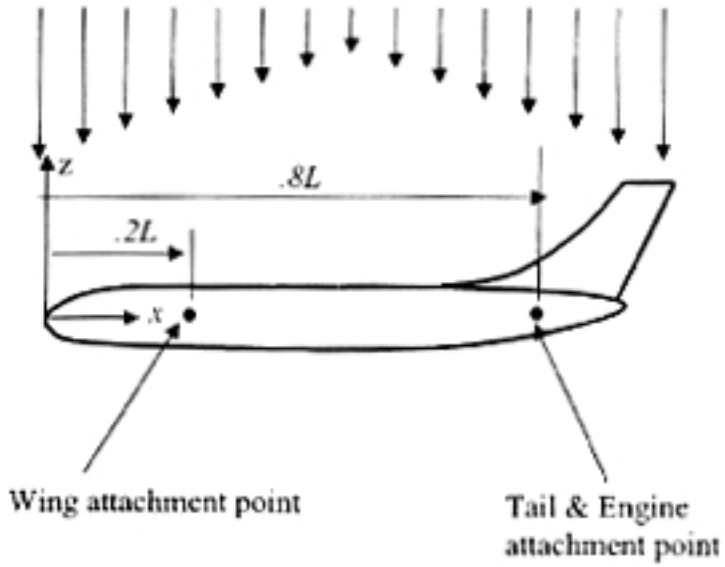
Problem 1 (33 pts). Consider an airplane of length L=30m in level flight as it is increasing its speed at a rate of 2 m/s^2 while adjusting the effective wing and tail angles of attack so it does not start to climb or pitch.

1) Lift produced by the tail is 20% of the lift produced by the wings.
2) Total craft weight is 350kN. Wing weight = 55kN, Tail & engine weight = 55kN. The remaining aircraft weight is uniformly distributed along the length of the fuselage as w(x) = 8kN/m
3) The unusual wind shear depicted below strikes the plane, producing an acceleration of 2.02 m/s. The wind shear force is f(x) = (-3.3 + 0.12x) N/m between 0 and 15 meters, (i..e. at x=0, there is a downward force of 3.3N/m) and f(x) = (0.3-0.12x) N/m between 15 and 30meters.

Use a right hand rule sign conventions and the given x,y,z axes.



a) Solve for the thrust and wing lift in terms of acceleration and mass.
b) Sketch and label an appropriate Free Body Diagram showing all (external and inertial) forces.
c) ~~Solve for the axial force distribution along the length of the plane.~~
d) Obtain the appropriate equations for axial force F(x) and sketch normalized axial force versus normalized length (e.g. x/L).
e) Solve for the internal shear forces and moments $V_y(x)$ and $M_y(x)$ in the region $.2L \leq x \leq .8L$ of the airplane.

Problem 2 (33 pts)

Consider the two-cell cross-section of a wing box at a certain location "X" along the span of the wing, as shown below. The wing box consists of a rectangular wing box and a D-spar, as shown. The cross section is subjected to a torque, T. Assume the following information:

1. The shear modulus of the material is $G = 3.85 \times 10^6$ [psi],
2. The maximum allowable shear stress is 30 ksi.
3. Assume that the two web thicknesses are the same, and they are twice the skin thickness
4. The skin thickness is a constant, t_c=0.05 in.
5. Assume that a = 10 in, b = 12 in, c = 6 in, r = 5 in
6. Assume that $\bar{A}_1 = 120$ in^2 and $\bar{A}_2 = 99.27$ in^2
7. The CCW shear flow produced by torque T in the rightward cell is $q_2 = 0.00215 \cdot T$ [lb/in]
8. The design safety factor to be used is 1.5.

Answer the following:

(a) What are the **magnitude and direction** of the shear flow in each piece of the cross section due to the applied torque, T?

(b) Determine the maximum torque, T_{max}, that the section can carry.

(c) Determine the angle, θ, (rad/in) for rotation of the cross section due to the applied torque, T_{max}.

Assume T_{max} was produced by a weight suspended 5 inches from the cross section's shear center.

(d) What is the maximum weight that can be suspended, and is it suspended at y= plus or minus 5 inches from the shear center?

(e) Determine if the web thickness is thick enough to withstand the shear load at this cross section due to this weight. (You may neglect any contributions of the skin to supporting the shear load.)