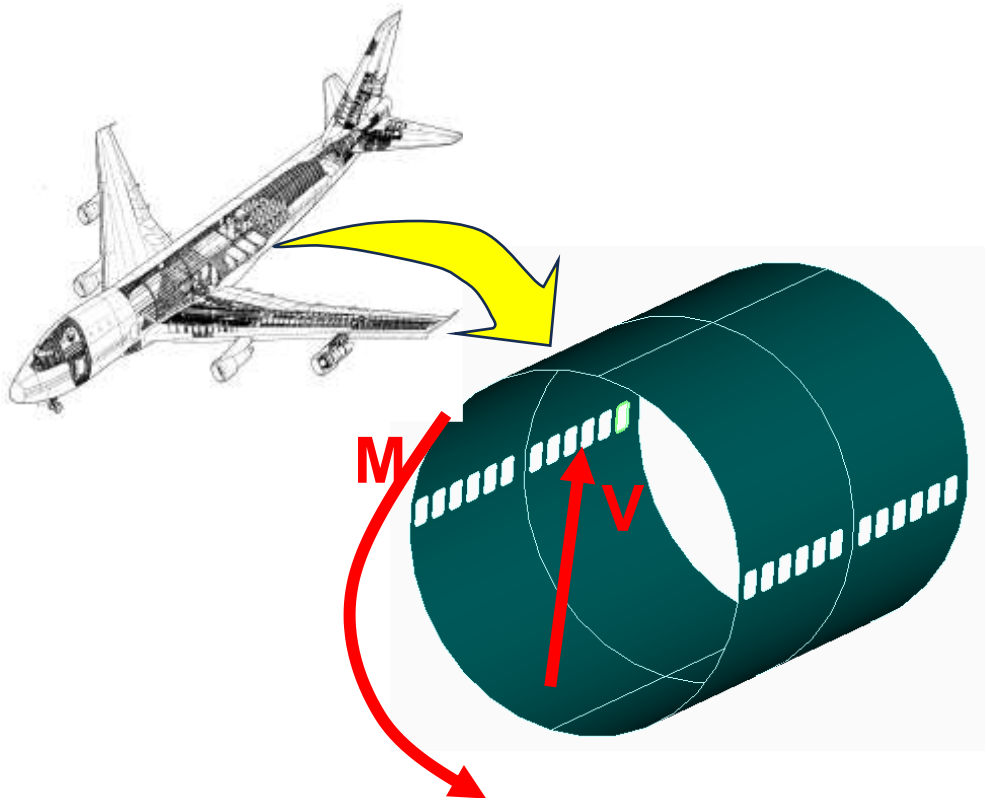


## AE4ASM109 Design and Analysis of Composite Structures I

### Final Project (CK portion)

Due via e-mail on April 19 at 5 pm.

As competition between aircraft manufacturers increases, it becomes necessary to have an efficient organization which can create new models rapidly in order to stay ahead of the competition. Among others, this implies the existence of a very fast and reliable design group which can create trade studies very quickly. You are to interview with the elite design organization of one of the big aircraft manufacturers. During the discussions, you made a good impression but the group leads are not sure if you have “what it takes”. So, towards the end of the day, when you are tired and want to go home, they pose to you the following problem for which they give you two hours to complete.



The new model they are considering has a fuselage with 6 m diameter. At its most highly loaded location a shear load  $V=1.5$  MN and a bending moment  $M=15$  MNm are applied. (a) Design a monolithic cross-section assuming Aluminum is used. (b) Design the same monolithic cross-section but now assume it is made out of a composite material (c) Design the same cross-section but now use skin and T stiffeners. (d) Determine the % weight reduction from (a) to (b) to (c). Include sketches showing the geometry and layup(s) of skin and stiffeners.

Material (average) properties:

Property	Aluminum	Composite (UD tape)
$E_x$ (GPa)	69	142
$E_y$ (GPa)	69	11.2
$G_{xy}$ (GPa)	26	5
$\nu_{xy}$	0.29	0.3

$X^t$ (MPa)	410 (yield)	2200
$X^c$ (MPa)	430 (yield)	1800
$Y^t$ (MPa)	400 (yield)	70
$Y^c$ (MPa)	430 (yield)	300
$S$ (MPa)	230 (yield)	100
$t_{ply}$ (mm)	Not applicable	0.135
$P$ (kg/m <sup>3</sup> )	2770	1610

Notes:

- (1) For the AI design you can assume the same thickness everywhere
- (2) For the monolithic composite design you must have at least three different thicknesses around the circumference.
- (3) For the skin-stiffened composite design you must have at least three different thicknesses for the skin and at least three different stiffener cross-sections. Also, in each stiffener, the web layup must be different than the flange layup.
- (4) It is up to you to decide how many stiffeners you will use and at what spacing. The spacing need not be constant.
- (5) No need to check for panel breaker condition, global buckling (skin + stiffeners together), no need to check for skin-stiffener separation. Only material covered so far in the course.
- (6) You can work in teams of up to four persons per team. Each team member submits his/her own report in his/her own words. On the first page, the names of the other group members must also be mentioned.