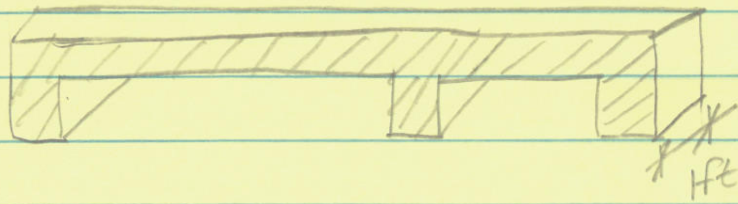
Sep 15

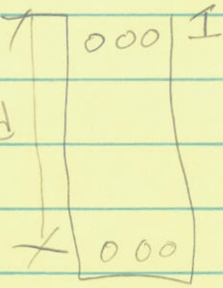
One Way Slab Analysis



Design of 1 Way Slabs
Example
Example

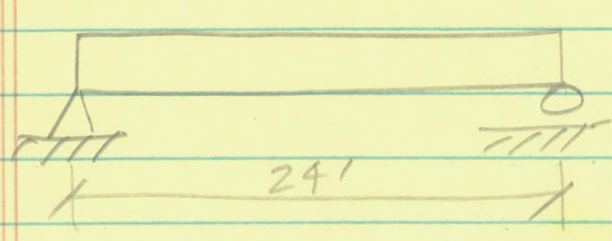
HW #4
4.16; 4.20
4.26, 4.30

- Very similar to beam analysis
- based on 1ft wide strip



Design of 1way Slab

Exam Monday 27th
HW #4 due Wed.



$\gamma_c = 150 \ \#/ft$

$f_y = 60$ ksi

$f'_c = 4$ ksi

(1) Find minimum thickness
[ACI table 9.5(a)]

$\frac{l}{20} = \frac{(12''/ft)(24)}{20} = 14.4''$

→ assume $h = 14.5$ ½" increments
$d = 13.5$

(2) Calculate beam Weight

$\frac{h}{12}(\gamma) = \frac{14.5}{12}(150) = 181.25 \ \#/ft$

(3) Calculate factored loads

$W_u = 1.2(DL) + 1.6(LL)$
$= 1.2(181.25) + 1.6(125)$
$= 417.5 \ \#/ft$

$M_u = \frac{(0.4175)(24)^2}{8} = 30.06$ ft-k

(4) Calculate ρ_{req}

$$\frac{M_u}{\phi b d^2} = \frac{(12''/ft)(30.060)}{(0.9)(12'')(13.25)} = 190.25$$

$\rho_{req} = 0.00325$ (Tbl A.17)

(5) Check ρ_{min}

$$\rho_{min} = \max \begin{cases} \frac{3\sqrt{f'_c}}{f_y} = \frac{3\sqrt{4,000}}{60,000} = 0.00316 \\ \frac{200}{f_y} = \frac{200}{60,000} = 0.0033 \end{cases}$$

[Tbl A.13]

(6) Calculate A_s

$A_s = \rho bd = (0.0033)(12'')(13.25'') = 0.525\ in^2/ft$

[Tbl A.6]

Use #6 @ 10" O.C. ($0.53\ in^2/ft$)

(7) Calculate Temp & Shrinkage

$\rho_{TS} = 0.0018$

$A_{TS} = \rho_{TS}\, b h = (0.0018)(12'')(14.5'')$

h — not d!!

$A_{TS} = 0.313\ in^2/ft$

Use #5 @ 12" O.C.

Doubly Reinforced Beams

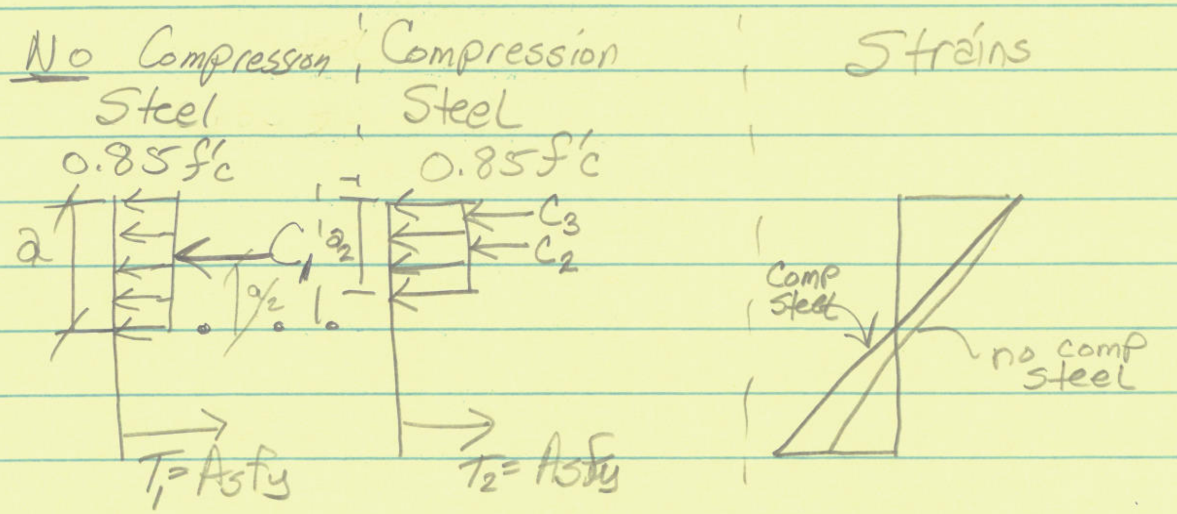
Doubly Reinforced Concrete Review Test

→ beams with steel in the tension & compression zones

Why doubly reinforce?

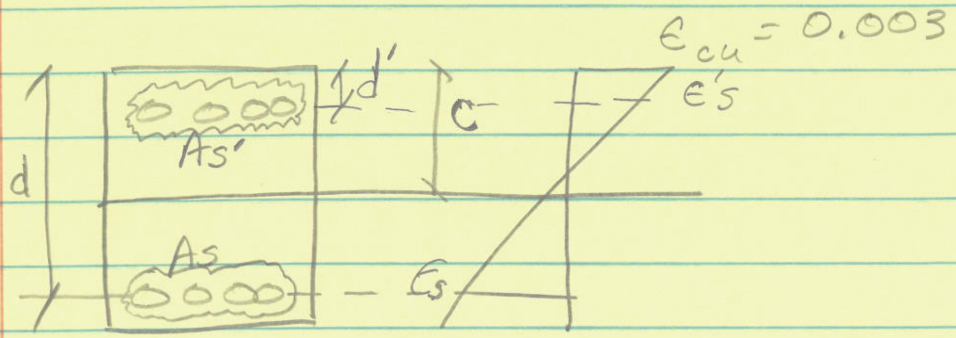
- Helps increase ϵ_T
  - → increase ϕ
  - → help meet [10.5.3] ($\epsilon_t \geq 0.004$)
  - → increase ductility
- Reduces compression stress on Concrete
  - → reduces creep, decreases long term deflection
- Can be helpful if height restrictions exist

The addition of Compression Steel



Assume tension steel yielding

Do not assume compression steel is yielding



$d' \equiv$ compressive surface to centroid of A_s

$A_s' \equiv$ Area of compression steel

$\epsilon_s' \equiv$ Strain in $A_s' = \frac{0.003(c-d')}{c}$

f'_s = stress in A_s'

Design a simply supported rectangular concrete beam with tension steel only to carry a service dead load of 1.35 k/ft and a service live load of 1.9 k/ft. The dead load does not include self weight. The span is 18ft Assume #4 stirrups. Use $f'_c = 4\,ksi$; $60\,ksi = f_y$

