VERY IMPORTANT

I AM AWARE THAT THE CIVE310 FINAL EXAM IS NOW RE-SCHEDULED TO

Tuesday, January 21, 2003, at 3:00 PM, in Wing D

Your Signature, please: _____

QUIZ 2

Fall 2002-2003

(Thursday, January 9, 2003)

CIVE310 - MECHANICS OF MATERIALS

CLOSED BOOK, 1 ½ HOURS

Name: _____ **ID#:** _____

NOTES

- 3 PROBLEMS – 17 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.

YOUR COMMENT(S)

_ _

_ _

DO NOT WRITE IN THE SPACE BELOW

MY COMMENT(S)

_ _

_ _

YOUR GRADE

Problem I:	_ _ _ /50
Problem II:	_ _ _ /15
Problem III:	_ _ _ /35
Other:	_ _ _
TOTAL:	/100

Problem I: *(50 points)*

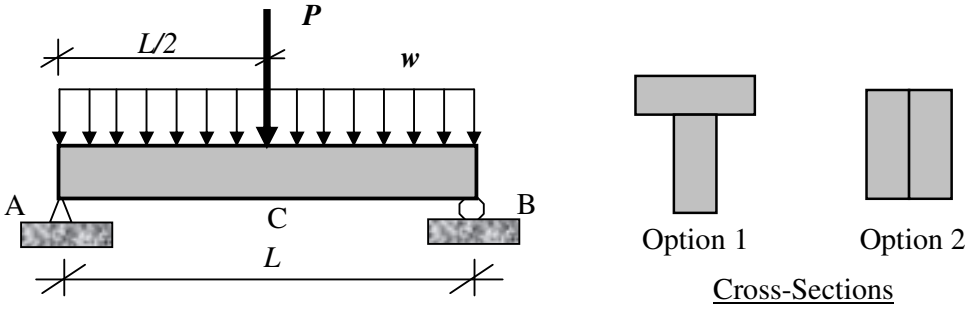


Figure I

A simply supported beam is loaded as shown in Figure I. Two options (1 and 2) of cross-sections will be studied having the same cross-sectional area; they are each made of two equal pieces arranged as shown. Assume linear elastic behavior and that the beam is safe in shear.

The ***dimensions*** of the beam are given as follows:

- L = 6 m
- a = 0.20 m
- b = 0.60 m

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

- E = 20 x 10^6 kPa (kN/m^2) : Modulus of elasticity
- σ_{YT} = 40000 kPa : Yield stress in tension
- σ_{YC} = 40000 kPa : Yield stress in compression

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

- w = 50 kN/m : Distributed load including own weight of the beam
- P : Load positioned at mid-span

1. Let P = 200 kN
   Draw the shear and bending moment diagrams 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 safety between the options and briefly comment (*20 points*)

   Calculations and/or Diagrams:

Calculations and/or Diagrams (cont'd):

Calculations and/or Diagrams (cont'd):

2. If a factor of safety of FS=1.5 is desired, determine the maximum allowable load *P* in each of the options and compare. Do your comparisons in Question 1 and 2 make sense with each others? (*20 points*)

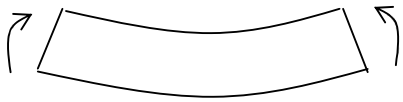
   Calculations and/or Diagrams:

Calculations and/or Diagrams (cont'd):

Calculations and/or Diagrams (cont'd):

Problem II: (*15 points*)

This problem is unrelated to Problem I, though solving Problem I first can help. No calculations are needed.



Beam Longitudinal Section

Option 1 Option 2 Option 3 Option 4

Figure II

A beam is subjected to a positive bending moment as shown in the longitudinal section in Figure II. Each of the cross-sections used is made of the same two equal pieces (each piece is 0.2x0.6 m) arranged as shown (Options 1 to 4), i.e. they have the same cross-sectional areas.

1. Rate the sections from best to worse for bending, assuming that the allowable stresses in tension and compression are equal. *(7 points)*

Best: 2nd: 3rd: Worst:

2. Assuming that the allowable stress in tension is larger than the allowable stress in compression. Circle the correct answer. *(8 points)*

   - Option 1 is better than Option 3 for Bending: **TRUE** **FALSE**

   - Option 2 is better than Option 4 for Bending: **TRUE** **FALSE**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Problem III: *(35 points)*

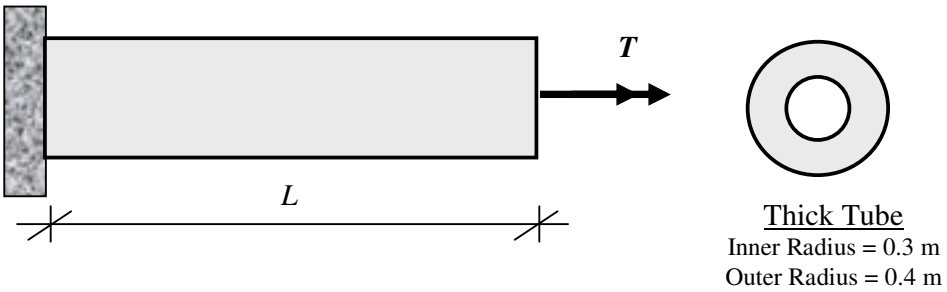

Figure III

The ***thick*** tube shown in Figure III is to be replaced by an equivalent
- (i) ***solid*** tube
- (ii) ***thin*** tube (thickness = 1 cm = 0.01 m)

1. Determine the radii of the solid and thin tubes which will have the same rotation at the free end as the thick tube. Evaluate the savings or the additional cost (comparing solid and thin vs. thick, in percentage) that this will entail, assuming that cost is dependent only on the amount of material used. (15 points)

   Calculations and/or Diagrams:

Calculations and/or Diagrams (cont'd):

2. Determine the radii of the solid and thin tubes which will have the maximum shear stress as the thick tube. Compare savings or additional cost with Question 1 and briefly comment. *(15 points)*
   Draw the shear stress distribution on the cross-sections for the three tubes for T = 100 kNm. *(5 points)*

   Calculations and/or Diagrams:

Calculations and/or Diagrams (cont'd):

EXTRA SHEET: Continued from page _____

Name: _____ **ID#:** _____

Calculations and/or Diagrams:

EXTRA SHEET: Continued from page _____

Name: _____ **ID#:** _____

Calculations and/or Diagrams: