Course Assessment

Course: CIEG 302 Structural Design

Instructor: Michael Chajes and Dennis Mertz

Semester: 04S **Enrollment:** 54 **Credits:** 4

Assessed Outcome: #1 Knowledge of Math & Science

Assignment Assessed: Midterm Exam, Problem #2

Number of Samples Assessed: 53

Average Score: 2.87

Standard Deviation: 0.92

CIEG 302, Spring 2004 Exam Name ____________________

Problem 1	Problem 2	Problem 3	Total

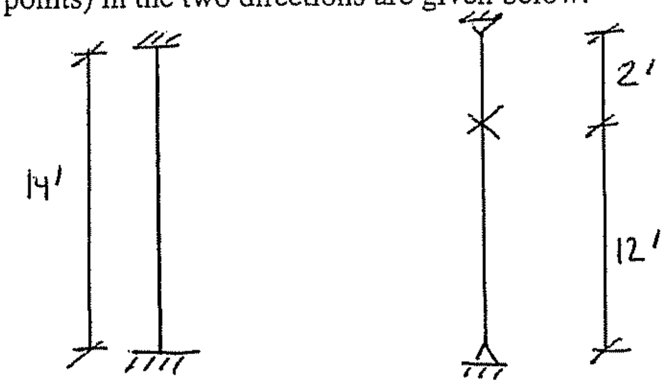
(35 points) Problem 1

A 6" x ¾" plate and a 4" x 4" x ½" angle ($A_g = 3.75$ in^2) are bolted together. In the connection, three 7/8" diameter bolts are used. In addition, there are three empty holes in the outstanding leg of the angle that have also been drilled for 7/8" bolts. These holes are staggered from the holes in the connected leg. Assuming that the bolts do not fail, **find the maximum tensile load that can be carried**. Both the angle and plate are made of Grade 50 steel. In your solution, take U=1.0 for the plate and U=0.85 for the angle.

As part of your answer, be sure to explain what governs the maximum load (i.e. failure mode and member).

(35 points) Problem 2

A Grade 50 W14x58 rolled section is to be used for a 14 foot tall column. For the member, $A_g = 17.0$ in^2, $r_x = 5.28$ in, and $r_y = 2.51$ in. The boundary conditions (and any intermediate brace points) in the two directions are given below.



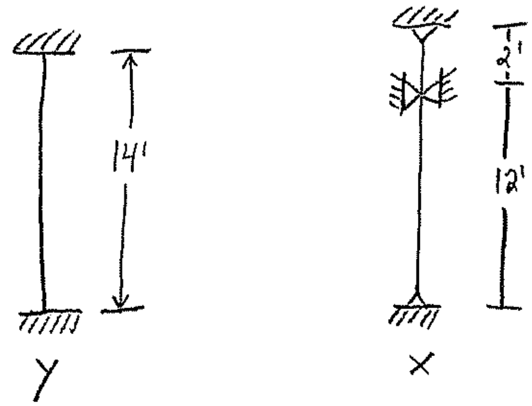
Find the maximum factored load Pu that the column can carry. As part of your answer, be sure to tell us how the column cross-section should be oriented.

(30 points) Problem 3

Design the reinforced concrete cross-section that can carry a factored load.
Pu = 1,000 kips and has the minimum gross area Ag. In your design, use only #9 rebar having an fy = 60 ksi and concrete having a strength of f'c = 6 ksi.

As part of your answer, sketch the cross-section and label important parameters.

Problem 2



$K_xL_x = (1.0)(2) = 2.0$

$K_xL_x = (1.0)(12) = 12.0$ ← Controls

$K_yL_y = (0.5)(14) = 7.0$

0.65

which one?

$12.0\left(\frac{2.51}{5.28}\right) = 5.70$

$\frac{KL}{r} = 2.27$

units!