① Assume self wt = 300 #/ft

② Calculate factored load & moment

$$W_u = 1.2\,w_{DL} + 1.6\,W_{LL} = 1.2[1.35 + 0.3] + 1.6[1.9]$$
$$= 5.02\ \#/ft$$

$$M_u = \frac{w l^2}{8} = \frac{(5.02\#/ft)(18)^2}{8} = 203.31\ ft\text{-}k$$

③ $\rho_{bal} = 0.0285$

$\rho_{max} = 0.75(0.0285) = 0.0214$

$\rho = \frac{1}{2}\rho_{max} = 0.0107$ ← using this

④ from Tbl A.13

$$\frac{M_u}{\phi b d^2} = 581.2 \Rightarrow bd^2 = \frac{(203.31)(12)(1000)}{0.9(581.2)}$$

$$bd^2 = 4664.14$$

⑤ Select section (Guess)

$12 \times 19.7 \Rightarrow d \approx 20$ try 12×22 ($d \approx 20$)

$14 \times 21.6 \Rightarrow d \approx 22$

(6) Check self wt.

$$\frac{12 \times 22}{144}(150) = 275 \text{ \#/ft}$$

(7) Calculate $A_s = \rho bd = (0.0107)(12)(20)$

$= 2.568 \text{ in}^2$

Bars	$A_s (in^2)$	b required (in)
3 #9	3.00	9.8

(8) Check Solution

$d = h - c - \text{stirrup} - \frac{1}{2} d_{bar}$

$= 22 - 1.5 - \frac{4}{8} - \frac{1}{2}\left(\frac{9}{8}\right)$

$= 19.44 \text{ in}$

$$\rho = \frac{A_s}{bd} = \frac{(3.00)}{(12)(19.44)} = 0.0129$$

$> \rho_{min} = 0.0033$

$< \rho_{max} = 0.0181$

$\therefore \epsilon_t > 0.005$

$\therefore \phi = 0.9$

for $\rho = 0.0129$, $\frac{M_u}{\phi bd} = 685.6$

$\phi M_n = M_u$

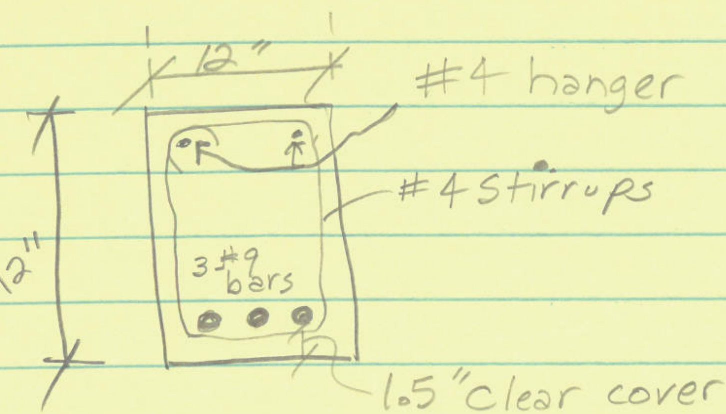
