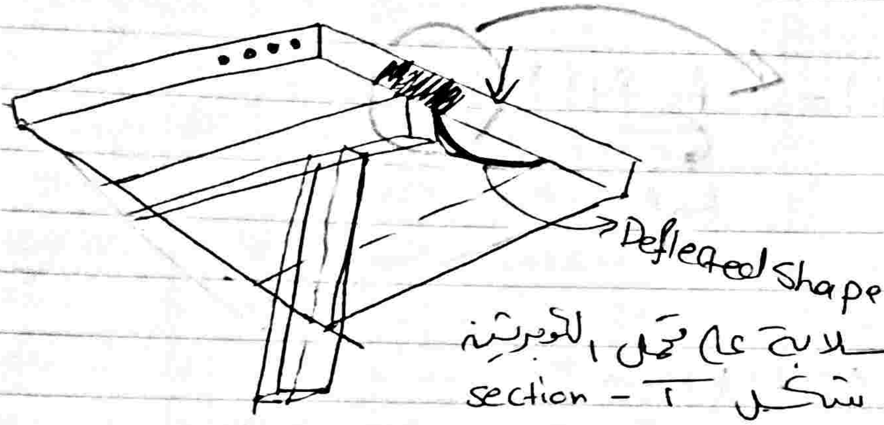
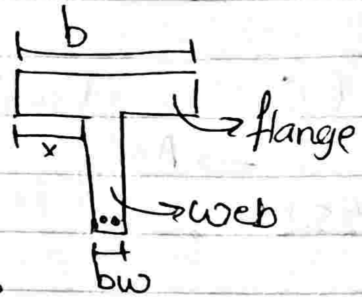
• What are T-section Beams:-

Beams + slabs → Continuous → mono lithic constraction



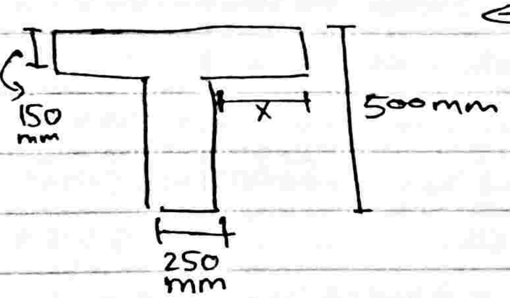


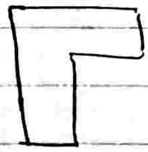
• بصير البيم يعمل مع السلابة على تحمل الحمولة
فيصير على شكل T - section

⇒ ACI - Code Table 6.3.2.1 @

flange location		effective width (b)
Each side of web	least of	8h sw/2 ln/8
one side of web	least of	6h sw/2 ln/12

• Example: $l_n = 4m$, $S_w = 3m$





$$x = \begin{cases} 8h = 8 \times 150 = 1200 mm \\ S_w/2 = 3/2 = 1500 mm \\ l_n/8 = 4/8 = 500 mm \checkmark \end{cases}$$

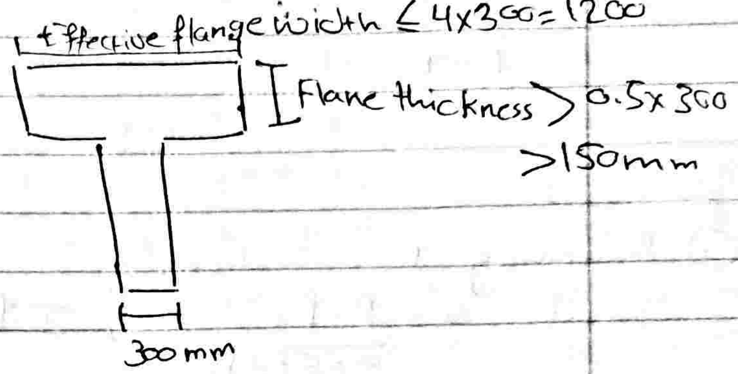
→ $b_e = 500 + 500 + 250 = 1250 mm$

• أحياناً المهندس بصمم على أساس Section (T) كي يزيد (compression area).

