

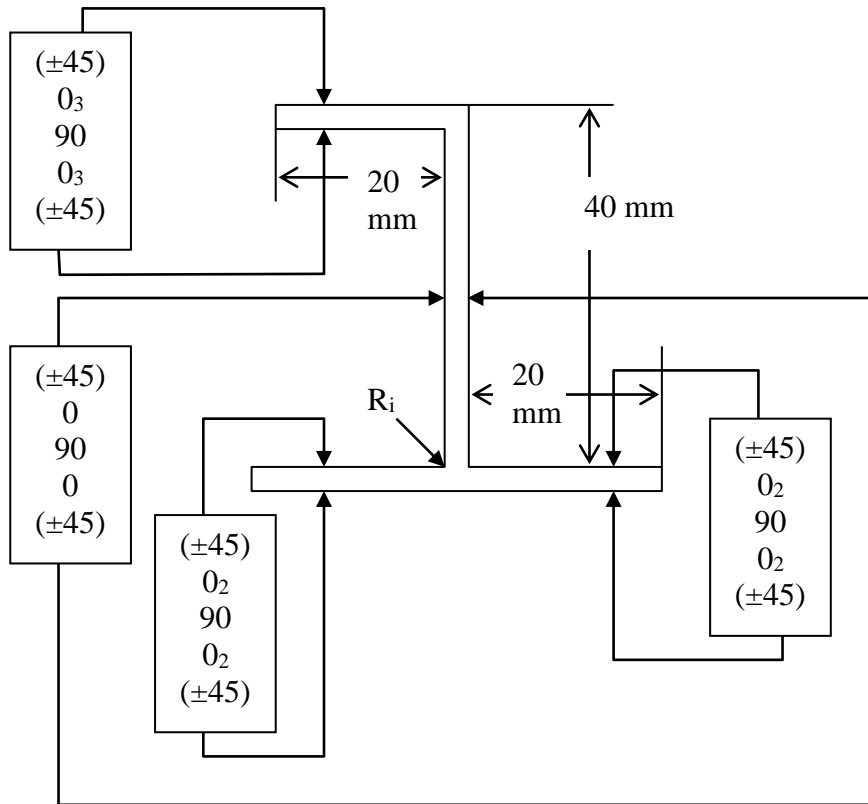
# AE4509 Advanced design and optimization of composites

## Assignments

## Advanced Design and Optimization of Composite Structures – Part 1

### Problem Set 3

1. A J-stiffener has the geometry and layups shown below. It is under a load of 17792N. Determine the minimum value of  $R_i$  so that there is no failure. (Assume thin-walled structure).



Material properties:

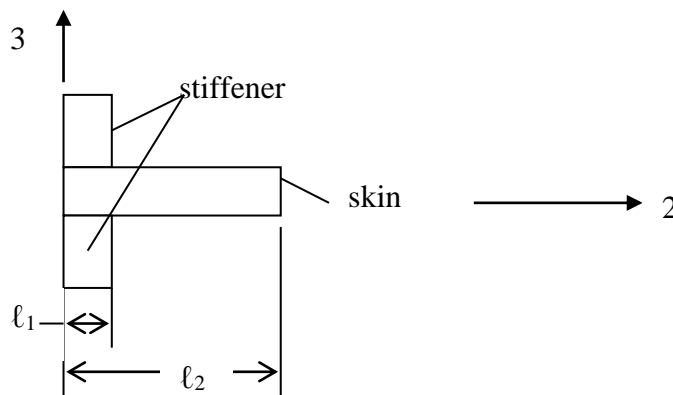
	UD tape	PW Fabric
$E_x$	$1.23E+11$ Pa	$55.152E9$ Pa
$E_y$	$8.48E+09$ Pa	$55.152E9$ Pa
$\nu_{xy}$	0.29	0.05
$G_{xy}$	$5.24E+09$ Pa	$4.826E9$ Pa
t <sub>ply</sub>	0.13970 mm	0.4191 mm
$X_t$	1693855800 Pa	534.3 MPa
$X_c$	1276079400 Pa	577.7 MPa
$Y_t$	25507800 Pa	534.3 MPa
$Y_c$	115819200 Pa	577.7 MPa
S	100652400 Pa	70.3 MPa

2. Given the value of  $R_i$  obtained in the previous problem, calculate a new flange length (up to the tangency point) and obtain the maximum flange load that can be applied without inter-rivet buckling load. The countersunk fasteners are at 25 mm spacing. What is the margin of safety for these two flanges at the bottom?

3. For a stiffened panel with stiffeners in the 1 direction, it was stated in lecture that the equivalent  $A_{22}$  for the entire panel is given by:

$$A_{22} \approx (A_{22})_{skin}$$

Consider a portion of the stiffened panel as shown below. It is made symmetric for simplicity.



Let  $E_s$ ,  $A_s$  the stiffness and area of the stiffener **in the 2 direction**. Let  $E_{sk}$  and  $A_{sk}$  the corresponding values for the skin. Determine an expression for the  $A_{22}$  of the skin-stiffener combination as a function of any pertinent quantities. Factor out  $E_{sk}A_{sk}$  and keep the rest in terms of  $l_1/l_2$  and  $E_sA_s/E_{sk}A_{sk}$ . Create a plot of  $A_{22}$  as a function of  $l_1/l_2$  as  $l_1/l_2$  ranges from 0 to 1 for  $E_sA_s/E_{sk}A_{sk}=0.1$  and  $E_sA_s/E_{sk}A_{sk}=0.5$ . On the basis of this plot, provide recommendations when you think the above approximation is valid. (If you need the dimension of the skin/stiffener combination perpendicular to the page, assume it is equal to 1 unit of length).