

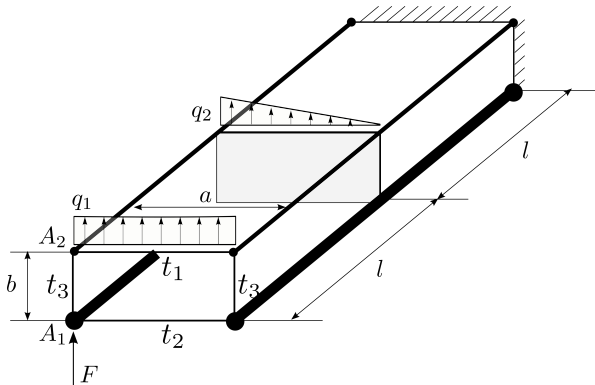
Course of Aerospace Structures

Written test, June 26th, 2019

Exercise 1

Consider the single-cell, thin-walled beam in the figure. The beam length is equal to $2l$; the section has dimensions $a \times b$, and is stiffened by four stringers, each characterized by lumped area equal to A_1 (at the bottom) and A_2 (at the top). The thickness of the panels is denoted with t_1 , t_2 and t_3 , as illustrated in the figure. Referring to the loading conditions reported in the sketch:

- determine the shear stresses in the panels and the axial stresses in the stringers for the section at a distance $l/2$ from the constraint;
- plot the internal actions on the rib at the mid-span, assuming that the rib can be modeled as a beam.



Data

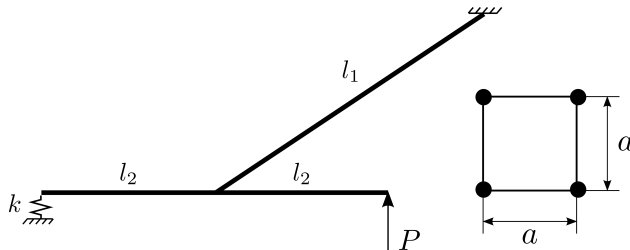
$l = 1500 \text{ mm}$; $a = 400 \text{ mm}$; $b = 250 \text{ mm}$;
 $t_1 = 1 \text{ mm}$; $t_2 = 2 \text{ mm}$; $t_3 = 1.5 \text{ mm}$;
 $A_1 = 2000 \text{ mm}^2$; $A_2 = 1000 \text{ mm}^2$;
 $q_1 = 90 \text{ N/mm}$; $q_2 = 300 \text{ N/mm}$;
 $F = 10 \text{ kN}$;

Exercise 2

A structure is composed of three beams of length l_1 and l_2 . All the beams are characterized by a square section – see the figure –, with panels of thickness t and stiffened by four stringers, each of lumped area A . One end is fixed, the other is grounded by means of an elastic constraint of stiffness k , and the third end is loaded with a concentrated load P .

Determine:

- the vertical displacement in correspondence of the spring, with and without accounting for the beam shearing stiffness contribution
- the strain energy stored in the structure (including the spring)



Data

$l_1 = 1000 \text{ mm}$; $l_2 = 500 \text{ mm}$;
 $a = 100 \text{ mm}$; $t = 1 \text{ mm}$;
 $A = 200 \text{ mm}^2$;
 $E = 70 \text{ GPa}$; $\nu = 0.3$;
 $P = 2 \text{ kN}$;
 $k = 400 \text{ N/mm}$;

Question 1

Discuss and illustrate the compatibility condition for a semi-monocoque beam with N cells.