• condition:-

- Flange thickness $\geq 0.5 b_w$
- Effective flange width $\leq 4 b_w$

• Example:



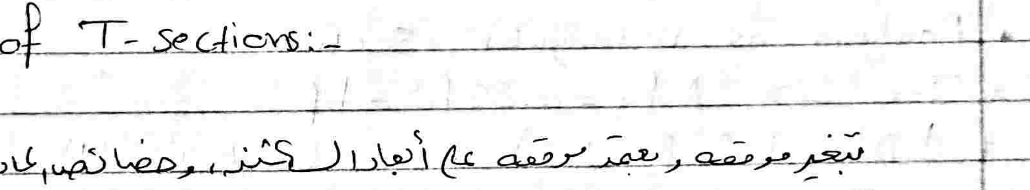
⟹ Analysis of T-sections:-

• N.A ⟹ تتغير موقعه، يعتمد موقعه على أبعاد الـ Section، وخصائص المادة وكمية الستيل.

• If N.A lies In:-

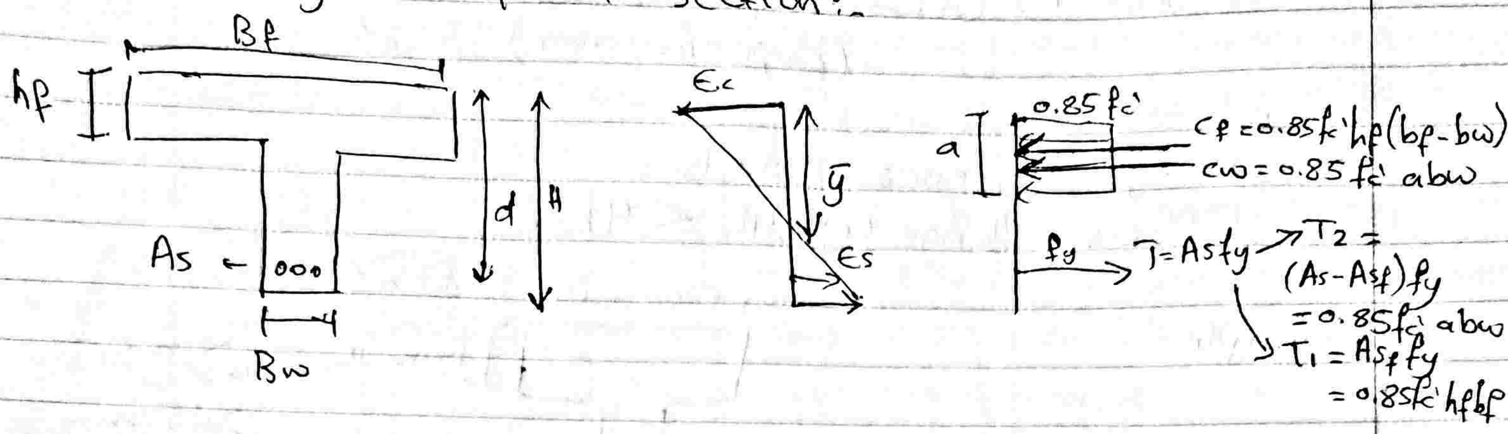
① flang :- بنقدر نعتبر السكشن كأنه ريكتانجيولر اللي بتغير إنه بنقلل كمية الباطون لمن يكون (T)، والمسافة اللي بنحط الستيل فيها بتقل (b_w) فبنقلل عدد ليرز أكثر من الستيل.

② Web:-



Total capacity = $C_1 + C_2$

* Analysis of T-section:-



① Assuming rect. section ,

② Cheack $a = \frac{A_s f_y}{0.85 f_c' b}$, If a:-

ⓐ $a \le h_f$

- * Analysis as rectangular section
- * $T = C \Rightarrow A_s f_y = 0.85 f_c' \, a \, b_f$
- * $\phi M_n = \phi A_s f_y (d - \frac{a}{2}) \Rightarrow$ Cheuck width = Bw

ⓑ $a \ge h_f$

+ Analysis as T-section

Ⅰ $T_1 = C_f \Rightarrow A_{sf} f_y = 0.85 f_c' h_f (b_f - b_w)$
$\Rightarrow \phi M_{nf} = \phi A_{sf} f_y (d - \frac{h_f}{2})$

Ⅱ $T_2 = C_w \Rightarrow (A_s - A_{sf}) f_y = 0.85 f_c' \, a \, b_w$
$\Rightarrow \phi M_{nw} = \phi (A_s - A_{sf}) f_y (d - \frac{a}{2})$

