بسم الله الرحمن الرحيم

King Fahd University of Petroleum & Minerals

DEPARTMENT OF CIVIL ENGINEERING

Second Semester 1433-34 / 2012-13 (122)

# CE 203 STRUCTURAL MECHANICS I

## Major Exam I

**Tuesday, March 12, 2013 6:30-8:45** P.M.

| Student Name | Family | | | | | First | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| ID No. (9 Digits) | | | | | | | | | |

| CIRCLE YOUR COURSE--SECTION NO. | | | | | |
|---|---|---|---|---|---|
| Section # | 1&4 | 3 | 2&8 | 5&6 | 7 |
| Instructor | Hamdan | Suwaiyan | Salah | Khathlan | Gadhib |

### Summary of Scores

| Problem | Full Mark | Score |
|---|---|---|
| 1 | 20 | |
| 2 | 20 | |
| 3 | 20 | |
| 4 | 20 | |
| 5 | 20 | |
| Total | 100 | |
| Remarks | | |

**Notes:**

1. **A sheet that includes selected Basic Formulae and definitions is provided with this examination.**
2. **Write clearly and show all calculations, FBDs, and units.**

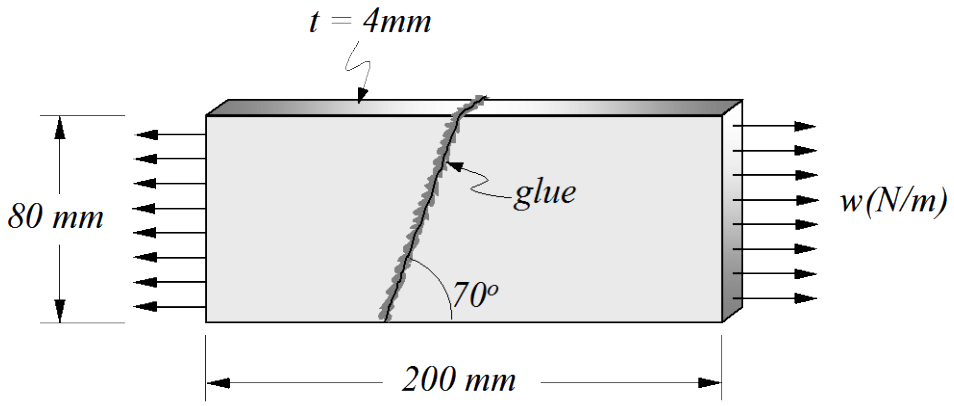
**Problem 1**: (20 points)

The given thin plate is made of two parts glued together as shown. The plate is subjected to an axial distributed load ***w*** *(N/m)*. Determine the largest value of ***w*** that can be applied.

For the plate material : ultimate normal stress = 60 *MPa*

For the glue : ultimate normal stress = 30 *MPa* , and ultimate shear stress = 15 *MPa*

**For the whole problem, use safety factor *S.F.* = 3**

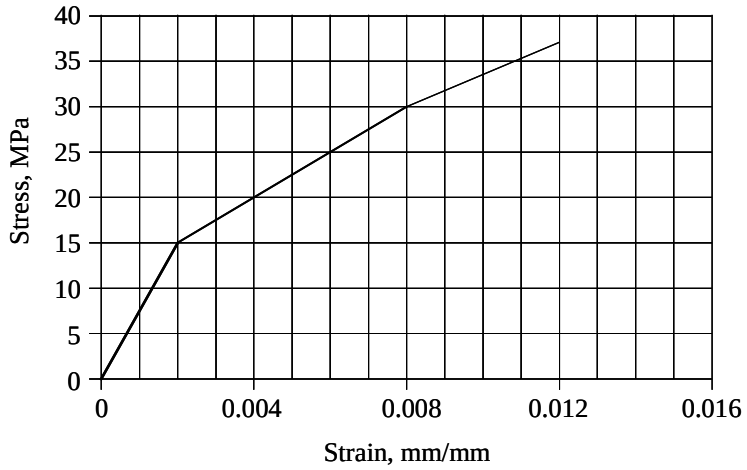


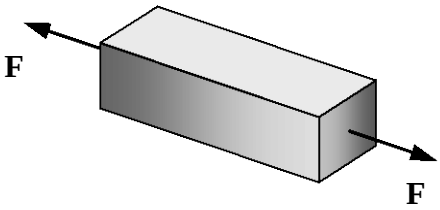
## **Problem 2**: (20 points)

A bar with the stress-strain diagram shown was originally 1 m long with a square cross-sectional area of 100 mm x 100 mm.
When an axial tension load F is applied, the square cross-section became 99.95 mm x 99.95 mm.
Determine the following:

a) The magnitude of the applied force F.
b) The final length of the bar when the load F is applied.
c) The final length of the bar when the load F is released.
d) The final length of the bar when the applied load is 300 kN.
e) The final length of the bar when the 300 kN load is released.

**Poisson's ratio, ν = 0.25**



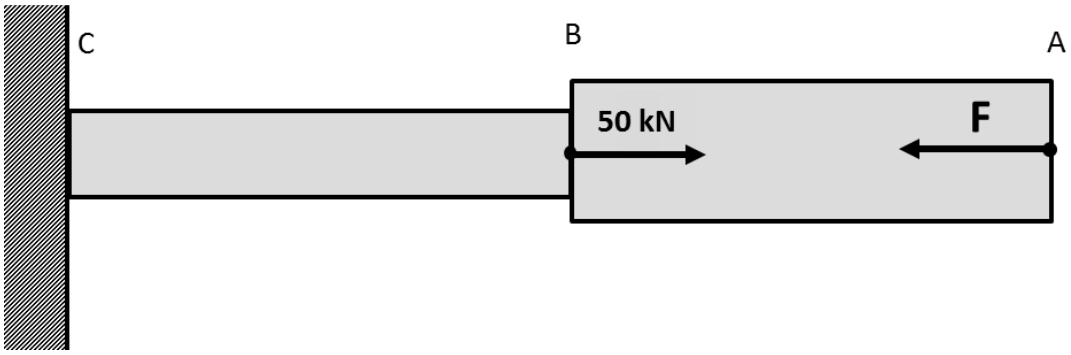



**Problem 3** (20 pts.)

The rods AB and BC are subjected to the *loads and temperature changes* shown in the figure and table below. Determine the **maximum allowable force F** that can be applied (in the shown direction) if

- the maximum allowable normal stress in AB is 150 MPa (tension or compression), and
- the maximum allowable normal stress in BC is 100 MPa(tension or compression), and
- the maximum allowable displacement of point A is $5(10)^{-4}$ m.

| *Properties* / *Member* | L (m) | A ($m^2$) | E (GPa) | $\Delta T$ (°C) | $\alpha$ ( /°C) |
|---|---|---|---|---|---|
| AB | 0.5 | $4\ (10)^{-4}$ | 200 | +40 | $20\ (10)^{-6}$ |
| BC | 0.6 | $3\ (10)^{-4}$ | 100 | -60 | $15\ (10)^{-6}$ |



