Quesn: 1, 4, 5, 6, 7

NAME:
ROLL NO:
FST-2 (PAPER-1)
DATE:

Section - A

Q-1-a) Good brick Earth contains following ingredients:

1) Alumina (30-40%) A brick earth must contain alumina as it helps in bricks during moulding

2) Silica (50-60%) : It imparts strength and soundness to the bricks and prevents the bricks from cracking and shrinkage.

3) Lime (4-5%) : It also imparts strength and soundness to the bricks but if in excess leads to melting of bricks.

4) Iron Oxide: (5-6%) Imparts reddish brown tinge to the bricks and also imparts strength.

5) Magnesia (< 1%) Presence of magnesia in small percentage helps the bricks to gain uniform shape and size.

Harmful Ingredients of Brick Earth:

1) Stones and Pebbles:

2) Organic and Vegetative Matter.

3) Iron Pyrites:

4) Presence of soluble salts:

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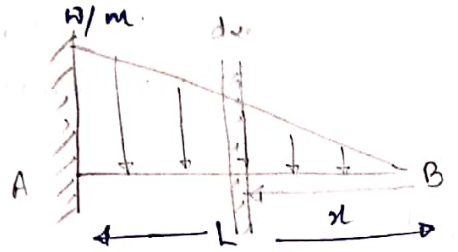
3) **Limestone :**

Q-1-b)



Consider a strip of 'dx' @ x from free end.

$\therefore$ load @ x $= \left(\frac{W}{L} \times x\right)$

$\therefore M_x = EI\frac{d^2y}{dx^2} = \frac{1}{2} \times x \times \frac{Wx}{L}\left(\frac{x}{3}\right)$

$\Rightarrow EI\frac{d^2y}{dx^2} = \frac{Wx^3}{6L}$

Int wrt 'x' both sides :

$EI\left(\frac{dy}{dx}\right) = \frac{Wx^4}{24L} + C_1$

Again on intg^n:

$EI(y) = \frac{Wx^5}{120L} + C_1x + C_2$

Putting boundary conditions we get :

@ $x=L$, $\left(\frac{dy}{dx} = 0\right)$

$\Rightarrow 0 = \frac{WL^4}{24L} + C_1$ $\Rightarrow C_1 = \left(\frac{-WL^3}{24}\right)$

@ $x=L$, $y=0$

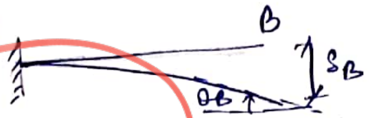
$\Rightarrow 0 = \frac{WL^5}{120L} - \frac{WL^4}{24} + C_2$ $\Rightarrow \frac{WL^4 - 5WL^4}{120} + C_2 = 0$

$\Rightarrow C_2 = \left(\frac{-WL^4}{30}\right)$

$\therefore$ for slope @ free end $(x=0)$

$\Rightarrow EI(\theta_B) = c_1$

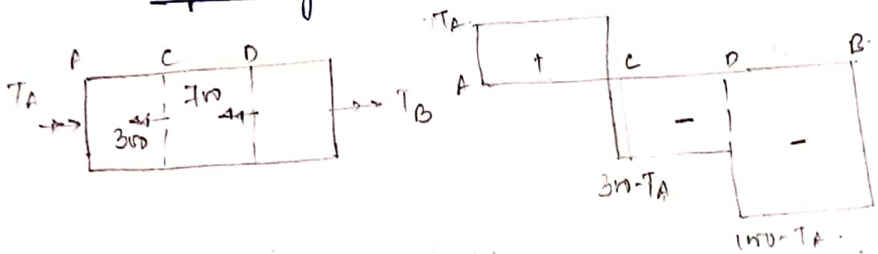
$\Rightarrow \theta_B = \left(\frac{-Wl^3}{24EI}\right)(\circlearrowleft)$



@ $x=0$

and $\delta_B = \frac{1}{EI}[c_2] = \left(\frac{-Wl^4}{30EI}\right)(\downarrow)$

1-c) Torque diagram:



$\Sigma f_x = 0$

$T_A + T_B = 1000\,Nm$ — (1)

from compatibility

$\theta_{AD} = 0 = \left(\frac{T_A \times 2}{GJ}\right)_B + \left[-\frac{(300-T_A)\times 2}{GJ}\right]_{Al} + \left[-\frac{(1000-T_A)\times 2}{GJ}\right]_{St} = 0$

$\frac{T_A \times 2 \times 10^6}{\frac{\pi}{32}\times 25^4 \times 35} + \frac{(T_A - 300)\times 2\times 10^6}{28\times\frac{\pi}{32}\times 50^4} + \frac{(T_A - 1000)\times 2\times 10^6}{83\times\frac{\pi}{32}\times 25^4} = 0$

$\Rightarrow [1.49T_A + 0.11641(T_A - 300) + 0.6281(T_A - 1000)] = 0$

$2.2344T_A - 662.92 = 0$

$\Rightarrow T_A = \underline{296.88\,Nm}$ and $T_B = \underline{703.12\,Nm}$.

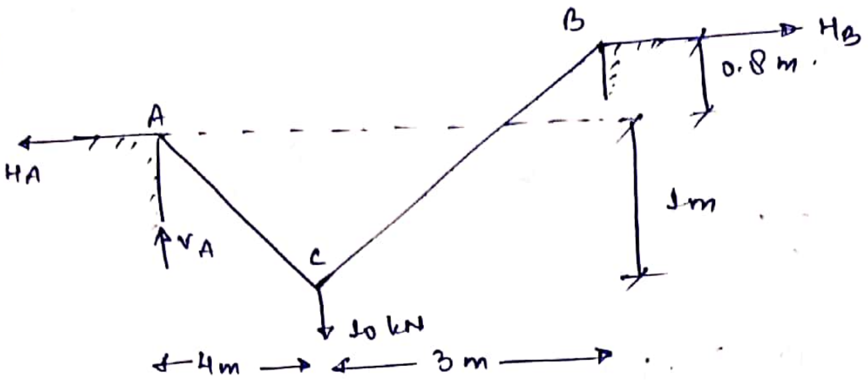
$\therefore$ Max shearing stresses:

In bronze: $\frac{16T_A}{\pi d^3} = \frac{16\times 296.88\times 10^3}{\pi\times 25^3} = \underline{96.768\,MPa}$.

In Aluminium: $\frac{16\times 3.12\times 10^3}{\pi\times 50^3} = \underline{0.127\,MPa}$.

In Steel: $\frac{16\times 703.12}{\pi\times 25^3} = \underline{229.18\,MPa}$. Ans

1-d)



$\underline{\Sigma M_B = 0}$

$V_A \times 7 + H_A(0.8) = 10 \times 3 \quad \Rightarrow \quad 7V_A + 0.8H_A = 30 \quad — (1)$

also $\underline{\Sigma M_c = 0}$ $(L \to R)$

$V_A \times 4 - 1H_A = 0 \quad \Rightarrow \quad \boxed{4V_A = H_A}$.

$\therefore$ from eq (1)

$7V_A + 0.8(4V_A) = 30 \quad \Rightarrow V_A = 2.941\ kN$

and $H_A = 4V_A = 11.765\ kN.$

and $\Sigma f_y = 0 \quad V_A + V_B = 10\ kN$

$\Rightarrow V_B = 10 - V_A = 10 - 2.941 = \underline{7.059\ kN}$

$\Sigma M_c = 0 \quad (R \to L)$

$-V_B \times 3 + H_B(1.8) = 0$

$\Rightarrow H_B = \left(\frac{V_B \times 3}{1.8}\right) = \underline{11.765\ kN}$

$\therefore$ Tension in segments

$AC = \sqrt{V_A^2 + H_A^2} = \sqrt{2.941^2 + 11.765^2} = \underline{12.127\ kN}$

$BC = \sqrt{V_B^2 + H_B^2} = \sqrt{7.059^2 + 11.765^2} = \underline{13.72\ kN}$

Support Rxn's:

At A.

$V_A = 2.941\ kN$

$H_A = 11.765\ kN$

At B.

$V_B = 7.059\ kN$

$H_B = 11.765\ kN.$

1-e) Processes involved in Manufacturing of Tiles:

a) Preparation of clay: Preparation of clay involves cleaning and removing unwanted matter from the clay used for preparation.

b) Blending / Batching: Mixing ingredients in required proportions.

c) Tempering: Process of inducing required plasticity to clay

d) Moulding: Process of giving required shape and size to moulds.

e) drying: Process of removing the moisture either naturally or artificially to make it fit for next operation of burning.

f) burning: Process of achieving hard and dense mass.

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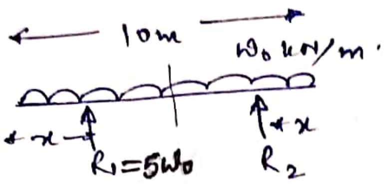
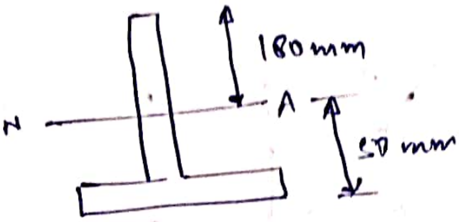
Q-4-a) i)



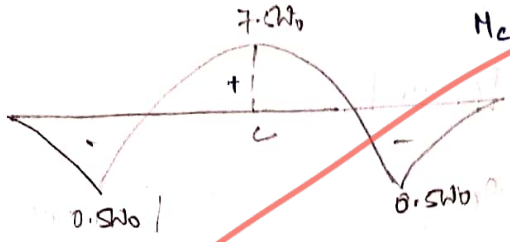


Given: $f_{bt} = 20$ MPa.

$f_{bc} = 80$ MPa.

$I_{NA} = 36 \times 10^6 \, mm^4$

Soln: BMD



M_c(centre) $= 5W_0 \times 4 - W_0 \times 5 \times 2.5$

$= \underline{7.5W_0}$ kNm.

Sagging BM $= 7.5W_0$

Hogging BM $= 0.5W_0$

for sagging BM

$\therefore \dfrac{7.5W_0 \times 10^6}{36 \times 10^6} \times 180 \le f_{bc}\,(80)$

$\underline{W_0 \le 2.133 \text{ kN/m}}$ — (1)

$\dfrac{7.5W_0 \times 10^6}{36 \times 10^6} \times 50 \le f_{bt}\,(20)$ $\underline{W_0 \le 1.92 \text{ kN/m}}$ — (2)

for hogging moment

$\dfrac{0.5 \times W_0 \times 10^6}{36 \times 10^6} \times 180 \le f_{bt}\,(20)$

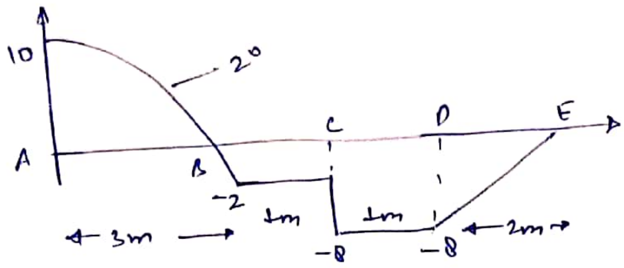
$\underline{W_0 \le 8 \text{ kN/m}}$. — (3)

$\dfrac{0.5W_0 \times 10^6}{36 \times 10^6} \times 50 \le f_{bc}\,(80)$

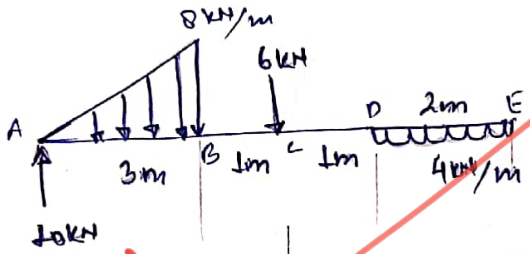
$\Rightarrow \underline{W_0 \le 115.2 \text{ kN/m}}$. — (4)

$\therefore$ from above values $\underline{W_{max} = 1.92 \text{ kN/m}}$. (Ans)

4-a-ii) SFD

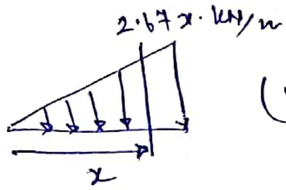


Soln: Loading diagram



Bending Moments

Let @ x SF be zero from (A)



$(0 \le x \le 3m)$

$\therefore SF_x = 10 - \frac{1}{2} \times x \times 2.67x = 0$

$\Rightarrow 10 = \frac{1}{2} \times 2.67 x^2$

$\Rightarrow x = 2.737m. < 3m$ (ok)

$M_A = 0$ kNm.

$\therefore M_x = 10 \times 2.737 - \frac{1}{2} \times 2.67 \times 2.737 \times 2.737^2 \times \frac{1}{3}$

$= 20.528$ kNm.

$M_B = 10 \times 3 - \frac{1}{2} \times 8 \times 3 \times 1 = 18$ kNm.

$M_C = 10 \times 4 - \frac{1}{2} \times 8 \times 3 \times \left(\frac{3}{3} + 1\right) = 16$ kNm.

$M_D = 10 \times 5 - \frac{1}{2} \times 8 \times 3 \times \left(\frac{3}{3} + 2\right) - 6 \times 1 = 8$ kNm.

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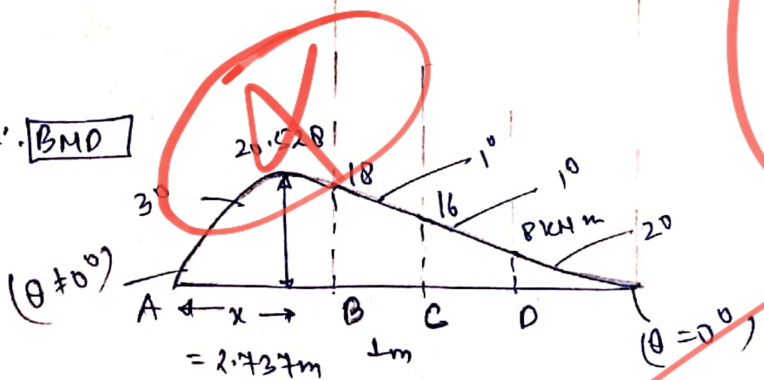
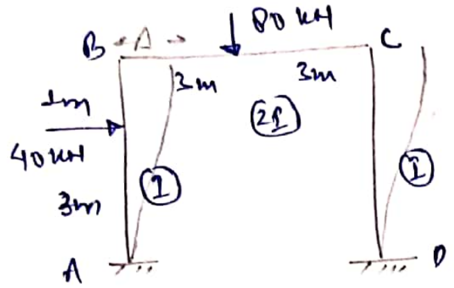
$\therefore$ $\boxed{BMD}$



Q-4-b)



① $D_k = 3\ (\theta_B, \theta_C, \Delta_x)$

② FEM's.

$$M_{fAB} = \frac{-Wab^2}{l^2} = \frac{-40 \times 3 \times 1^2}{4^2} = -7.5\,kNm.$$

$$M_{fBA} = 22.5\,kNm.$$

$$M_{fBC} = -60, \quad M_{fCB} = 60$$

$$M_{fCD} = M_{fDC} = 0\ kNm$$

③ for θ_B, $\Sigma M_B = 0 \Rightarrow \underline{M_{BA} + M_{BC} = 0}$ — ①

$$M_{BA} = 22.5 + \frac{2EI}{4}\left(2\theta_B + 0 - \frac{3\Delta}{4}\right) = 22.5 + EI\theta_B - 0.375EI\Delta.$$

$$M_{BC} = -60 + \frac{2E(2I)}{6}(2\theta_B + \theta_C) = -60 + 1.33\,EI\theta_B + 0.67EI\theta_C$$

∴ from eq ①

$$2.33EI\theta_B + \cancel{0.335EI\theta_C}\ 0.67EI\theta_C - 0.375EI\Delta = 37.5 \quad — (A)$$

④ for θ_C, $\Sigma M_C = 0 \Rightarrow \underline{M_{CB} + M_{CD} = 0}$ — ②

$$M_{CB} = 60 + \frac{2EI(2)}{6}(2\theta_C + \theta_B) = 60 + 1.33EI\theta_C + 0.67EI\theta_B$$

$$M_{CD} = 0 + \frac{2EI}{4}\left(2\theta_C + 0 - \frac{3\Delta}{4}\right) = EI\theta_C - 0.375EI\Delta.$$

∴ from eq ②

$$0.67EI\theta_B + 2.33EI\theta_C - 0.375EI\Delta = -60 \quad — (B)$$

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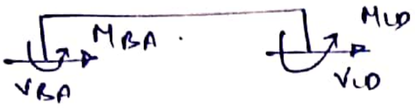
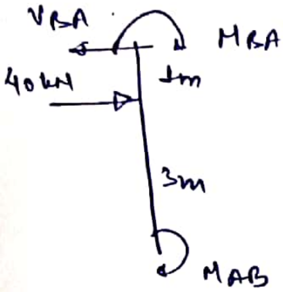
(5) for Δx, $\underline{\Sigma f_x = 0}$

$$\Rightarrow \underline{V_{BA} + V_{CD} = 0} \quad -(3)$$



<u>for VBA.</u>

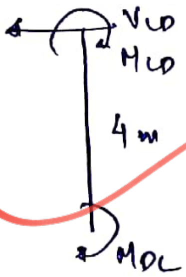


$\underline{\Sigma M_A = 0}$

$$-V_{BA} \times 4 + M_{AB} + M_{BA} + 40 \times 3 = 0.$$

$$\Rightarrow V_{BA} = \left(\frac{M_{AB} + M_{BA} + 120}{4}\right)$$

<u>IIly VCD.</u>



$$\Rightarrow V_{CD} = \frac{M_{CD} + M_{DC}}{4}$$

$\therefore$ <u>from eq (3)</u>

$$M_{AB} + M_{BA} + M_{CD} + M_{DC} = -120 \quad — (C)$$

<u>where</u> $M_{AB} = -7.5 + \frac{2EI}{4}\left(\theta_B - \frac{3\Delta}{4}\right) = -7.5 + 0.5EI\theta_B - 0.375EI\Delta$

$$M_{DC} = 0 + \frac{2EI}{4}\left(0 + \theta_C - \frac{3\Delta}{4}\right) = 0.5EI\theta_C - 0.375EI\Delta$$

$\therefore$ <u>from eq (C)</u>

$$(-7.5 + 0.5EI\theta_B - 0.375EI\Delta) + (22.5 + EI\theta_B - 0.375EI\Delta) + (EI\theta_C - 0.375EI\Delta + 0.5EI\theta_C - 0.375EI\Delta) = -120.$$

$$15 + 1.5EI\theta_B - 1.5EI\Delta + 1.5EI\theta_C = -120$$

$$\Rightarrow \underline{1.5EI\theta_B + 1.5EI\theta_C - 1.5EI\Delta = -135} \quad -(D)$$

<u>solving eq (A), (B) and (D)</u> we get:

$$\theta_B = \frac{39.367}{EI}, \quad \theta_C = -\frac{13.367}{EI}, \quad \Delta = \frac{110}{EI}$$

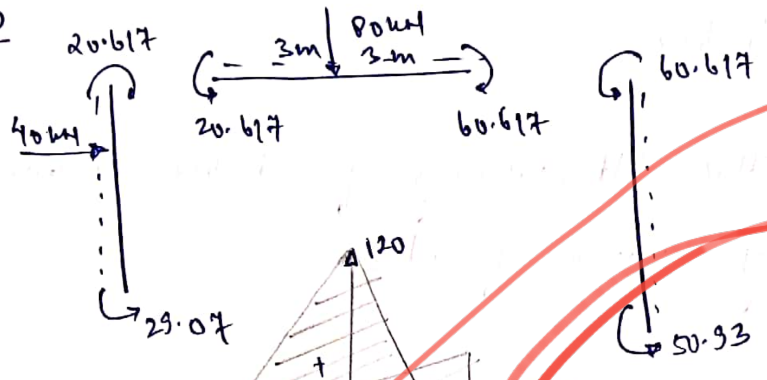
(6) FINAL END MOMENTS:

$M_{AB} = -29.07$ kNm. $M_{BA} = 20.617$ kNm.

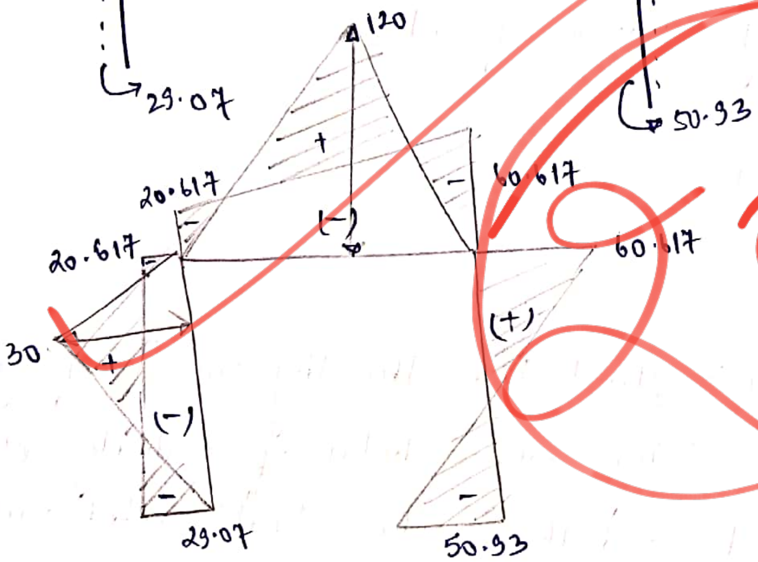
$M_{BC} = -20.617$ kNm. $M_{CB} = 60.617$ kNm.

$M_{CD} = -60.617$ kNm $M_{DC} = -50.93$ kNm.

(7) FBD



(8) BMD



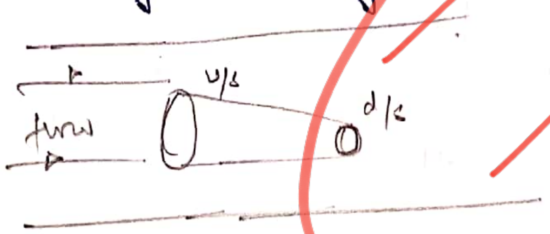
Q-4-(ii) Methods of Artificial seasoning of timber are:

a) Boiling: It is one of the quickest method of seasoning of timber but sections obtained from this method is liable to twist and warp because of improper seasoning.

b) Chemical/salt seasoning: In this method timber is soaked in a soln of chemical such as $ZnCl_2$ or $HgCl_2$ due to which heartwood which is dead and dry absorbs chemicals faster and hence a uniform shrinkage is attained at interior and outer parts of the timber.

c) Kiln seasoning: In this method of seasoning Timber sections are placed in an air tight kiln's in which saturated air is passed through The Timber sections placed at sufficient spacing between them. saturated air at pressure of 21 kg/cm2 is maintaed for few hours and then the moisture inside The chamber is Then reduced which causes drying of timbers.

d) Water seasoning: In This mild seasoning of timber section is carried out by weathering action of water.



e) Electric seasoning: Timber is placed b/w alternating currents of high frequency and the Timber being non conductor of electricity provides resistance to flow of current and Thus produces heat, which causes seasoning of Timber.

4-c-ii) Mechanical ~~trea~~ Treatment of steel involves all those Treatments which are given to steel by manual or machine methods to give it required shape and size, so That it can be directly used in engineering constructions.

Various Mechanical Treatments given to steel are:

1) forging: In this process steel is beated with The help of hammer and Anvil to remove the surface strains if any.

2) Drawing: The process of reducing the 4s of a steel specimen and turning it into wire is called drawing of steel.

3) Pressing: In this method steel is pressed in die and punch to given The molten ingots into specific shape and size.

4) Milling (Rolling): The process of rolling The steel sections in a mechanical mills or rollers to give them the desired compact structure.

Section - B

5-a) Limit state is a state which implies that the structure is no longer able to perform its satisfied function.

As per IS: 800-2007, there are two types of limit states:

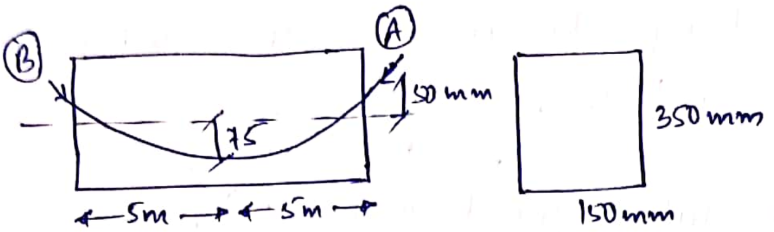
1) Limit state of strength: In this state, the structure is loaded to such a worse combination of loads that failure of structure occurs. The limit state of strength includes:

→ Loss of stability
→ Yeilding
→ collapse

2) Limit state of serviceability: This limit state describes or deals with the performance of the given structure against permissible limits. This limit state includes:

→ deflection (excessive)
→ vibration, cracking or corrosion
→ ponding of structure
→ fatigue failure

5-b)



$A = 500\ mm^2$

$p_0 = 1000\ N/mm^2$

Soln: effective eccentricity @ Mid span $= (75+50) = \underline{125\ mm}$.

