ENCE 335
FINAL EXAM

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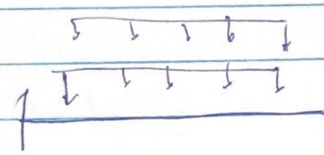
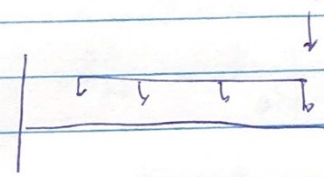
118140l



Question 1:

$U = 1.2DL + 1.6LL$

Cross-Section
550mm x 350mm
H x B



design for Shear:

$f_c' = 28$ MPa , $f_y = 420$ MPa

assume Ø36 assume $d = 550 - 40 - 10 - 36/2$

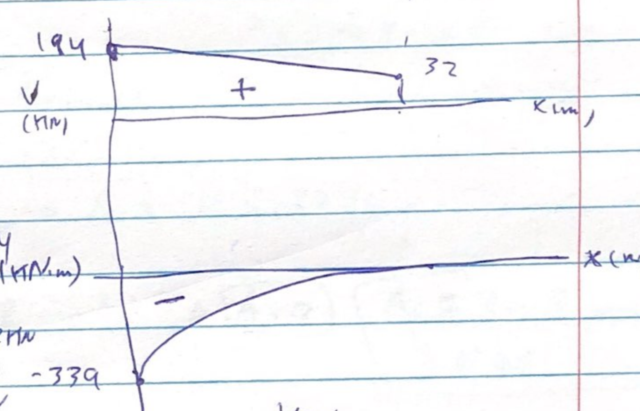
$\phi V_c = \phi\, 0.17 \sqrt{f_c'}\, bd$

$d = 482$ mm

$\phi V_c = 113.82$ KN

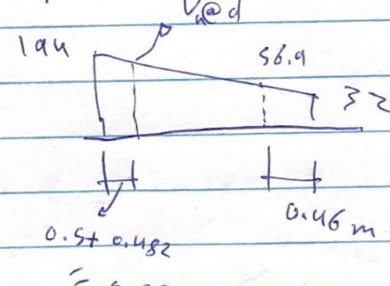
$\phi V_c / 2 = 56.9$ KN

$\phi = 0.75$



$V@d = 108.972 + 32 =$ ~~104.972~~ 140.972 KN

assume width of Column = 0.5m

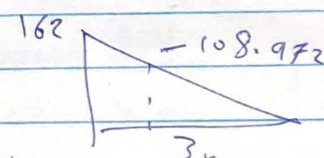


~~$\phi V@d = \phi V_s + \phi V_c$~~

~~$V_s = \frac{\phi V@d - \phi V_c}{\phi} = 10.788$ KN~~

~~$\phi V_c = 113.82$ KN $> V_{u@d}$~~

$V_s = \frac{V@d - \phi V_c}{\phi} = 36.2$ KN



$V_s < 2(V_c) = 2(151.76)$

assume Stirrup Ø10

$S_{max} = \min \left\{ \frac{A_v f_y}{0.062\sqrt{f_c'}\, b_w}, \frac{A_v f_y}{0.35 b_w}, d/2, 600 \text{ mm} \right\}$ (574, 538, 241)

$A_{v\,stirrup} = 2\left(\frac{\pi}{4}(10)^2\right)$

$A_v = 157 \text{ mm}^2$

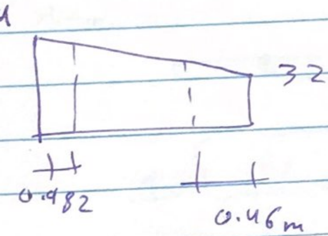
$S_{max} = 241$ mm ≈ 200 mm

$$V_{s\,max} = \frac{A_v f_y d}{S_{max}} = 158.9 \text{ KN} > V_u @d = 141$$

$\therefore$

$S_{max} = 200$ mm

$\therefore$ no need for Special design for Shear.



