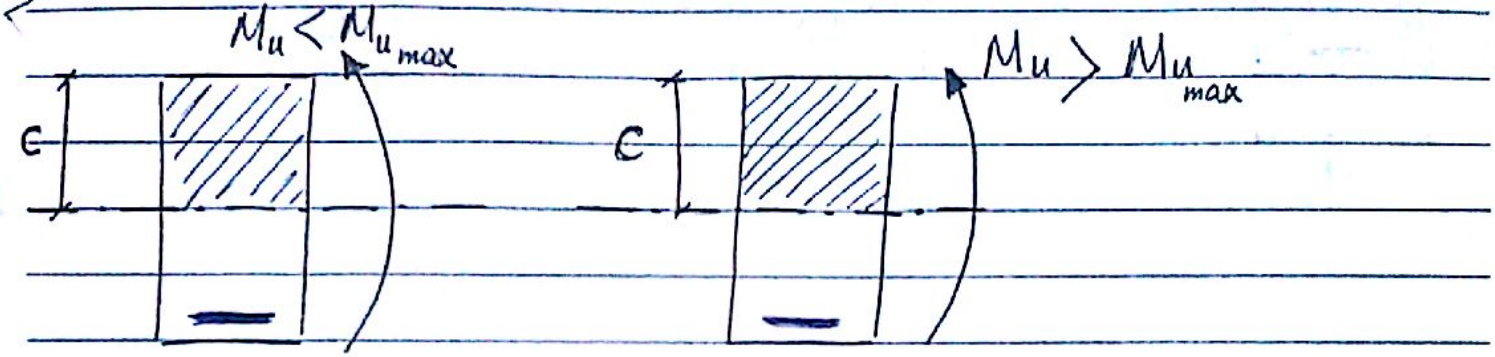
R.F. Concrete * Lec 3/12

Dale:

NO:

* Double Reinforcement (Rec. section)

Rec: $\frac{c}{d} > \frac{c_{max}}{d}$ Unsafe → increase dim. (t)
→ Comp. steel



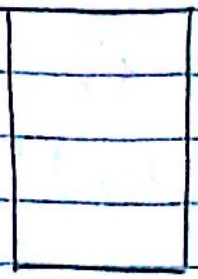
$C < C_{max}$

$C > C_{max}$ unsafe → Make Bigger (t)
→ Double. R.

$$M_{u\,max} = R_{max} \cdot \frac{F_{cu}}{\gamma_c} \cdot b \cdot d^2$$

(F_{cu}: const., γ_c: const., b: const., d: const.)

$M_u > M_{u\,max}$



$$M_u = M_{u\,max} + \Delta M$$
$$= R_{max} \cdot \frac{f_{cu}}{\gamma_c} \cdot b \cdot d^2 + \Delta M$$

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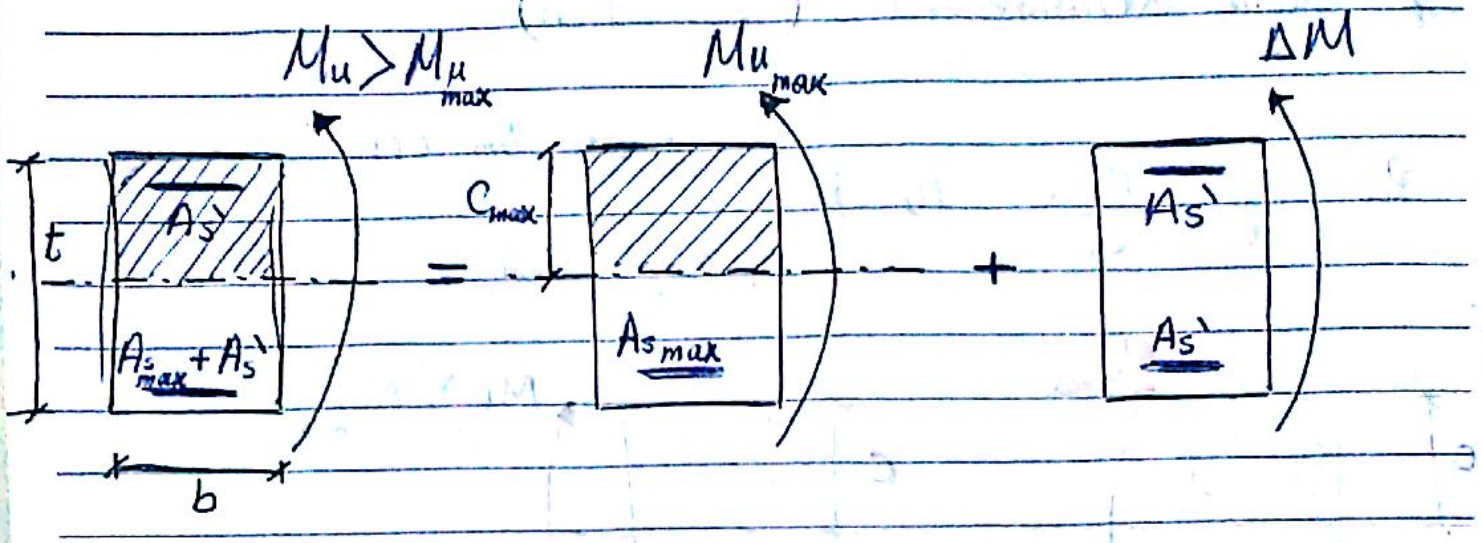

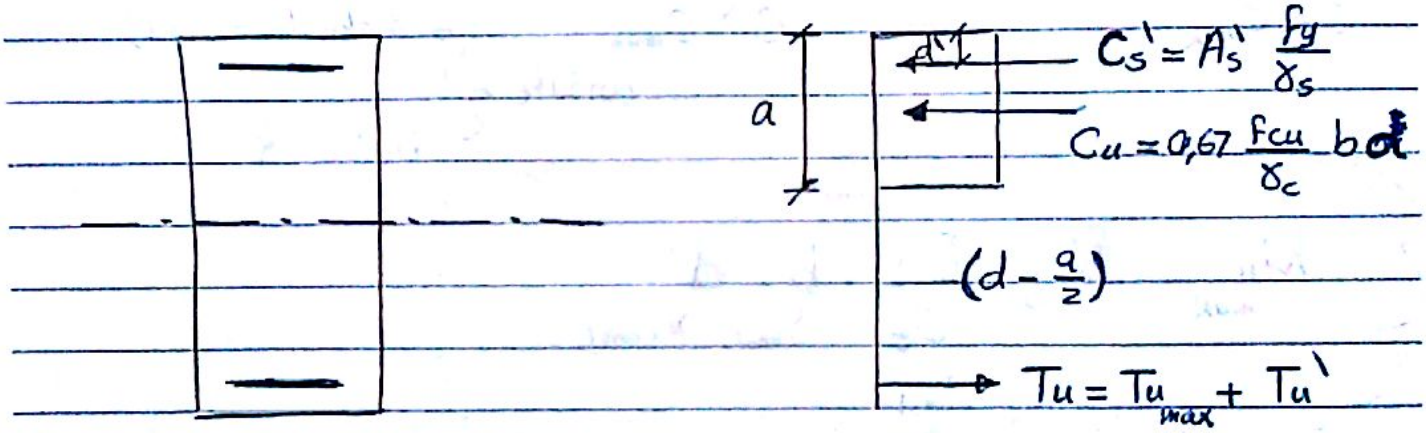

$$M_u = C_u\left(d - \frac{a}{2}\right) + C_s'(d - d')$$

$$= 0{,}67\,\frac{f_{cu}}{\gamma_c}\,b\,a\left(d - \frac{a}{2}\right) + A_s'\,\frac{f_y}{\gamma_s}(d - d')$$

$$M_u = R_{max}\,\frac{f_{cu}}{\gamma_c}\cdot b\cdot d^2 + A_s'\,\frac{f_y}{\gamma_s}(d - d')$$

$$M_u = M_{u_{max}} + A_s'\,\frac{f_y}{\gamma_s}(d - d')$$

Date:

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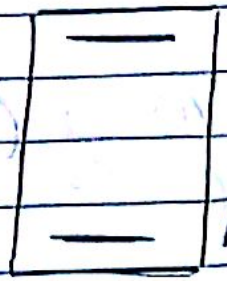
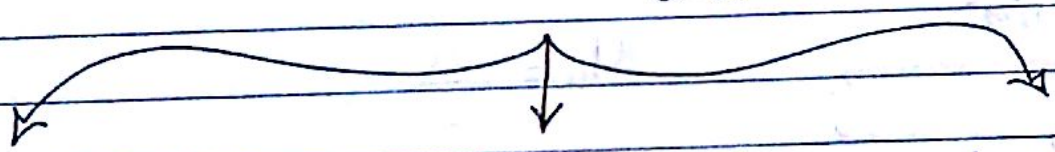