$\because P_L(\text{loss}) = p_0(kx + \mu\alpha)$

@ $x = 10\ m$ and $\alpha = \left(\frac{8h}{l}\right) = \frac{8 \times 0.125}{10} = 0.1$

$\therefore P_L = p_0(0.0015 \times 10 + 0.1 \times 0.55) = 0.07 p_0$

$\therefore P_B = p_0 - P_L = 0.93 p_0$

$\therefore P_B$ (other end) $= 0.93 \times 1000 \times 500 \times 10^{-3} = \underline{465\ kN}$

% loss of prestress $= \frac{0.07 p_0}{p_0} \times 100 = \underline{7\%}$ Ans

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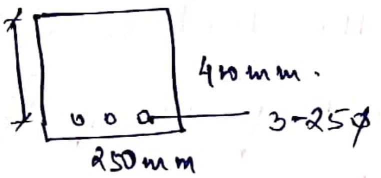
5-c)

M35

fe 415



Soln: ① $A_{st} = 3 \times \frac{\pi}{4} \times 25^2 = 1472.62\ mm^2$

② Assuming URS.

$\therefore$ from $\boxed{\text{C-force} = \text{T-force}}$

$\Rightarrow 0.36 \times 25 \times 250 \times x_u = 0.87 \times 415 \times 1472.62$

$x_u = 168.79\ mm$.

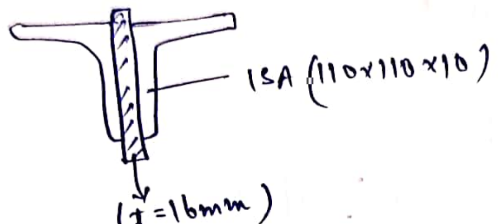
where $x_{ulim} = kd = 0.48 \times d = 0.48 \times 400 = 192\ mm$

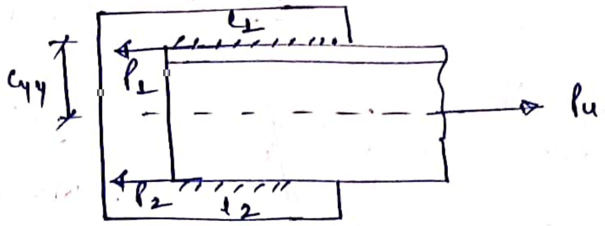
$\because$ $\underline{x_u < x_{ulim}}$ (URS, $\underline{\text{assm OK}}$)

$\therefore (\text{MOR})_{beam} = 0.87 f_y A_{st}(d - 0.42 x_u) = [0.87 \times 415 \times 1472.62 \times (400 - 0.42 \times 168.79) \times 10^{-6}]$

$\text{MOR} = \underline{174.983\ kNm}$. Ans

5-d)





Soln:

→ let the weld lengths be 'L_1' and 'L_2' respectively

P_u = (factored loads) = $640 \times 1.5 = \underline{960\text{ kN}}$

∴ load carried through one ISA will be $\left(\frac{960}{2}\right) = \underline{480\text{ kN}}$

from $\Sigma f_x = 0$

$P_1 + P_2 = P_u = 480$ —①

$(\Sigma M)_{cg} = 0 \Rightarrow -P_1(C_{yy}) + P_2(110 - C_{yy}) = 0$

$\Rightarrow P_1(30.9) = P_2(110 - 30.9)$

$30.9 P_1 = 79.1 P_2$

$\Rightarrow \underline{P_1 = 2.56 P_2}$ —②

$\Rightarrow \underline{P_1 = 345.168\text{ kN}}$ and $\underline{P_2 = 134.83\text{ kN}}$

size of weld =
(@ ①) = $10 - 1.5 = 8.5\text{mm}$

@ location ②

$s = \frac{3}{4}t = \frac{3}{4} \times 10 = 7.5$

∴ Assume $\underline{s = 5\text{mm}}$ all around.

∴ length of weld at ①

$(Ks) l_{eff_1} \times \frac{410}{\sqrt{3} \times 1.25} \geq P_1 (345.168)$

$(0.7 \times 5) \times l_{eff_1} \times \frac{410}{\sqrt{3} \times 1.25} \geq 345.168 \times 10^3$

$(l_{eff_1}) \geq 533.79 \Rightarrow \underline{535\text{ mm}}$ (say)

length of weld @ ②

$0.7 \times 5 \times l_{eff_2} \times \frac{410}{\sqrt{3} \times 1.25} \geq 134.83 \times 10^3$

$(l_{eff_2}) \geq$ ~~208~~ 208.51 mm.

$\Rightarrow (l_{eff})_2 = \underline{210\text{mm}}$ (say)

(Ans).

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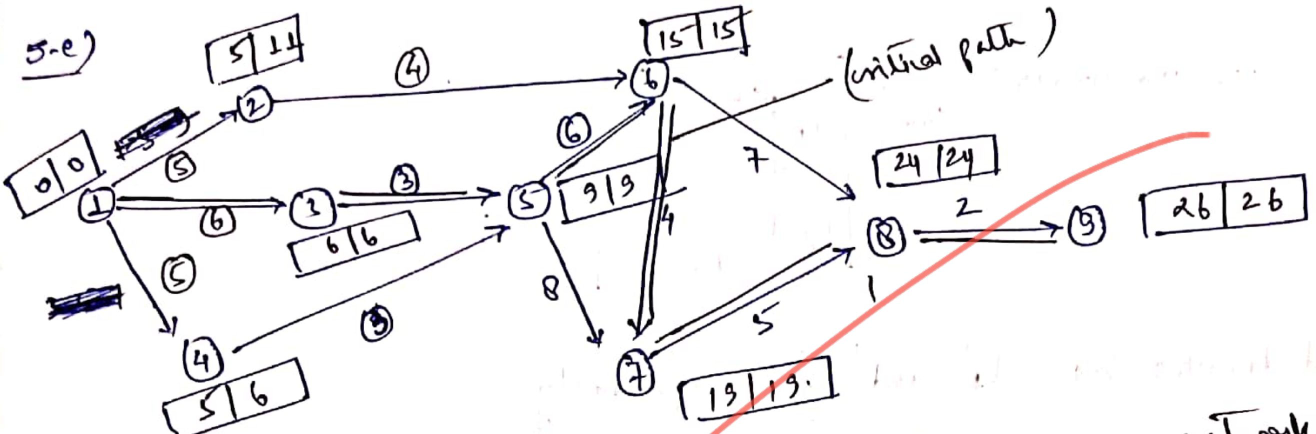
5.e)



Activity	$T_E = \left(\frac{T_o + 4T_m + T_p}{6}\right)$	Event (show on network itself)
1-2	5	
1-4	5	
1-3	6	
2-6	4	
3-5	3	
5-6	6	
5-7	8	
6-7	4	
6-8	7	
7-8	5	
8-9	2	
4-5	3	

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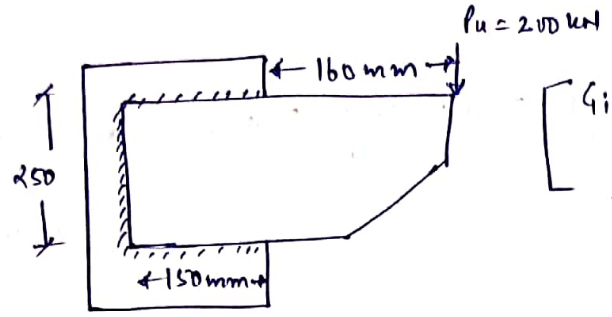
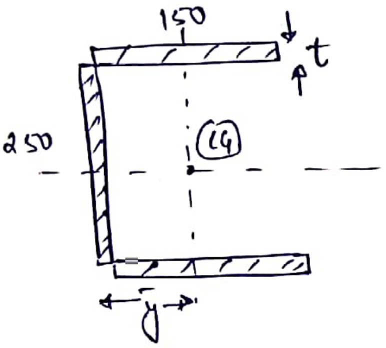
Q-6-a)



[Given (fu) = 410 MPa.
Shop weld]

Soln: weld c.g. (Treating $\frac{t}{2}$, t^2 and t^3 as negligible in analysis)



$$\bar{y} = \left[\frac{(150\times t\times 75\times 2) + (250\times t\times \cancel{\tfrac{t}{2}})}{(250\times t + 150\times t\times 2)}\right] = 40.91\,mm.$$

neglect

$\therefore$ Torsion @ weld = $200\times(160 + (150-40.91)) = 53818.18$ kN mm.

and eccentricity (e) = $(160+150-40.909) = 269.09$ mm.

$$(I_{xx})_{weld} = 2\times\left[\cancel{\frac{150\times t^3}{12}} + 150\times t\times 125^2\right] + \frac{t\times 250^3}{12} = 5.989\times 10^6\,t\ mm^4$$

neglect

$$(I_{yy})_{weld} = 2\times\left[\frac{t\times 150^3}{12} + 150\times t\,(75-40.91)^2\right] + \left[\cancel{\frac{t^3\times 250}{12}} + 250\times t\,(40.91^2)\right]$$

neglect

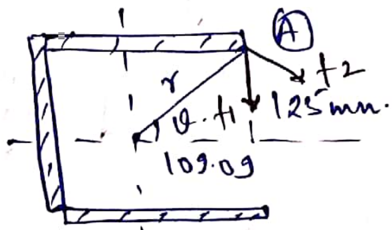
$= 1.329\times 10^6\,t\ mm^3$

$(I_p)_{weld} = (I_{xx}+I_{yy}) = 7.318\times 10^6\,t\ mm^4$

→ force / stress Analysis (At Point A)

f_1 (direct shear stress) = $\left(\frac{200\times 10^3}{150\times t\times 2 + 250\times t}\right) = \frac{363.64}{t}$ N/mm²

f_2 (torsional shear) = $\left(\frac{T}{I_p}\times r\right)$



where $r = \sqrt{125^2 + 109.09^2} = 165.908$ mm.

$\tan\theta = \frac{125}{109.09}$

$\Rightarrow \theta = 48.89^0$

$\therefore f_2 = \frac{53818.18\times 10^3}{7.318\times 10^6\,t}\times 165.908 = \frac{1220.12}{t}$ N/mm²

$$f_R = \sqrt{f_1^2 + f_2^2 + 2f_1f_2\cos\theta} = \sqrt{\left(\frac{363.64}{t}\right)^2 + \left(\frac{1220.12}{t}\right)^2 + \frac{2\times 363.64\times 1220.12}{t^2}\cdot\cos(48.83)}$$

$$\Rightarrow f_R = \frac{1484.714}{t}\ N/mm^2$$

and for weld to be safe in shear:

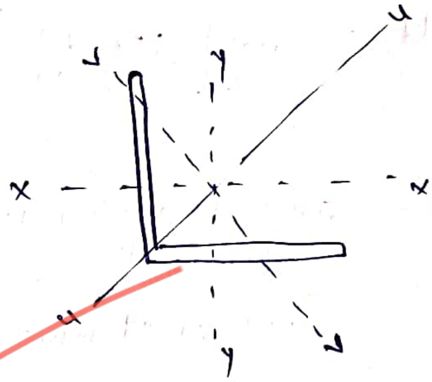
$$f_R = \frac{1484.714}{t} \le \frac{f_u}{\sqrt{3}\times 1.25}$$

$$\Rightarrow t \ge 8.036\,mm$$

$$\therefore s \ge \left(\frac{8.036}{0.7}\right) = 11.48$$

$$\Rightarrow s = 12\,mm \quad \text{(Ans.)}$$

6-b) ISA 200×150×15 length = 5m.



