# Homework assignment #4

## ENCE 335

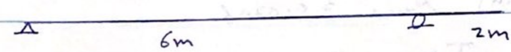
Mohanad Moayad Shannak

- 1181401 -.

**-B 1:**

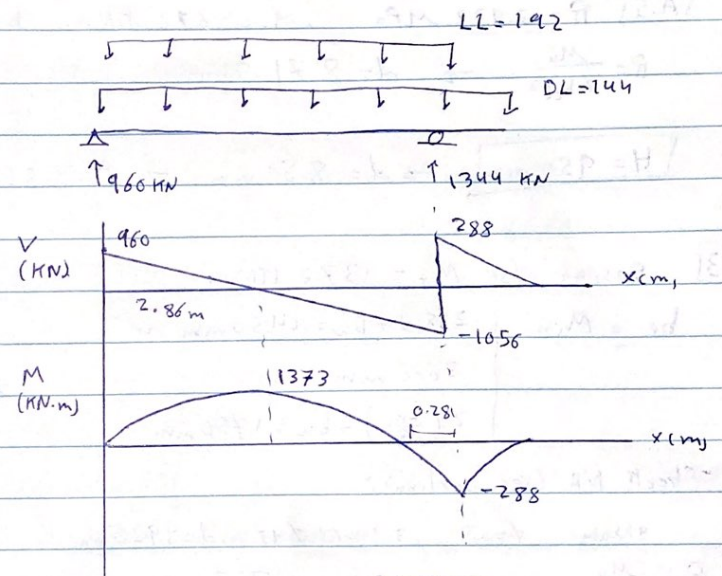
$DL = 1.2(120) = 144 \ \frac{KN}{m}$

$LL = 1.6(120) = 192 \ \frac{KN}{m}$.



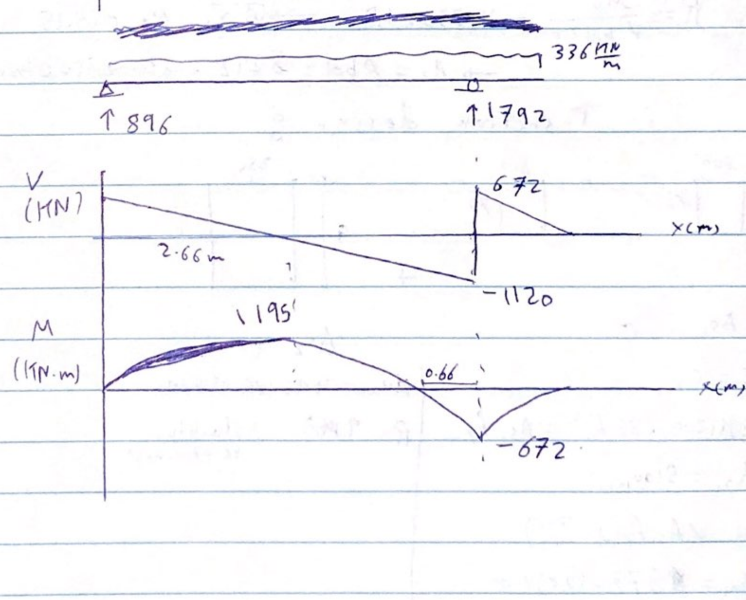

I.L

$\Rightarrow M_{+max}$



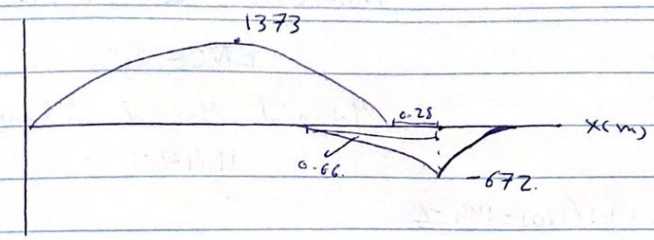

I.L

$\Rightarrow M_{-max}$.



- Envelope:

B.M.




[2] [A.4] $\rho_{max} = 0.0206$

Take $\rho = 0.5\ \rho_{max} = 0.0103$

[A.5] $R = 3.932$ MPa , $M_- = -672$ KN.m , $b = 250$ mm. assume $\phi = 0.9$.

