QUIZ 2
Fall 2003-2004
(Thursday, January 8, 2004)
CIVE310 - MECHANICS OF MATERIALS
CLOSED BOOK, 2 HOURS

Name: _____ **ID#:** _____

FORMULAS/EQUATIONS: GENERAL FORM (USE CAREFULLY)

$P/A;$	$Tc/J;$	$Mc/I;$	$bh^3/12;$	$\Pi R^4/2;$	$2\Pi R^3 t$

NOTES
- 2 PROBLEMS – 12 PAGES.
- ALL YOUR ANSWERS SHOULD BE PROVIDED ON THE QUESTION SHEETS.
- **TWO EXTRA SHEETS ARE PROVIDED AT THE END.**
- **ASK FOR ADDITIONAL SHEETS IF YOU NEED MORE SPACE.**
- SOME ANSWERS MAY REQUIRE MUCH LESS THAN THE SPACE PROVIDED.
- ***DO NOT*** USE THE BACK OF THE SHEETS FOR ANSWERS.
- DRAFT BOOKLET WILL BE PROVIDED; BUT DO NOT USE FOR ANSWERS.
- BOTH QUESTION SHEETS AND DRAFT BOOKLET SHOULD BE RETURNED.
- CHECK BOXES ARE FOR YOU TO CONFIRM THAT HAVE SOLVED A QUESTION ☑

YOUR COMMENT(S)

_ _

_ _

DO NOT WRITE IN THE SPACE BELOW

MY COMMENT(S)

_ _

_ _

YOUR GRADE

Problem I: _ _ _ /60
Problem II: _ _ _ /40

_____
TOTAL: /100

Problem I: *(60 points)*

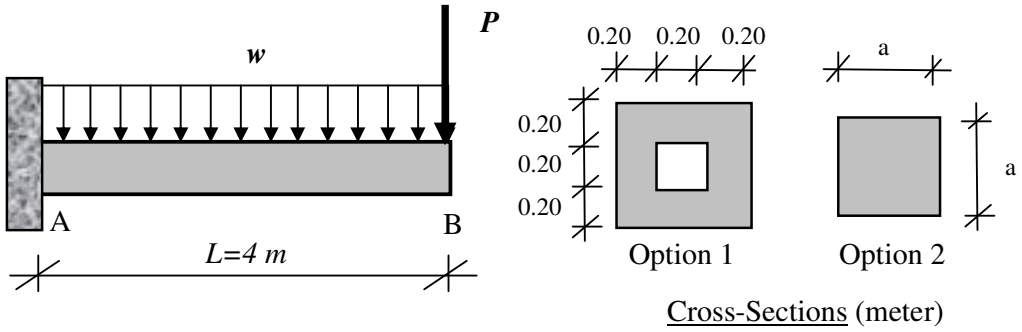


Figure I

A fixed beam is loaded as shown in Figure I. Two options of cross-sections will be studied: Option 1 is a hollow square box shape, and Option 2 is a solid square shape. Assume linear elastic behavior and that the beam is safe in shear. Neglect the own weight of the beam.

The ***dimensions*** of the beam are shown on the Figures.

The following are the ***properties*** of the system:

- $E = 20 \times 10^6$ kPa (kN/m^2) : Modulus of elasticity
- $\sigma_{YT} = 40{,}000$ kPa : Yield stress in tension
- $\sigma_{YC} = 30{,}000$ kPa : Yield stress in compression

The following ***loads*** are to be considered:

- w : Distributed load through L
- P : Concentrated load at tip of beam

1. Let w = 50 kN/m and P = 100 kN.
   Let a = 0.60 m for Option 2.
   - Draw the shear and bending moment diagrams, and sketch the deflected shape in the beam. (*10 points*) ☐
   - For each option, show the stress distribution due to bending on the critical cross-section, and discuss the safety of the beam for bending. Compare cost and safety between the two options and briefly comment. (*20 points*) ☐
   - Calculate the curvature of the beam at A. (*5 points*) ☐

   Calculations and/or Diagrams:

Calculations and/or Diagrams (cont'd):

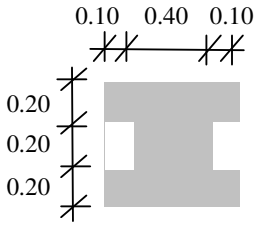
Calculations and/or Diagrams (cont'd):

2. Determine the moment capacity for Option 1? How does this moment capacity correlate with Option 1 in Question 1? (*10 points*) ☐
   Find "a" for Option 2 which will lead to the same moment capacity as Option 1. Compare cost for Options 1 and 2, and comment on the effect of the inner void in Option 1. (*10 points*) ☐

   Calculations and/or Diagrams:

Calculations and/or Diagrams (cont'd):

3. How would Questions 1 and 2 change if Option 1 is replaced by the I shape below? Explain very briefly. This is a 3 mn, 3 lines question with no calculations needed. (*5 points*)



Calculations and/or Diagrams:

Problem II: *(40 points)*

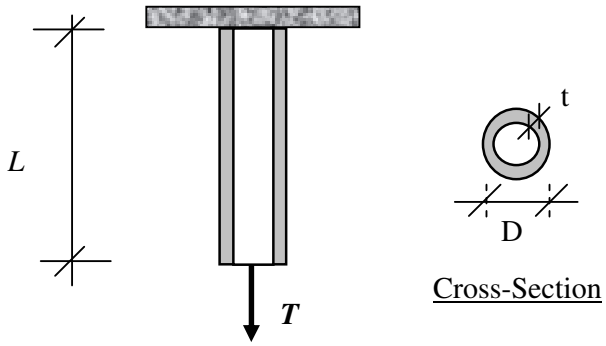


Figure II

- Design (find cross-section and length) of the thin tubular steel shaft shown in Figure II, given the loading, properties and constraints below. (25 points)
- Draw the stress distribution on the cross-section along the circumference, and calculate by integration the equivalent to torque and compare to the applied torque. (15 points)

- ***This should be a thin tube with t/D< 1/20***
- Ignore own weight
- T = 1,000 kNm
- G = 100 x 10^6 kPa (kN/m^2) : Shearing modulus of elasticity
- $\gamma_{allowable}$ = 0.001 : Allowable shear strain
- Rotation limited to 0.01 rad

Calculations and/or Diagrams:

Calculations and/or Diagrams (cont'd):

EXTRA SHEET: Continued from page _____

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Calculations and/or Diagrams: