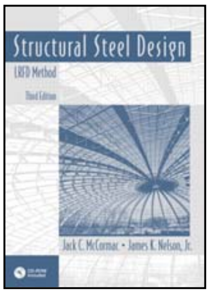
Name: ______________________________

University of Maryland, College Park

Department of Civil & Environmental Engineering

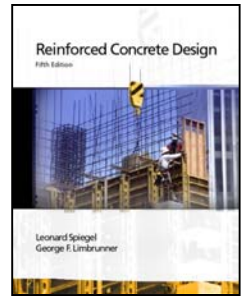
ENCE 355 – Introduction to Structural Design



<u>Honor Pledge Code</u>

"I pledge on my honor that I have not given or received any unauthorized assistance on this assignment/examination."

Signature: ______________________________



Grading:

Problem 1:	______	/ 40
Problem 2:	______	/ 30
Problem 3:	______	/ 30
Total:	______	/ 100

EXAM II

Friday, December 6, 2002
9:00 AM – 9:50 AM, EGR 2112

Instructor: Dr. I. Assakkaf

Policies:

1. Write your name on all sheets.
2. Use only the paper provided. Ask for additional sheets, if required.
3. Place only one problem on each sheet (front and back).
4. Draw a box around answers for numerical problems.
5. Give all answers to 3 or 4 significant figures.
6. Include free body diagrams (FBD's) for all equilibrium problems.
7. Closed book / closed notes; Manual and formula sheet permitted.
8. **<u>SHOW ALL WORK USED TO ARRIVE AT YOUR ANSWER</u>.**

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Problem #1 (40 points)

I. True or False (8 points)

If each of the following statements is true, circle T, otherwise circle F:

(1) Under certain conditions steel may lose its ductility, and brittle fracture may occur at places of stress concentration. — (T) F

(2) The accurate determination of the loads to which a steel structure or steel structural element will be subjected is always predictable. — T (F)

(3) Steel is very weak in compression. — T (F)

(4) Dead loads are defined as gravity loads that can act when the structure is in service, but can vary in magnitude and location — T (F)

(5) According to the LRFD design philosophy, one factor of safety is used that accounts for the entire uncertainty in loads and strength. — T (F)

(6) Environmental loads include, but not limited to, snow, wind, earthquake, and rain loads. — (T) F

(7) One inch of snow load is equivalent to a load of approximately 0.5 psf. — (T) F

(8) The strength of structural steel member can be increased if this member is subjected to cyclic loading (fatigue loading). — T (F)

II. Fill in the blanks (12 points)

Complete the following five statements. Note that you are allowed to ONLY use terms from the list below; other terms WILL NOT be accepted.

(a) For most structures, the use of steel columns is very economical because of their high strength-to-weight ratios. However, as the length and slenderness of a compressive column is increased, its danger of _**buckling**__ increases.

(b) The important thing to remember about specifications and building codes is that they are written, not for the purpose of restricting engineers, but for the purpose of protecting the ___**public**____.

(c) Under certain conditions steel may lose its ___**ductility**___, and brittle fracture may occur at places of stress concentration. Fatigue type loadings and very low temperatures trigger the situation.

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(d) The yield strength of steel is always less than its __**tensile strength**__.

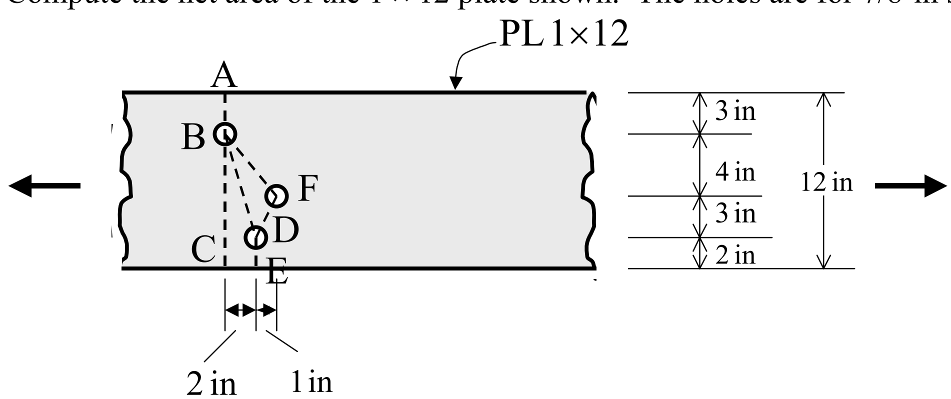
(e) The properties of steel used in structures can be greatly changed by varying the quantities of _____**carbon**_________ present and adding other elements such as silicon, nickel, manganese, and copper. Steel having a significant amount of these elements is referred to as _____**alloy**_____ steel.

List of possible terms:

brittle	tensile strength	hydration	compressive strength
ductility	remain the same	Young's modulus	modulus of elasticity
deform	public	carbon	Old's modulus
alloy	modulus of rupture	splitting tensile strength	buckling

III. Net Area of a Tension Member (20 points)

Compute the net area of the 1 × 12 plate shown. The holes are for 7/8-in standard bolts.