$x_2 \to 3 - 0.46 - 0.482$

$x_2 = 1.558$ m

S_{max} Stirrups

flexure design:

assume bar ϕ 36

1 layer

$\phi = 0.9$

$M_u = -339$ KN.m (top reinforcment)

$$R = \frac{M_u}{\phi b d^2} = 4.63 \text{ MPa} \to \rho = 0.012375 \quad [A.5.a]$$

$\to A_s = \rho b d = 2088$ mm^2 $\to$ [A.2] [$A_s = 3018$ mm^2, 3 ϕ 36]

checks:

- width: [A.7] ✓

$S = 71$ mm $> S_{min} = \max\{36, 25, \frac{4}{3} d_{agg} = 25.33\}$

from A_4: $\beta_1 = 0.85$

✓ $\rho_{max} = 0.0206$, $\rho_{0.005} = 0.0181$, $\rho_{min} = 0.0033$

~~$\rho < \rho_{max}$~~ $\rho = 3018/bd = 0.0178897$ $< \rho_{max}$ ✓

$< \rho_{0.005}$

$> \rho_{min}$

✓ $\rho > \rho_{0.005}$ $\therefore \phi = 0.9$

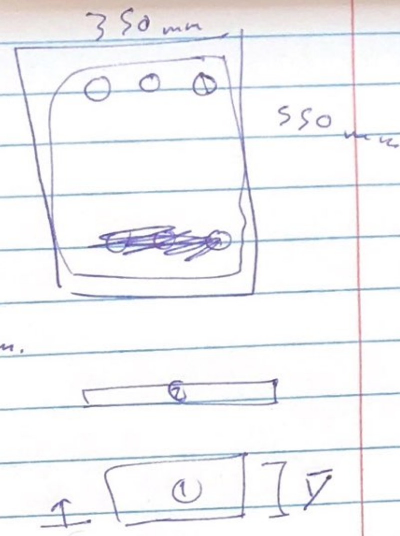
Check Moment Capacity: $\rho = 0.0178897 \to R = 6.33$ MPa [A.5a]

$\Rightarrow \phi M_n = \phi R b d^2 = 463.18$ KN.m $> M_u$ ✓

Check S_{max}: from A8: minimum # of bars 36 in width 350

Cover = 40 mm $= 2 < 3$ bars ✓

deflection Check:



$I_g = \frac{1}{12} BH^3 = 4.85 \times 10^9 \; mm^4$

$I_{cr} = 66.6 \times 10^6 \; mm^4$

$M_{cr} = \frac{f_r I_g}{H/2} = 57.86 \; kN.m.$

$f_r = 0.62 \lambda \sqrt{f_c'} = 3.28 \; MPa$

Not supporting → Δ_L

$M_D = 112.5 \; kN.m > \frac{2}{3} M_{cr}$

$\Rightarrow I_e = I_{cr} / \left(1 - \left(\frac{2}{3}\frac{M_{cr}}{M_D}\right)^2 \left(1 - \frac{I_{cr}}{I_g}\right)\right)$

Service load

$I_e = 7.55 \times 10^7 \; mm^4$

$\Delta_D = \Delta_{max} = \frac{W_D L^4}{8 E I_e} =$ ~~0.135 mm~~ $134.8 \; mm$

$E_c = 4700 \sqrt{f_c'} = 24870 \; MPa$

$M_{D+L} = 240 \; kN.m > \frac{2}{3} M_{cr}$

$I_e = 6.84 \times 10^7 \; mm^4$

$\Delta_{D+L} = \frac{W_{D+L} L^4}{8 E I_e} =$

$\Delta_{D+L} = \Delta_{D+L}$ (dis. load) $+ \Delta_L$ (Con. load) $=$

$\Delta_{D+L} = \frac{W_{D+L} L^4}{8 E I_e} + \frac{P_L L^3}{3 E I_e} =$ ~~343.9 mm~~ $238.2 \; mm$

