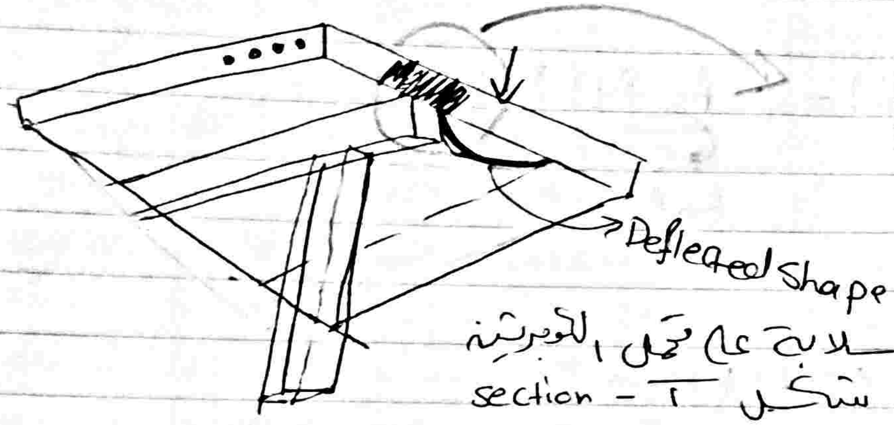
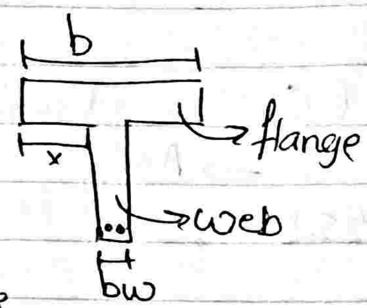
• What are T-section Beams:-

Beams + slabs → Continuous → mono lithic constraction



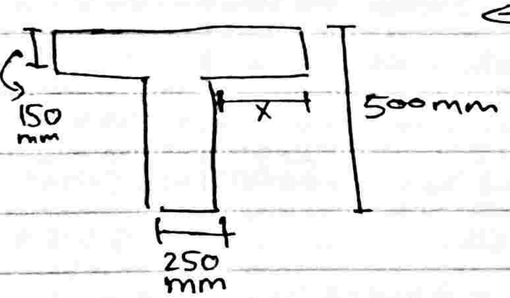


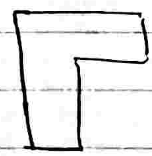
• بصير البيم يعمل مع السلابة على تحمل الكويرشنية
فتصير على شكل T - section

⇒ ACI - Code Table 6.3.2.1 a

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: $l_n = 4m$, $S_w = 3m$





$$x = \begin{cases} 8h = 8\times150 = 1200mm \\ S_w/2 = 3/2 = 1500mm \\ l_n/8 = 4/8 = 500mm \checkmark \end{cases}$$

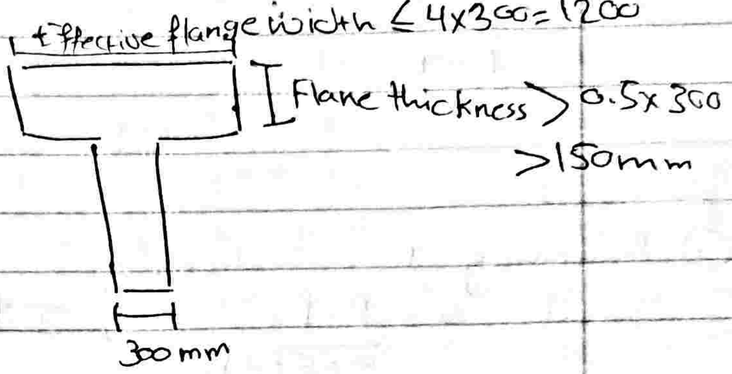
→ $b_e = 500 + 500 + 250 = 1250mm$

• أحياناً المهندس بصمم على أساس Section (T)
كمان بزيد (compression area).

• condition:-

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

• Example:

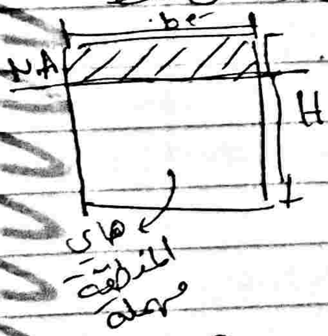


⟹ Analysis of T-sections:-

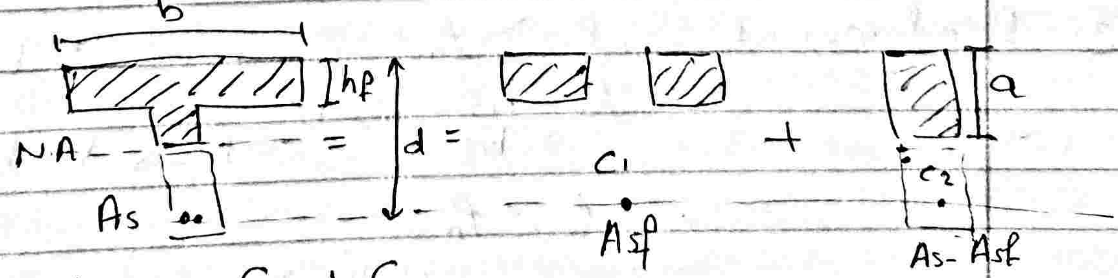
• N.A ⟹ بتغير موقعه، بعتمد موقعه على أبعاد الـ سكشن، وخصائص المادة وكمية الستيل.

• If N.A lies In:-

① flang :- بنقدر نعتبر السكشن كأنه ريكتانجولر
اللي بتغير انه بتقل كمية الباطون لما يكون (T)، والمسافة اللي بنحط الستيل فيها بتقل (b_w) فبنحط عدد ليرز أكثر من السيك.

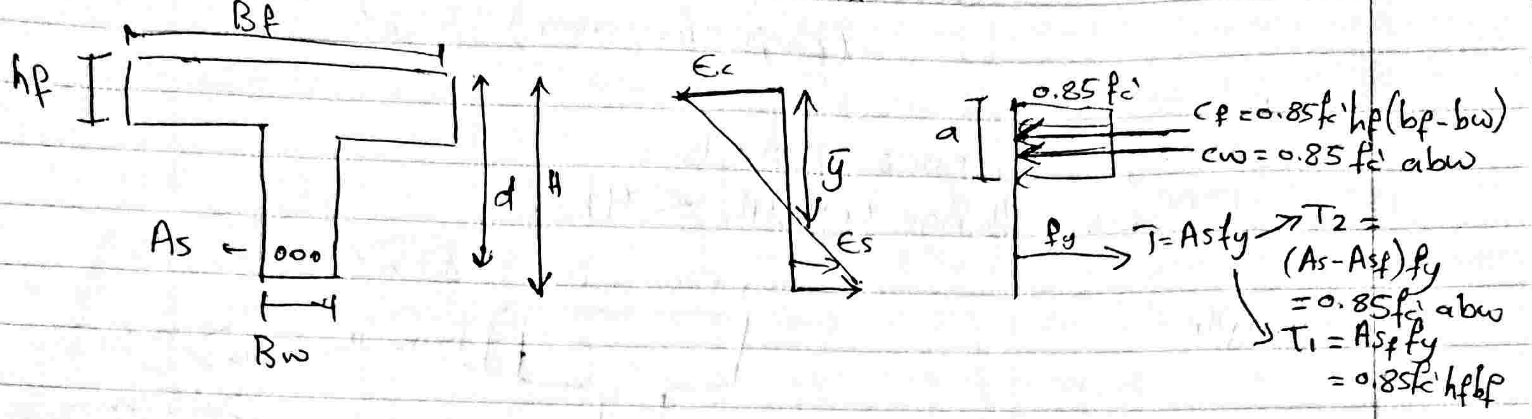


② Web:-



Total capacity = $C_1 + C_2$

* Analysis of T-section:



① Assuming rect. section,

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

ⓐ $a \le h_f$

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

ⓑ $a \geq h_f$

+ Analysis as T-section

Ⓘ $T_1 = C_f \Rightarrow A_{sf} f_y = 0.85 f_c' h_f (b_f - b_w)$

$\Rightarrow \phi M_{nf} = \phi A_{sf} f_y (d - \frac{h_f}{2})$

Ⓘⓘ $T_2 = C_w \Rightarrow (A_s - A_{sf}) f_y = 0.85 f_c' \, a \, b_w$

$\Rightarrow \phi M_{nw} = \phi (A_s - A_{sf}) f_y (d - \frac{a}{2})$

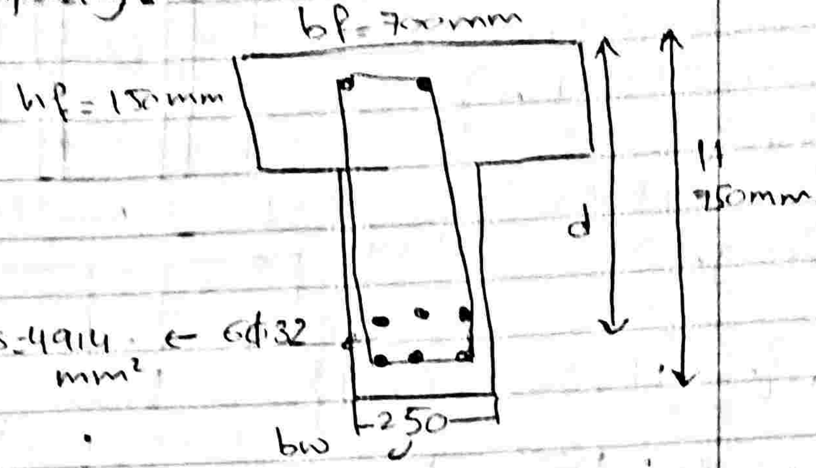
③ Reinforcement $\Rightarrow \rho_w > \rho_{min}$