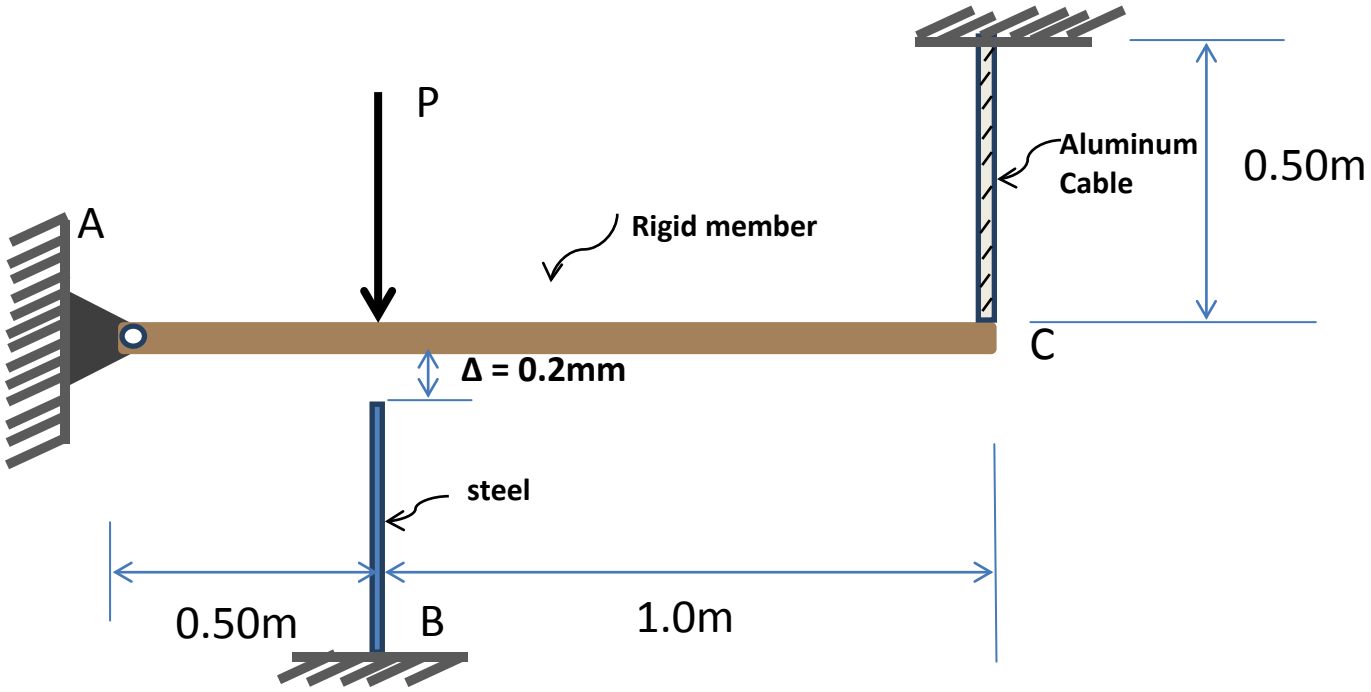
**Problem 4**: (20 points)

Rigid member AC is hinged at A and is supported by an aluminum cable at C. Before applying the load, AC was horizontal and a gap, $\Delta = 0.2$ mm separated it from a steel rod as shown.

If P = 24 kN, determine the following:

a) the stress in the aluminum cable.
b) the displacement of point C.

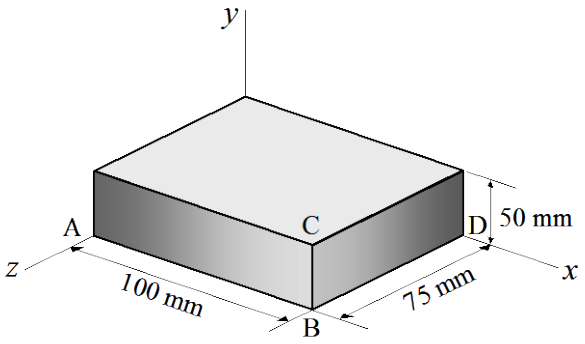
**$E_{aluminum}$ = 70 GPa, $E_{steel}$ = 200 GPa, $L_{steel}$ = 0.5 m**
**$A_{aluminum}$ = $A_{steel}$ = 50 $mm^2$**



**Problem 5**: (20 points)

The steel block shown is subjected to a uniform pressure p on all the faces. Knowing that the change in length of edge AB is $-30 \times 10^{-3}$ mm and using E = 200 GPa, and G = 75 GPa, determine the followings:

a) The magnitude of the applied pressure, p.
b) The strains in the x, y, and z directions.
c) The new length of AB, CB, and BD after the application of the uniform pressure p.
d) The change in volume, using any approach.




Initial Dimensions