$\phi M_n = \phi\, 685.6\, bd^2$

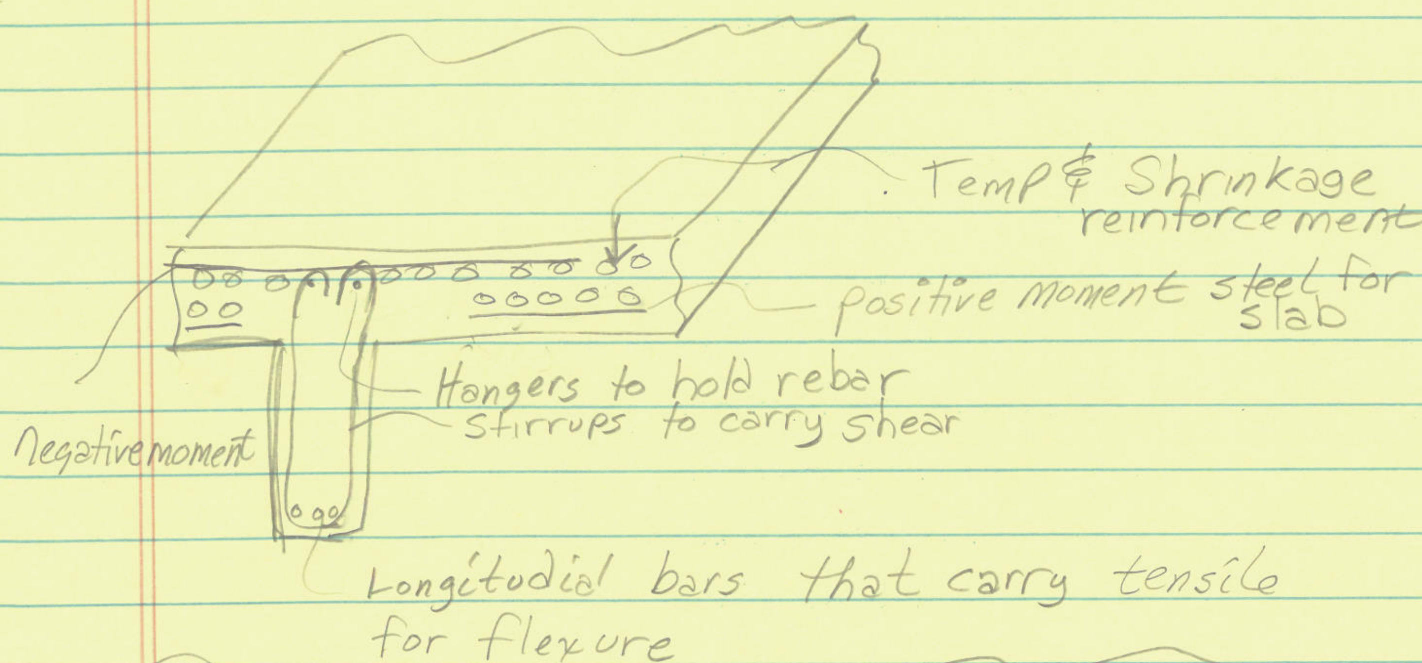
$M_n = 685.6 (12)(19.44)^2$

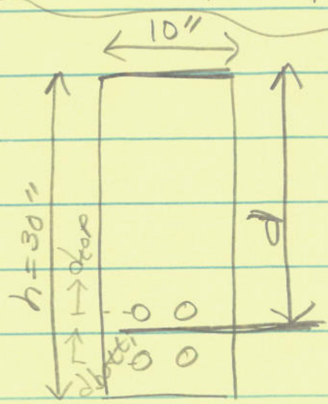
$\phi M_n \overset{?}{\geq} M_u$

$0.9(259) \overset{?}{\geq} 203.31$

$233 > 203.31$ ✓ OK







$f_y = 60$ ksi

$f'_c = 4000$ psi

#4 stirrups

4 #9 bars

1.5" Clear cover

find M_n & ϕ

next

$\beta_1 = 0.85$

$A_s = 4.00 \, in^2$

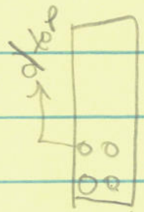
$d = h^{eight} - c^{over} - \text{stirrups } \phi - \text{bottom bar } \phi - \frac{1}{2} S_v$

$= 30 - 1.5 - 0.5 - 9/8 - \frac{1}{2}(1.5)$

$= 26.125 \, in$

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(4)(60ksi)}{0.85(4ksi)(10)} = 7.06 \, in$

$c = a/\beta_1 = \frac{7.06}{0.85} = 8.30$



$d_b = h - c_{\text{clear cover}} - \text{stirrup} - \frac{1}{2} \text{bar } \phi$

$= 30 - 1.5 - 4/8 - \left(\frac{9}{8}\right)\left(\frac{1}{2}\right)$

$d_b = 27.72 \, in$ $\quad d + \frac{1}{2} S_v + \frac{1}{2} \text{bar } \phi \quad 27.44$

$\epsilon_t = \frac{0.003(d_t - c)}{c} = 0.0070 > 0.005 \therefore \phi = 0.90$

$M_n = T \left(d - \frac{a}{2}\right) = (4.00^{in})(60ksi)\left(26.125 - \frac{7.06}{2}\right)$ (T = $A_s f_y$; d = d_b)

$M_n = 5{,}423 \text{ in-k or } 451.9 \text{ ft-k}$

$\phi = 0.90$