$\Delta_L = \Delta_{D+L} - \Delta_D = 103.4 \; mm$

~~$\Sigma A\bar{Y} = A_1 \bar{Y}/2 + A_2(d)$~~

~~$(A_s + \bar{Y}(350))\bar{Y} = \bar{Y}(350)\bar{Y}/2$~~

~~$175(\bar{Y})^2 + \bar{Y} A_s = 0$~~

~~$(\bar{Y})^2 + (17.25)\bar{Y} = 0$~~

~~$A_s = 3018$~~

~~$(\bar{Y})(\bar{Y} + 17.25) = 0$~~

~~$\bar{Y} = 17.25$~~

$\bar{Y} = \frac{\bar{Y}(350)(\bar{Y}/2) + A_s d}{\Sigma A}$

$\bar{Y} = \frac{175\bar{Y}^2 + 3018 d}{3018 + \bar{Y} 350}$

$350\bar{Y}^2 + 3018\bar{Y} = 175\bar{Y}^2 + 3018 d$

$0 = 175\bar{Y}^2 + 3018\bar{Y} - 1454676$

$\bar{Y}^2 + 17.25\bar{Y} - 8312 = 0$

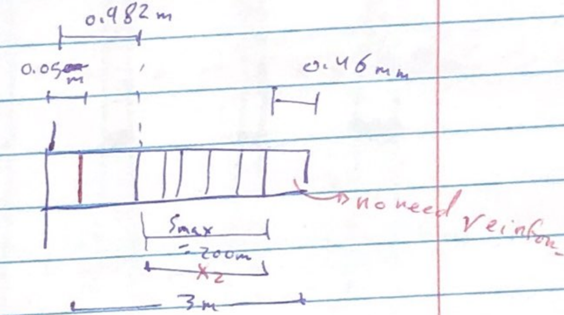
$\bar{Y} = 82.45 \; mm$

not carrying non structural members (interior floor):

def. lim. $= L/360 = 8.33$ mm

$\Delta_i >$ def. lim. Not Satisfy.

$x_2 = 1.558$ m

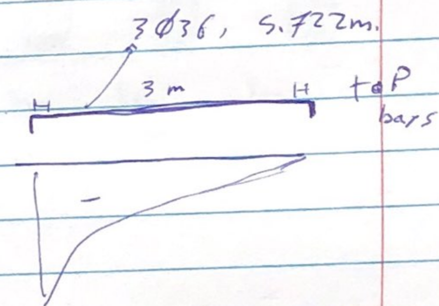


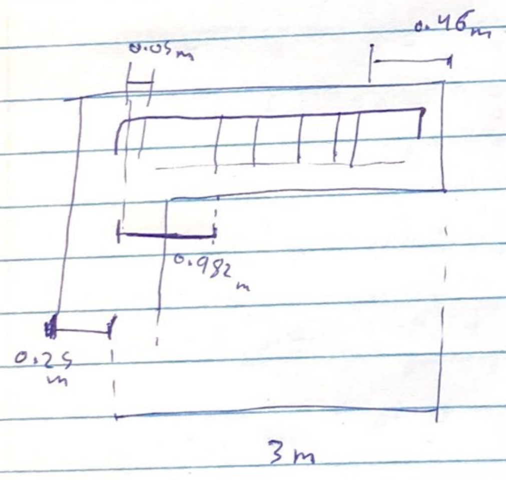
$\#$ of stirrups $= 1 + \frac{X_2}{S_{max}}$

