Design 1

HW 4

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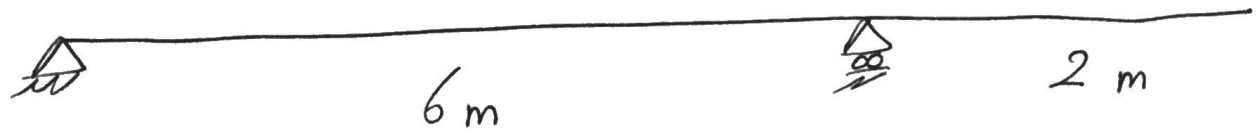
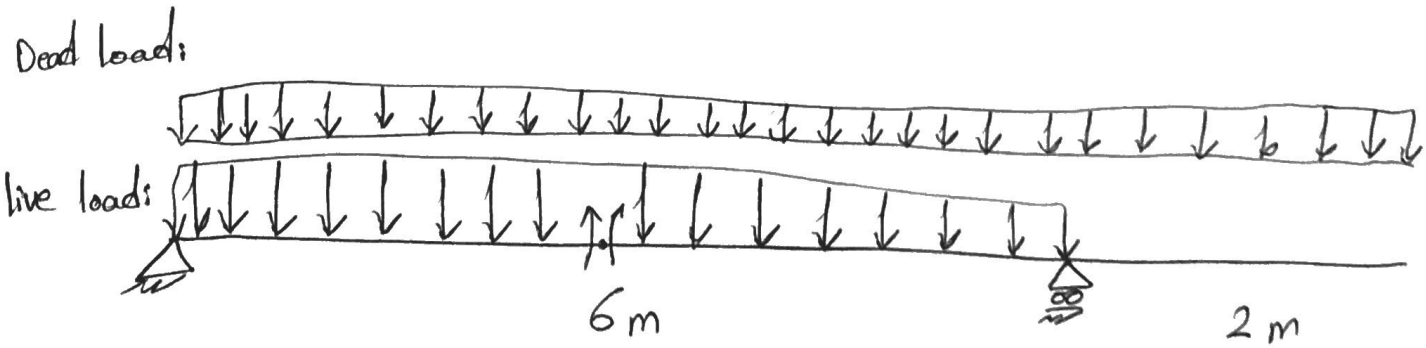
Solution :-

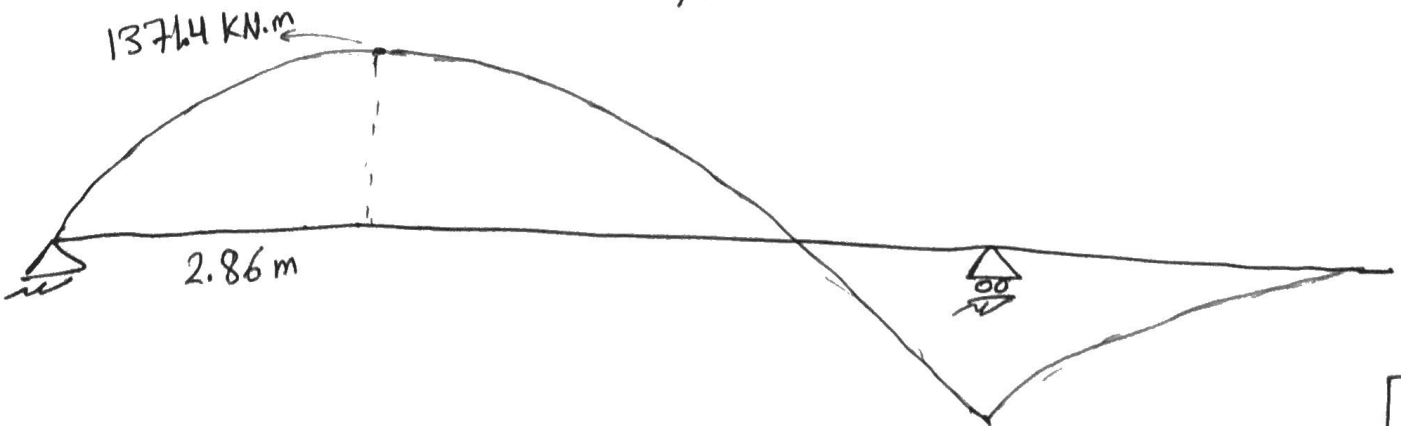


to maximize positive and negative moments :-

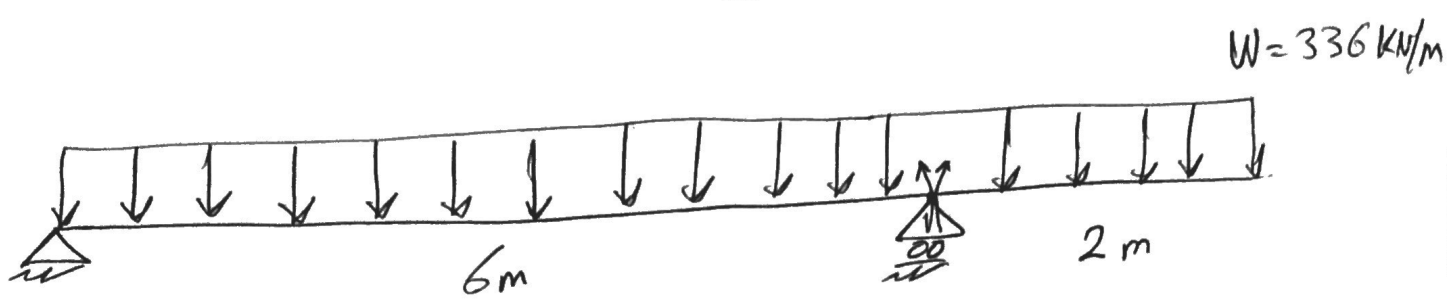
* load case (I) : to maximize positive moment :

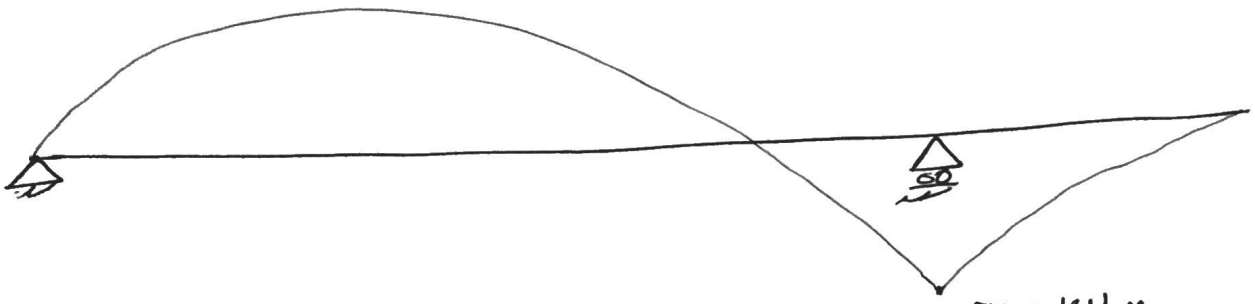


$w = 1.2d + 1.6L = 336$ KN/m



*load case (II): to maximize negative moment:

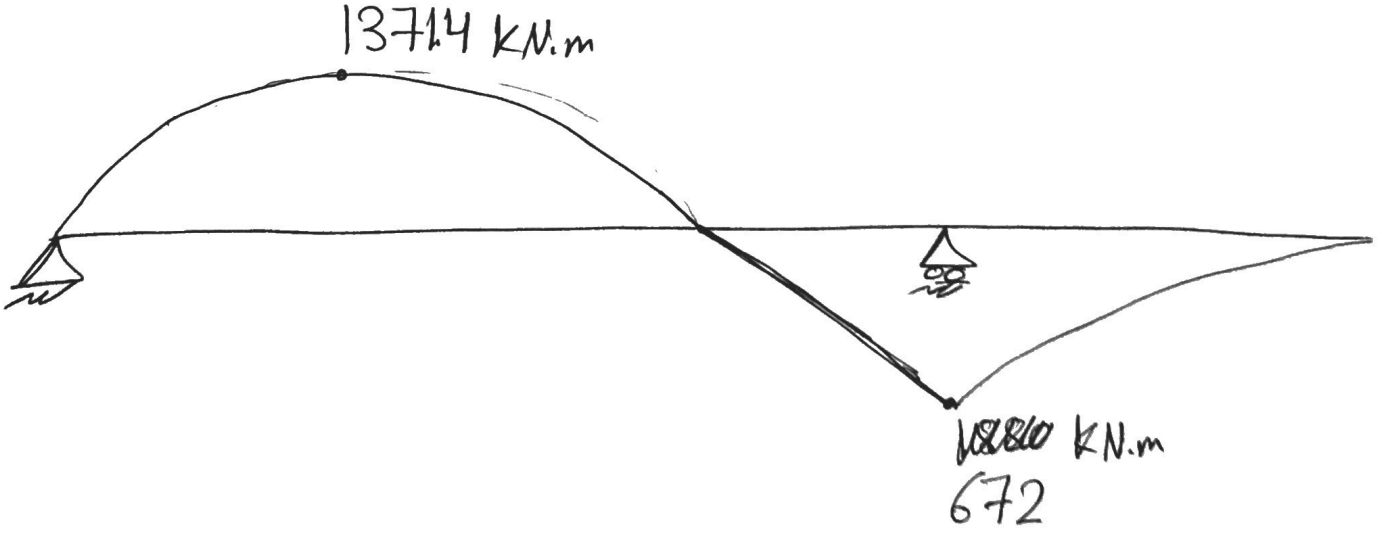




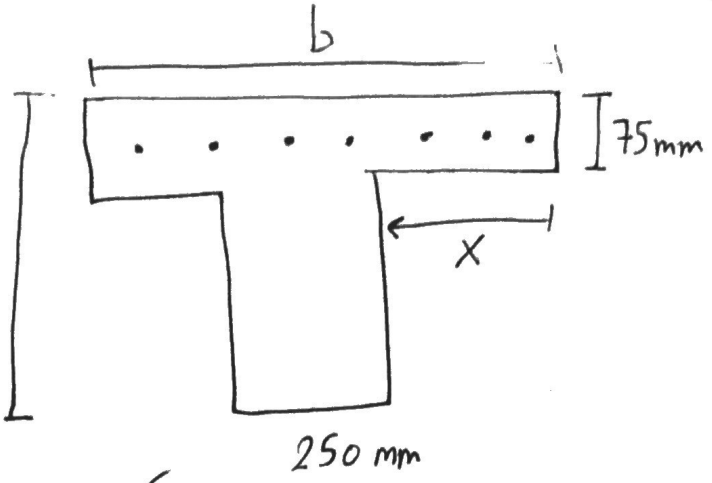
~~1280~~ KN.m

$\left(672 * \frac{2}{2}\right)$

The Envelope:



② $M_u = 672$ KN.m (negative)



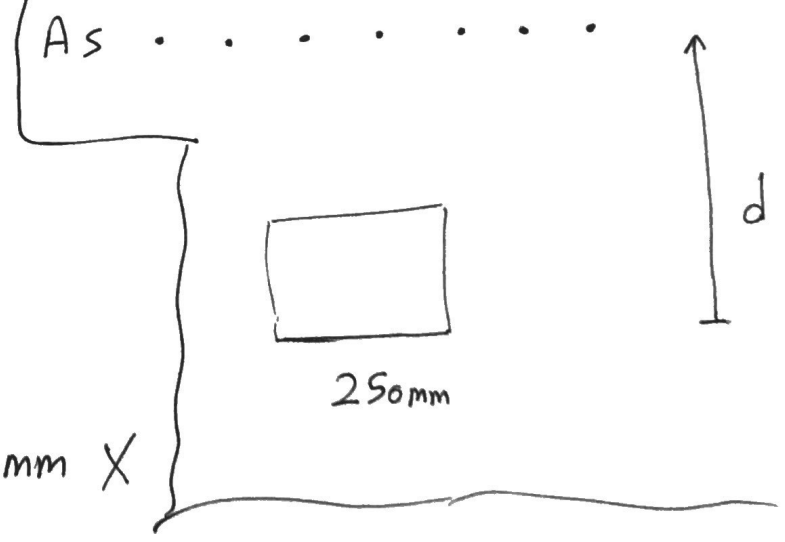
$X = \begin{cases} 8(75) = 600 \text{ mm} \checkmark \\ 3/2 = 1500 \text{ mm} \\ 8/8 = 1000 \text{ mm} \end{cases}$

$b_e = 2(600) + 250 = 1450$ mm

المنطقة التي يوجد فيها Concrete و نهمل الـ steel فيها

*Assume $H = 700$ mm

$d = 700 - 40 - 10 - 12.5 = 637.5$ mm



* Iteration for @: assume $a = 200$ mm

$M_u = \phi A_s f_y (d - \frac{a}{2})$

$A_s = 3307.5 \text{ mm}^2$

Check: $a = \frac{A_s f_y}{0.85 f_c' b} = 233.5$ mm X

* assume $a = 230$ mm

$A_s = 3402 \text{ mm}^2$

Check: $a = 240$ mm X

* assume $a = 240$

$A_s = 3435 \text{ mm}^2$

Check: $a = 242.5$ mm ✓

From Design Aid:

$A_s = 3435\ mm^2 \longrightarrow 7\phi 25\ (3570\ mm^2)$

new a: $a = \dfrac{(3570)(420)}{0.85(28)(250)} = 252\ mm$

Check S: $\dfrac{1450 - (7*25) - 80 - 20}{6} = 195.83 > 25_{mm}$ ✓

Check ϕ: $\rho = \dfrac{A_s}{bd} = \dfrac{3570}{1450(637.5)} = 0.00386$

$> \rho_{min}$

$< \rho_{0.005}$

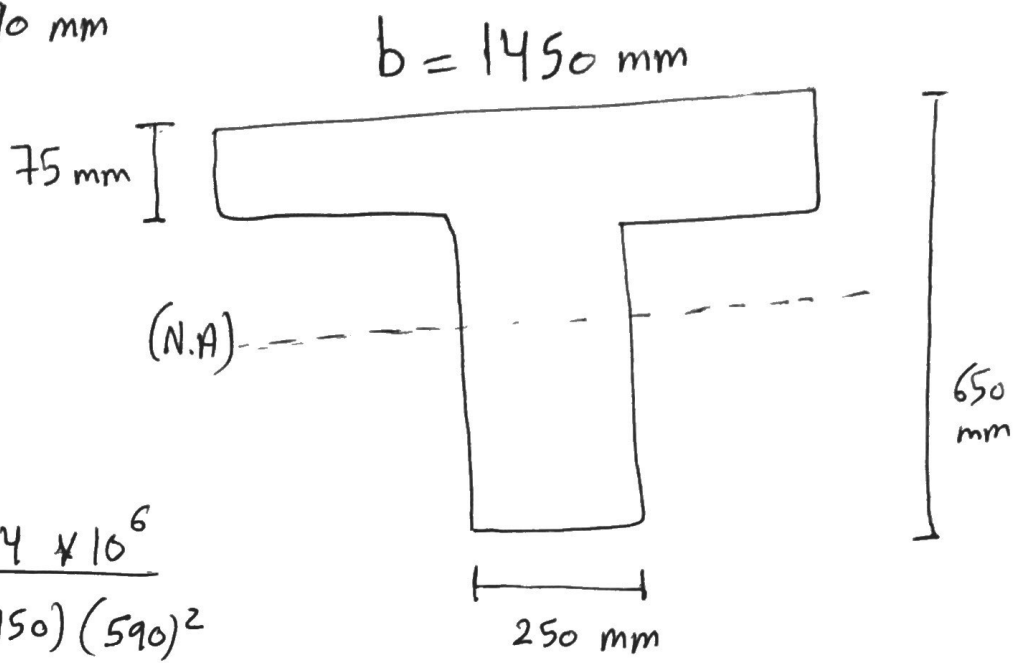
Check: $\phi M_n = \phi A_s f_y \left(d - \frac{a}{2}\right)$

$= 0.9(3570)(420)\left(637.5 - \frac{252}{2}\right)$

$= 690.25\ KN.m > M_u$ ✓

3 Positive moment: $M_u = 1371.4$ kN.m

$d = 650 - 50 - 10 = 590$ mm



(a)

* Assume N.A $< h_f$

→ rec. section

* Assume $\phi = 0.9$

$$R = \frac{M_u}{\phi b d^2} = \frac{1371.4 \times 10^6}{0.9(1450)(590)^2}$$

$$= 3.019 \text{ MPa}$$

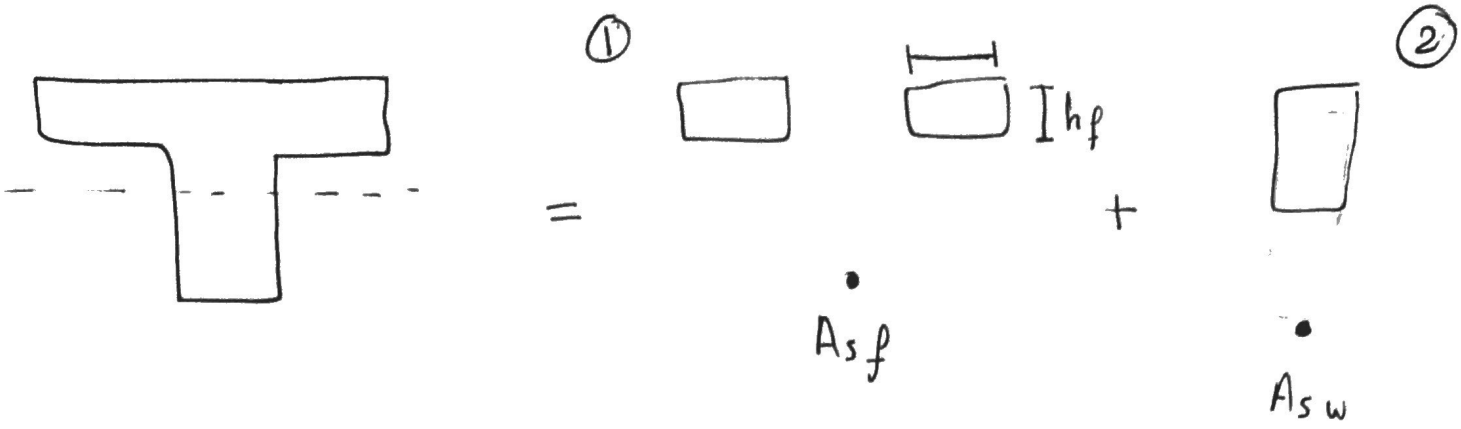
$$\rightarrow \rho = 0.00772$$

$$A_s = \rho d b = 6604.46$$

Check a: $T = C$: $a = \frac{A_s f_y}{0.85 f'_c b} = 80.38$ mm

$\therefore a > h_f \rightarrow$ T-section

→



* $\phi M_{nf} \rightarrow C_f = T_1$

$$0.85 f'_c \, h_f (b_f - b_w) = A_{sf} f_y$$

$$A_{sf} = 5100 \text{ mm}^2$$

$$\phi M_{nf} = \phi A_{sf} f_y \left(d - \frac{h_f}{2}\right) = 1065.11 \text{ KN.m}$$

* $\phi M_{nw} = 1371.4 - 1065.11 = 306.29 \text{ KN.m}$

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

Iterations for a : assume $a = 105$ mm

$$A_{sw} = 1507.5 \text{ mm}^2 \approx 1508 \text{ mm}^2$$

Check: $a = \dfrac{A_{sw} f_y}{0.85 f'_c \, b_w} = 106.4$ mm ✓

$\longrightarrow A_s = A_{sf} + A_{sw} = 5100 + 1508$

$= 6608\ mm^2$

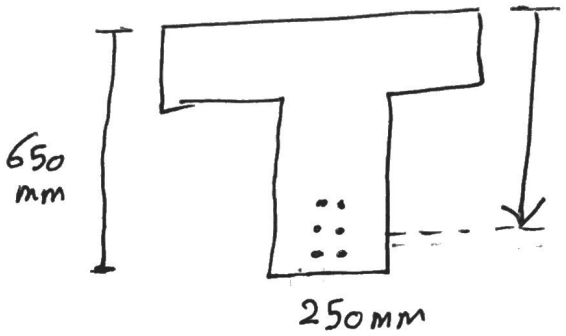
From Design Aid:

$6\ \phi\ 43 \rightarrow (8712\ mm^2)$

3 layers:

$S = 250 - (2*43) - 100$

$= 64\ mm$ ✓



new d = 650 - 50 - 43 - 43 - 43/2

d = 492.5 mm

Check: ① ϕ: $\rho = \frac{A_s}{bd} = 0.0122 < \rho_{0.004}$

$> \rho_{0.005}$

② $\phi M_n = \phi A_s f_y \left(d - \frac{a}{2}\right)$

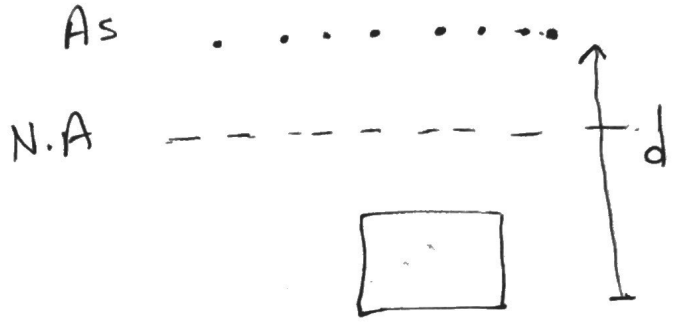
* $a = \frac{A_s f_y}{23.8\,b} = 106\ mm$

$\rightarrow \phi M_n = 1447.3\ KN.m > M_u$

* Negative moment: $M_u = 672$ kN.m

$d = 650 - 50 - 10 = 590$ mm

* the region that I will put the steel in it, I remove the concrete from it.



$h = 650$ mm

$d \approx 590$ mm

$b_w = 250$ mm

* Iteration for a :-

① assume $a = 150$ mm

$$M_u = \phi A_s f_y \left(d - \frac{a}{2}\right)$$

$\rightarrow A_s = 3452$ mm^2

Check: $a = 243.7$mm X

② assume $a = 277$ mm

$A_s = 3938$ mm^2 ✓

Check: $a = 277.9$ mm

from Design Aid: $8 \phi 25$ (4080 mm^2)

* Check S : $7S = 1450 - (8*25) - 100$

$S = 164.3\ mm$ ✓

$a = \frac{4080(420)}{(23.8)(250)} = 288\ mm$ / $d = 650 - 50 - 12.5 = 587.5\ mm$

Check: ① ϕ : $\rho = \frac{4080}{(1450)(587.5)} = 0.00479 < \rho_{0.004}$ $> \rho_{0.005}$

