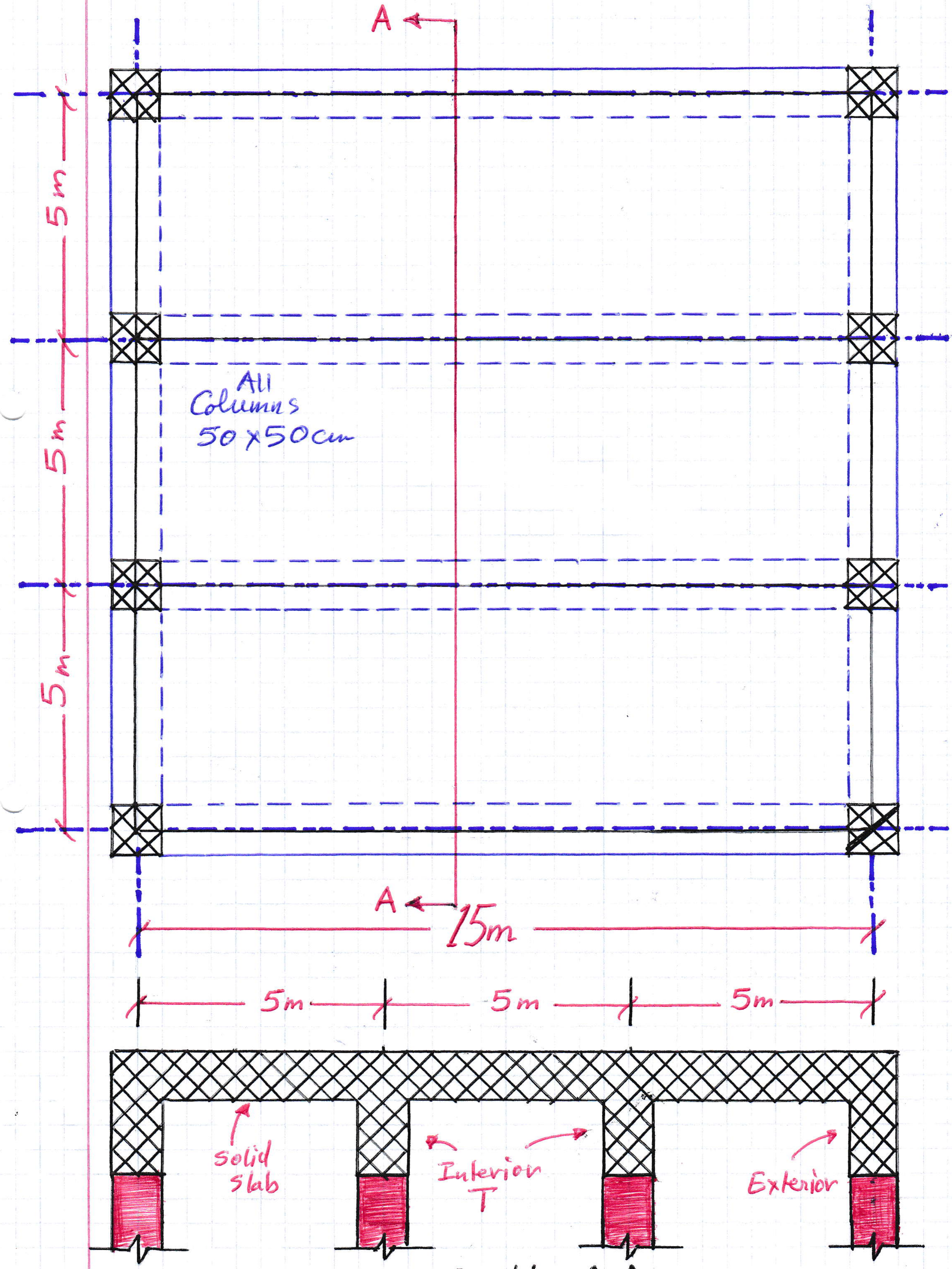
T- Sections

①

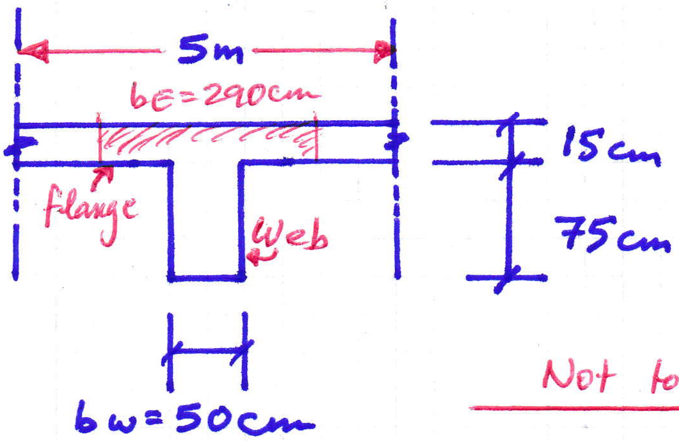


Section A-A

Example :

$f_c' = 28\,MPa$

$f_y = 420\,MPa$



Not to scale !

$W_u = 2\ t/m^2$

$\therefore$ Wu for an interior beam = 10 t/m
(Tributary area)
Same as the flange

$$M_u = \frac{(10)(15^2)}{8} = 281.2\ t.m$$

$$M_{n\,req} = \frac{281.2}{0.9} = 312.5\ t.m$$

C must be checked

$$b_E = 500\ cm$$
$$= 50 + \frac{1450}{4} = 412.5\ cm$$
$$= 50 + 16(15) = \underline{290\ cm} \quad \text{controls}$$

$a < t = 15\,cm$?

if $a = t$, $C = 0.85(0.28)(290)(15) = 1035\,t$

$$M_n = 1035\left(\frac{83.5 - 15/2}{100}\right) = 787\,t.m$$

which significantly exceeds $M_{n\,req} = 312.5\,t.m$

$\therefore$ it is clear that $a_{actual} < t$

$\therefore$ Proceed as a rectangular section with $b = 290\,cm$

$$R_{n\,req} = \frac{31250\,t.cm}{(290)(83.5)^2} = 0.01546\,t/cm^2$$

$\rho_{req} = 0.003808$

$As_{req} = 0.003808 \times 290 \times 83.5 = 92.21\,cm^2$

$13.04\,\phi 30 \Rightarrow$ use $14\,\phi 30$ in two layers
$7\phi 30$ in each layer

$d_{actual} = 80.75\,cm$

Check capacity :

$As_{actual} = 98.98\,cm^2$, $T = 415.7\,t$

$$a = \frac{415.7}{0.85(0.28)(290)} = 6.02\,cm$$

$$M_n = 415.7\left(\frac{80.75 - \frac{6.02}{2}}{100}\right) = 323.2\,t.m$$

$\phi M_n = 290.8\,t.m > M_u = 281.2\,t.m$

$\phi = 0.9$?

