

## ARCH 631. Assignment #6

**Date:** 10/2/18, due 10/18/18

Worth 20 pts.

### Problems:

1. Determine the ultimate moment capacity,  $\phi_f M_n$ , of a beam with dimensions  $b = 14$  in.,  $d_{\text{effective}} = 17.5$  in., and  $h = 20$  in., and that has three No. 10 bars ( $3.81 \text{ in.}^2$ ) of tension-reinforcing steel.  $F_y = 60$  ksi, and  $f'_c = 4$  ksi.

Answer:  $\phi_f M_n = 258.9$  k-ft

2. For the beam of Problem 1 which is simply supported and 32 ft long, and where the loads are dead load = 320 lb/ft (not including self weight) and live load = 185 lb/ft, determine if the beam is adequate in bending.  $\gamma = 150 \text{ lb/ft}^3$  (normal weight).

Answer: yes ( $M_u = 131.8$  k-ft)

3. For the beam of Problem 1, check whether the amount of tension steel is within the limits for ductile beam behavior. (Refer to the table for maximum  $\rho$  in Note Set 10.1)

**Partial Answer:** yes ( $A_{s\text{-max}} = 4.43 \text{ in.}^2$ )

4. For the beam of Problem 1 and 2, calculate the shear capacity,  $\phi_v V_c$ , and determine if the beam will require stirrups. Also, determine the spacing,  $s$ , if #3 U stirrups are required of grade 60 steel ( $f_y = 60$  ksi). Assume  $\lambda = 1.0$  for normal weight concrete.

Answer: yes ( $V_u = 15.0$  k at  $d$ , and  $> \frac{\phi_v V_c}{2} = 11.6$  k,  $s_{\text{req'd}} = 18.86$  in.,  $s_{\text{max}} = 8.75$  in.)

5. A reinforced concrete column in a rigid frame has a design compression load of  $P_u = 170$  kips, and a design moment of  $M_u = 34$  k-ft. With the interaction diagram provided on the next page, determine the amount of reinforcement (number and size of bars) required for a 10 in. square column.

**Partial Answer:** more than 4-#7.

6. A two story, three bay portal frame has lateral loads from wind at each story as shown. All columns are W12 x 40's while all beams are W 18 x 55's. Using a computer-based structural analysis program, determine the shear, bending moment and axial load in each member ( $V$ ,  $M$  &  $P$ ). Identify the column and beam with the critical design values. *Submit the model file (.vap) on E-learning, and provide a print of the diagrams.*

**Partial Answers:**  $V_{\text{max}}$  (2<sup>nd</sup> windward column, 1<sup>st</sup> story) = 31.35 kN

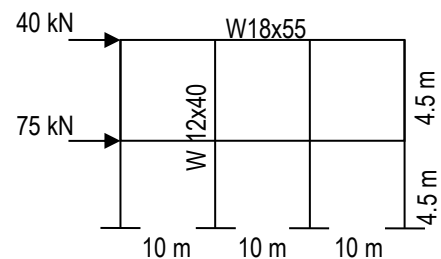
$V_{\text{max}}$  (1<sup>st</sup> windward beam, 1<sup>st</sup> story) = 11.10 kN

$P_{\text{max}}$  (exterior columns, 1<sup>st</sup> story) = 14.9 kN

$P_{\text{max}}$  (1<sup>st</sup> windward beam, 1<sup>st</sup> story) = 54.19 kN

$M_{\text{max}}$  (2<sup>nd</sup> windward column, 1<sup>st</sup> story) = 75.76 kN-m

$M_{\text{max}}$  (1<sup>st</sup> windward beam, 1<sup>st</sup> story) = 60.43 kN-m



7. Is the ultimate tensile capacity of 2-#6 grade 40 reinforcing bars greater than that of 1-#8 grade 60 bar?

*Partial Answer:* 2-#6  $T = 35.2$  kips, 1-#8  $T = 47.4$  kips