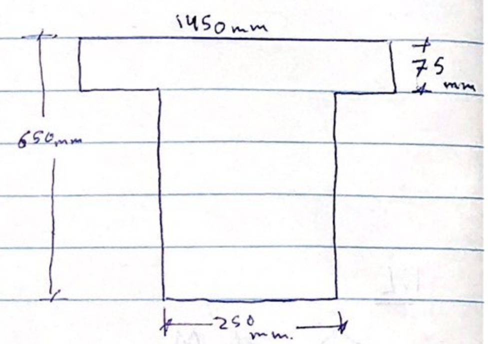
$R = \frac{M_u}{\phi b d^2} \Rightarrow d = 871.5$ mm.

$H = 950$ mm $\rightarrow d = 880$ mm $\rightarrow R = 3.857$ MPa $\rightarrow \rho < \rho_{0.005}$

$\therefore \phi = 0.9$.

[3] Design for $M_+ = 1373$ KN.m

$b_e = Min \begin{cases} 2(8h) + b_w = 1450\text{mm} \checkmark \\ 3000\text{ mm} \\ 2\left(\frac{L_n}{8}\right) + b_w = 1750\text{mm} \end{cases}$



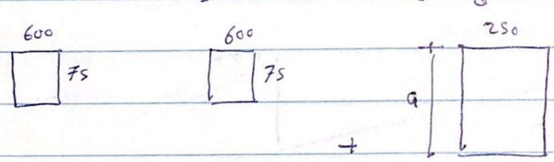

- Check NA (rec. section):

assume $\phi = 0.9$ , 3 layers $\phi 43$ , $d = 492.5$mm.

$R = \frac{M_u}{\phi b d^2} = 4.338$ MPa $\rightarrow$ [A.5] $\rho = 0.0115$

$\rightarrow A_s = \rho b d = 8212\ mm^2 \rightarrow T = C \rightarrow a = \frac{f_y A_s}{0.85 f_c' b} \rightarrow a = 100$ mm $> 75$ mm

$\therefore$ T-section design:




$A_{s_1}$ ①

$T_1 = C_1$

$(75)(1200)\, 0.85 f_c' = A_{s_1} f_y$

$A_{s_1} = 5100\ mm^2$

$\phi M_{n_1} = \phi A_{s_1} f_y (d - 75/2)$

$\phi M_{n_1} = 877.15$ KN.m

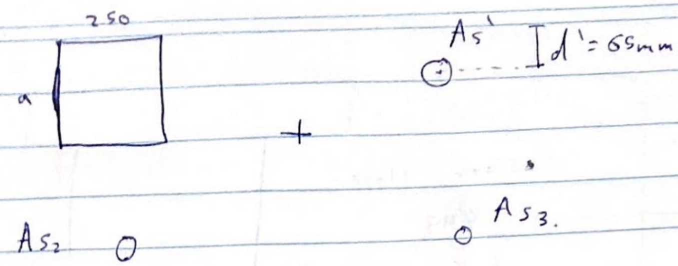
$\phi M_{n_2} = 1373 - \phi M_{n_1}$

$= 495.85$ KN.m

$A_{s_2}$ ②

$\phi M_{n_2} = 495.85$ KN.m

$R = 9$ MPa. $\therefore$ doubly. reinforcement.




Take $\rho = 0.018 \rightarrow$ $\boxed{A_{s2} = 2216\ mm^2}$

[A.5] $R = 6.36MPa$, assume $\phi = 0.9$, $d' = 65mm$

$\rightarrow M_{n2} = R\phi bd^2 = 347KN.m.$

$M_n' = 148.85KN.m.$

$\rightarrow a = \frac{A_s f_y}{0.85 f_c' b} = 156mm \rightarrow \bar{Y} = 184mm \rightarrow \epsilon_s = 0.00503$ $\therefore \phi = 0.9$ $\rightarrow \epsilon_s' = 0.00194$ not Yeild

$\rightarrow f_s' = 388MPa.$

$M_n' = A_s' f_c' (d - d') \rightarrow$ $\boxed{A_s' = 897\ mm^2}$

$T_3 = C_3 \Rightarrow A_s' f_s' = A_{s3} f_y \rightarrow$ $\boxed{A_{s3} = 829\ mm^2}$

