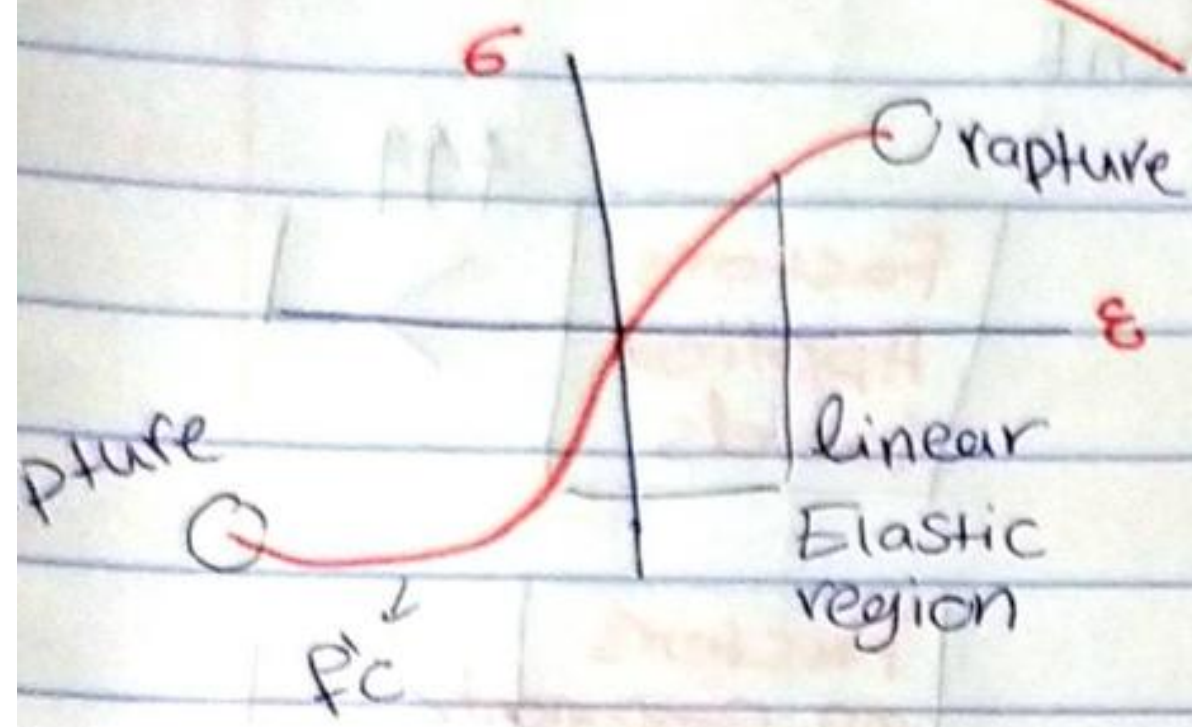


* Concrete

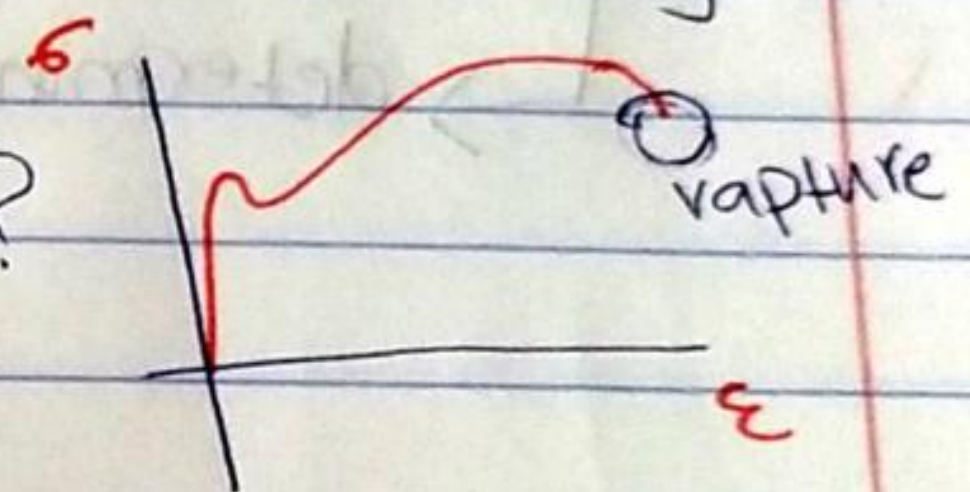
- Water
- Gravel + Sand
- Cement
- additives

- high Compression Strength
- Normal strength 10-40 MPa
- High strength 40-150 MPa
- Brittle material
- durable



* Steel \rightarrow High strength In tension, ductility

- location of needed steel reinforcement?
- main steel (Tension).



• **Design:-** is the process of devising a system and/or a component to meet desired demand.

