CIE 429 Reinforced Concrete Design
Fall 2005

Name: Solution

Midterm Examination

Duration one hour and fifteen minutes (75 minutes)
Open Book, Notes & Other stuff.
No Neighborly Participation

"The fine print": Notes on the whole examination:

1) *The total points on the exam are 120. You are given an extra 20 points to account for computational and inadvertent errors. However your grade will not exceed 100 even if your score is more than 100. If you score 93, you will get a 93. If you score 110 your score will be 100.*
2) ***PLEASE BUDGET YOUR TIME**. YOU MAY WANT TO ANSWER FIRST THE SHORT (OR BEST KNOWN ANSWER) QUESTIONS.*
3) *If you feel that you are missing some data, ask or make a reasonable assumption.*

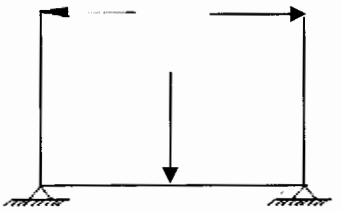
Problem #1: (20 points)

For the cantilever shown in the sketch with equal concentrated forces P in all places marked determine approximately:

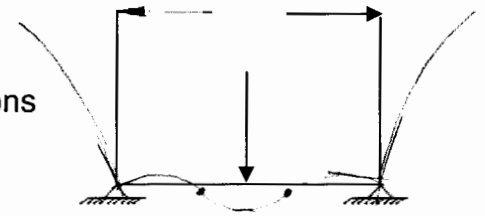
a) The deflected shape (5)
b) The moment diagram (5)
c) The shear diagram (5)
d) Show the location of reinforcement (side of structure and approximated length) (5)

Notes: *Show the answer graphically.* ***Use the exam sheet to answer your question.*** *Indicate the critical points. Indicate moments on the tension side and indicate the shear force pair (sign) for orientation. No credit of calculations; your answer must be estimated*

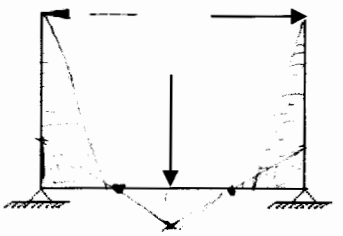
Problem



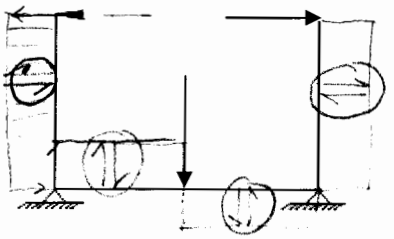
Deflections 5



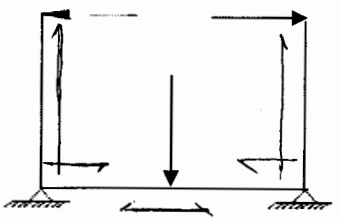
Moments 5



Shear 5



Reinforcement
~~Shear~~ 5



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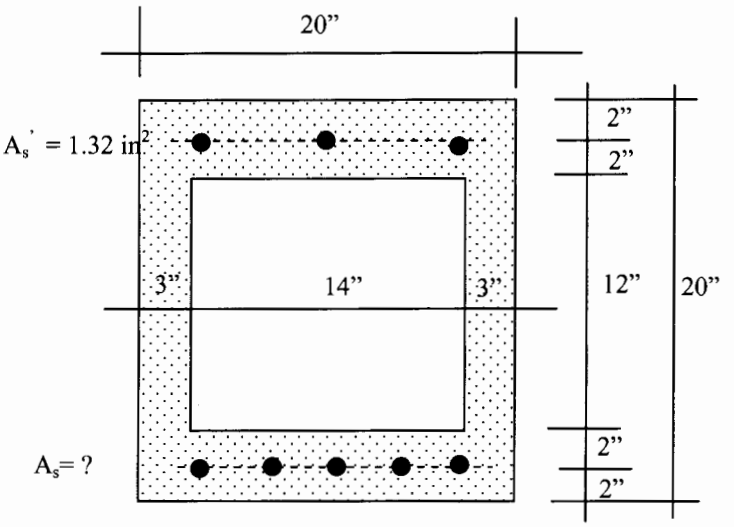
Problem #2: (40 points)

Determine the maximum reinforcement and the associated moment capacity M_{cap} of the section shown in the figure on the right according to ACI 318-05. The section is compressed in the top side.

1) Determine the allowable maximum value of the parameter which governs the maximum strength. (5)
2) Determine the moment contributed by the reinforcement provided in the compressed zone (7)
3) Determine the maximum moment capacity (23)
4) Determine the design moment capacity (5)

Parameters: $f_c' = 6$ ksi, $f_y = 60$ ksi



$\beta_1 = 0.85 - (6-4)\cdot 0.05 = 0.75$

(1) $k_{max} = \beta_1 \cdot \frac{\varepsilon_{cu}}{\varepsilon_{cu} + \varepsilon_{s,min}} = 0.75 \times \frac{0.003}{0.003 + 0.005} = 0.281$

(2) $M_s' = 1.32 \times 60 \times 16 =$ 1267.2 k-in or 105.6 k-ft

(3) $M_f = 14 \times 4 \times 0.85 \times 6 \times 16 =$ 4569.0 k-in = 380.8 k-ft

$M_{Sides} = 0.85 \times 6 \times (3+3) \times 18^2 \times 0.281 \times (1 - 0.281/2) =$

$= 2396.3$ = 199.7 k-ft

$M_{TOTAL} =$ 8233.1 k-in = 686.1 k-ft

(4) $M_d = \phi M_{TOT} = 0.9 \times 10191.5 =$ 7409.8 k-in = 617.5 k-ft

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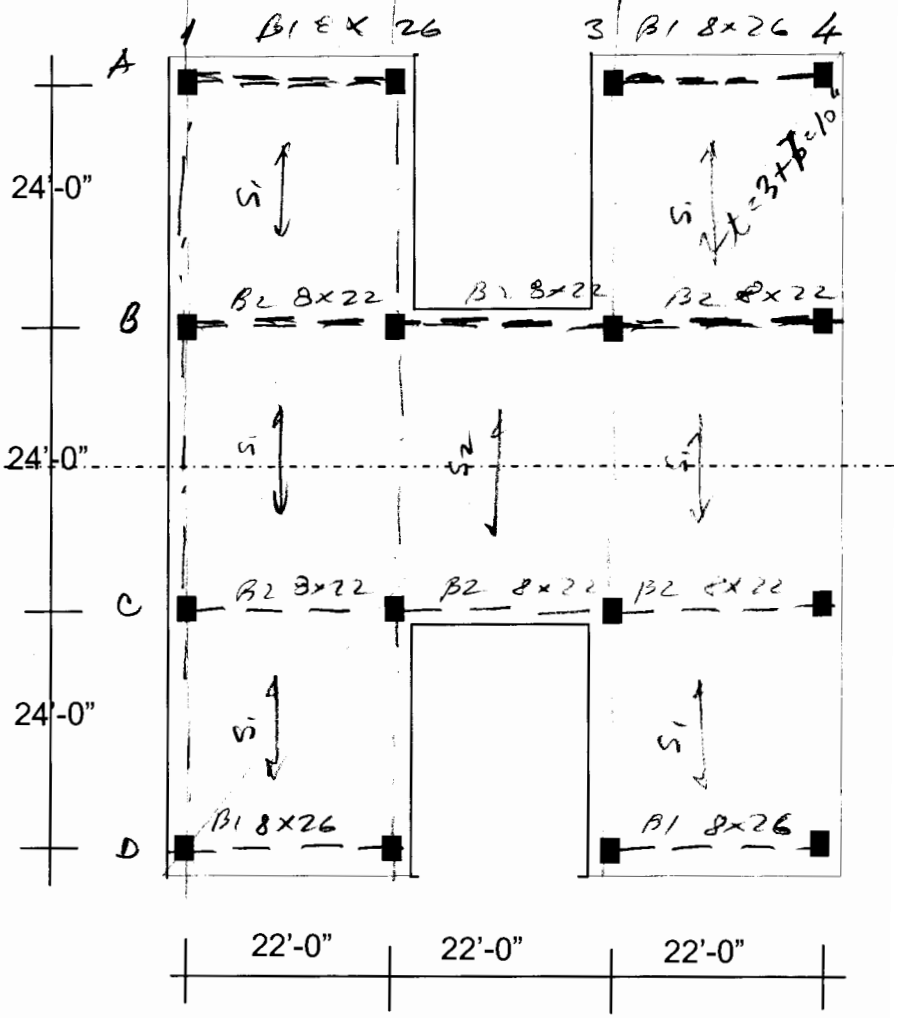
Problem #3 (20 points)

Overall: Design a floor for a structure using approximations and determine the load cases for a typical three spans slab strip.

