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	1.92	4.700	5.499°
ANSYS/ABAQUS	1.79	-6.49	4.419°
Analytical	1.92	4.700	5.499°

2.

a) The total strain energy from the commercial FE code is: 322.755

b) The work of the applied load in the commercial FE code is: 324.06

c) The corresponding work in the MatLab code is: 235

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.

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.

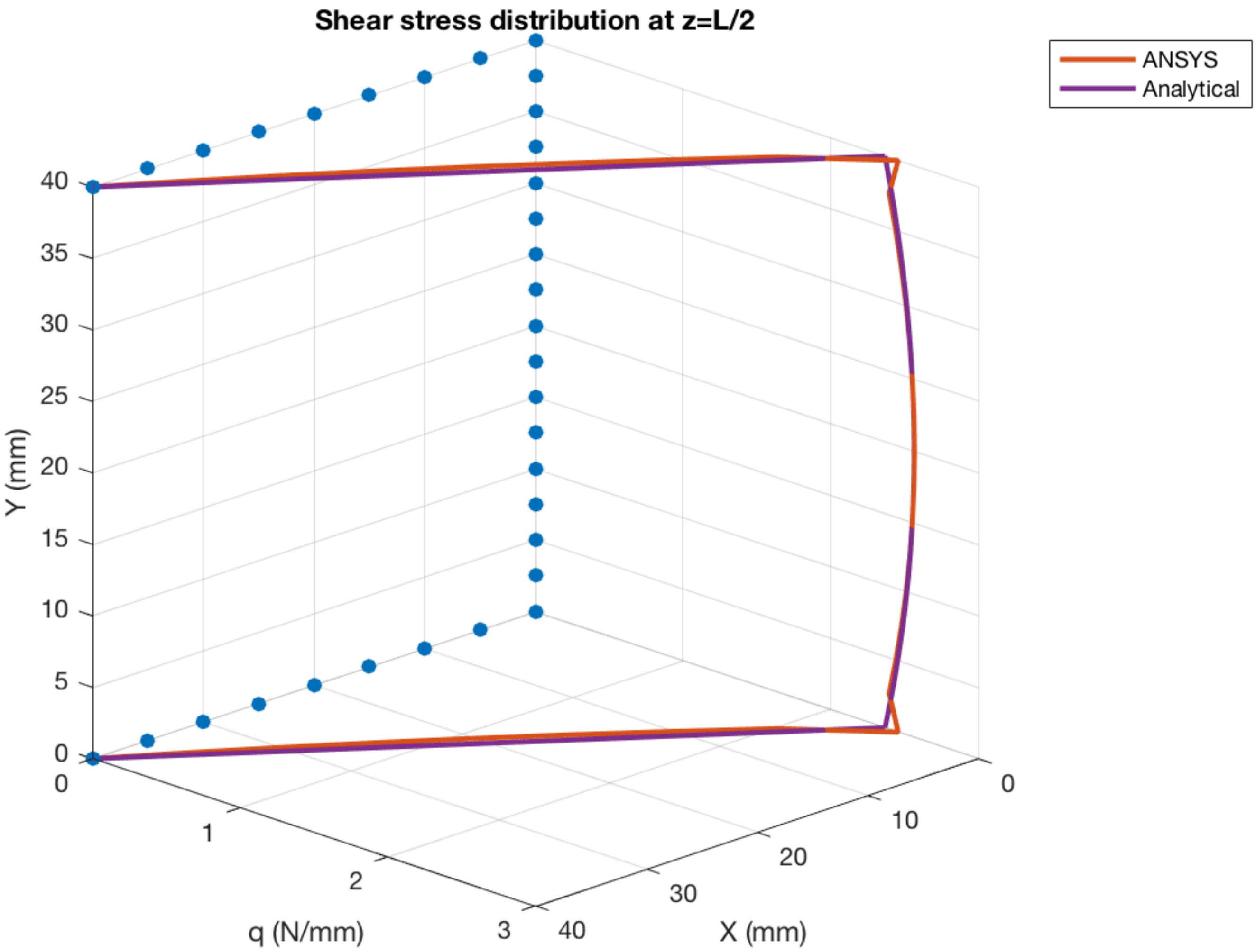
Complete the following table:

P_{cr} [N]	*L = 500 mm*	*L = 1000 mm*	*L = 2000 mm*
Analytical, Euler (E) **Torsion (T)** **Local (L)** **Combined (C)**	Ex = 70.0 kN (E) Ey = 31.6 kN (T) T = 33.2 kN L = 42.4 kN (L) C = 24.2 kN (C)	Ex = 17.5 kN (E) Ey = 7.90 kN (T) T = 16.4 kN L = 42.4 kN (L) C = 9.18 kN (C)	Ex = 4.38 kN (E) Ey = 1.97 kN (T) T = 12.2 kN L = 42.4 kN (L) C = 3.42 kN (C)
FEM **P_{cr1} (mode)** **P_{cr2} (mode)** **P_{cr3} (mode)** **P_{cr4} (mode)** **P_{cr5} (mode)**	12.6 kN (T) 31.1 kN (Ey) 39.9 kN (L) 41.4 kN (L) 50.9 kN (L)	6.92 kN (C) 7.89 kN (Ey) 20.4 kN (C) 36.8 kN (C) 41.4 kN (L)	1.98 kN (Ey) 3.19 kN (C) 10.2 kN (C) 16.5 kN (C) 17.7 kN (Ey)
MatLab **P_{cr1} (mode)** **P_{cr2} (mode)** **P_{cr3} (mode)** **P_{cr4} (mode)** **P_{cr5} (mode)**	31.6 kN (Ex) 70.0 kN (Ey) 138 kN (T) 284 kN (Ex) 630 kN (Ey)	7.90 kN (Ex) 17.5 kN (Ey) 71.1 kN (Ex) 138 kN (T) 158 kN (Ey)	1.97 kN (Ex) 4.38 kN (Ey) 17.8 kN (Ex) 39.4 kN (Ey) 49.4 kN (Ex)

