Lightweight structures and FEM - Lab 2

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In Lab 2 results from a commercial FE code (ANSYS or ABAQUS) should be compared with results from your MatLab FE code, and with analytical solutions.

Hint: You have to introduce a torque in the MatLab FE model in order to account for the applied shear load not acting through the shear centre. The corresponding torque should be applied in the analytical calculations. Don't forget to enter the correct beam bending and torsional stiffness into your MatLab code.
Assume that the cross sections are thin-walled in your analytical calculations. Trying to take thickness effects into account will most likely deteriorate your results rather than improve them.

1. Complete the following table:

	Horizontal displ. u(L)	***Vertical displ. v(L)***	***Twist,, φ(L)***
MatLab	N.A.	3.749 mm	0.093 rad
ANSYS/ABAQUS	0.22E-10 mm	3.473 mm	0.080 rad
Analytical	0 mm	3.749 mm	0.093 rad

2.

a) The total strain energy from the commercial FE code is: 172.062 mJ

b) The work of the applied load in the commercial FE code is: 173.650 mJ

c) The corresponding work in the MatLab code is: 187.450 mJ

3. Plot and print the shear stress distributions requested in task 7 in the lab instructions. Add your analytically calculated shear stress distribution (τ=q/t) to the plot (by hand if you like) and compare the solutions. Please, try to incliude shear due to torsion as well.

4. Plot and print the warping and normal stress distributions requested in tasks 8 and 9 in the lab instructions. Add your analytical results and compare the solutions.

Comments or questions (optional):

The critical buckling load for the beam is estimated. Results are derived analytically, with the commercial FE code and with the MatLab code, which should be modified for this task. For the FE results, examine (at least) the 5 first critical buckling loads and try to distinguish which buckling modes they represent. In general try to find as many different buckling types as possible for each beam length.

Complete the following table:

P_{cr} [N]	$L = 500\ mm$	$L = 1000\ mm$	$L = 2000\ mm$
Analytical, Euler (E) **Torsion (T)** **Local (L)** **Combined (C)**	35.376 kN (E) Pcrx = 161.664 kN 55.946 kN (T) 21 kN (L) 208 kN (C) 61.3 kN	8.844 kN (E) Pcrx = 40.416 kN 21.073 kN (T) 21 kN (L) 61 kN (C) 20.8 kN	2.211 kN (E) Pcrx = 10.104 kN 12.355 kN (T) 21 kN (L) 21 kN (C) 7.22 kN
FEM P_{cr1} **(mode)** P_{cr2} **(mode)** P_{cr3} **(mode)** P_{cr4} **(mode)** P_{cr5} **(mode)**	18.593 kN (T) 19.180 kN (L) 34.837 kN (E/L) 36.165 kN (L) 36.180 kN (L)	8.781 kN (E) 9.350 kN (E/T) 19.500 kN (L) 31.750 kN (L) 35.949 kN (L)	2.209 kN (E) 5.481 kN (E/T) 13.643 kN (L/T) 18.647 kN (L) 20.589 kN (L)
MatLab P_{cr1} **(mode)** P_{cr2} **(mode)** P_{cr3} **(mode)** P_{cr4} **(mode)** P_{cr5} **(mode)**	14.942 kN (T) 14.942 kN (T) 14.942 kN (T) 14.942 kN (T) 14.942 kN (T)	8.843 kN (E) 14.942 kN (E) 14.942 kN (T) 14.942 kN (T) 14.942 kN (T)	2.210 kN (E) 14.942 kN (T) 14.942 kN (T) 14.942 kN (T) 14.942 kN (T)

Comments or questions (optional):

Date and examiners signature:..