② $\phi M_n = \phi A_s f_y \left(d - \frac{a}{2}\right)$

$= 683.98\ KN.m > M_u$

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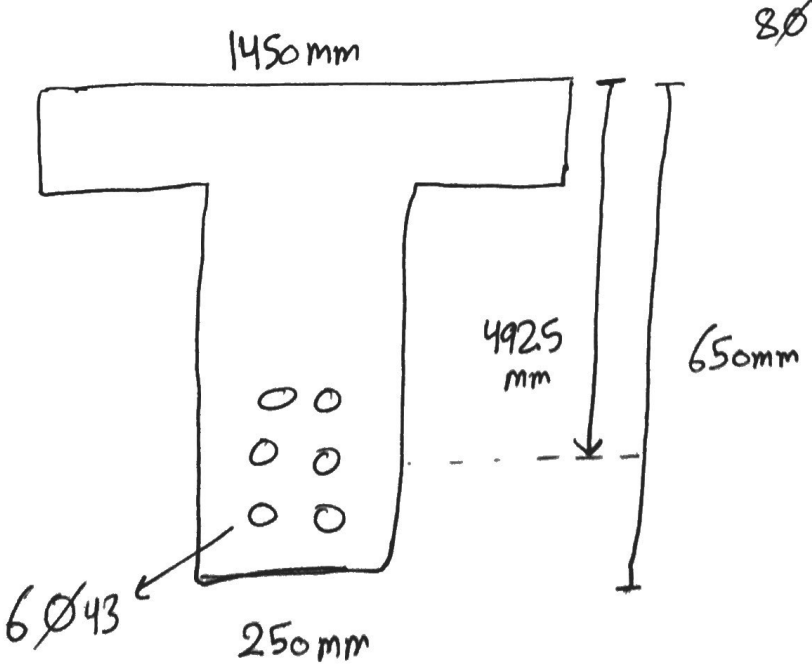
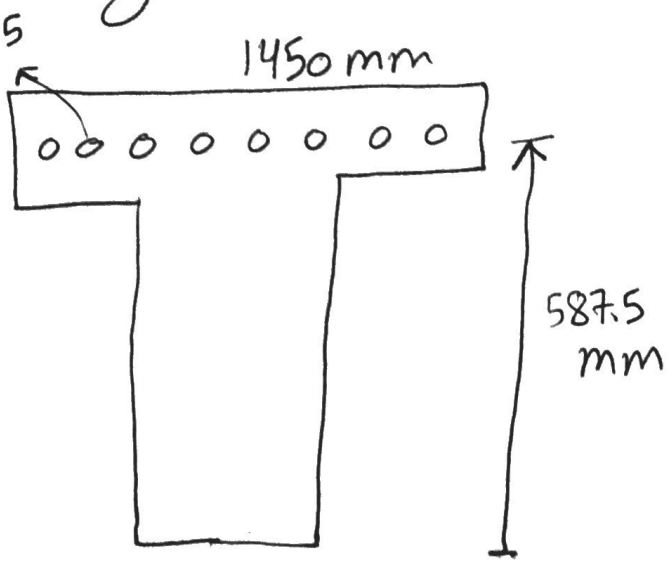
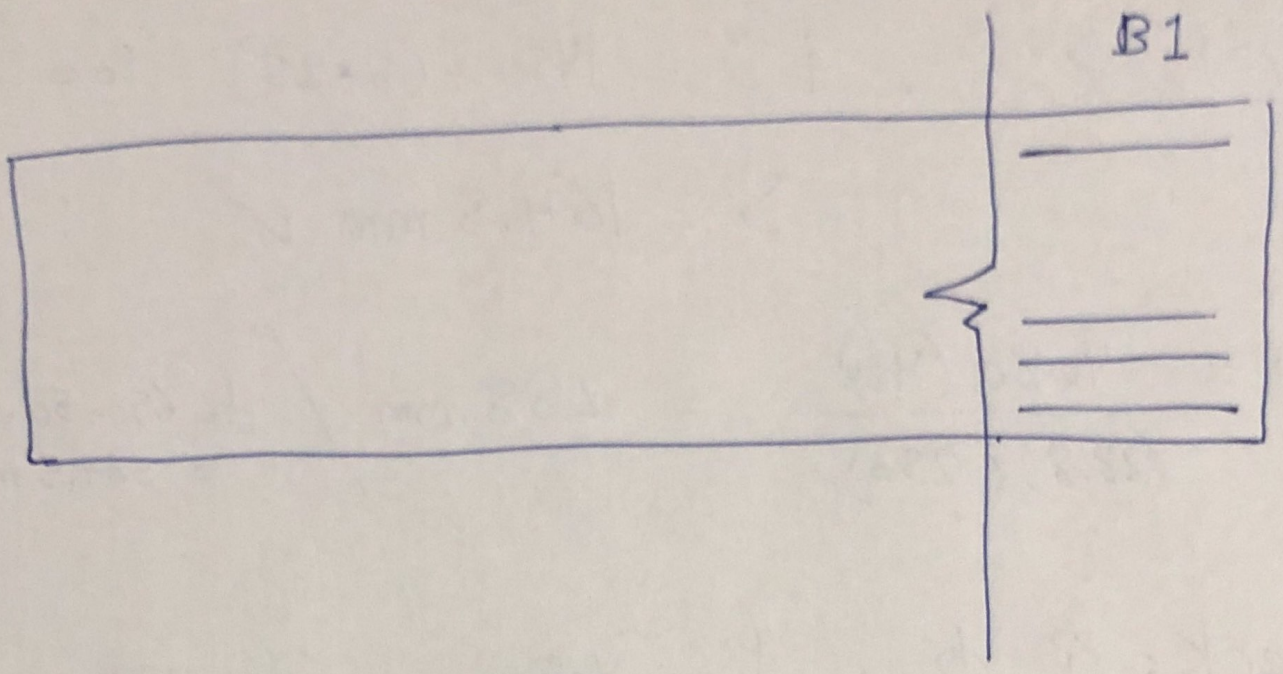
Positive moment



Negative moment




B1