③ Reinforcment $\Rightarrow \rho_w > \rho_{min}$ rect $\rightarrow b = b_f$

$\rho_w = \frac{A_s}{b d} \rightarrow b$ T $\rightarrow b = b_w$

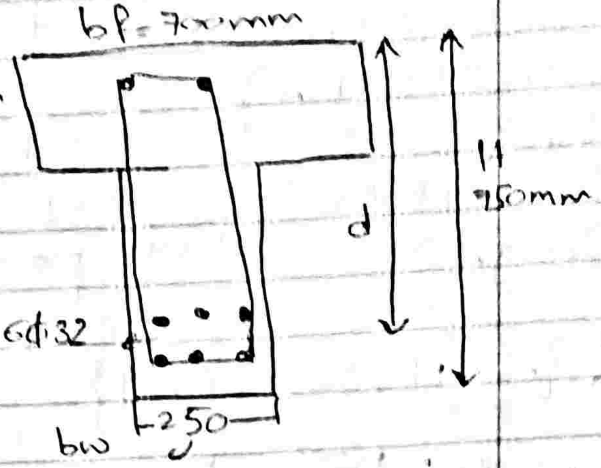
$\Rightarrow \rho_w < \rho_{max}$

$\epsilon_s = \epsilon_u \frac{d - \bar{y}}{\bar{y}} > 0.004$ ↗ إذا ما تحققت بانلجأ للدبل أو نتغير الأبعاد

• Example: $f_y = 420\,MPa$, $f'_c = 21\,MPa$

Calculat the moment Capacity?

$h_f = 150\,mm$



$6\phi32 \rightarrow A_s = 4914\ mm^2 \leftarrow$ من الجداول بنعرف إنه 250

يوسع لـ 2 بار، عشان هيك

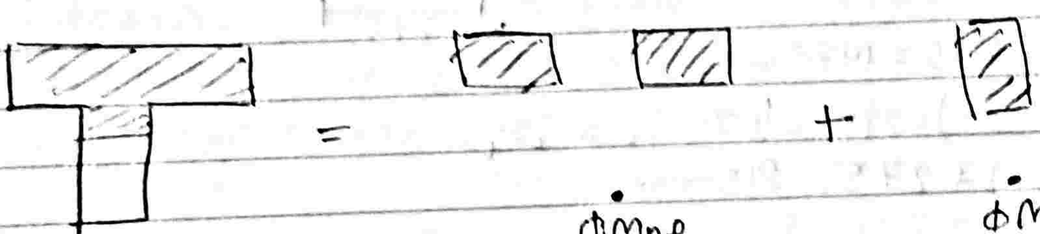
عدد الطبقات = 3

$d = H - 40 - 10 - 32 - 32 - 32/2 = 620\ mm$

• Assume rect : $T = C \Rightarrow 0.85 f'_c a b = A_s f_y$

$a = 165.18\ mm > h_f$

⇒ T-section design:-



ϕM_{nf} ϕM_{nw}

• for the flange:- $T_1 = C_f \Rightarrow A_{sf} f_y = 0.85 f'_c h_f (b_f - b_w)$

$A_{sf} \times 420 = 0.85 \times 21 \times (150)(700 - 250)$

$A_{sf} = 2869\ mm^2$

$A_{sw} = A_s - A_{sf} = 2045\ mm^2$

$\Rightarrow \phi M_{nf} = \phi A_{sf} f_y \left(d - \frac{h_f}{2}\right) = 591\ kN.m$ (φ = 0.9)

• for the web :- $T_2 = C_w \Rightarrow A_{sw} f_y = 0.85 f'_c b_w a$

$a = 192.5\,mm$

$\Rightarrow \phi M_{nw} = \phi A_{sw} f_y \left(d - \frac{a}{2}\right) = 404.9\ kN.m$

• Cheack $\phi \rightarrow \epsilon_s \Rightarrow \bar{y} = \frac{a}{\beta_1} \rightarrow \epsilon_s = 0.0052 > 0.005 \Rightarrow \phi = 0.9$

