Stages(1&2)

Solved Examples

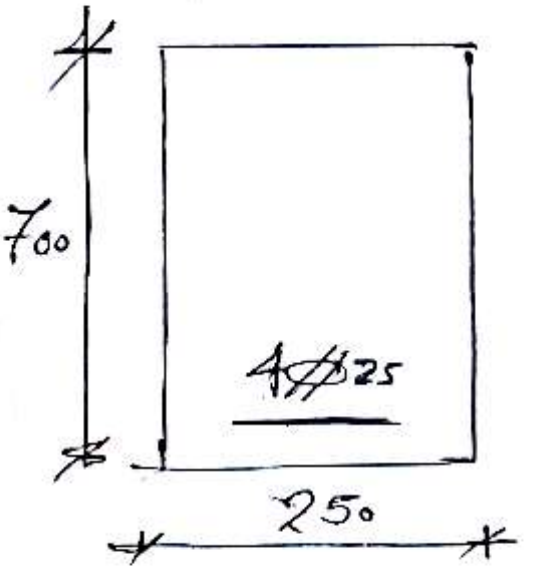
Eng:Ahmed Yehia

Example (1) :-

Data Given :-

$f_{cu} = 25$ MPa

Steel grade 360/520



it's Required To :-

(1) Determine The Cracking Moment

(2) Draw Stress Distribution Due to $M = M_{cr}$

(3) Draw Stress Distribution Due to $M = 2M_{cr}$

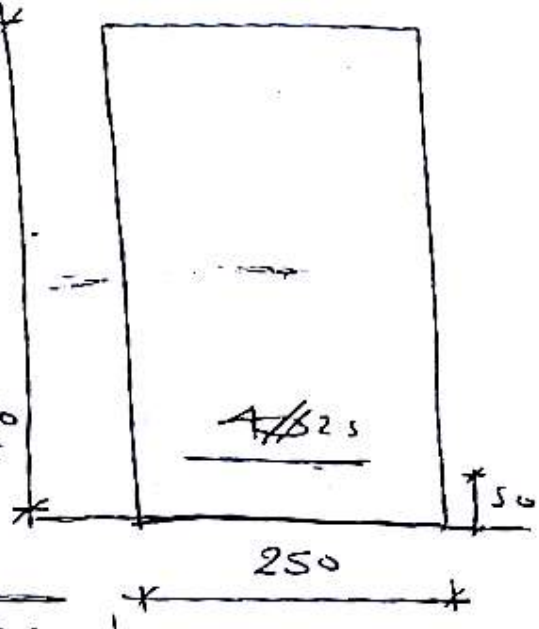
(4) Check Safty of section if it Subjected

To $M = 2M_{cr}$

① M_{cr}:

① $f_{ctr} = 0.6\sqrt{f_{cu}}$

$= 0.6\sqrt{25} = 3\ N/mm^2$ 700



② $\bar{y} = \dfrac{250 * 700 * 350 + 10 * 4 * 491 * 50}{(250 * 700) + 10 * 4 * 491}$