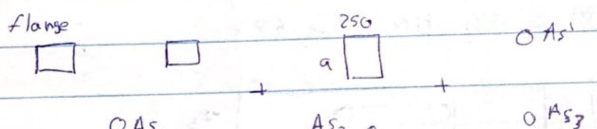
[A.2] $A_s' = 897\ mm^2 \rightarrow 2\phi 29$, $\boxed{A_s' = 1290mm^2}$

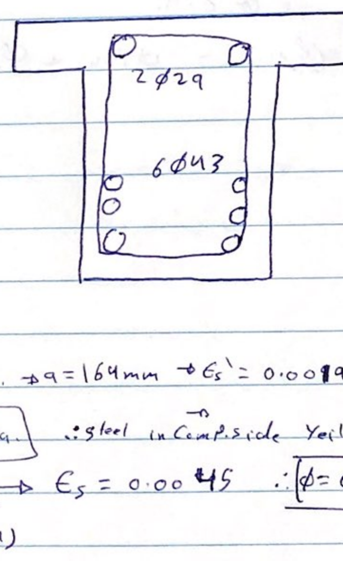
$A_s = 5100 + 2216 + 829 = 8145\ mm^2$ $\xrightarrow{[A.2]}$ $6\phi 43$, $A_s = 8712mm^2$

3-layers

[A.7] 2 bars in each layer.

- Check moment Capasety:




$\phi M_{n1} =$ ~~[illegible]~~ $877$ KN.m. | $a = 130.8mm.$ | $A_s' = 1290mm^2 \rightarrow A_{s3} = 1192mm^2.$

$A_{s1} = 5100mm^2$ | | $f_s' =$ ~~[illegible]~~ $347MPa$

$T = C \Rightarrow A_s f_y = 2142000 + 0.85 f_c' a 250 + A_s' f_s'$

$f_s' = 347MPa \rightarrow a = 180mm \rightarrow \epsilon_s' = 0.0021$ Yeild $\therefore f_s' = 420MPa. \rightarrow a = 164mm \rightarrow \epsilon_s' = 0.00199$

$\rightarrow f_s' = 398MPa \rightarrow$ $\boxed{a = 168mm}$ $\rightarrow \epsilon_s' = 0.002015 \rightarrow$ $\boxed{f_s' = 420MPa.}$ $\therefore$ steel in Comp. side Yeild.

$\bar{Y} = 197mm \rightarrow \epsilon_s = 0.0045$ $\therefore$ $\boxed{\phi = 0.858}$

$\phi M_n = \phi M_{n1} + \phi M_{n2} + \phi M_{n3}$

$= \phi A_{s1} f_y (d - \frac{75}{2}) + \phi\ 0.85 f_c' a (250)(d - a/2) + \phi (A_s' f_y)(d - d')$

$= 1385.3\ KN.m > 1373\ KN.m.$

- Design for $M_- = -672$ KN.m.

$R = \frac{M}{\phi b d^2} = 10.4$ MPa

$\therefore$ doubly.

Take $\rho = 0.6\ \rho_{max}$

$\rho = 0.01236 \rightarrow A_{s_1} = 1655\ mm^2$.

assume 2 layer

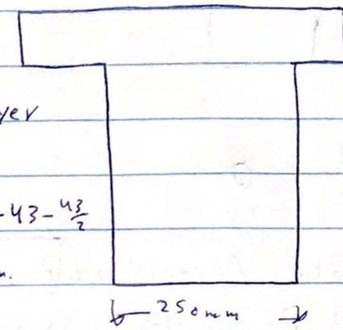
$\phi 43$

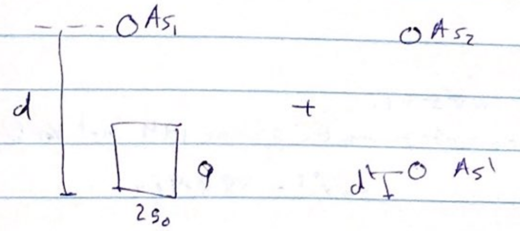
$d = 650 - 50 - 43 - \frac{43}{2}$

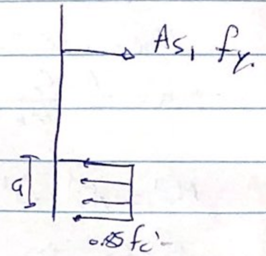
$= 535.5$ mm.

$\phi = 0.9$.

$d' = 64.5$ mm.