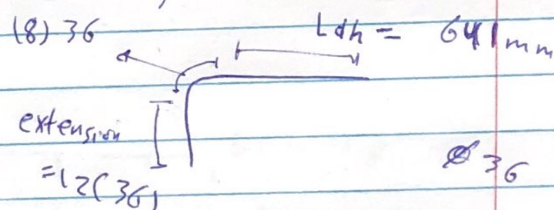
$\#$ stirrups $= 9$

exact length for bars $= 3 + 2(1.361)$

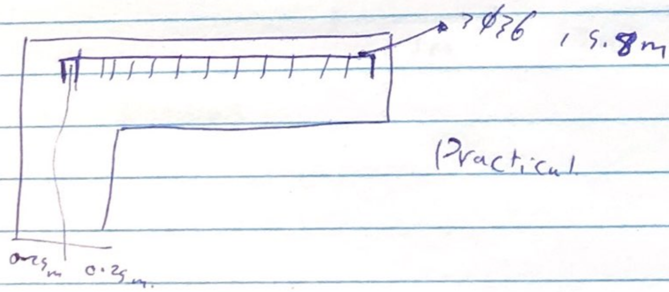
$L_{bars} = 5.722$ m







$L_t = 1.361$ m



Practical

Question 2

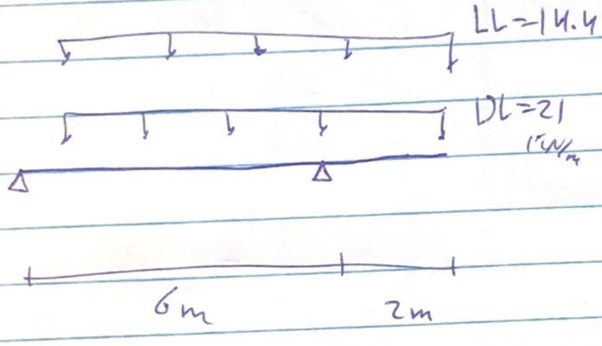
DL = 7 kN/m2 (include SW)