• **The system:** Beams, Slabs, Columns

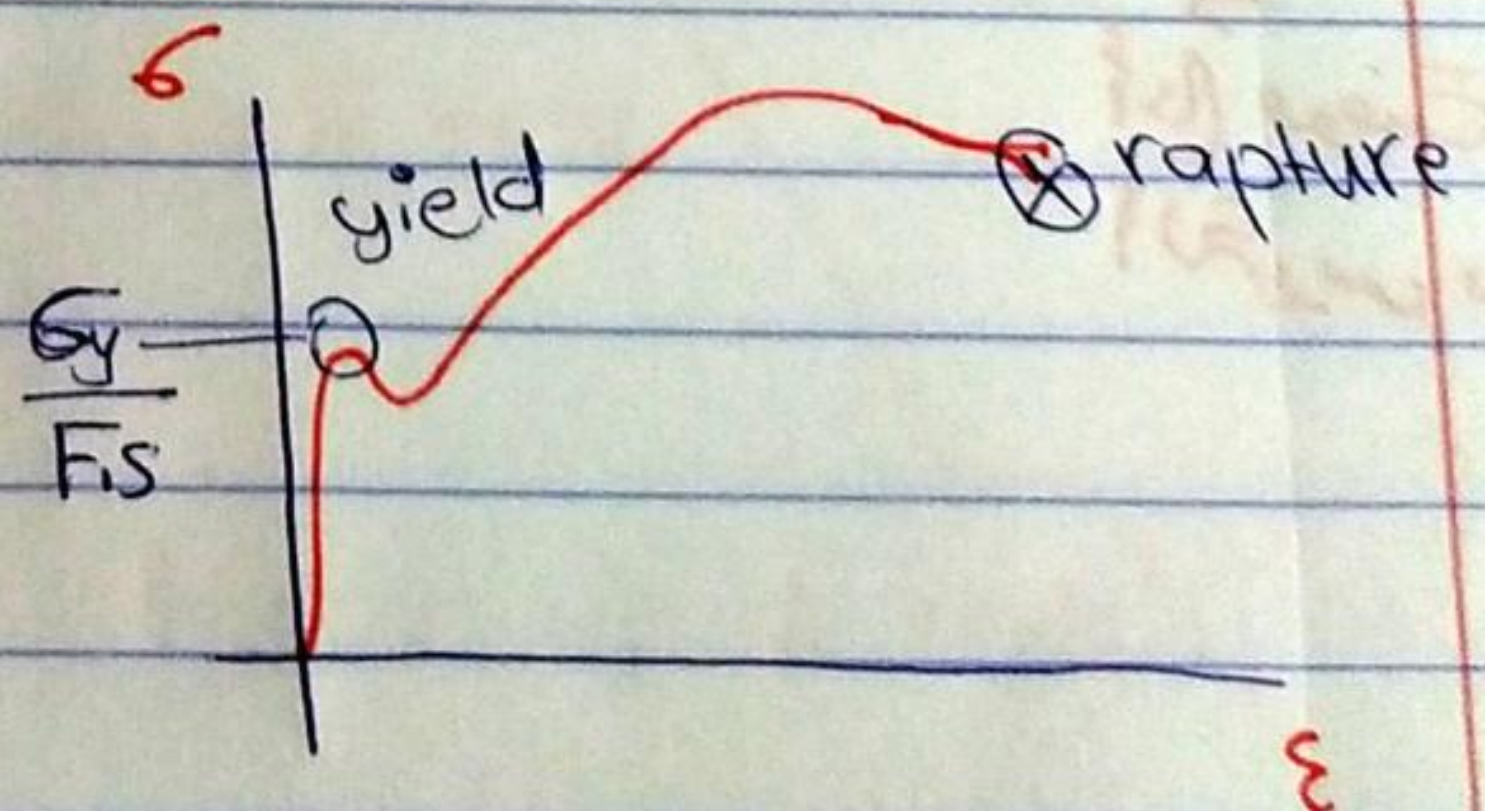
• **The demand:** loads

Reinforced concrete design??