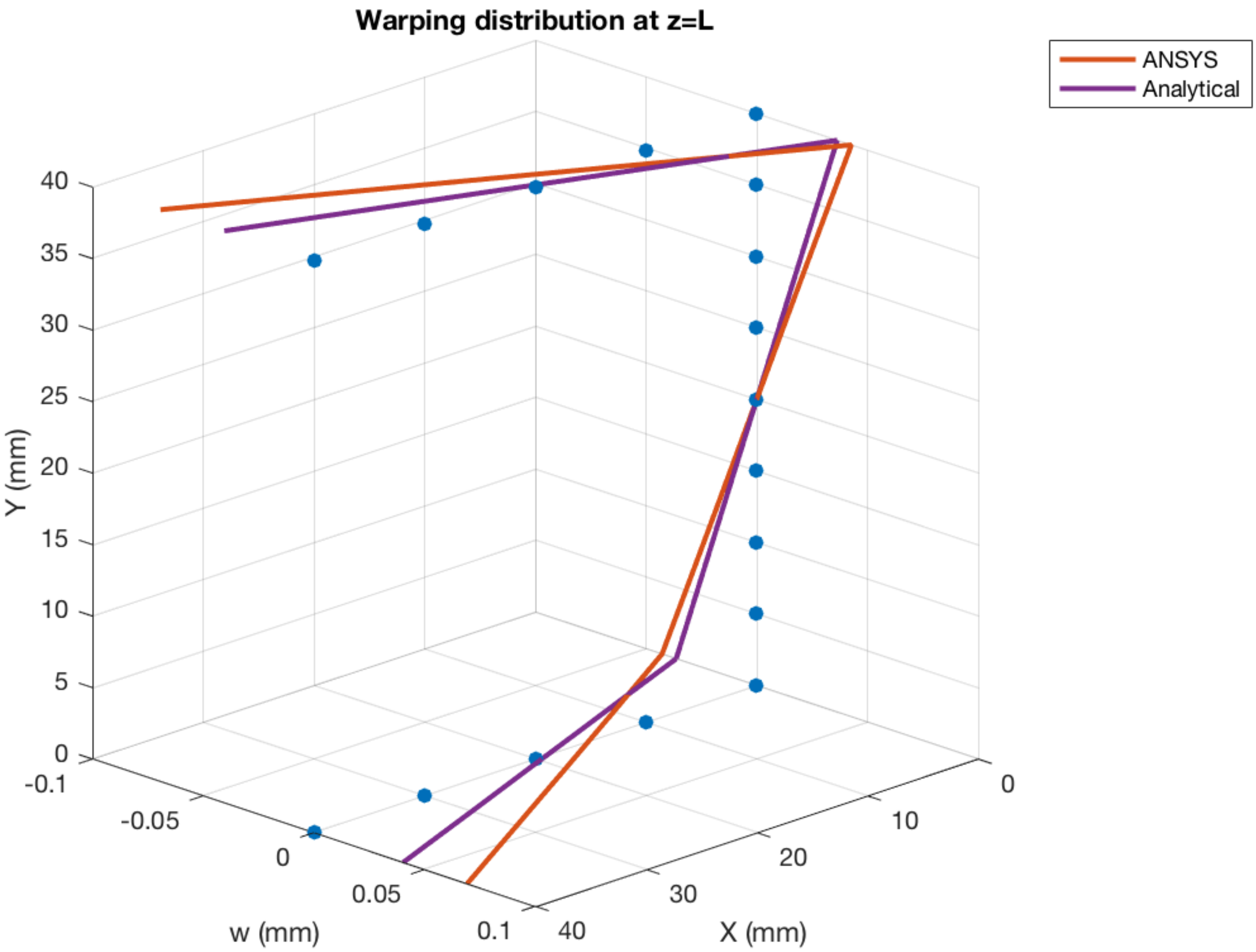
Comments or questions (optional):

Graphs for questions 3 and 4 presented in next pages.

Date and examiners signature:..



Shear stress distribution at z=L/2
ANSYS
Analytical
Y (mm)
0
5
10
15
20
25
30
35
40
q (N/mm)
0
1
2
3
X (mm)
0
10
20
30
40



Warping distribution at z=L
ANSYS
Analytical
Y (mm)
0
5
10
15
20
25
30
35
40
-0.1
-0.05
0
0.05
0.1
w (mm)
40
30
20
10
0
X (mm)