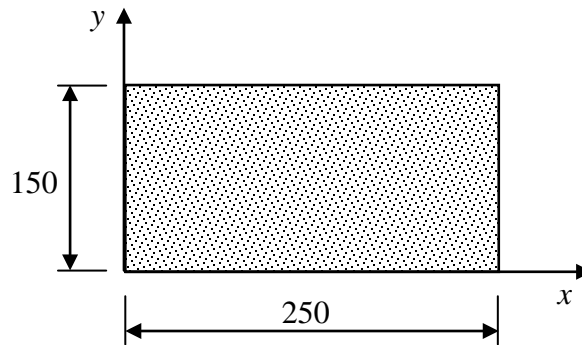


## MEK 4540 – Autumn 2011: Compulsory Assignment no. 2

Deadline 11.15 Tuesday 25.10.2011 (see below)



A rectangular, flat plate 250 mm x 150 mm is built up from 8 unidirectional plies of fibre reinforced composite material. Each ply has thickness  $h = 0.5$  mm and the following elastic properties:

E-modulus parallel to fibres:	$E_1 = 42.1$ GPa
E-modulus transverse to fibres:	$E_2 = 13.1$ GPa
Shear modulus:	$G_{12} = 3.94$ GPa
Poisson's ratio:	$\nu_{12} = 0.27$

The panel is simply supported at all four edges and is subjected to a uniformly distributed pressure of 100 kPa.

Four lay-ups shall be considered, where the angles are measured in degrees from the  $x$ -axis:

$$[90_8], [90/0]_{2s}, [-45/+45]_{2s}, [90/45/-45/0]_s.$$

- Calculate the ABD-matrix for each laminate by means of Matlab (or other analysis tools).
- Calculate the following response parameters:
  - The deflection  $w_{\max}$  at the middle of the plate
  - The maximum bending moment per unit length about an axis parallel to the  $x$ -direction,  $M_{y,\max}$
  - The maximum bending moment per unit length about an axis parallel to the  $y$ -direction,  $M_{x,\max}$
  - The maximum twisting moment per unit length,  $M_{xy,\max}$Explain how you have decided on the number of terms to use in the series solutions. (Equation 5.11 in Z&B is used to calculate the moments, with  $D_{16} = D_{26} = 0$ . Note that for some cases the maximum moments do not occur at the centre of the plate.)
- Present the results in a table and comment on the differences between them.
- For the second of the four lay-ups,  $[90/0]_{2s}$ , calculate the ply stresses, and hence the Tsai-Wu strength ratio index  $R$ , in layers 1 and 8 at the centre of the plate. Assume the same ply strength properties as specified in Assignment No. 1 part f).
- The same plates are subjected to a loading in the  $xy$ -plane such that the edges  $x = 0$ ,  $x = 250$  mm experience equal, uniformly distributed compressive forces. Calculate the lowest critical value of this compressive loading that will cause buckling for each lay-up.

***It is recommended that the problem is solved using Matlab or a similar software tool and that the method is first tested for one or more cases from Z&B example 5.1 or 5.2 and also 5.6. Note that Z&B in fact tabulate  $M_x$  and  $M_y$  at the centre of the plate (not the true  $M_{x,\max}$  and  $M_{y,\max}$ ) and that the values given for  $M_{xy,\max}$  are one-half of the correct values.***

The assignment shall be handed in by Tuesday 25 October 2011 at 11.15:

- by email (preferably in pdf-format) to [brianha at math.uio.no](mailto:brianha@math.uio.no), or
- on paper to Brian's mailbox on the 7th floor or directly at the start of the lecture.

Matlab files are to be handed in with the assignment and also sent by email. BH/11.10.2011