- Geometry of concrete member
- Amount and location of steel reinforcement

* **Design method:-**

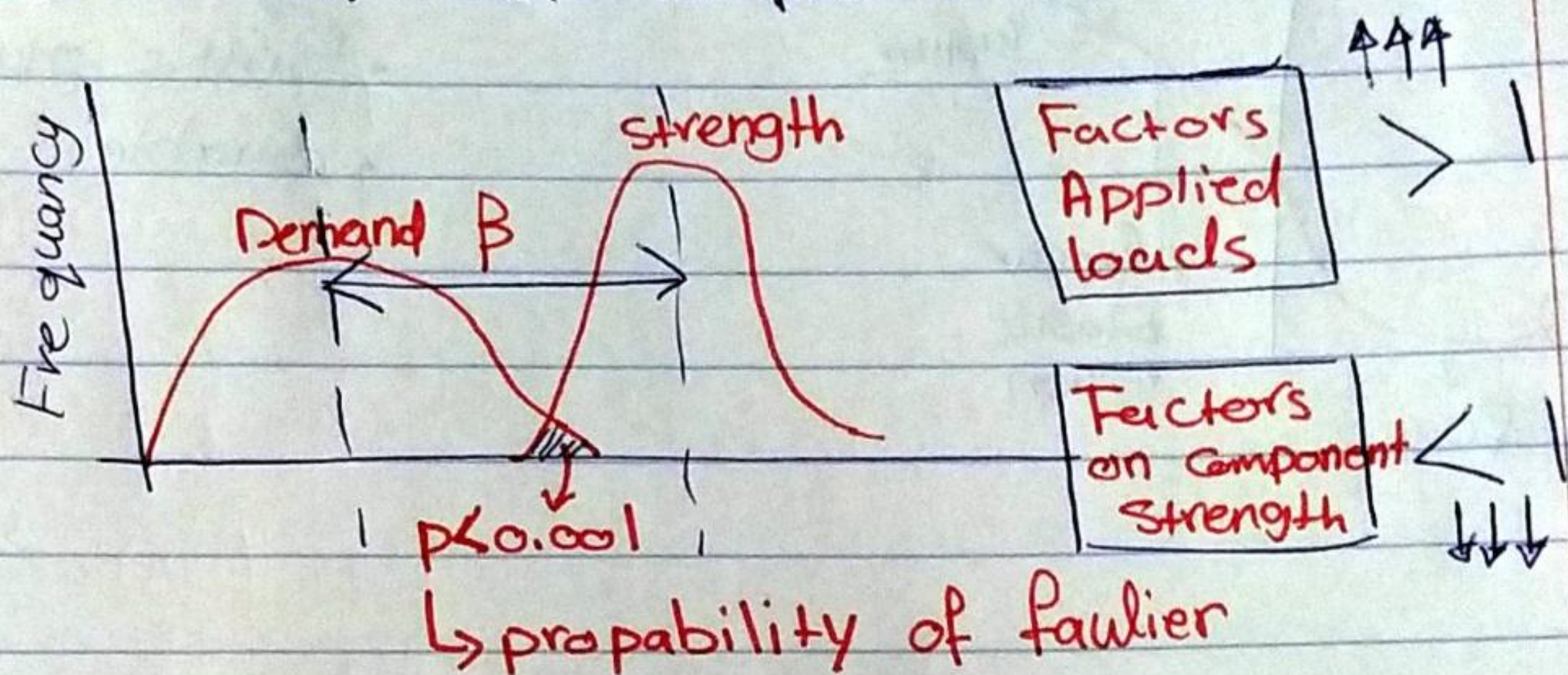
[1] Allowable Stress design (ASD)



2] load and resistance factored design (LRFD).

→ Considers the variability in the applied loads (Internal) and Component.

more than one load applied in variable



→ determine from the Table 5.3.1

• ASCE

• ACI

$\beta \rightarrow$ $\beta = 3$ (typical)

9.27_{min}

• main load that we use $U = 1.2D + 1.6L$

Dead load Live load

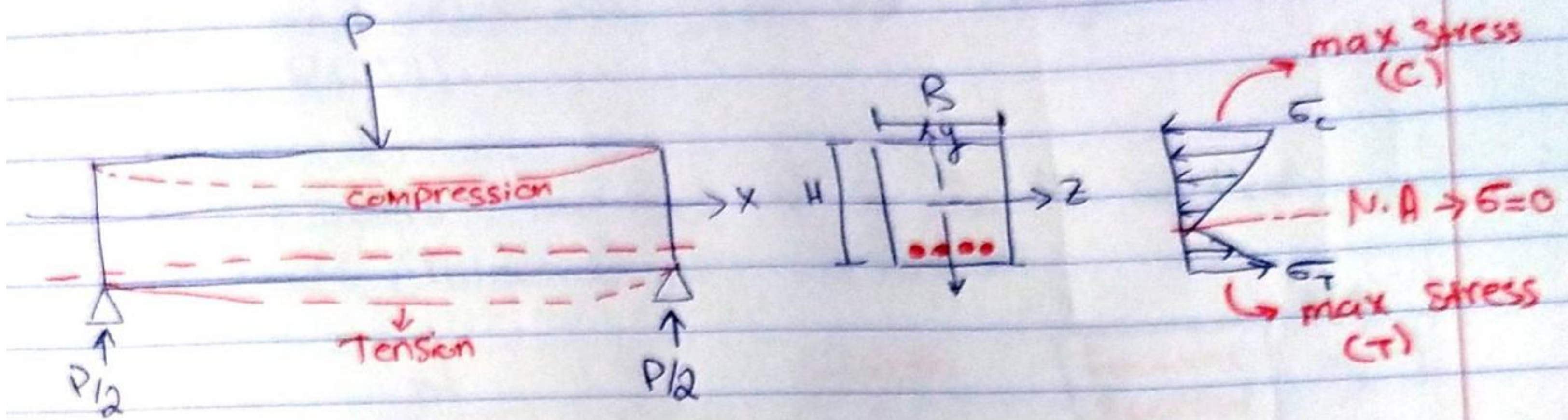
• After structural analysis we get ultimate Internal Factors 21.2.1

• **Nominal strength** : Statics and Mechanics of mat.

• $\phi M_n \geq M_u$

→ Ultimate moment

أعلى قوة يتحملها
العنصر المستطيل



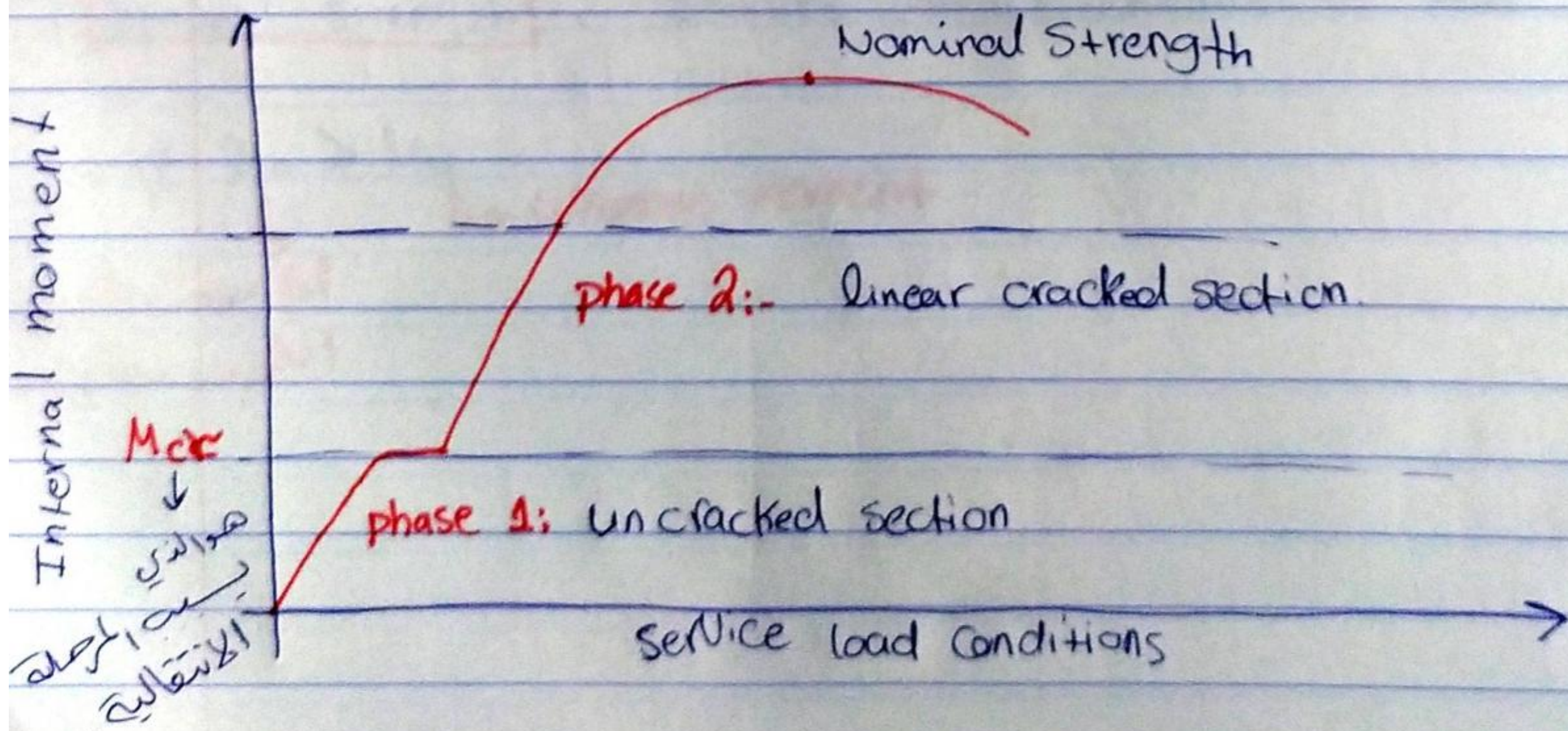
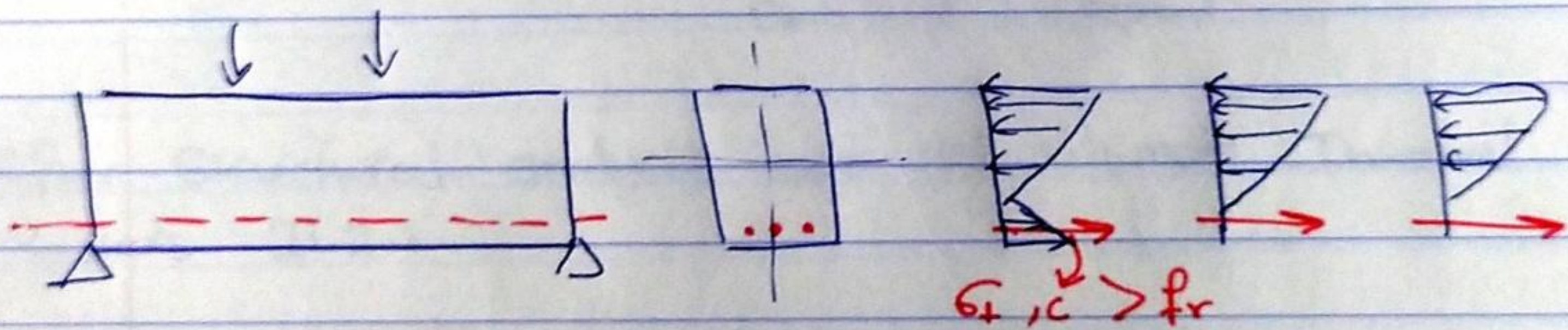
$$N_{max} = PL/4, \quad V_{max} = P/2$$