$\phi M_n = \phi M_{nf} + \phi M_{nw} = 995.9\ kN.m$

Example: $l_n = 7.5m$

$S = 1.2m$

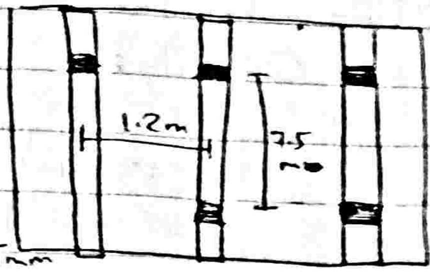
Web → (−) moment

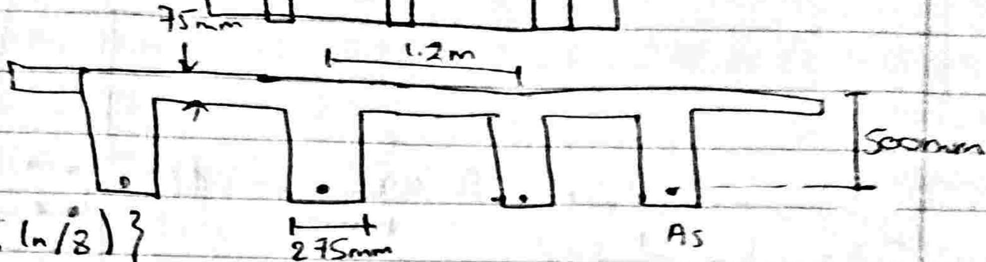
positive ($M_u = 750$ KN.m)

$f_y = 420$ MPa

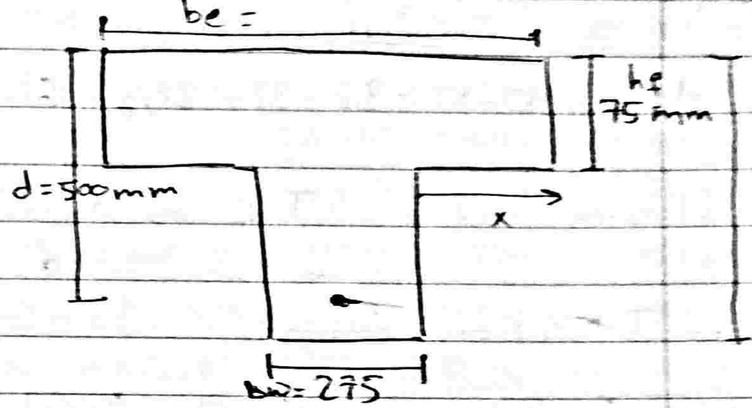
$f'_c = 21$ MPa

. Design?





$x = \{\min(8h, S_w/2, l_n/8)\}$



$b_e = \min \begin{cases} 2(600) + 275 = 1475mm \\ 2\left(\frac{1200-275}{2}\right) + 275 = \boxed{1200} mm ✓✓ \\ 2(437.5) + 275 = 2150mm \end{cases}$

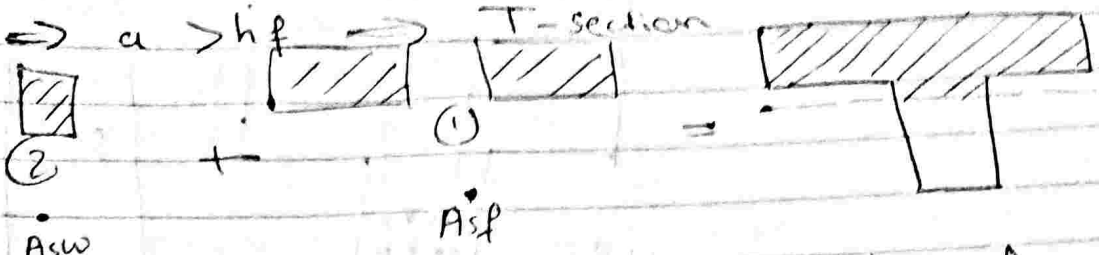
. Assum $a < h_f$ ⇒ $d = 500mm$, $b = 1200 mm$

⇒ $R = \frac{M_u}{\phi b d^2} = \frac{750 \times 10^6}{0.9 \times 1200 \times 500^2} = 2.78$ MPa

⇒ $\rho = 0.00723$ → from table

⇒ $A_s = \rho b d = 4338$ mm

⇒ check $a = \frac{A_s f_y}{0.85 f'_c b}$ ⇒ $a = 85$



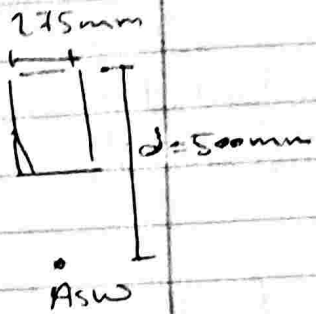
$\Rightarrow a > h_f$

(1) $\phi M_{nf} \Rightarrow C_f = T_1 \Rightarrow 0.85 f'_c h_f (b_f - b_w) = A_{sf} f_y$