***** SOLUTION *****

Net widths:

$$ABC = 12 - (1)\left(\frac{7}{8} + \frac{1}{8}\right) = 11.0 \text{ in}$$

$$ABDE = 12 - (2)\left(\frac{7}{8} + \frac{1}{8}\right) + \frac{(2)^2}{4(7)} = 10.12 \text{ in}$$

$$ABFDE = 12 - (3)\left(\frac{7}{8} + \frac{1}{8}\right) + \frac{(3)^2}{4(4)} + \frac{(1)^2}{4(3)} = 9.65 \text{ in} \leftarrow \text{controls}$$

Net area:

$$A_n = 9.65(1.0) = \boxed{9.65 \text{ in}^2}$$

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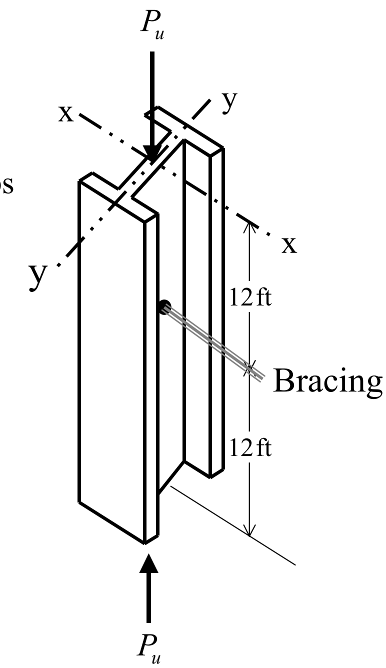
Problem #2 (30 points): A W section is to be selected to support axial compressive dead and live loads of P_D = 400 kips and P_L = 700 kips, respectively. The member, which is to be 24 ft long and to be pinned top and bottom, has lateral support (pinned) supplied in the weak direction at middepth as shown. Select the lightest W12 section using A572 Grade 50 steel.

***** SOLUTION *****



Trying W12's:
$P_u = 1.4\,(400) = 560$ kips
$P_u = 1.2\,(400) + 1.6\,(700) = 1600$ kips ← controls
Entering LRFD tables with $K_yL_y = 12$ ft, $F_y = 50$ ksi and $P_u = 1600$ kips

Try W12 × 152 ($\frac{r_x}{r_y} = 1.77$)

Equivalent $K_yL_y = \dfrac{K_xL_x}{\frac{r_x}{r_y}} = \dfrac{24}{1.77} = 13.56\text{ ft} > K_yL_y = 12$ ft

Therefore,
Reenter tables with $K_yL_y = 13.56$ ft and $P_u = 1600$ kips
And hence,

Select W12 ×170

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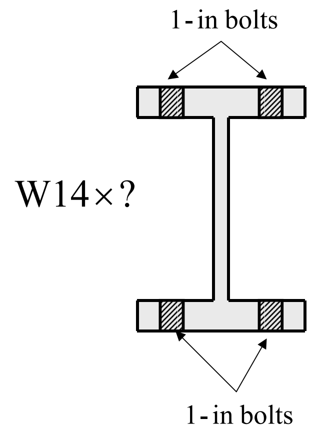
Problem #3 (30 points): Neglecting block shear, select the lightest W14 section available to support a factored tensile load P_u of 664 kips. The member is to be 30 ft long and is assumed to have two lines of holes for 1-in standard bolts in each flange as shown. There will be at least three bolts in each line 4 inch on center. Use F_y = 50 ksi and F_u = 65 ksi. (Note that $U = 1 - \frac{\bar{x}}{L} \leq 0.90$)

***** SOLUTION *****



$$\min A_g \text{ required} = \frac{P_u}{\phi_t F_y} = \frac{664}{0.9(50)} = 14.76 \text{ in}^2$$

Assume $U = 0.9$

$$\min A_g = \frac{P_u}{\phi_t F_u U} + \text{estimated area of holes}$$

$$= \frac{664}{0.75(65)(0.9)} + 4\left(1 + \frac{1}{8}\right)(0.72) = 18.37 \text{ in}^2 \Leftarrow$$

$$\min r = \frac{L}{300} = \frac{12(30)}{300} = 1.20 \text{ in}$$

Try W14 × 68 (A_g = 20.0 in^2, t_f = 0.720 in, r_y = 2.46 in)

<u>Checking:</u>

$\phi_t P_n = 0.9(50)(20) = 900 \text{ kips} > 664 \text{ kips}$ OK

$A_n = 20 - 4\left(1 + \frac{1}{8}\right)(0.72) = 16.76 \text{ in}^2$

$\bar{x} = \bar{y}$ for a WT7 × 34 = 1.29 in

$U = 1 - \frac{\bar{x}}{L} = 1 - \frac{1.29}{8} = 0.839 < 0.9$ OK

$\phi_t P_n = 0.75(65)(0.839)(16.76) = 685.5 \text{ kips} > 664 \text{ kips}$ OK

$\frac{L}{r} = \frac{12(30)}{2.46} = 146.3 < 300$ OK

Therefore,

Select W14 ×68