$\bar{y} = 319.7\ mm \simeq 320\ mm$

③ $I_g = \dfrac{250\,(700)^3}{12} + 250 * 700\,(320 - 350)^2$

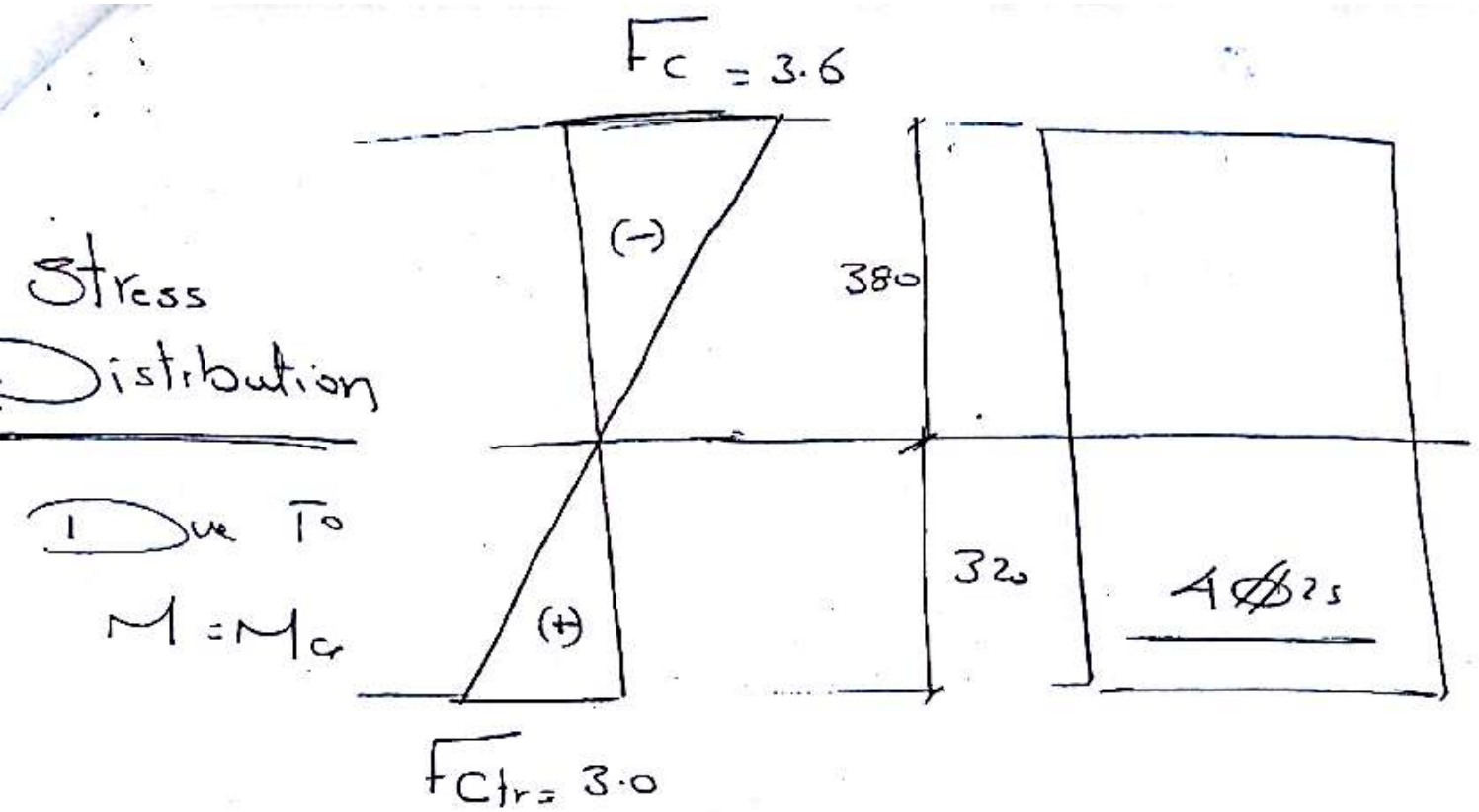
$+ \ 10 * 4 * 491 * (320 - 50)^2$

$I_g = 873089333\ mm^4$

④ $f_{ctr} = \dfrac{M_{cr} * 10^6}{I_g}\ \bar{y}$

$3.0 = \dfrac{M_{cr} * 10^6}{873089333} * (320$

$M_{cr} = 81.9\ KN\text{-}m$



1 Due To $M = M_{cr}$

$$\frac{F_c}{380} = \frac{3.0}{320}$$

$$F_c = 3.6 \ N/mm^2$$

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(3) $M_1 = 2 M_{cr}$

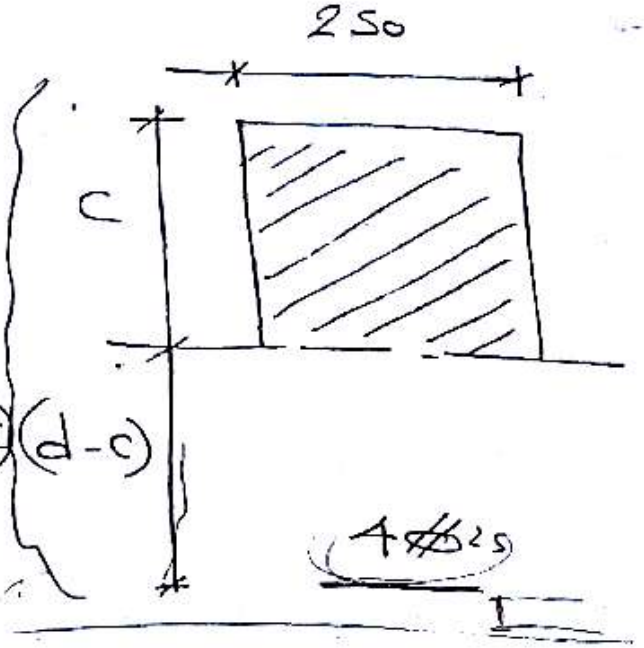
$M_1 = 2 * 81.9 = 164$ KN.m

1 Due $M_1 > M_{cr}$

So Stage II

$$d = 700 - 50 = 650\,mm$$

عزم الى سه الى نوه = الى تحت



$$250 * C * \frac{C}{2} = 15 * 4 * 491 (650 - C)(d - C)$$

بالتقريب

$$C \simeq 0.4\,d$$

$$C \simeq 0.4 * 650 = 260\,mm$$

$$I_{cr} = \frac{bc^3}{3} + 15 A_s (d - c)^2$$

$$I_{cr} = \frac{250 (260)^3}{3} + 15 * 4 * 491 (650 - 260)^2$$

$$I_{cr} = 653526600\,mm^4$$

$$f_{c_{act}} = \frac{M * 10^6}{I_{cr}} * C$$

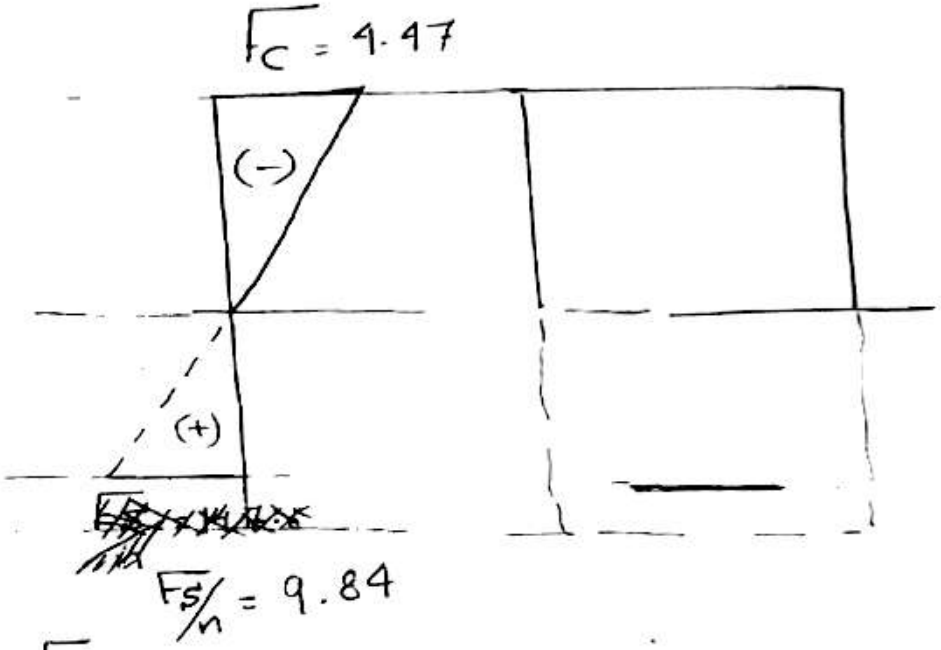
$$f_s / n = \frac{M * 10^6}{I_{cr}} * (d - c)$$

$$F_{Cact} = \frac{164 * 10^6}{6535266000} * 260 = 4.47 \text{ N/mm}$$

$$F_{S_{act}} = \frac{164 * 10^6}{6535266000} * (650 - 260)^{*15} = 147.6 \text{ N/m}$$

Stress Distribution

Due To $M = 2 M_a$



(4) Check Safty:

F_{Call} من جدول F_a 38

$F_{Call} = 9.5 \text{ N/mm}^2$

$F_{S_{all}}$ Type → st 240 → $F_{Sall} = 140 \text{ N/mm}^2$

st 360 → $F_{Sall} = 200 \text{ MPa}$

$f_{c_{act}} = 4.47 < f_{c_{all}} = 9.5$ Safe

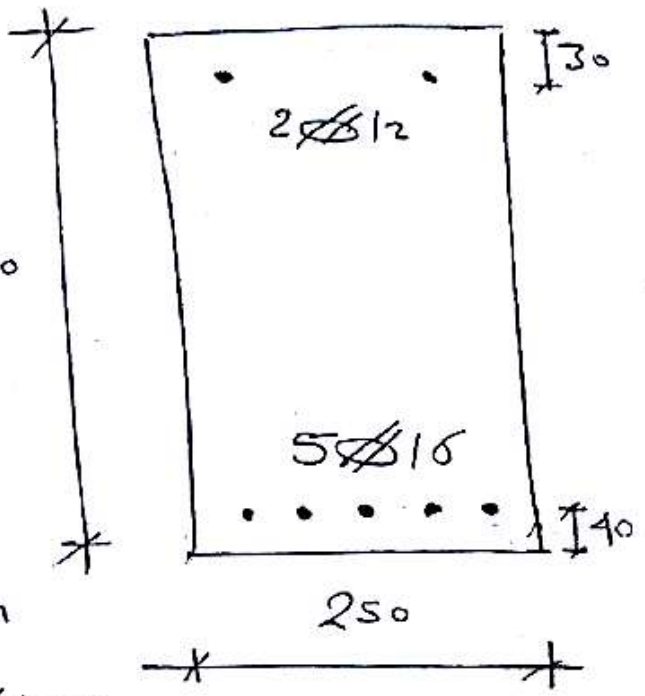
$f_{s_{act}} = 14.8 < f_{s_{all}} = 200$ Safe

The section is safe

1 Data Given:-

$f_{cu} = 30$ MPa.

$f_y = 360 / 520$



1 Draw stress 1 Distribution

1 Due To $M = 70.0$ KN.m

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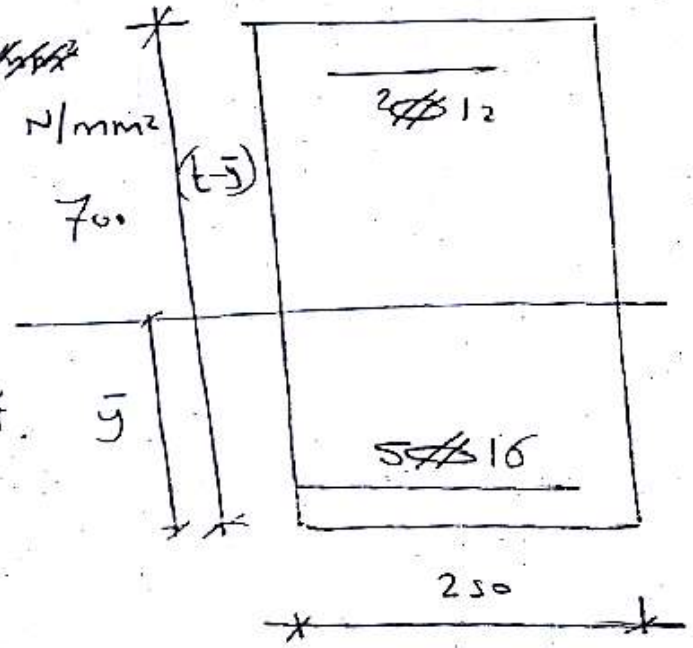
① Get M_{cr}:-

① $f_{ctr} = 0.6\sqrt{30} = 3.29$ N/mm²

② $\bar{y} = 337.2$ mm

③ $I_g = 8312994819$ mm⁴



④ $f_{ctr} = \dfrac{M_{cr} * 10^6}{I_g} \bar{y}$

$M_{cr} = 81.1$ KN.m

$M < M_{cr}$

Stage I ← نفس خصائص I_g نفس $\bar{y}$ نفس

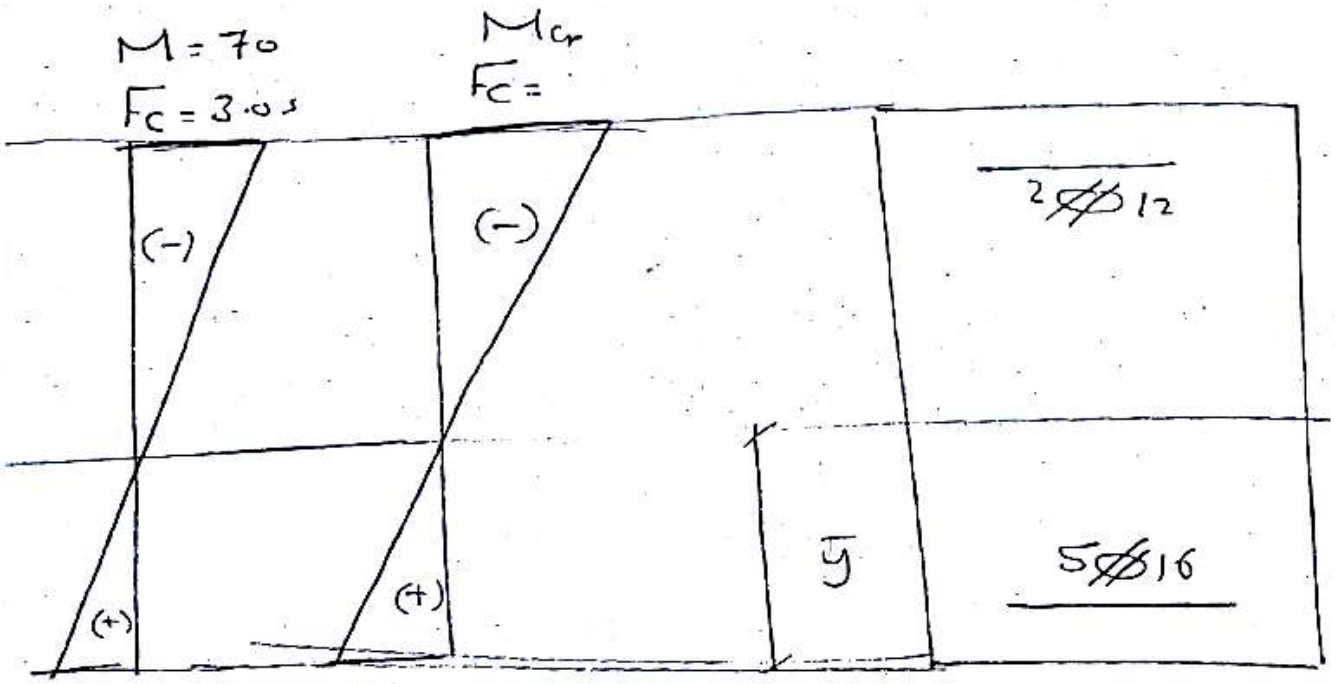
$$f_c = \frac{M * 10^6}{I_g} (t - \bar{y})$$

f_{ctr}

$$f_t = \frac{M * 10^6}{I_g} \bar{y}$$

$$f_c = \frac{70 * 10^6}{8312994819} (700 - 337.2) = 3.05 \text{ N/mm}^2$$

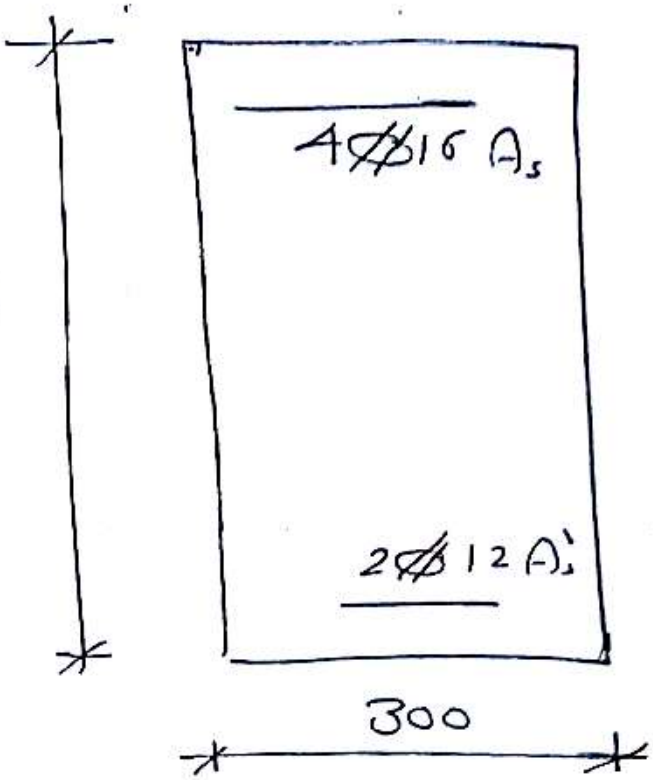
$$f_t = \frac{70 * 10^6}{8312994819} (337.2) = 2.8 \text{ N/mm}^2$$



