Ministry of Higher Education
Giza Higher Institute of Engineering & Technology
Civil Engineering Department
Course Name: **Theory of Structures (1)B**
Course Code : **CIV 121** Date : **30 / 3 / 2019**

Academic Year : **2018/2019**
Semester : **Second**
Level : **1st Civil**
Time : 1 **Hour**
Examiner: ***Dr. M. Abdel-Kader***

Answer of Mid-Term Exam

Total Marks: **30** No. of Questions:**2** (Attempt all questions)

Student Name: Code:

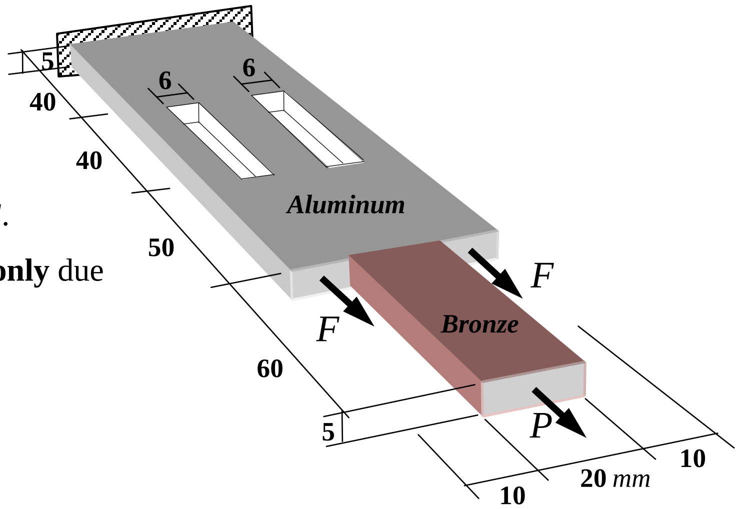
Question (1): (15 Marks)

A bar of variable cross-section is subjected to axial forces as shown.

(a) Determine the maximum safe values of ***P*** and ***F***.

(b) Determine the deformation of the **Bronze** part **only** due to the force P_{Safe} calculated in (a).

Given Data:
Allowable stress for bronze = 100 *MPa*
Allowable stress for aluminum = 90 *MPa*
E =2.0 *GPa*



Solution:

(a)

For bronze:

$$\sigma_{bronze} = \frac{P_{bronze}}{A_{bronze}} \le 100\ N/mm^2 \rightarrow \frac{P}{20\times 5} \le 100 \rightarrow P \le 10000\ N$$

$$\therefore\ P_{Safe} = 10000\ N\ \ldots (1)$$

For aluminum (the critical section is at the hollow part):

$$\sigma_{alum} = \frac{P_{alum}}{A_{alum}} \le 90\, N/mm^2 \rightarrow \frac{P_{Safe} + 2F}{(40-2\times 6)\times 5} \le 90$$

$$\rightarrow \frac{10000+2F}{(40-2\times 6)\times 5} \le 90 \rightarrow F \le 1300\ N$$

$$\therefore\ F_{Safe} = 1300\ N\ \ldots (2)$$

Form (1) and (2), the maximum safe values of axial forces ***P*** and ***F*** are **10 *kN and* 1.3 *kN***

(b)

$E = 2.0\ GPa = 2.0\times 10^3\ MPa = 2.0\times 10^3\ N/mm^2$

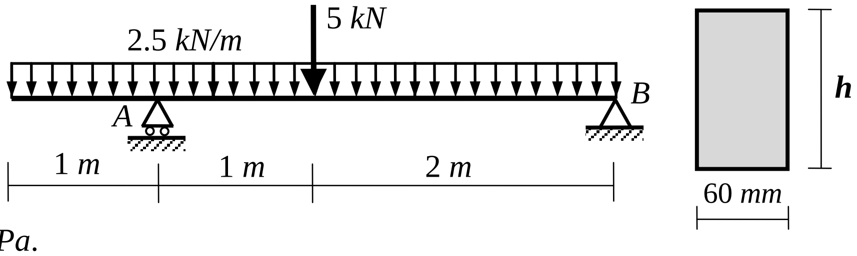
$$\Delta = \frac{P_{safe} L}{EA} = \frac{10000\times 60}{2000\times(20\times 5)} = 3\ mm$$

The deformation of the **Bronze** part **only** due to P_{Safe} = 3 mm **Δ = 3 *mm***

Please turn over

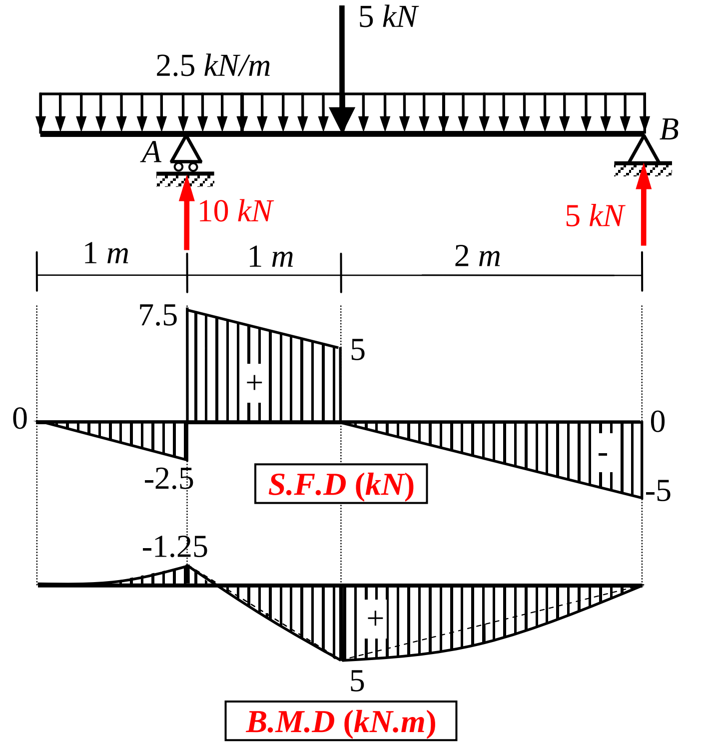
Question (2): (15 Marks)

Determine the minimum height ***h*** of the cross section of the beam loaded as shown.



The maximum flexural stress, $f_{b\,max} = 30\ MPa$.
Note: *S.F.D* and *B.M.D* are required.

Solution:



$+\circlearrowleft \sum M_B = 0:$

$A_y(3) - (2.5\times4)(2) - 5(2) = 0 \rightarrow A_y = 10\ kN \uparrow$

$+\uparrow \sum F_y = 0:$

$A_y + B_y - (2.5\times4) - 5 = 0 \rightarrow B_y = 5\ kN \uparrow$

$$I_x = \frac{60h^3}{12} = 5h^3\ mm^4$$

$$M_{max} = 5\ kN.m = 5(1000)(1000)\ N.mm$$

$$= 5\times10^6\ N.mm$$

$$y_{max} = \tfrac{1}{2}h\ mm$$

$$f_{b\max} = \frac{M_x}{I_x} y_{max} \rightarrow 30 = \frac{5\times10^6}{5h^3}(\tfrac{1}{2}h)$$

$$\rightarrow 30 = \frac{0.5\times10^6}{h^2} \rightarrow h^2 = 18750\ mm^2 \rightarrow h = 129.1\ mm$$

$\therefore$ **The minimum height $h = 129.1\ mm$**

With best wishes
Dr. M. Abdel-Kader