ORDRE DES INGÉNIEURS DU QUÉBEC

SESSION IN MAY 2018

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.

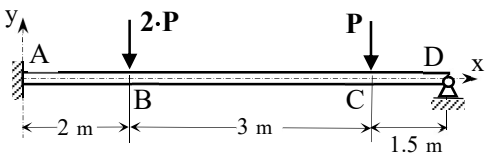
Question 1 (25 points)

The beam ABCD is fixed at A and simply supported at D. The beam is subjected to a load **2·P** downward at B and a load **P** downward at C.

The dimensions of the cross section of the beam are given in figure 1.

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

Calculate the value of **P** at fully plastic state of this beam (P_P).



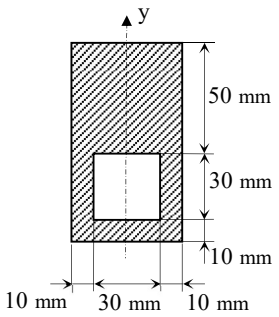


Figure 1

Question 2 (25 points)

Three strain gauges a, b and c (Figure 2) glued on the free surface (i.e. in plane stress state) of the steel part registered the following strains when the part is loaded: $\varepsilon_a = 120*10^{-6}$, $\varepsilon_b = 180*10^{-6}$ and $\varepsilon_c = 320*10^{-6}$.

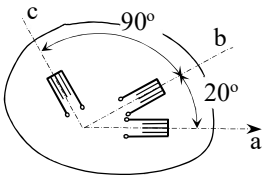


Figure 2

The elastic properties of steel are: Modulus of elasticity $E = 2*10^5$ MPa; Poisson's ratio $\nu = 0.3$ and Yield stress $S_Y = 250$ MPa. Calculate:

a) the principal strains,

b) the principal stresses of this stress state,

c) its safety factor according to the Von-Mises yield criteria.

Question 3 (25 points)

The beam AB with the diameter d = 128 mm, is fixed at A and welded with the beam BC which has a rectangular cross section 20×64 mm (see Figure 3).

The point C is simply supported in the vertical direction.

All members are made of steel with modulus of elasticity $E = 2*10^5$ MPa and Poisson's ratio $\nu = 0.3$.

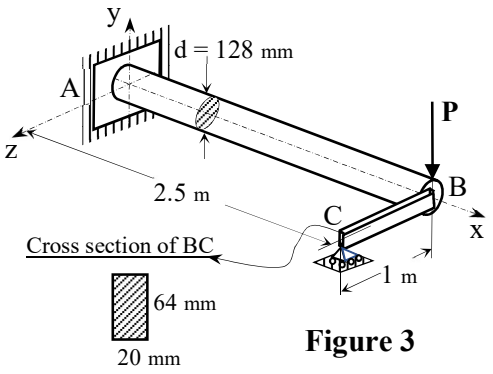


Figure 3

By neglecting the energies due to shear force, calculate the reaction force at C due to a vertical load P = 2 kN applied at B.

Question 4 (25 points)

The platform DC is rigid and supported by a hinge at D and a steel rectangular tube 48×72×6 mm BA having the modulus of elasticity $E = 2*10^5$ MPa and the yield stress $S_Y = 250$ MPa.

The joints B and A are also supported in the y direction (out of ABCD plane) and are eccentric by 0.06 m on the negative side of x-axis of the cross section (see Figure 4).

Under the vertical load of 80 kN downward and by neglecting the weight of the members, calculate:

a) Safety factor with respect to buckling of BA about x axis;

b) The maximum normal stress in compression in the member BA.

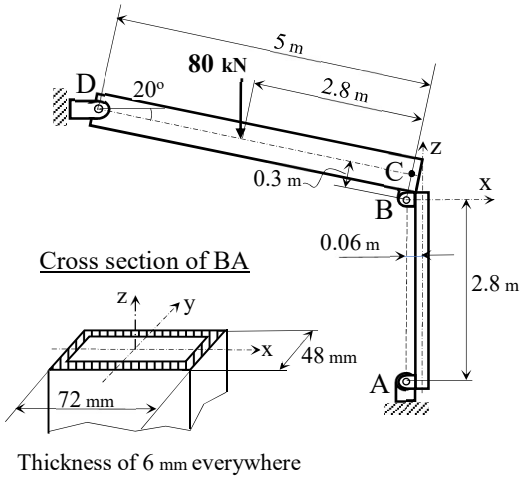


Figure 4