1 Data Given:-

$f_{cu} = 25\ MPa$

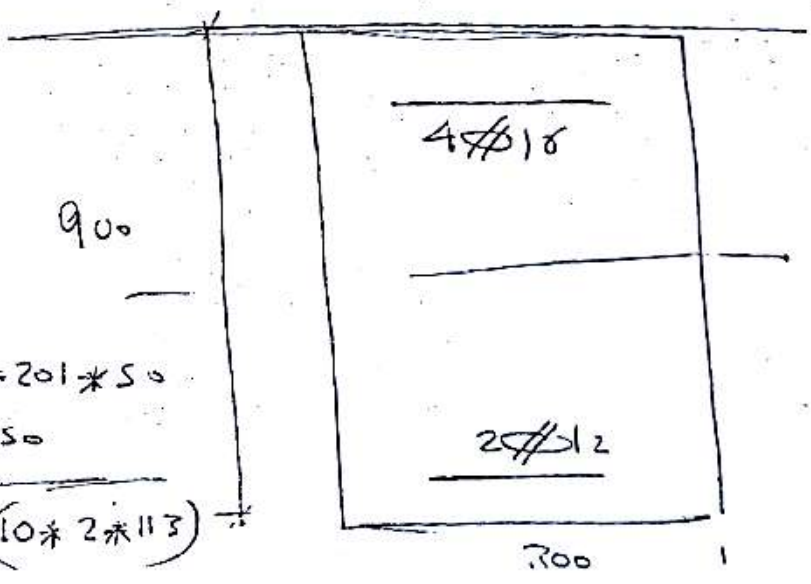
St 360/520



it is Required To:-

1) Get M_{cr}
2) stress Distrbution Due To M_{cr}
3) stress Distrbution Due To $M = 3M_{cr}$
4) Chcek Safty of section if it is subjcted To $M = 3M_{cr}$
5) Get $M_{max\ safe} < M_{all}, M_w, M_R$

1) Get M_{cr}:



1) $f_{ctr} = 0.6\sqrt{f_{cu}} = 0.6\sqrt{25}$

$= 3\ N/mm^2$

2) $\bar{y} = \dfrac{300*900*450 + 10*4*201*50 + 10*2*113*850}{(300*900)+(10*4*201)+(10*2*113)}$

$$\boxed{\bar{y} = 441.7 \text{ mm} \approx 442 \text{ mm}}$$

③ $$I_g = \frac{bt^3}{12} + bt(\bar{y} - 450)^2 + 10 A_s (\bar{y} - 50)^2 + 10 A_s' (\bar{y} - 850)^2$$

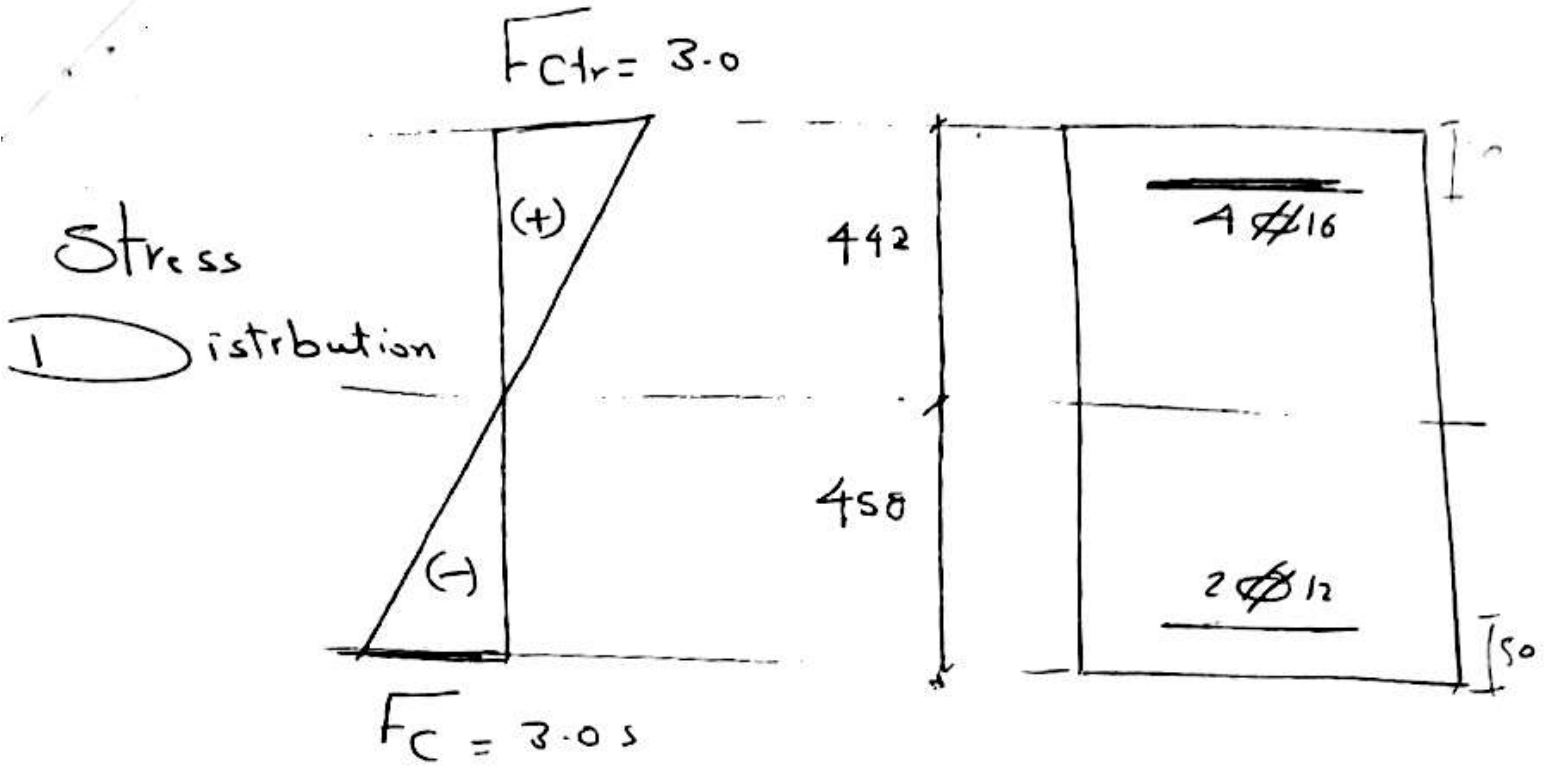
$$I_g = \frac{300(900)^3}{12} + 300 * 900 (442 - 450)^2 + 10 * 4 * 201 (442 - 50)^2 + 10 * 2 * 113 (442 - 850)^2$$

$$I_g = 1.9 * 10^{10} \text{ mm}^4$$

④ $$\therefore f_{ctr} = \frac{M_{cr} * 10^6}{I_g} * \bar{y}$$

$$3.0 = \frac{M_{cr} * 10^6}{1.9 * 10^{10}} * 442$$

$$\boxed{M_{cr} = 134.7 \text{ KN.M}}$$



$$\frac{f_c}{450} = \frac{3.05}{442}$$

$$f_c = 3.05 \ N/mm^2$$

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(3) $M_1 = 3 M_{cr}$

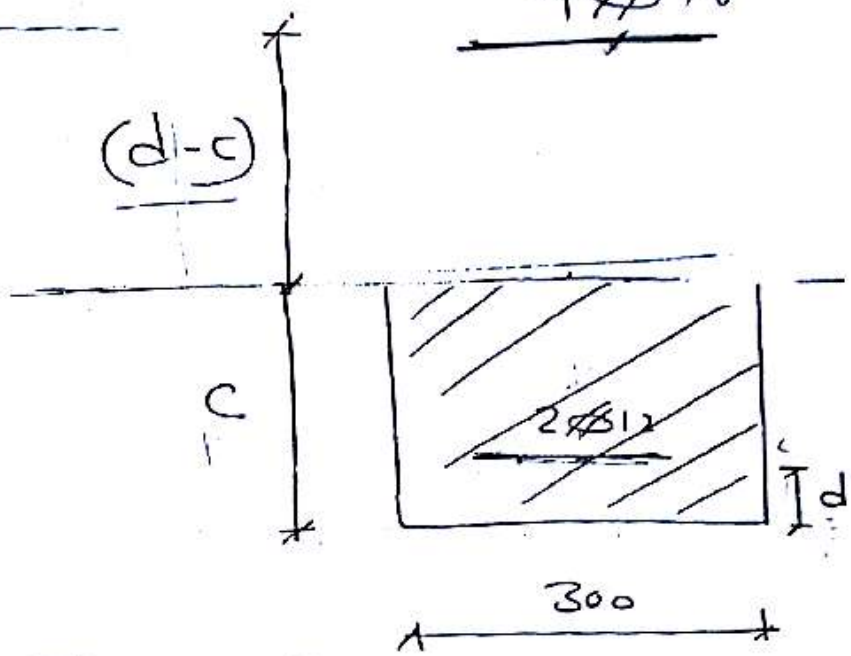
$M_1 = 3 * 134.7 = \underline{404 \ KN.m}$