$A_g = 5025\ mm^2$

$I_{xx} = 2\times10^7\ mm^4 \quad I_{yy} = 9.7\times10^6\ mm^4$

Sol^n: $I_{xy} = 8.3\times10^6\ mm^4$

$$I_{uu}/I_{vv} = \frac{I_{xx}+I_{yy}}{2} \pm \frac{1}{2}\sqrt{(I_{xx}-I_{yy})^2 + 4I_{xy}^2}$$

$$I_{uu}/I_{vv} = \frac{2\times10^7 + 9.7\times10^6}{2} \pm \frac{1}{2}\sqrt{(2\times10^7 - 9.7\times10^6)^2 + 4\times(8.3\times10^6)^2}$$

$$\Rightarrow I_{min} = I_{vv} = 5.082\times10^6\ mm^4$$

$$\because I_{min} = A_g \times r_{min}^2$$

$$\therefore r_{min} = \sqrt{\frac{I_{min}}{A_g}} = \sqrt{\frac{5.082\times10^6}{5025}} = 31.8018\,mm.$$

(Assuming discontinuous strut)

$$\therefore \lambda = \left(\frac{kL}{r_{min}}\right) \qquad \therefore l_{eff} = 0.85l$$

$$\therefore \lambda = \left(\frac{0.85\times5\times10^3}{31.8018}\right) = 133.64$$

$\therefore f_{cd} = 57 - \dfrac{57-51}{140-130}(133.64-130) = \underline{54.815\ N/mm^2}$

$\therefore P_c$ (factored load carrying capacity) $= (f_{cd} \times A_g) = (54.815 \times 5025 \times 10^{-3})$

$= 275.449\,kN.$

$\therefore P_{safe} = \left(\dfrac{P_c}{1.5}\right) = \left(\dfrac{275.449}{1.5}\right) = \underline{183.633\ kN}$ (Ans)

Q-6-c) i) Dragline:

Purpose: a) It is used for excavation of soft soils and fills.

b) It has cutting edge That is used To loosen The soil with impact and dragging The ~~fut~~ bucket against The earth. To collect it.

c) It can be used for excavation of earth both above and below The track level.

Advantages of Dragline:

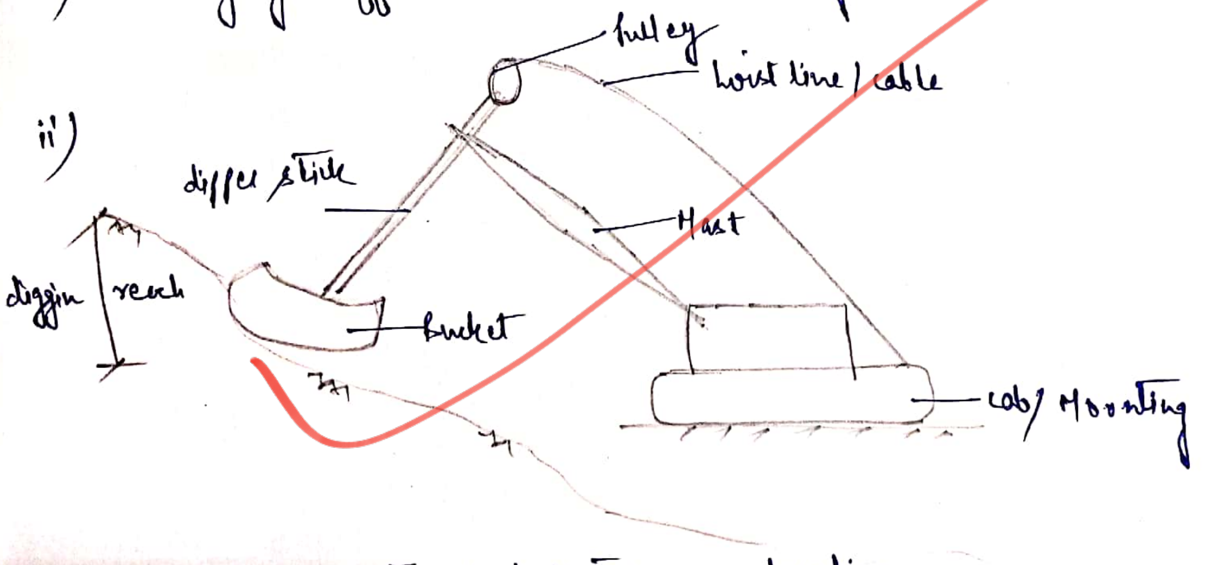
1) It can be used for excavation in soils below water table.

2) digging reach of dragline is comparatively more Than That of power shovels.

3) draglines can directly be emptied into The trucks.

4) highly efficient under close range works.

ii)



Typical sketch of dragline.

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iii) Factors affecting output of a Dragline:

a) Size of Bucket: Larger the size of the bucket more will be the material handel and thus lesser will be the ogt cycle time.

b) Material to be dug: Harder materials offers greater resistance to excavation and vice-versa.

c) depth of cut and angle of swing: Higher will be the depth of cut more will be the material excavated in single operation

$$\eta(\text{efficiency}) \propto \left(\frac{1}{\text{Angle of swing}}\right)$$

d) Size of hauling units: Larger the size of hauling units, lesser will be the delay in emptying the earth and greater will be the output.

e) Skill of operator: The output of various excavating equipments depends on the skill and the proficiency of the operator handling it.

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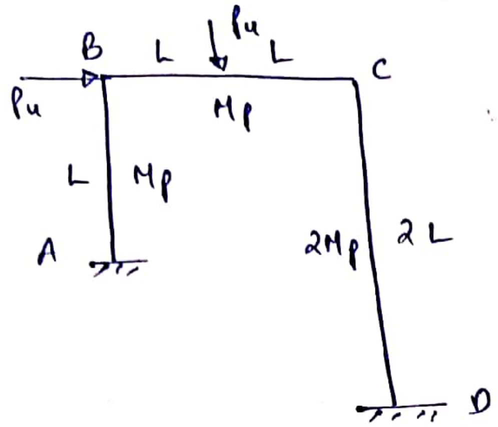
Q-7-a)



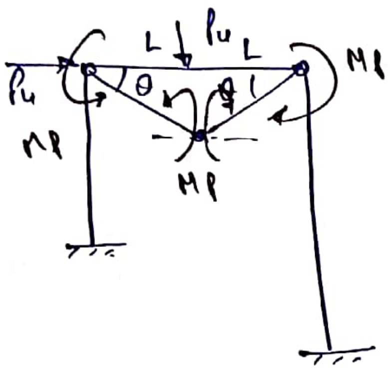
① $D_s = 6 - 3 = 3$

$\Rightarrow (D_s + 1) = n = 4$ plastic hinges

② $K = N - D_s = 5 - 3 = 2$

(In addition to above 2 mechanisms, there will also be a combined mechanism)