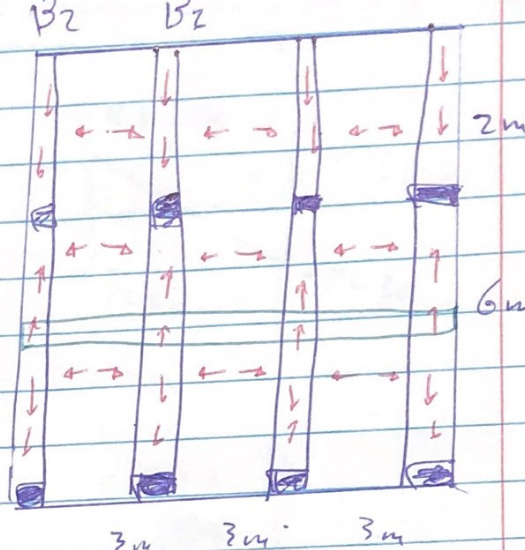
LL = 4.8 kN/m2

Solid slab H = 150mm

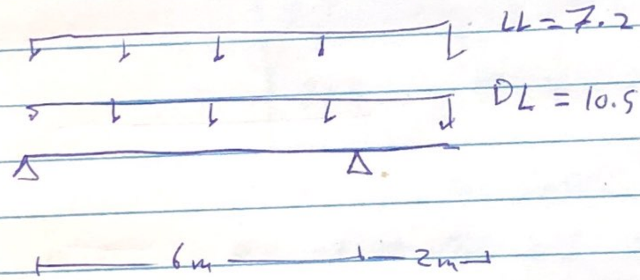
Service load

B_1

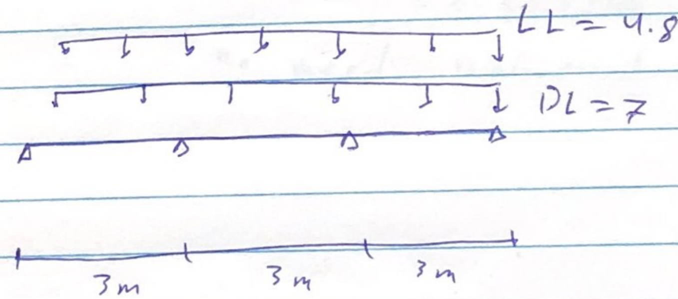




B_2



Strip of slab to anlys and design



~~Strip of Slabs~~

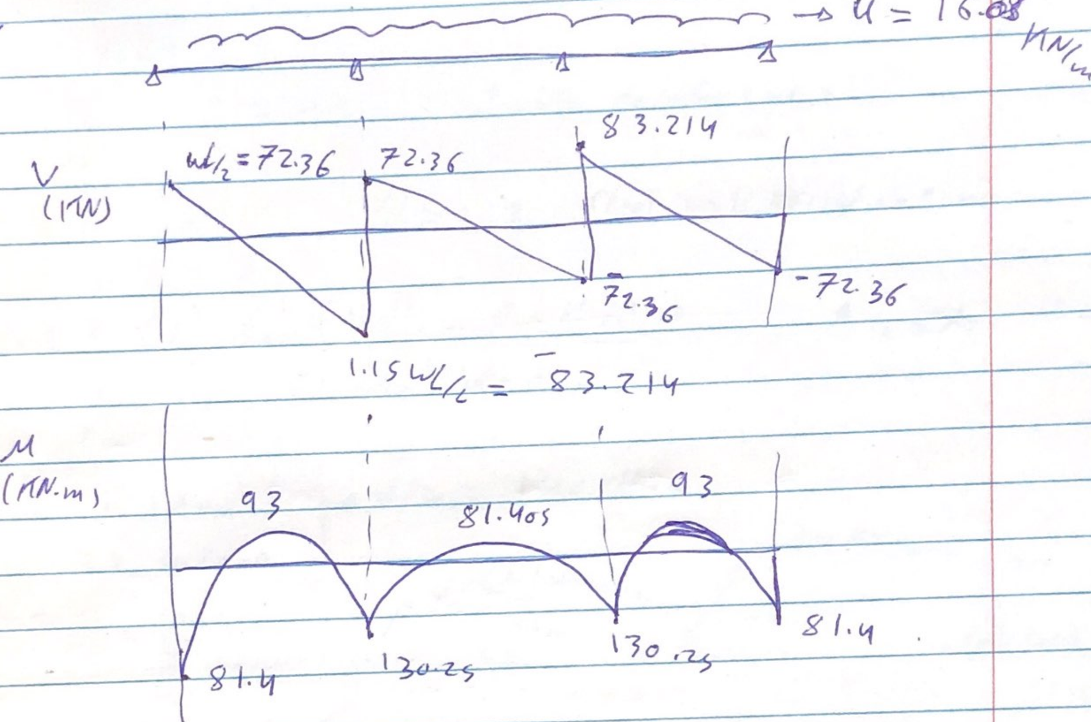
• Strip of Slab:

$f'_c = 28\ MPa$

$f_y = 420\ MPa$

$L.C = 1.2D + 1.6LL$

$u = 16.08\ KN/m$



design shear: ϕ stirrub = 10 (assume)

assume ϕ 16

d = 122 mm

Cover = 20

b = 1000 mm

$\phi V_c = \phi\, 0.17 \sqrt{f'_c}\ b d$ = ~~82.30~~ KN

82.309 KN > V_u@d

no need reinforment shear.

Design flexural:

$M_u = 130.25$ KN.m

$\phi 16$, $d = 122$ mm , $b = 1000$ mm

assume $\phi = 0.9$

$R = \frac{M_u}{\phi b d^2} = 9.7$ MPa ∴ doubly reinforcement

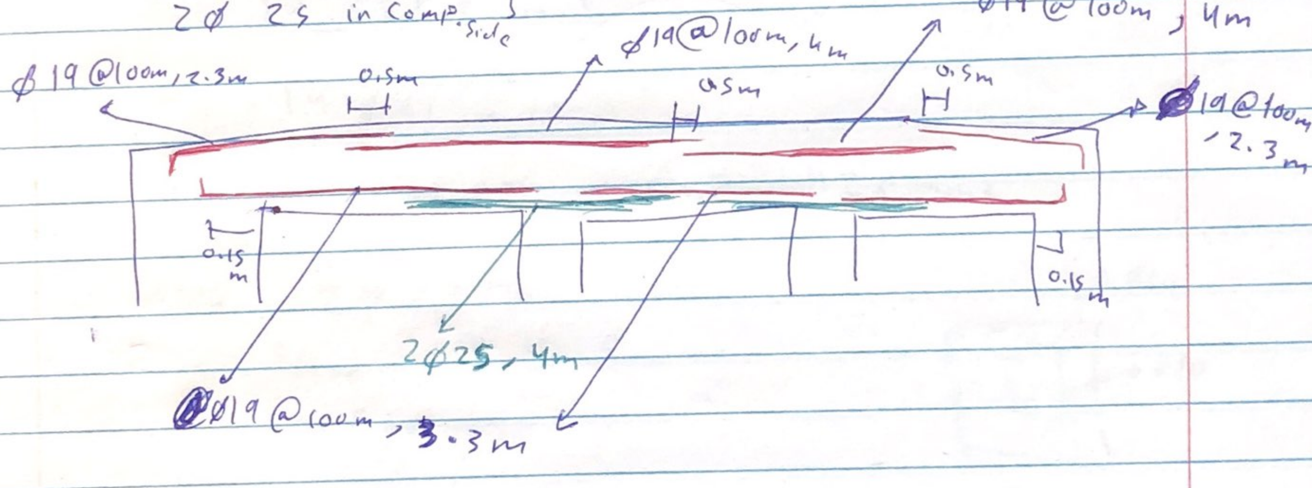
$2\phi 10$ in comp. $d'/d \geq 0.13$ steel will yield in comp.

$\phi M_n = \phi A_s' f_s' (d-d') + \phi\, 0.85 f_c' ab$ $A_{s2} = A_s'$

$= \phi f_y (A_{s1} + A_2)(d-d')$

=

A-38 $\phi 19$ @ 100m } → $\phi M_n = 140$ KN.m
$2\phi 25$ in comp. side }

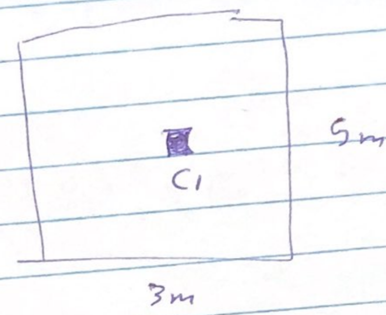


(4) $\rho = 0.02$

$P = 4\ (3)(5)$

$P = [(1.2)7 + 1.6(4.8)]\ 15$

$\frac{P}{4} = 241.2\ KN$



$\rho = 0.02 = \frac{A_{steel}}{A_g} \Rightarrow A_{steel} = 0.02 A_g$

$r = 0.8$ assume tied

$\phi = 0.65$ $\phi P_n = r\ \phi\ \{0.85 f_c'\ (A_g - A_{st}) + f_y A_{st}\}$

$241200 = r\phi\ \{0.85 f_c' (0.98 A_g) + f_y (0.02 A_g)\}$

$A_g = 14\ 621.3\ mm^2 \Rightarrow$ assume square with width $= 120\ mm^2$

$A_g = 14\ 641\ mm^2$

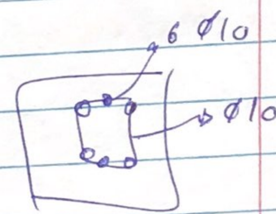
$A_{steel} = 292.82 \Rightarrow A_s = 426\ mm^2$

$6\phi10$

$\phi P_n = 274.1\ KN$

Space min < S

max { 30, (40) }



S =

$\rho = 0.02$ > 0.01, < 0.08 ✓

Question 3