Due To $M_1 > M_{cr}$

So Stage II

$d = 900 - 50$

$\boxed{d = 850 \text{ mm}}$



① To Get (C):

$$\frac{300 * C^2}{2} + 15 * 2 * 113 * (C - 50) = 15 * 4 * 201 * (850 - C)$$

$\boxed{C \simeq 0.3\,d}$ تكتب

$\boxed{C = 255 \text{ mm}}$

$$I_{cr} = \frac{bc^3}{3} + 15(A_s)(C - d')^2 + 15(A_s)(d - c)^2$$

$$I_{cr} = \frac{300(255)^3}{3} + 15 * 2 * 113(255 - 50)^2 +$$

$$15 * 4 * 201(850 - 255)^2$$

$$I_{cr} = 6068883000 \text{ mm}^4$$

$$f_{Cact} = \frac{M * 10^6}{I_v} c$$

$$f_{S/n\,act} = \frac{M * 10^6}{I_v} (d - c)$$

$$f_{Cact} = \frac{404 * 10^6}{606888300} * 255 = \underline{16.9}\ N/mm^2$$

$$f_{S/15} = \frac{404 * 10^6}{606888300} * (850 - 255) =$$

$$f_{S\,act} = 595\ N/mm^2$$

$f_{Call} = \underline{9.5}\ N/mm^2 <$ act $\rightarrow$ unsafe

$f_{Sall} = \underline{200}\ N/mm^2 <$ act $\rightarrow$ unsafe

If Section is unsafe

(5) To Get M_{safe}

Put $F_{cact} = F_{call} \longrightarrow M_1$

Put $F_{sact} = F_{sall} \longrightarrow M_2$

Take $M_{min} = M_{safe} = M_w = M_R$
$= M_{all}$

$$F_{Call} = \frac{M_1 * 10^6}{I_v} * C$$

$$9.5 = \frac{M_1 * 10^6}{606888300} * 255$$

$$\boxed{M_1 = 227.1 \text{ KN.m}}$$

$$F_{sall} = \frac{M_2 * 10^6}{I_v} (d-c) \, 15$$

$$200 = \frac{M_2 * 10^6}{606888300} * (850 - 255) * 15$$

$$\boxed{M_2 = 135.7 \text{ KN.m}}$$

E

$\therefore M_w = M_{safe} = M_{all} = M_R$

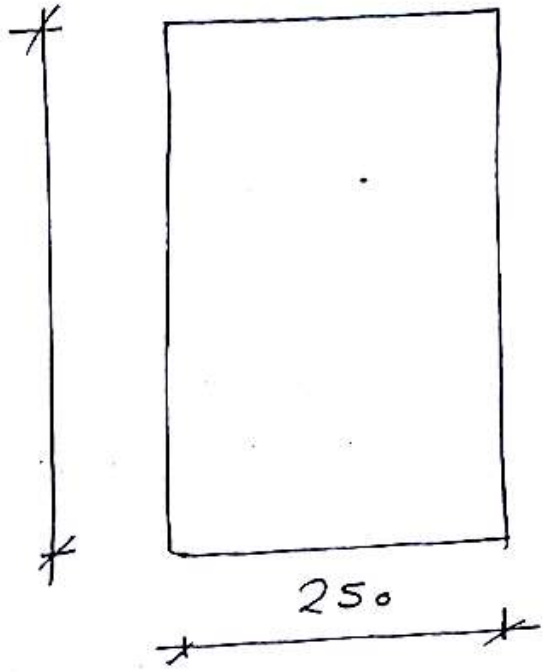
$= M_{min} = 135.7 \text{ KN.m}$

$M_{safe} = 135.7 \text{ KN.m}$

Solved Example:

1 Data Given:

$f_{cu} = 25$ MPa



Required:

Get Max Safe Moment

Get Failure Moment

Get Mallowable

Get Moment of Resistance

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Cracking

① $f_{tcr} = 0.6\sqrt{f_{cu}} = 3\ N/mm^2$

② $\bar{y} = \frac{t}{2} = 350\ mm$

③ $I = \frac{bt^3}{12} = \frac{250\,(700)^3}{12}$

$$I = 7145833333\ mm^4$$

④ $f_{tcr} = \frac{M_{cr} * 10^6}{I}\,\bar{y}$

$$M_{cr} = 61.25\ KN.m$$

∴ Max Safe Moment / Fatigue Moment / Allowable Moment of Resistance $= 61.25\ KN.m$