$\rho_w = \frac{A_s}{bd} \rightarrow b$ — rect $\rightarrow b = b_f$; 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
بنلعب بالحديد
أو بتغير الأبعاد

• Example: $f_y = 420\,MPa$, $f'_c = 21\,MPa$
Calculat the moment Capacity?

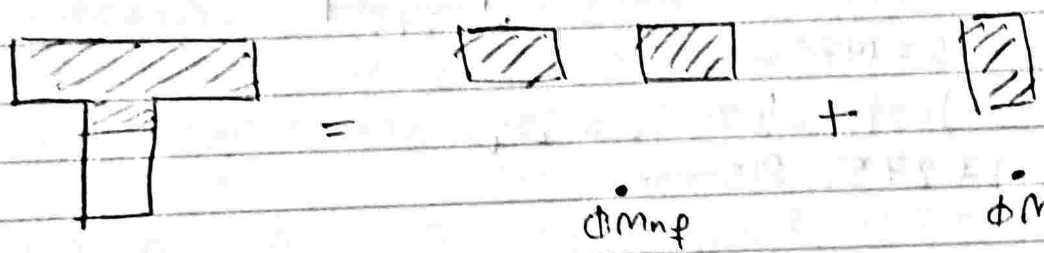


250 تم الاعتبار بنوع إنه ← $A_s = 4914\ mm^2$ ← $6\phi32$
يوسع لـ 2 بار ، عشان
عدد الطبقات = 3

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

• Assume rect : $T = C \Rightarrow 0.85 f'_c a b = A_s f_y$
$a = 165.18\ mm > h_f$

⇒ T-section design:



• 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 :- $T_2 = C_w \Rightarrow A_{sw} f_y = 0.85 f'_c b_w a$
$a = 192.5\ mm$

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

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

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

Example: $l_n = 7.5m$

$S = 1.2m$

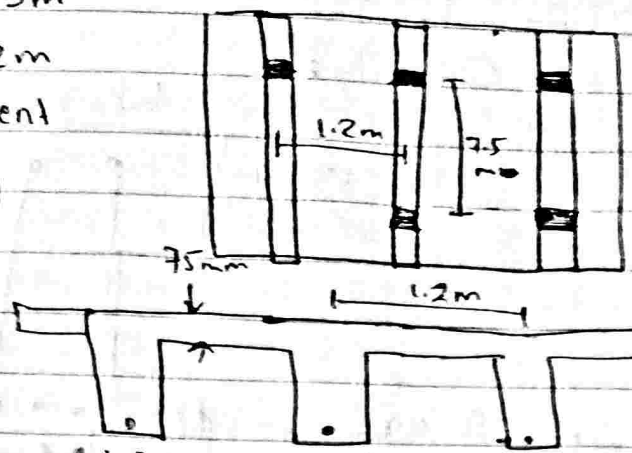
Web → (−) moment

Positive ($M_u = 750$ KN.m)

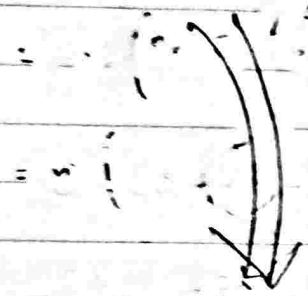
$f_y = 420$ MPa

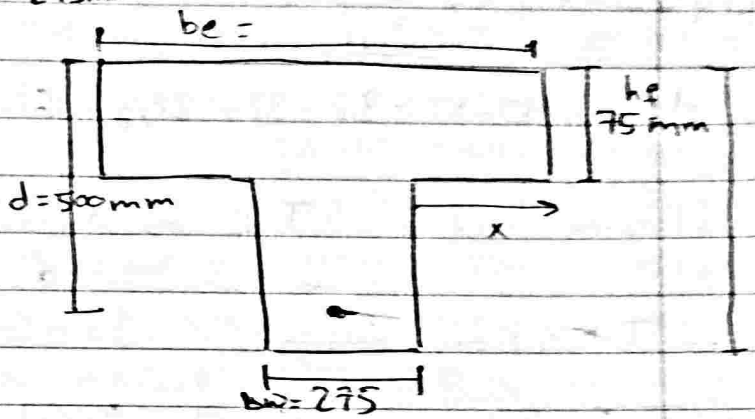
$f'_c = 21$ MPa

• Design ?



