$= 3000000 \text{ Nmm}$$

$$M_{max} = M_B$$

The magnitude of shear force and bending moment is maximum at the root section of the wing. For this task, only the moment will be considered for stress calculation.

Solution – cont'd:

b) Calculate the necessary cross-sectional properties for the selected section in (a),



Element		Size		Centroid		A	Ay	Ay ²	I _{xx}
i	#	b	h	x	y				
		[mm]	[mm]	[mm]	[mm]	[mm ²]	[mm ³]	[mm ⁴]	[mm ⁴]
1		45.00	3.00	25.00	54.50	135.00	7357.5	400984	101
2		25.00	3.00	25.00	51.50	75.00	3862.5	198919	56
3		2.00	10.75	36.50	44.63	21.50	959.4	42815	207
4		2.00	10.75	36.50	33.88	21.50	728.3	24672	207
5		2.00	10.75	36.50	23.13	21.50	497.2	11497	207
6		2.00	10.75	36.50	12.38	21.50	266.1	3293	207
7		25.00	4.00	25.00	5.00	100.00	500.0	2500	133
8		50.00	3.00	25.00	1.50	150.00	225.0	338	113

Results		
y _{cg}	ΣA	I _{xx}
[mm]	[mm ²]	[mm ⁴]
26.37	546.00	306679

Solution – cont'd :

- c) Calculate the Stresses and Margin of Safety for the material given below:

Material allowables for Aluminum 7050 T7351:

$$F_{tu} = 524 \text{ [MPa]}, F_{cy} = 469 \text{ [MPa]}$$

Applied Loads	
M_x [Nmm]	P_z [N]
-3000000	0

Allowables	
F_{tu} [MPa]	F_{cy} [MPa]
524	469

Element	Size					Stress	
i #	b [mm]	h [mm]	z [mm]	c [mm]	A [mm ²]	σ_z [MPa]	M.S. [-]
1	45.00	3.00	54.50	28.1	135.00	-275.2	0.70
2	25.00	3.00	51.50	25.1	75.00	-245.9	0.91
3	2.00	10.75	44.63	18.3	21.50	-178.6	1.63
4	2.00	10.75	33.88	7.5	21.50	-73.5	5.39
5	2.00	10.75	23.13	-3.2	21.50	31.7	15.53
6	2.00	10.75	12.38	-14.0	21.50	136.9	2.83
7	25.00	4.00	5.00	-21.4	100.00	209.0	1.51
8	50.00	3.00	1.50	-24.9	150.00	243.2	1.15

Note that;

$+M_x$ moment produce
 $+\sigma_z$ in upper flange
 $-\sigma_z$ in lower flange

$-M_x$ moment produce
 $-\sigma_z$ in upper flange
 $+\sigma_z$ in lower flange

and

$+P_z$ force produce
 $+\sigma_z$ in the section

$-P_z$ force produce
 $-\sigma_z$ in the section