$\phi M_{n_1} = \phi A_{s_1} f_y (d - a/2)$

$a = \frac{A_{s_1} f_y}{0.85 b f_c'} = 117\ mm. \rightarrow \epsilon_s > 0.005 \rightarrow \bar{y} = 137\ mm \rightarrow \epsilon_s' = 0.0015876 \rightarrow f_s' = 317$ MPa

$\therefore \phi = 0.9$.

$\phi M_{n_1} = 298$ KN.m. $\Rightarrow \phi M_2 = 374$ KN.m $= \phi A_s' f_s' (d - d') \rightarrow A_s' = 2783\ mm^2$.

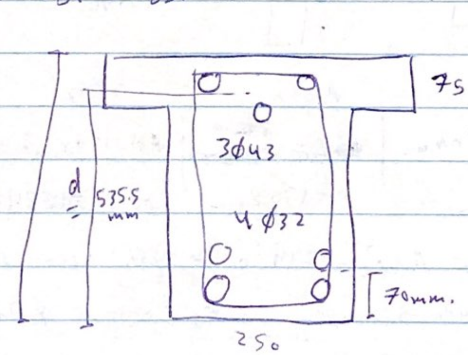
**A.2** $A_s = 3756\ mm^2$, $A_s' = 2783\ mm^2$ $\rightarrow A_{s_2} = 2100\ mm^2$.

$3\phi 43$ $A_s = 4356\ mm^2$, ~~$5\phi 29$, $A_s' = 3225\ mm^2$~~

$4\phi 32$, $A_s' = 3276\ mm^2$

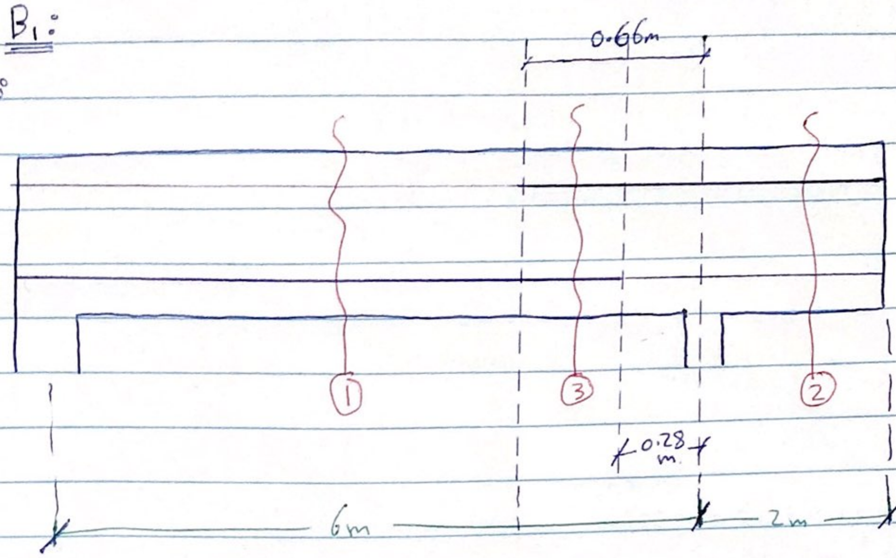
$\therefore \phi = 0.9$.

$\phi M_n = \phi M_{n_1} + \phi M_{n_2} = 300 + 581 = 881$ KN.m $> 672$.

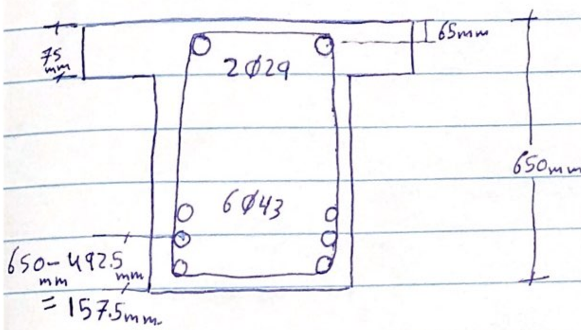


## 4- $B_1$:

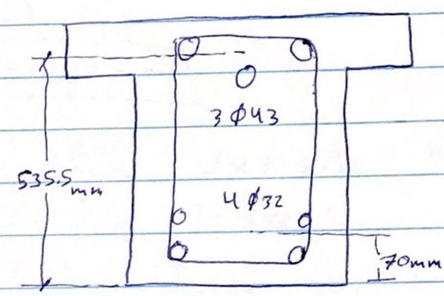
Side-view:



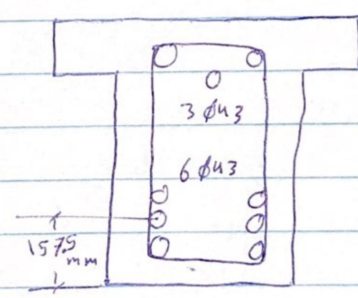

-Section 1:




-Section 2:




-Section 3:



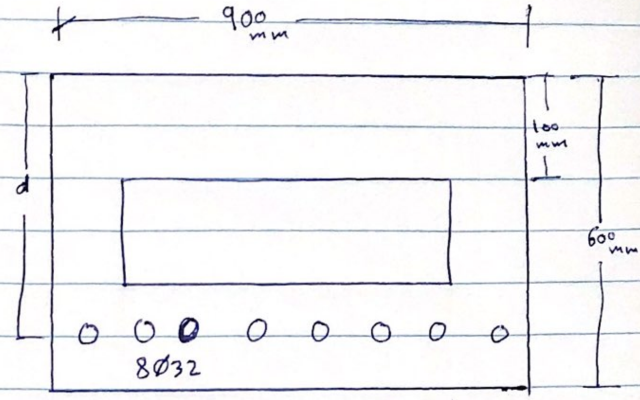

Covere = 40mm

$d_s$ = 10mm.

## - Part 2:

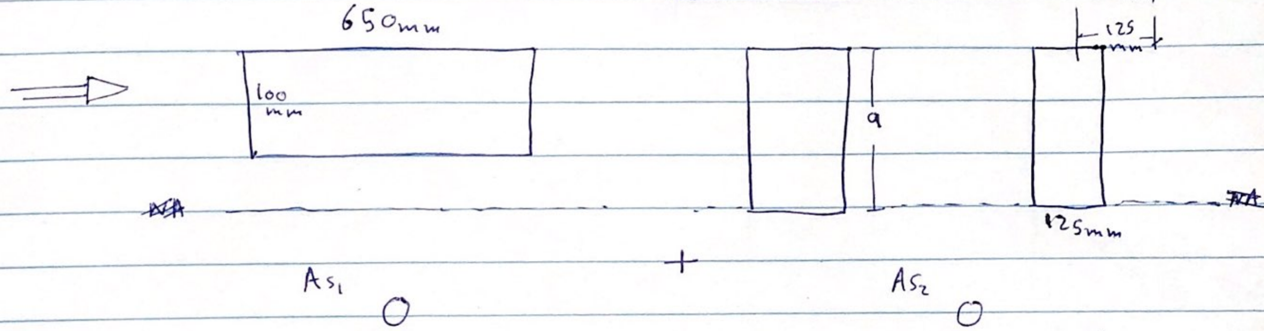
$f_c' = 28\ MPa$

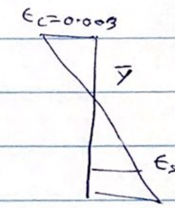
$f_y = 420\ MPa$




[A.2] $A_s = 6552\ mm^2$ // $d = 534\ mm$.

assume rect. section : $a = \frac{A_s f_y}{0.85 f_c' b} = 128\ mm$.




$T_1 = C_1 \Rightarrow A_{s_1} f_y = 0.85 f_c (650)(100)$

$\Rightarrow A_{s_1} = 3683.33\ mm^2 \quad \Rightarrow A_{s_2} = 2868.66\ mm^2$

$\phi M_n = \phi M_{n_1} + \phi M_{n_2}$

assume $\phi = 0.9$. // $\phi M_{n_1} = \phi A_{s_1} f_y (d - \frac{100}{2}) = 673.87\ KN.m$

2// $T_2 = C_2 \Rightarrow A_{s_2} f_y = 0.85 f_c' (250)(a) \Rightarrow a = 202.5\ mm.$ $\Rightarrow \bar{y} = 238.23\ mm$

assume $\phi = 0.9$ // $\phi M_{n_2} = 469.255\ KN.m.$ $\Rightarrow \epsilon_s = 0.0037246$

Tension not Controlled.

$\phi M_n = 673.87 + 469.255 = 1143.125\ KN.m.$