$M_u = ??$

* Check $\mu = \frac{A_s}{b \cdot d}$ *



$\mu < \mu_{max}$

∴ Safe

∴ A_s' مش موجود

$\mu = \mu_{max}$

$\frac{c}{d} = \frac{c_{max}}{d}$

$A_{s\,max}$

Safe

A_s' مش موجود

$M_u = M_{u\,max}$

$\mu > \mu_{max}$

$M_u = M_{u\,max} + \Delta M$

A_s' بيزيد

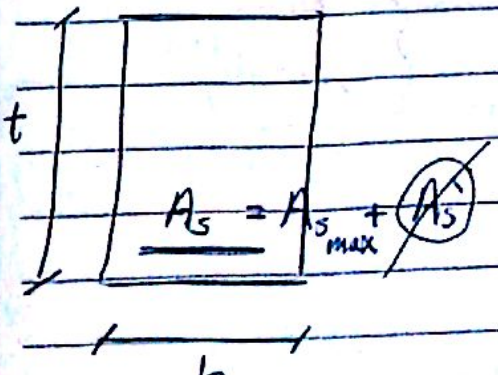
$A_s = A_{s\,max} + A_s'$

$M_u = M_{u\,max} + A_s' \frac{f_y}{\gamma_s}(d - d')$

■ Example: $b = \checkmark$ $t = \checkmark$ $A_s = \checkmark$ $M_u = ?$

∴ $M_u > M_{u\,max}$

$M_u = M_{u\,max} + \Delta M$



$A_s = A_{s\,max} + A_s'$

∴ $A_{s\,max} = \mu_{max}\, b\, d$

∴ $\mu_{max} = \frac{A_{s\,max}}{b\,d}$

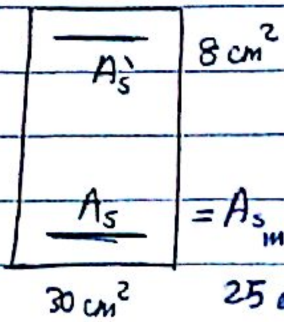
∴ $M_u = M_{u\,max} + \Delta M$

$= M_{u\,max} + A_s' \frac{f_y}{\gamma_s}(d - d')$

A_s' → Zero

■ Ex: ②

$$\mu = \frac{A_s}{bd} > \mu_{max}$$



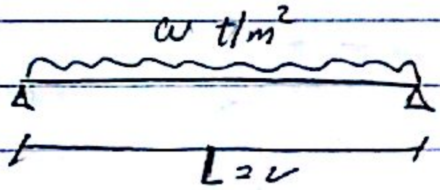
$= A_{s_{max}} + A_s'$

25 cm² 5 cm²

$$M_u = M_{u_{max}} + A_s' \frac{f_y}{\gamma_s}(d - d')$$

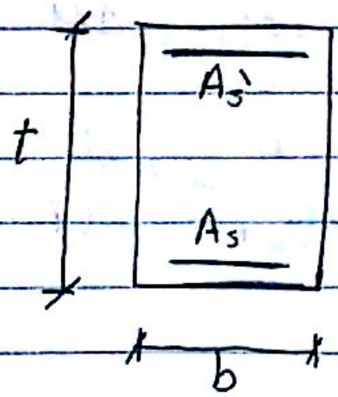
↙ الاقل
5 cm²

■ Ex: ③



$$M_u = \frac{\omega l^2}{8}$$

$$M_u > M_{u_{max}}$$



$$\therefore M_u = M_{u_{max}} + \Delta M$$

$A_s = ✓$ $\therefore A_{s_{max}} = \mu_{max}\, b\, d = ✓$

$$\therefore M_u = M_{u_{max}} + A_s' \frac{f_y}{\gamma_s}(d - d')$$

اكبر / اقل

$A_s' = A_s - A_{s_{max}}$ | A_s' المعطى

Date:

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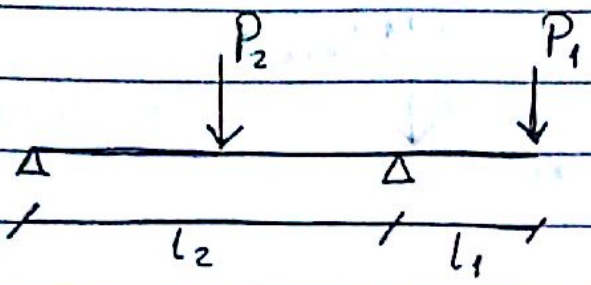
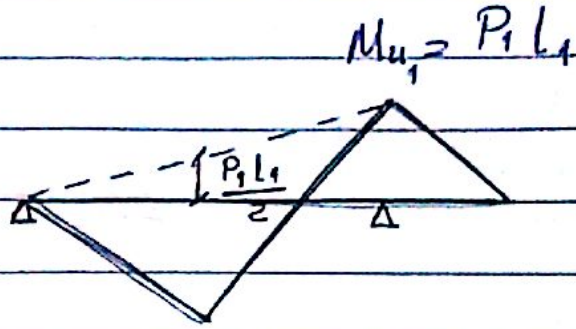
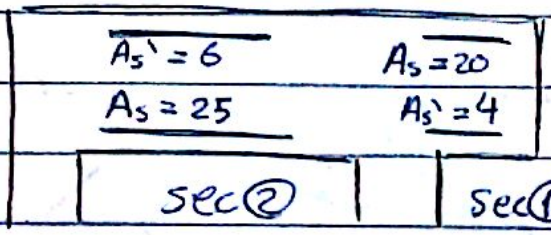
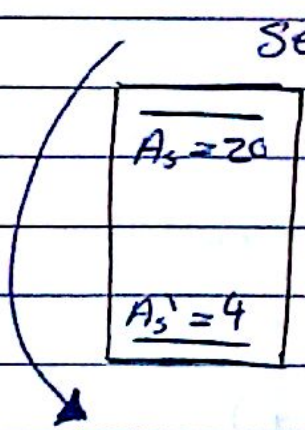
■ Ex :