$\Rightarrow A_{sf} = 2993\ mm^2$

$\phi M_{nf} = \phi A_{sf} f_y (d - h_f/2) = 521.6\ KN.m$

(2) $\phi M_{nw} = 750 - 521.6 = 228.4\ KN.m$



method (1) :-

$\phi M_{nw} = \phi A_{sw} f_y (d - \frac{a}{2})$ (unknown)

itr (a)

use :- $a = \frac{A_{sw} f_y}{0.85 f'_c b_w}$

method (2) :- $\Rightarrow \frac{R_n}{\phi b d^2} = \frac{M_u}{\phi b d^2} = \frac{228.4 \times 10^6}{0.9 \times 275 \times 500^2} = 3.69$

$\Rightarrow$ Table $\rho = 0.0099$, $A_s = \rho b d = 1367\ mm^2$

$\Rightarrow A_s = A_{sf} + A_{sw} = 4315\ mm^2$

$\Rightarrow a = 117\ mm$ ($\frac{a}{\beta_1 = 0.85}$), $\bar{y} = 137.6\ mm$, $\epsilon_s = 0.0079 > 0.005$

$\phi = 0.9$

(1) $A_s = 4315 \Rightarrow 7\phi 29 \rightarrow A_s = 4515\ mm^2$

or (2) $9\phi 25 \rightarrow A_s = 4590\ mm^2$

(3) $3\phi 43 \rightarrow A_s = 4365\ mm^2$

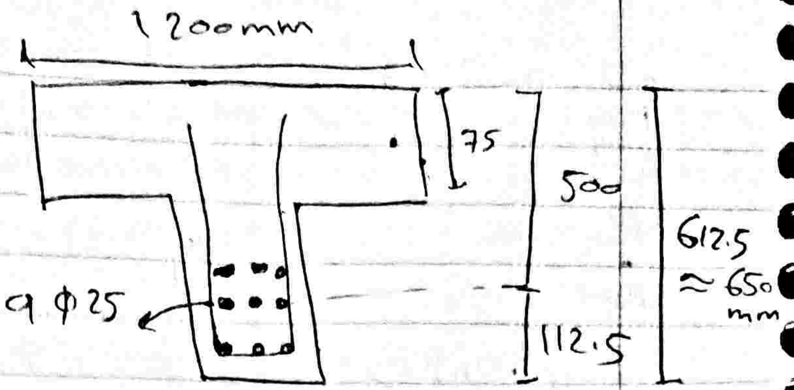
(4) $6\phi 32 \rightarrow 4914$ ...

} check spacing, ϕM_n

In case (3) $\Rightarrow b_w = 2(40) + 2(10) + 3(43) + 2s' \Rightarrow s' = 23$ X

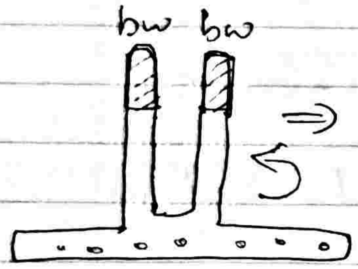
In case $9\phi 25 \Rightarrow$ 3 layers $\Rightarrow b_w = 2(40) + 2(10) + 3(25) + 2s' \Rightarrow s' = 62.5$

. Choose $9\phi 25 \Rightarrow$ 3 layers.

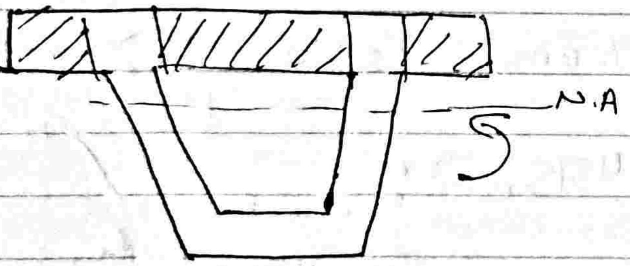


تغيرت (d) ⟸ بنعيد الديزاين ، بس ϕM_n زادت فمعنى احنا بال safe side

- Arbitary cross - section



$$\Rightarrow a = \frac{A_s f_y}{0.85 f_c' b} \quad b \Rightarrow 2b_w$$



- نقدر منه نقسم بطريقة مناسبة تسهل علينا الديزاين .