$M \rightarrow$ normal stress

$$\sigma = \frac{My}{I}$$

- $\gg \gg$. M : moment
 . y : The fur of Point from the N.A
 . I : Second moment of Inertia

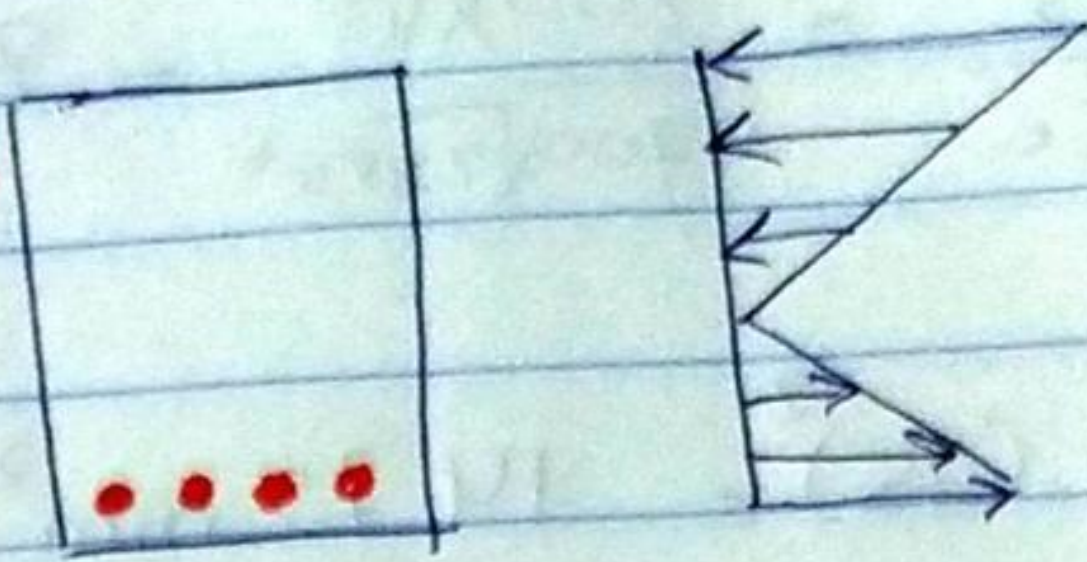
* max stress at $y = H/2$



* Phase 1:

Normal weight = 1

* Tension $< f_r = 0.627 \sqrt{f_c'}$
ACT

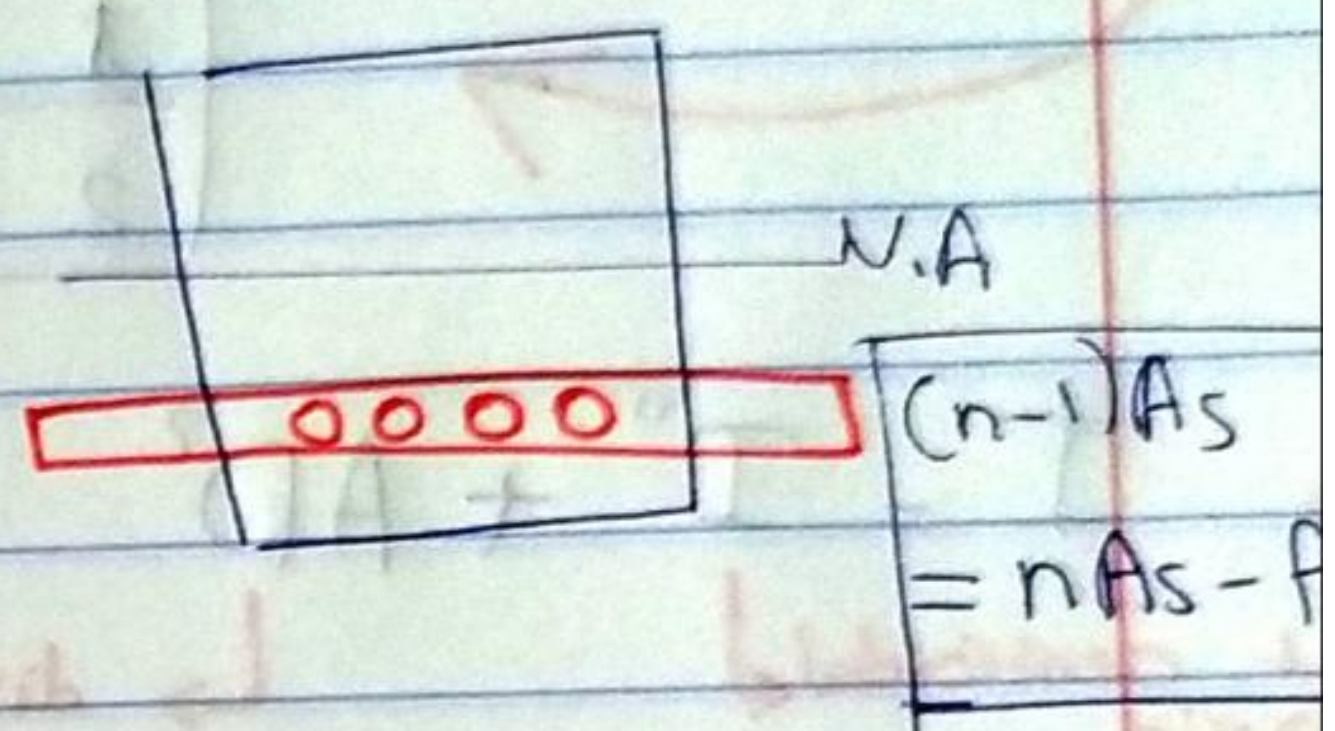


* Transformed using modular ratio (n)

$n = \frac{E_s}{E_c} \rightarrow$ modulus of elasticity of steel = 200 GPa
 \rightarrow modulus of elasticity of concrete $E_c = 4700 \sqrt{f_c'}$ MPa

* Stress In Concrete $\Rightarrow \sigma = \frac{M_y}{I}$

* Stress In Steel $\Rightarrow f_s = n \sigma_c$



* The Cracking moment M_{cr}

$M_{cr} = \frac{f_r I}{(h - \bar{y})}$

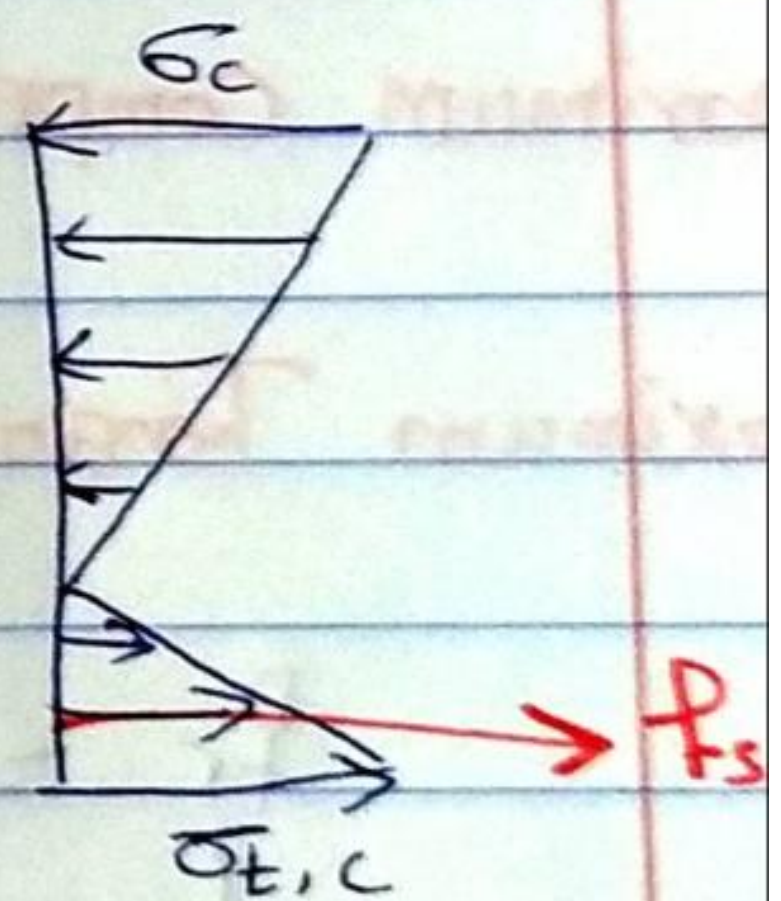
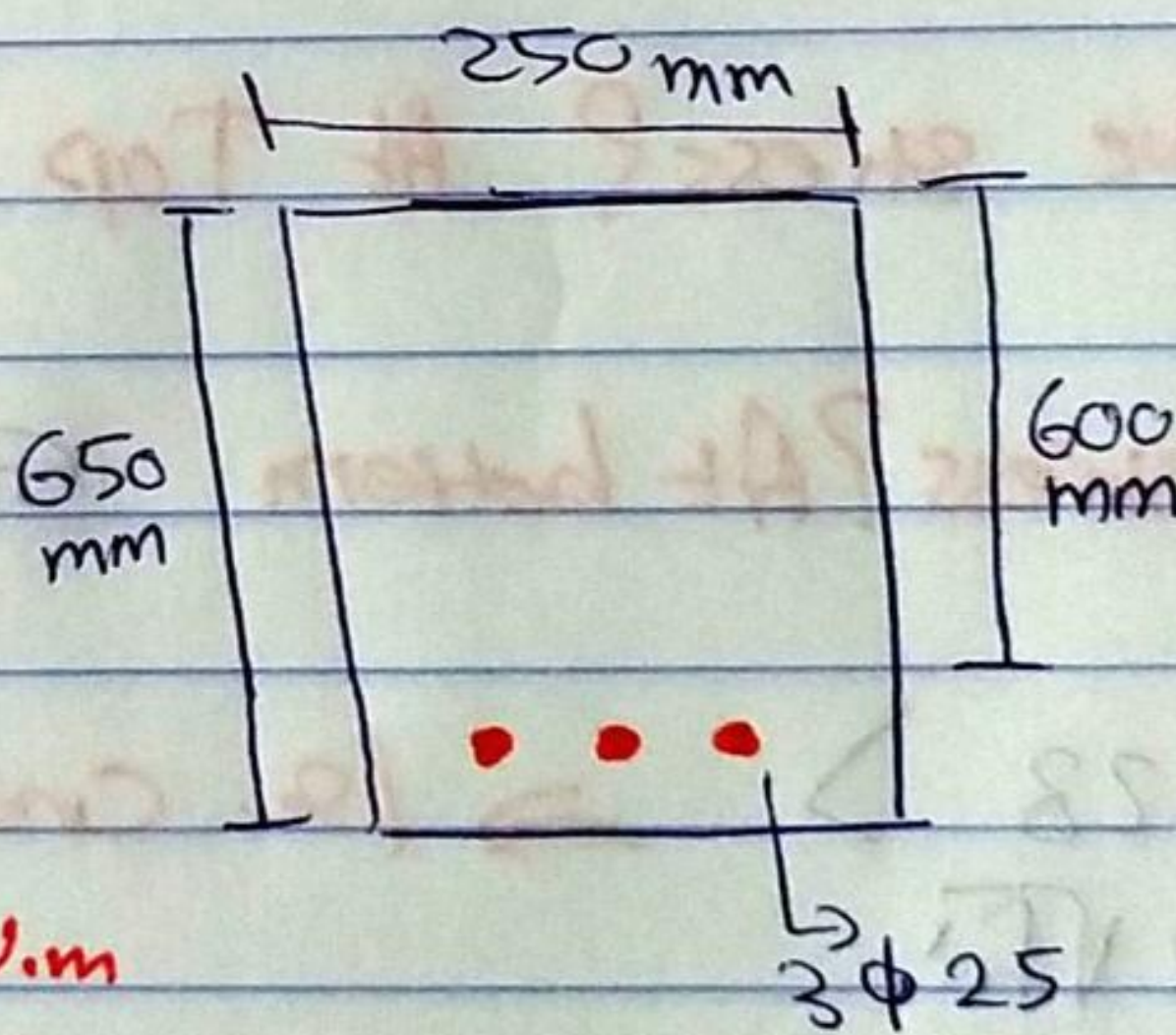
• Example:-

• $f_c' = 28 \text{ MPa}$

• $F_y = 420 \text{ MPa}$

• applied positive

moment in the section = 60 kN.m



\Rightarrow Find • σ_{Tmax} , σ_{Tmax} In concrete?

• M_{max} Before cracking?