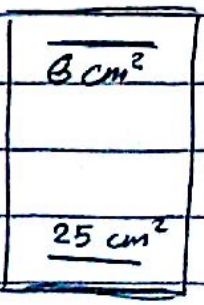
$$M_{u_2} = \frac{P_2 l_2}{4} - \frac{P_1 L_1}{2}$$





$= A_{s\,max} + A_s'$

$M_u = P_1 L_1 \longrightarrow P_{1\,max}$



$= A_{s\,max} + A_s'$

Date:

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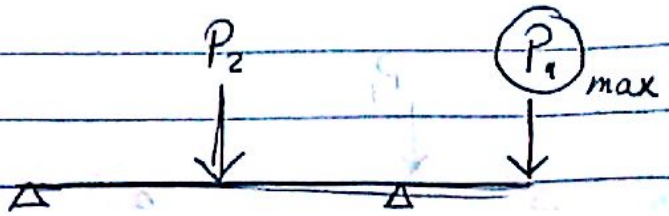
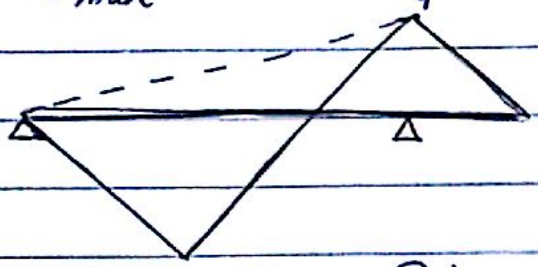


$P_{2\,max}$

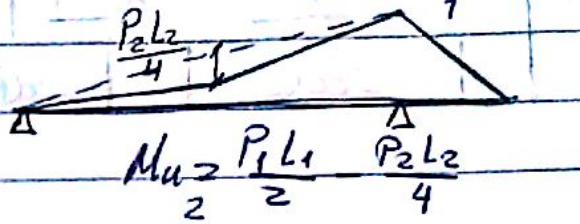
$L_{2\,max}$



$$M_{u_2} = \frac{P_2 L_2}{4} - \frac{P_1 L_1}{2}$$

$P_{2\,min}$

$L_{2\,min}$



$$M_{u_2} = \frac{P_1 L_1}{2} - \frac{P_2 L_2}{4}$$

$$M_u = M_{a,max} + A_s' \frac{f_y}{\gamma_s} (d - d')$$

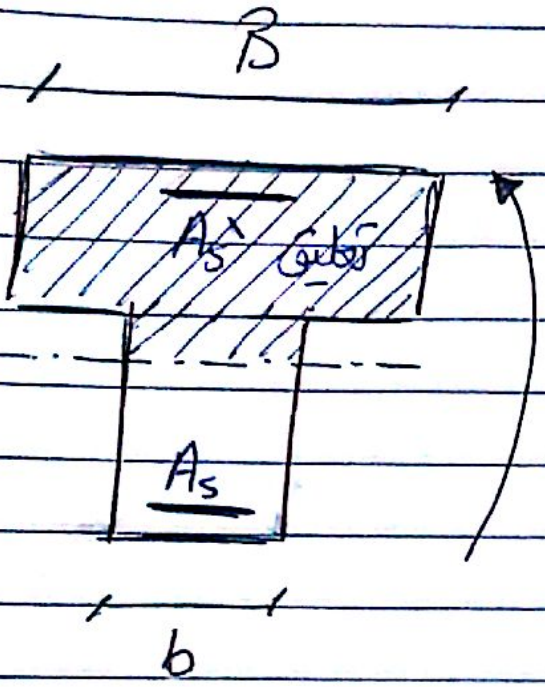
check for comp. steel

check: $\frac{A_s'}{A_s} \not> 0{,}4$

لو النسبة زادت لا يمكن استخدام Double. R.

Date:

NO:



$$M_u = 0{,}67 \frac{f_{cu}}{\gamma_c} B a \left(d - \frac{a}{2}\right)$$

$$a = 1{,}93 \frac{A_s}{B} \frac{f_y}{f_{cu}}$$

$a < t_s \Rightarrow \left(d - \frac{a}{2}\right)$

$a > t_s \Rightarrow \left(d - \frac{t_s}{2}\right)$