$\lambda_c = \frac{KL}{r\pi}\sqrt{F_y/E}$

$\lambda_c = 0.03$

10

$F_{cr} = 0.658^{\lambda_c^2}(F_y)$

$F_{cr} = 1.000(F_y)$

$P_u \leq \phi_c A_g F_{cr}$

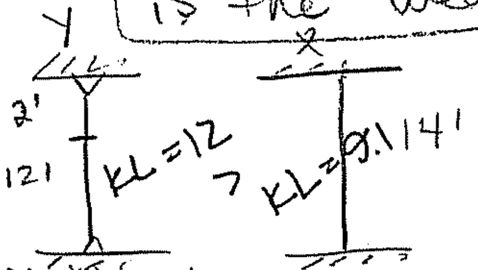
$P_u \leq (0.85)(17)(1)$

$P_u = 14\ k$ (F_y)

2) $F_y = 50\,ksi$ W14 × 58 14 ft = L = 168" 3

$A_g = 17.0\,in^2$ $r_x = 5.28\,in$ $r_y = 2.51\,in.$

Column should be oriented so Direction 2 is the strong axis (x) and Direction 1 is the weak axis (y). wrong!



$KL = (.65)(14)(12) = 109.2$

$L = (1)(2')(12) = 24$
$L = (1)(12)(12) = 144$

$\left(\frac{KL}{r}\right)_y = \frac{144}{25} = 57.6$ $\left(\frac{KL}{r}\right)_x = \frac{109.2}{5.28} = 20.68$

$\left(\frac{KL}{r}\right)_y$ is larger so it governs

$\lambda_c = \frac{57.6}{\pi}\sqrt{\frac{50}{29000}} = .7613 \leq 1.5$

so we use $F_{cr} = (.658^{\lambda_c^2})F_y$ for $\lambda_c \leq 1.5$

$F_{cr} = (.658^{.7613^2})(50) = 39.23\ ksi$

$P_u \leq \phi_c A_g F_{cr} = (.85)(17.0)(39.23) = 566.87\ kips$ X

check $\frac{L}{r} \leq 300 \Rightarrow \frac{168}{2.51} = 66.93 \leq 300$ so ok.

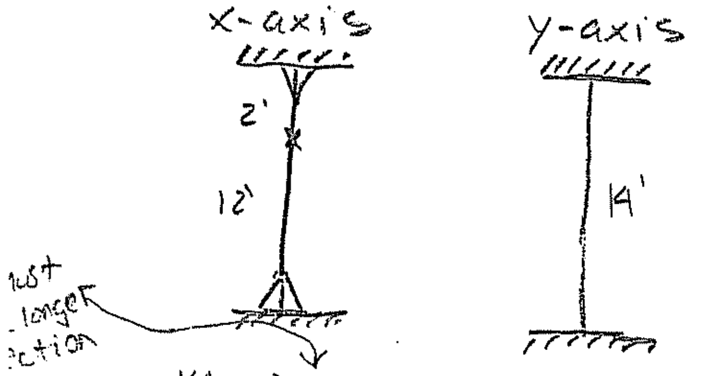
25

Grade 50 W14x58

14' tall column

$A_g = 17.0\,in^2$, $r_x = 5.28\,in$, $r_y = 2.51\,in$

MAX FACTORED LOAD P_u ? 4



KL => 12

KL => 14(.65) = 9.1

The y axis is the weak axis we want to place it in the direction that would make $\frac{KL}{r}$ smaller than placing it in the other section

∴

(35)

x axis => $\frac{KL}{r_x} = 27.27$

y axis => $\frac{KL}{r_y} = 43.51$ governs

put y axis in fixed support and x in pinned

$\lambda_c = \frac{KL}{r\pi}\sqrt{\frac{50\,Ksi}{29000}}$

$\lambda_c = \frac{14(.65)(12)}{2.51(\pi)}\sqrt{\frac{50}{29000}}$ => .575

$\frac{12}{2.51}$ or $\frac{9.1}{2.51}$ ⇓ ✓ smaller

$F_c = (.658^{(.575)^2})(F_y)$ => 43.53

$P_u = 17(43.53)(.85) =$ **629 Kips** ✓