$a = 6.02\ cm,$

$$x = \frac{6.02}{0.85} = 7.20\ cm$$

$$\epsilon_t = \frac{83.5 - 7.20}{7.20}(0.003) = 0.03179$$

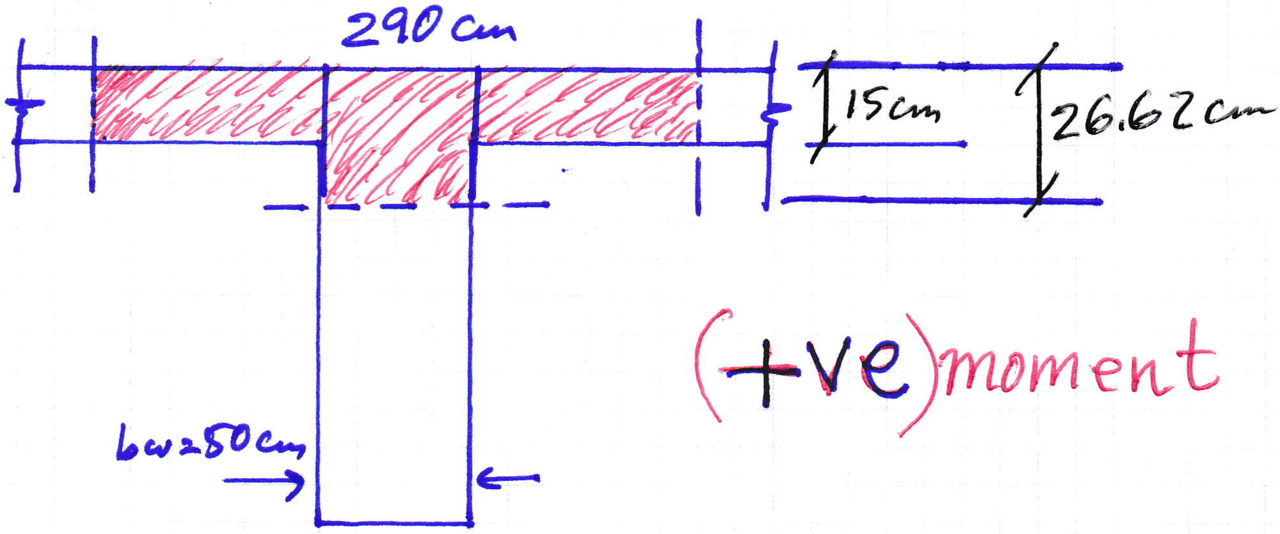
$>>> 0.005$

$\therefore \phi = 0.9$

$\underset{\epsilon_t = 0.005}{As_{max}} = ?$

$$\underset{\epsilon_t = 0.005}{x_{max}} = \frac{3}{8}(83.5) = 31.31\ cm$$

$$\underset{\epsilon_t = 0.005}{a_{max}} = 26.62\ cm > t = 15\ cm$$



(+ve) moment

$$\underset{\epsilon_t = 0.005}{C_{max}} = 0.85(0.28)(290-50)(15) + 0.85(0.28)(50)(26.62) = 1174\ t$$

$$\underset{\epsilon_t = 0.005}{As_{max}} = \frac{1174}{4.2} = 279.4\ cm^2$$

(+ve)

Note: $As_{actual} = 98.98\ cm^2$

$\therefore \phi = 0.9$

For (−ve) moment, the section is actually rectangular with $b = b_w = 50cm$ for our example,

and $A_{s\,max} = 75.40\,cm^2$
$\epsilon_t = 0.005$
(−ve)

$A_{s\,min}$, (+ve) moment
look at the tension side of the beam,
⇒ rectangular,

∴ $A_{s\,min}$ same as before,

For our example,

$$= \frac{0.25\sqrt{28}}{420}(50)(83.5) \geq \frac{1.4}{420}(50)(83.5)$$

$$= 13.15\,cm^2 \geq \underline{13.92\ cm^2}$$

For (−ve) moment,

$$A_{s\,min} = \frac{0.25\sqrt{f'_c}}{f_y}(b_f)(d_t) \geq \frac{1.4}{f_y}(b_f)(d_t)$$

larger

then Smaller

$$\frac{0.50\sqrt{f'_c}}{f_y}(b_w)(d_t) \geq \frac{2.8}{f_y}(b_w)(d_t)$$

larger

for our T-beam,

$A_{s\,min}$ (−ve) $= \frac{0.25\sqrt{28}}{420}(500)(83.5) \geq \frac{1.4}{420}(500)(83.5)$

$131.5\,cm^2$ $\quad \underline{139.2\,cm^2}$

$\frac{0.50\sqrt{28}}{420}(50)(83.5) \geq \frac{2.8}{420}(50)(83.5)$

$26.3\,cm^2$ $\quad \boxed{\underline{27.8\,cm^2}}$ Controls