

ORDRE DES INGÉNIEURS DU QUÉBEC
SESSION IN NOVEMBER 2017

Open Book examination
Calculators: Models allowed only
Duration of the examination: 3 hours

16-MC-A6 Advanced Strength of Materials

There are four (4) questions presented on two pages.

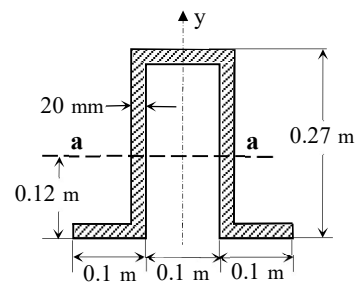
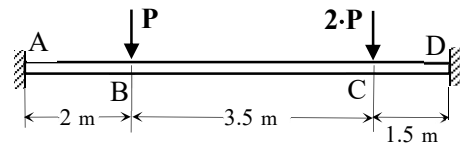
Question 1 (25 points)

The beam ABCD is fixed at two ends A et D. The beam is subjected to a load P downward at B and a load $2 \cdot P$ downward at C.

The dimensions of the cross section of the beam are given in figure 1. Note that the axis $a-a$ divides the area of the section into two equal parts.

The material of the beam is elastic perfectly plastic with the yield stress $S_Y = 250 \text{ MPa}$.

Calculate the fully plastic load P of this beam (P_p).



Thickness of 20 mm everywhere

Figure 1

Question 2 (25 points)

The figure 2 shows the plane stress state in a ductile material with the yield stress $S_Y = 250 \text{ MPa}$.

Determine the permissible limits of the normal stress σ_y for a safety factor of 2 with respect to the elastic limit according to the Tresca criterion.

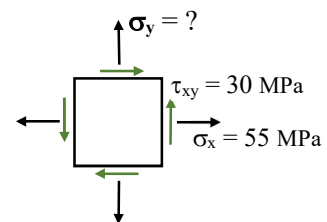


Figure 2

Question 3 (25 points)

The beam ABCD illustrated in figure 3 having a cross section of the square tube $50.8 \times 50.8 \times 6.35$ mm, is fixed at D and simply supported at A.

The beam is subjected to a vertical load $P = 5$ kN downward at C.

The modulus of elasticity of material is $E = 2 \times 10^5$ MPa.

By neglecting the energies due to shear force and the axial force, calculate the reaction force at A and the vertical displacement at C.

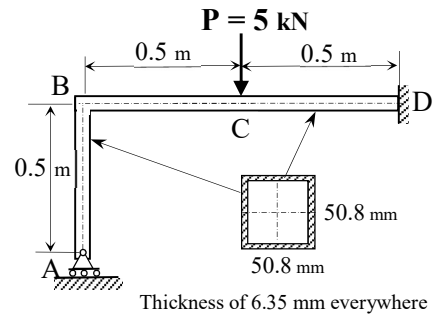


Figure 3

Question 4 (25 points)

The platform CD is rigid and supported by a hinge at D and a standard S75×11.2 steel member AB having the modulus of elasticity $E = 2 \times 10^5$ MPa and the yield stress $S_Y = 250$ MPa.

The joints A and B are eccentric of 0.09 m on the y axis of the cross section (see Figure 4).

Under the vertical load of 40 kN downward and by neglecting the weight of the members, calculate:

- Safety factor with respect to buckling of AB about y axis;
- The maximum normal stress in compression in the member AB.

Note: The properties of the cross section S75×11.2 are:

$A = 1426$ mm²; $h = 76$ mm; $I_{xx} = 1.22 \times 10^6$ mm⁴; $I_{yy} = 0.244 \times 10^6$ mm⁴

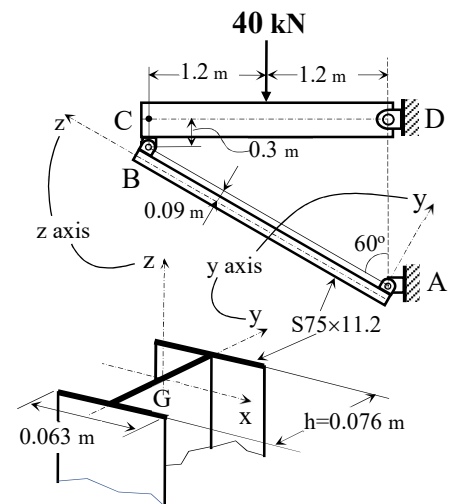


Figure 4