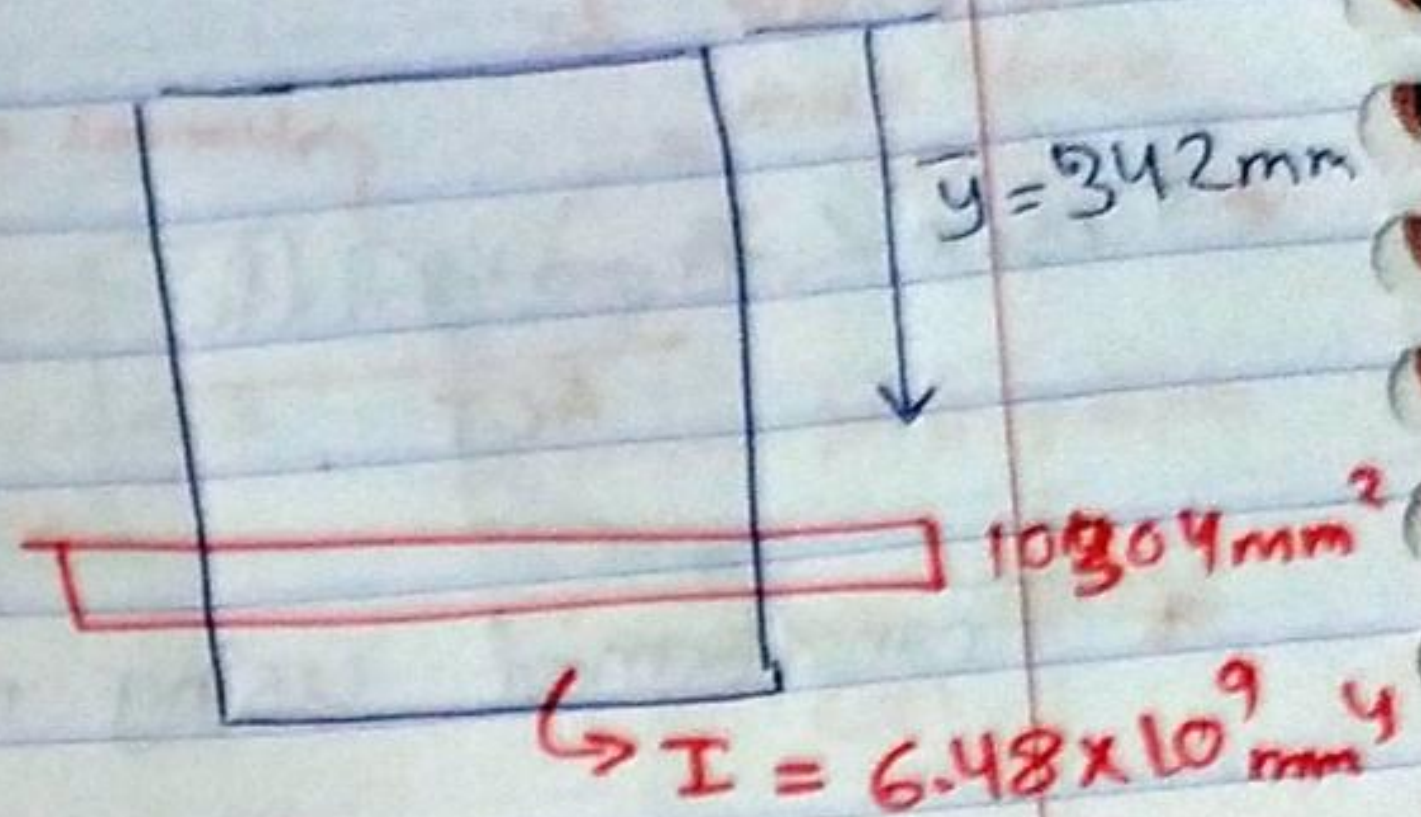
$$\rightarrow n = \frac{E_s}{E_c} = \frac{200 \times 10^6}{4700 \sqrt{28 \times 10^6}} = 8$$

$$\rightarrow A_s = 3 \frac{\pi}{4} (25)^2 = 1472 \text{ mm}^2$$

$$\rightarrow (n-1) A_s = 10304 \text{ mm}^2$$

$$\rightarrow \bar{y} = \frac{\sum A \bar{y}}{\sum A} = 342 \text{ mm}$$

#	A	y	Ay
1	250 x 650	325	---
2	10304	600	---



$$\rightarrow I = I'' + A D^2$$

\swarrow at centroidal axis \searrow distance between the centroid and the axis

#	I''	A	D	AD ²	I'' + AD ²
1	$\frac{1}{12} (650)^3 (250)$		342 - 325		
2	0		600 - 342		

Thickness لا يوجد

* maximum compressive stress? At Top $\sigma_c = \frac{60 \times 10^6 \times 342}{6.48 \times 10^9} = 3.17 \text{ MPa}$

* maximum Tension stress? At bottom $\sigma_t = \frac{60 \times 10^6 (650 - 342)}{6.48 \times 10^9} = 2.85 \text{ MPa}$

$f_r = 3.28 > \Rightarrow$ No crack.
 $\hookrightarrow 0.62 \sqrt{f_c}$

* calculate the stress in the steel bars?

$$f_s = n \times \sigma_c = 8 \times \frac{60 \times 10^6 \times (600 - 342)}{6.48 \times 10^9} = 19.11 \text{ MPa}$$

* $\mu_{cr} \Rightarrow f_r = \frac{M y}{I}$

$$M_c = \frac{f_r I}{650 - 342} = 69 \text{ KN.m}$$

\hookrightarrow No crack \checkmark