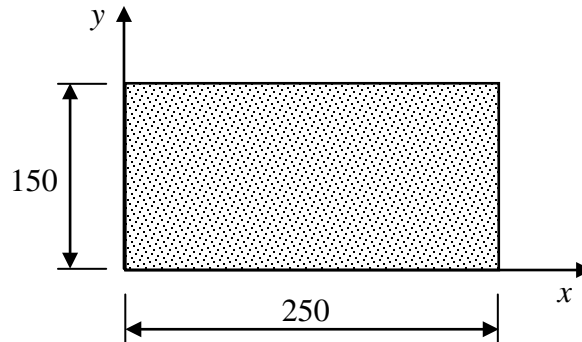# MEK 4540 – Autumn 2011: Compulsory Assignment no. 3

To be handed in by 08.11.2011 (see below)

Part A

The same panel as that studied in Assignment no. 2 is to be analysed by means of ANSYS. The panel has dimensions 250 mm x 150 mm as shown in the figure. The analysis is confined to the lay-up $[90/0]_{2s}$ in relation to the axes shown in the figure (i.e. the outermost plies are parallel to the y-axis). Each ply is assumed to have the following properties:

E-modulus in fibre direction:	$E_1 = 42.1$ GPa
E-modulus in transverse direction:	$E_2 = 13.1$ GPa
E-modulus out-of-plane:	$E_3 = 13.1$ GPa
Shear moduli:	$G_{12} = G_{13} = 3.94$ GPa
	$G_{23} = 2.0$ GPa
Poisson's ratio:	$v_{12} = v_{13} = v_{23} = 0.27$
Thickness:	$h = 0.5$ mm
Tensile strength in fibre direction:	$\sigma_{1t}^{f} = 490$ MPa
Compressive strength in fibre direction:	$\sigma_{1c}^{f} = (\text{-})463$ MPa
Tensile strength in transverse direction:	$\sigma_{2t}^{f} = 170$ MPa
Compressive strength in transverse direction:	$\sigma_{2c}^{f} = (\text{-})175$ MPa
Shear strength, in-plane (1-2 direction):	$\sigma_{12}^{f} = 189$ MPa
Stress coupling coefficient, 1-2 direction:	$C_{12} = -1.0$

The strength values in other directions are input as large values, e.g. 10 000 MPa; stress coupling coefficients in other directions than C_{12} are set equal to zero.

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

The element type SHELL281 shall be used and the properties shall be input for each ply. The recommended element size is 12.5 mm or less.

The following results shall be obtained from a linear analysis:

1. Maximum deflection (displacement in z-direction). The result is to be compared with that obtained in Assignment no. 2. Comment on any differences.
2. Maximum Tsai-Wu-factor (inverse strength ratio). Plies no. 1, 2, 7 and 8 should be checked. Compare the results for plies 1 and 8 with those obtained in Assignment no.2 and comment on any differences.

How large a pressure loading can the panel withstand if the deflection is not to exceed 1.5 mm (= 1% of the panel width) and, at the same time, the Tsai-Wu factor is not to exceed 0.3? *Hint: In this part use linear scaling of the results from the analysis that has already been performed – it is unnecessary to repeat the analysis with different load values because the response is linear-elastic.*

Part B

The thickness of each ply is reduced from 0.5 mm to 0.25 mm and an additional 15 mm thick layer of core material is inserted between plies 4 and 5 so as to make a sandwich panel. The core material can be considered as isotropic with the following properties:

E-modulus:	$E_c = 200$ MPa
Poisson's ratio:	$v_c = 0.37$
Shear strength:	$\tau_u = 2.6$ MPa
Tension/compression strength:	$\sigma_u = 3.5$ MPa

The pressure loading is maintained at 100 kPa.

Modify the FE model from Part A to take account of the new lay-up, and obtain the following from a linear analysis:

1. Maximum deflection (displacement in z-direction).
2. Maximum Tsai-Wu factor (inverse strength ratio) in the face laminates (***not*** in the core).
3. Maximum shear stresses in the core in both xz- and yz-directions.

How large a pressure loading can the panel support if the deflection is limited to 1.5 mm (= 1% of the panel width), the Tsai-Wu factor shall not exceed 0.3 and, at the same time, the shear stress in the core shall not exceed 40% of the above specified shear strength? *Hint: As in Part A, use linear scaling of the results you have already derived to find the smallest value of load that satisfies all three requirements.*

REPORT

A report shall be prepared. This shall be concise and contain:
- A brief overview of the steps in the modelling process
- Numerical results as specified above
- Any problems or uncertainties that were encountered
- A few images from the ANSYS analysis (e.g. displaced form, contours)
- Journal file from ANSYS (optional).

SUBMISSION

The report shall be submitted by 11:15 on Tuesday 8 November 2011 by one of the following means:
- directly by email to brianha at math.uio.no
- placed in Brian's mail pigeon-hole on the 7th Floor
- delivered by hand at lecture on 8 November

Reports may be either handwritten or typed using suitable word/text processing software. Solutions sent by email must be in either MS Word or (preferably) PDF format.

B. Hayman
25.10.2011