Detailed requirements:

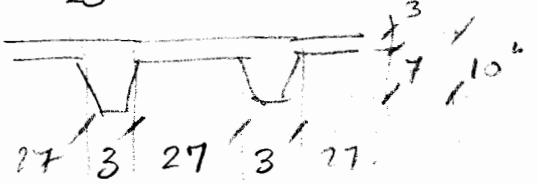
1) "Number" all columns **from the upper left corner**. (2)
2) Choose a layout of beams between the columns (either horizontal or vertical – but not both) and mark them in the sketch (5)
3) Layout one way **ribbed (joists) slab** supported by the beams, which you chose in (2) and show in the sketch.
4) Determine the thickness of the slab (unique for whole floor) using approximations ($h=L_{eq}/m$ or ACI recommendations).
5) Determine the dimensions of all beams using also approximations with the "width" approximately half of the height but not less than 8". Make all beams same dimensions.
6) Show the minimum number of load cases for a typical three span strip of this floor. *(You may show your sketch on the exam sheet)*



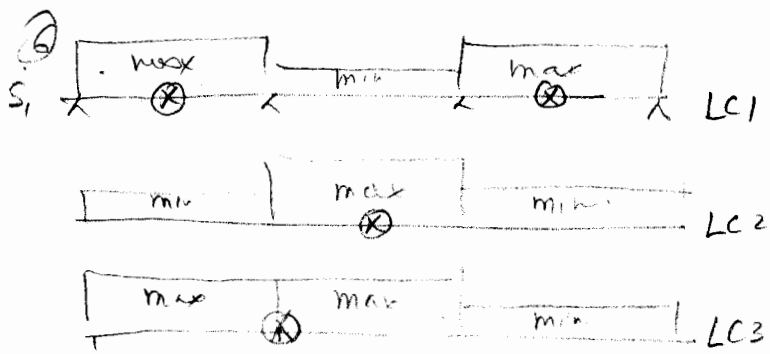
(5) $\frac{l^*}{20}$ $\frac{22' \times 12}{10} \approx 26"$

$\frac{0.8 \times 22 \times 12}{10} \approx 22"$

(4) $\frac{l^*}{25} = \frac{0.8 \times 24 \times 12}{25} \approx 10"$



(6)



LC4 ≡ mirror image of LC2.

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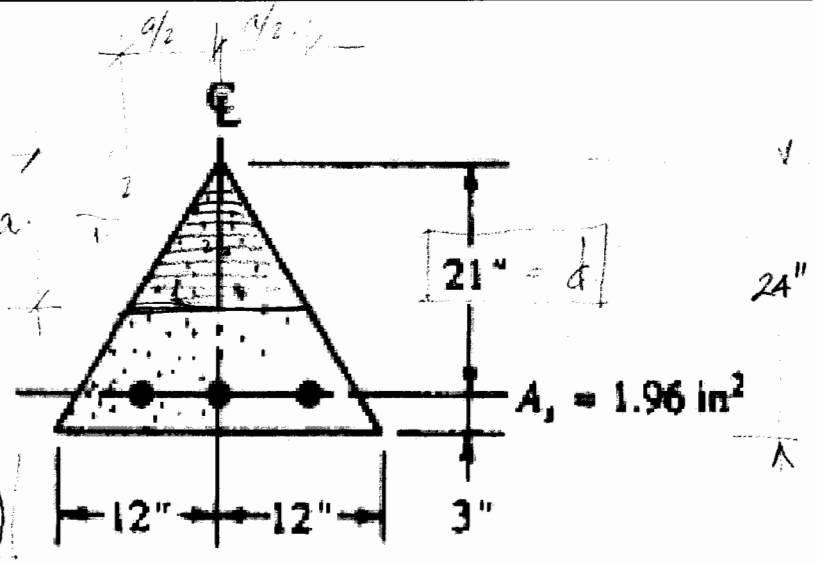
Problem #4 (20 points)

Determine the flexural design capacity φM_n of the triangular cross section shown in the figure on the right assuming f_c' =3.6ksi and GR60 steel.



$$M = T\times\left(d-\frac{2}{3}a\right) = T\times d\left(1-\frac{2}{3}k\right)$$

$T = A_s \times f_y = 1.96 \times 60 = 117.6$ kips $\quad T = C$

$$C = 0.85 f_c' \times a \times \left(2\times\frac{a}{2}\right)\cdot\frac{1}{2} = 0.85\times 3.6\times\frac{a^2}{2} = 1.53\,a^2 = T$$

$$a = \sqrt{\frac{T}{1.53}} = \sqrt{\frac{117.6}{1.53}} = 8.76 \text{ in.} \qquad k = \frac{8.76}{21} = 0.417$$

$$M = 117.6\times\left(21-\frac{2}{3}8.76\right) = 1782.26 \text{ K-in} = 148.5 \text{ k-ft}$$