ARCH 331. Assignment #9

Date: 6/29/15, due 7/1/15  Pass-fail work

Problems: as stated (none from Onouye)
Selected problems not required to be worked will be announced in class.

(17%) 9A) For the singly reinforced concrete beam sections described below, determine
i) depth of the compressive stress block
ii) acceptability of reinforcement ratio to minimum and maximums
iii) design moment capacity. (reinforced concrete beam analysis)

1) \( f_y = 60 \text{ ksi} \), \( f'_c = 6000 \text{ psi} \), \( A_s = 7.07 \text{ in}^2 \), \( b = 16 \text{ in} \), \( d = 30 \text{ in} \)

2) \( f_y = 60 \text{ ksi} \), \( f'_c = 5000 \text{ psi} \), \( A_s = 3.01 \text{ in}^2 \), \( b = 12 \text{ in} \), \( d = 20 \text{ in} \)

Partial answers to check with: 1.i) \( a = 5.20 \text{ in} \), ii) \( 0.0039 > \rho = 0.0147 < 0.0239 \), iii) \( \phi M_n = 872 \text{ k-ft} \); 2.i) \( a = 3.54 \text{ in} \), ii) \( 0.0035 > \rho = 0.0125 < 0.0213 \), iii) \( \phi M_n = 247 \text{ k-ft} \)

(18%) 9B) A rectangular concrete beam is to be designed using \( f'_c = 3000 \text{ psi} \), \( f_y = 40 \text{ ksi} \), density of 150 lb/ft\(^3\), \( b = 16 \text{ in} \), \( d = 32 \text{ in} \), and \( h = 36 \text{ in} \) for a simply supported span of 35 feet. Determine the area of steel required to carry superimposed loads (not including self weight) of 150 lb/ft dead and 400 lb/ft live. Assume the maximum coarse aggregate size is 1 in.. Check if the steel fits and if the steel reinforcement ratio is within limit. (reinforced concrete beam design)

Partial answers to check with: \( M_u = 235.8 \text{ k-ft} \), \( R_n < 200 \text{ psi (} \rho_{\text{min}} \) \), \( \rho = 0.0052 \) and \( \phi M_n = 243 \text{ k-ft} \)

(25%) 9C) Design a rectangular beam for a 22-ft simple span if a dead load of 2 k/ft (including an estimated self weight) and a live load of 2.9 k/ft are to be supported. Use \( f'_c = 4000 \text{ psi} \) and \( f_y = 60 \text{ ksi} \). The height of the beam should be between 1.5 to 2 times the width (which should be in whole inches). Assume there are \#3 U stirrups and a minimum of 1” clearance between bars and between rows (3/4” aggregate). Do not use bars larger than \#11’s. (reinforced concrete beam design)

Partial answers to check with: \( M_u = 425.9 \text{ k-ft} \). Your \( R_n \) with chosen \( b \) & \( h \) can range from 290 up to 434 psi where \( \rho_{\text{max}} - 0.005 = 0.0181 \). To check if the bars fit, subtract 3.75 in for cover and stirrups, the total number of bar diameters and spaces (no. of bars – 1) of 1 inch each. (Bars larger than \#8’s have custom diameters.) If the number is negative, the section is invalid. If your final reinforcement ratio is bigger than the max, the section is invalid.

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(20%) 9D) Find the area of steel reinforcement required for a concrete T-beam for the following data: \( f'_c = 3 \text{ ksi} \), \( f_y = 60 \text{ ksi} \), \( d = 18 \text{ in.} \), \( t = 4.5 \text{ in.} \), \( b_w = 10 \text{ in.} \), \( b_f = 36 \text{ in.} \), 3/4” aggregate, and the section sustains a total factored bending moment 82 k-ft. Note: the effective width does not need to be determined because the flange width is provided.

Partial answers to check with: \( a > 0.7 \text{ in.} \), \( A_{s-min} = 0.6 \text{ in.}^2 \)

(reinforced concrete T-beam design)

(20%) 9E) A one-way solid concrete slab is to be used for a simple span of 16 ft. In addition to its own weight, the slab carries a superimposed dead load of 55 lb/ft\(^2\) and a live load of 120 lb/ft\(^2\). Using \( f'_c = 4 \text{ ksi} \), and \( f_y = 60 \text{ ksi} \), design the slab for minimum overall thickness.

Partial answers to check with: \( t \approx 10 \text{ in.} \), \( R_n = 179 \text{ psi} \), so \( \rho_{min} \) governs,
\( A_s \geq 0.35 \text{ in.}^2/\text{ft} \), \( A_{temp-min} \approx 0.22 \text{ in.}^2/\text{ft} \) (transverse direction)

(reinforced concrete slab design)