$b_e = \{\min(8h_f, S_w/2, l_n/8)\}$





$$b_e = \min \begin{cases} 2(600) + 275 = 1475\,mm \\ 2\left(\frac{1200 - 275}{2}\right) + 275 = \boxed{1200}\,mm \checkmark\checkmark \\ 2(937.5) + 275 = 2150mm \end{cases}$$

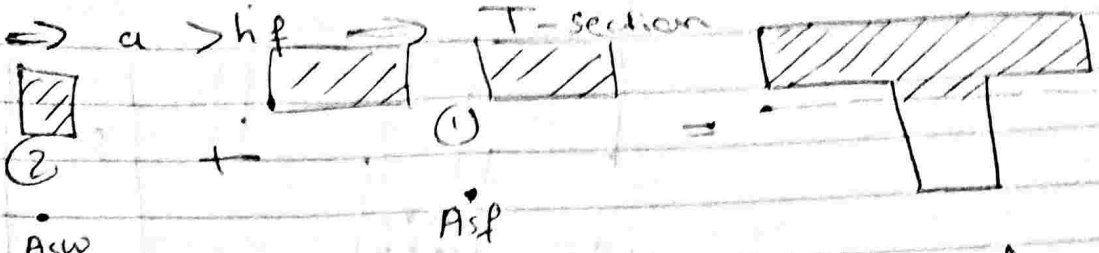
• Assum $a < h_f \Rightarrow d = 500mm$, $b = 1200$ mm

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

$\Rightarrow \rho = 0.00723 \rightarrow$ from table

$\Rightarrow A_s = \rho b d = 4338$ mm

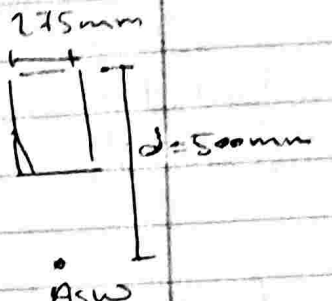
$\Rightarrow$ check $a = \frac{A_s f_y}{0.85 f'_c b} \Rightarrow a = 85$

$\Rightarrow a > h_f$ 

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

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

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



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

method (1) :-

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

unknow.

itr (a)

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

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

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

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

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

$\phi = 0.9$

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

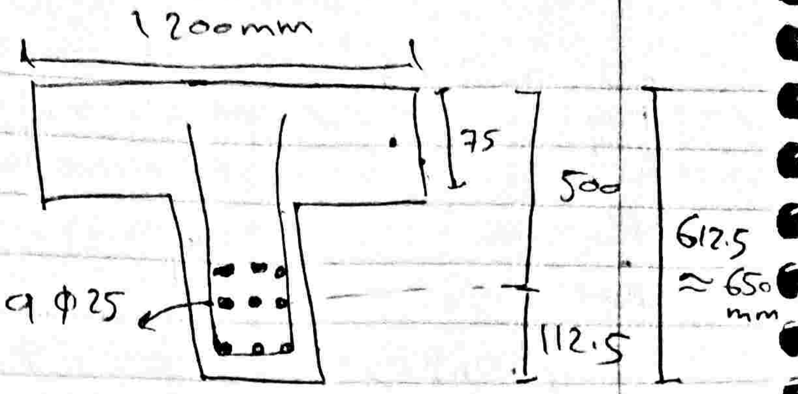
(4) $6\phi 32 \rightarrow 4914$ ...

} Check Spacing, ϕM_n

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

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

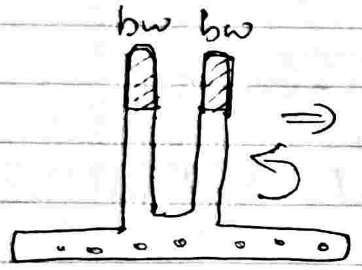
• Choose $9\phi 25 \Rightarrow$ 3layers.



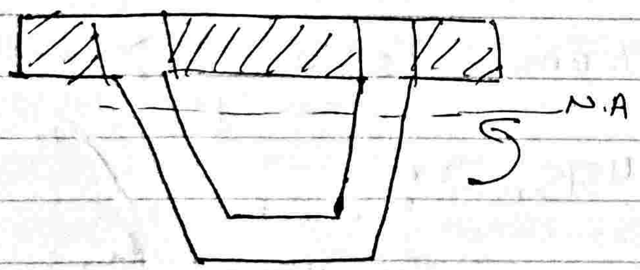
تغيرت (d) ⇐ بتغيير الديزاين ، بس

ϕMn زادت فبعطي احنا الـ safe side

• Arbitary cross-section



$\Rightarrow a = \frac{A_s f_y}{0.85 f_c' (b)}$ ⇐ 2bw



• فبقدر انه نقسم بطريقة مناسبة تشتغل عليه الديزاين.