AE4509 Advanced design and optimization of composites

Assignments

Delft
University of Technology

Challenge the future

Advanced Design and Optimization of Composite Structures – Part 1

Problem Set 2

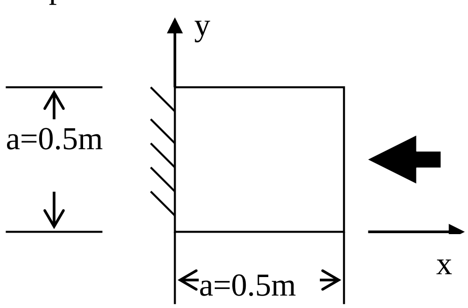
1. A rectangular composite panel is under compression. The panel is simply supported all around and has width (perpendicular to applied load) of 20 cm. The length varies from 10 cm to 1m. The layup consists of 8 total plies, it is symmetric, obeys the 10% rule and is made up of the following plies that can be shuffled in any order: 0, 90, 45, -45.
(a) Determine the best layup and the corresponding buckling load (N/mm) as a function of panel length. Assume $D_{16}=D_{26}=0$ Show your results in a graph of buckling load versus panel length. The material properties are as follows:

Ex	1.78E+07	1.23E+11	Pa
Ey	1.23E+06	8.48E+09	Pa
nuxy	0.29	0.29	
Gxy	7.60E+05	5.24E+09	Pa
tply	5.50E-03	0.13970	mm
Xt	245700	1693855800	Pa
Xc	185100	1276079400	Pa
Yt	3700	25507800	Pa
Yc	16800	115819200	Pa
S	14600	100652400	Pa

(b) Can the curve you found in part (a) be viewed as the "design curve" for this situation? If not discuss how it can be improved. (Neglect material scatter, environmental effects, or damage in your discussion).

2. Repeat 1a with clamped sides. Plot the result in the same graph as in part 1a.

3. Assume now that the best layup for the 0.5 m long panel in part 1a is used to make a square panel 0.5 m x 0.5 m with boundary conditions as shown below:



w=0 at x=y=0 and x=y=a
u=0 at x=0
v=0 at y=0 and y=a
u=-C at x=a
$D_{16}=D_{26}=0$

Suppose that the panel is to be designed for a certain PB. (a) Make a cut along y=a/2 and give the analytical expressions for the moments there..
(b) Calculate the total moment along the edge y=a/2 by integrating the expression(s) you found in (a).
(c) Calculate the maximum rotation of the panel along the edge y=a.

(d) Assume that the maximum rotation in (c) is caused by the moment(s) in (b). If now the panel were clamped, the rotation you calculated in (c) would be zero. You are to determine the GJ of a stiffener placed at the edge y=a such that its maximum rotation under a torque equals half your answer in (c) – because the other half is taken by the edge y=0 -- is 1% of the rotation you calculated in (c). This gives an idea of the requirements for stiffeners to be placed all around the panel to make it behave as if it were clamped. The stiffeners can be assumed clamped at their ends.

(e) Given your answer in problem 2 for a 0.5m x 0.5 m panel is the increase in weight by the stiffeners all around the panel edges worth the increase in buckling load from simply supported to clamped? How does your answer change if PB changes? You can assume material density = 1650 kg/m^3.