① BEAM MECHANISM:



from principal of virtual work

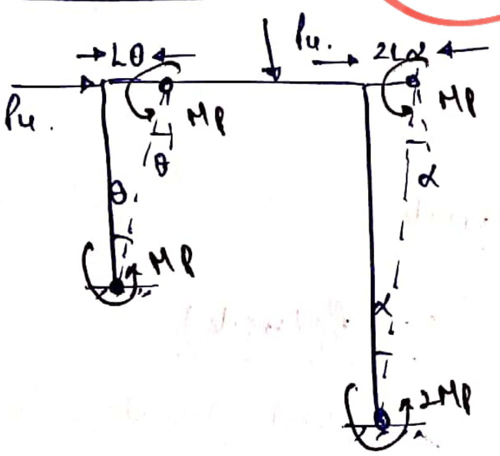
Internal WD = External WD

$M_p\theta + M_p(\theta + \theta) + M_p\theta = P_u \times L\theta$

$\Rightarrow 4M_p\cancel{\theta} = P_u \times L\cancel{\theta}$

$\Rightarrow P_u = \left(\frac{4M_p}{L}\right)$ — ①

② SWAY MECH M:



from strain compt:

$L\theta = 2L\alpha$

$\Rightarrow \boxed{\theta = 2\alpha}$

$\therefore$ from virtual work principle:

$M_p\theta + M_p\theta + M_p\alpha + 2M_p\alpha = P_u \times L\theta$

$2M_p\theta + M_p\left(\frac{\theta}{2}\right) + M_p\theta = P_u \times L\theta$

$3.5M_p\cancel{\theta} = P_u \times L\cancel{\theta}$

$\Rightarrow P_u = \left(\frac{3.5M_p}{L}\right)$ — ②

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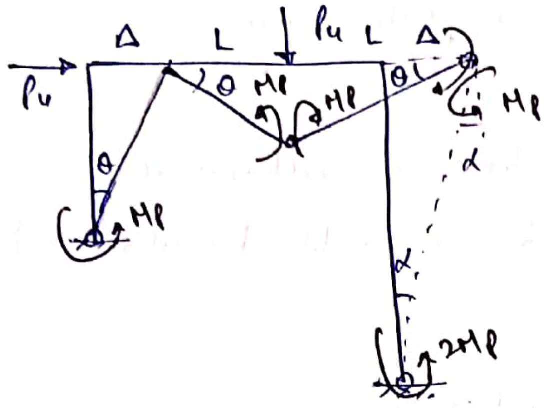
(3) Combined Mechanism:



$L\theta = 2L\alpha = \Delta$

$\Rightarrow \boxed{\alpha = 0.5\theta}$

∴ from virtual work mtd:

$P_u \times L\theta + P_u \times L\theta = M_p\theta + M_p(\theta+\theta) + M_p\theta + M_p\alpha + 2M_p\alpha$

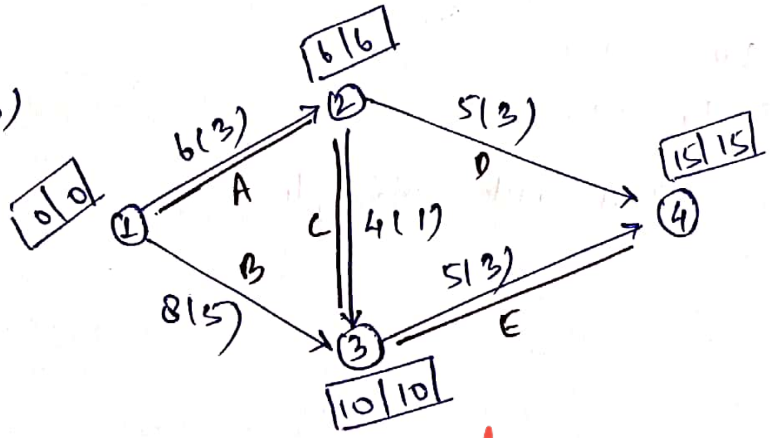
$2P_u \times L\theta = 4M_p\theta + 3M_p(0.5\theta)$

$\therefore P_u = \left(\frac{5.5M_p}{2L}\right) = \left(\frac{2.75M_p}{L}\right)$ — (3)

∴ from above mechanisms $P_u = \text{Minm}(①, ②, ③) = \left(\frac{2.75M_p}{L}\right)$ Ans

and correct failure mechanism is combined Mechm.

7-b)



IC = 3000/week.

Activity	Cs (Rs/week)
1-2 (A)	2500
1-3 (B)	1500
2-3 (C)	1000
2-4 (D)	3500
3-4 (E)	3000

Soln:

Basic step (T_n = 15 days)

DC = Rs 30,000

IC = 3000 × 15 = Rs 45000

TC = Rs 75,000

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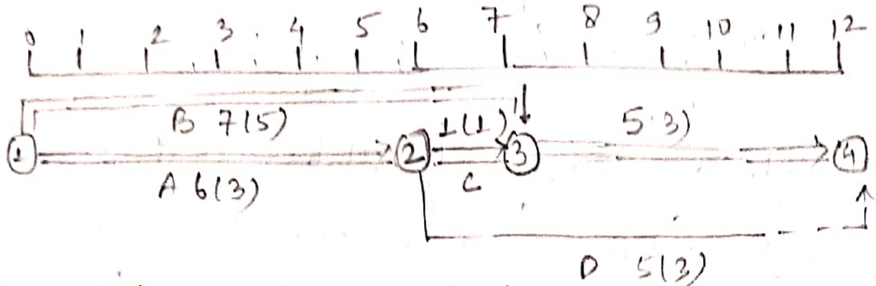
TIME SCALE DIAGM :



I st stage crashing (Tn = 13 weeks)

crash (activity C by 2weeks)

∴ Tn = 13 weeks

DC = 30,000 + 2×1000 = 32000

IC = 13×3000 = 39000

TC = Rs 71,000

IInd stage crashing (Tn = 12weeks)

crash activity (B and C by 1 week each)

DC = 32000 + 1500 + 1000 = 34500

IC = 12× 3000 = 36000

TC = Rs 70,500

IIIrd stage crashing (Tn = 11 weeks)

crash (activity E by 2weeks.)

∴ DC = 32000 + 3000×2 = 38000

IC = 3000×11 = 33000

TC = Rs 71,000

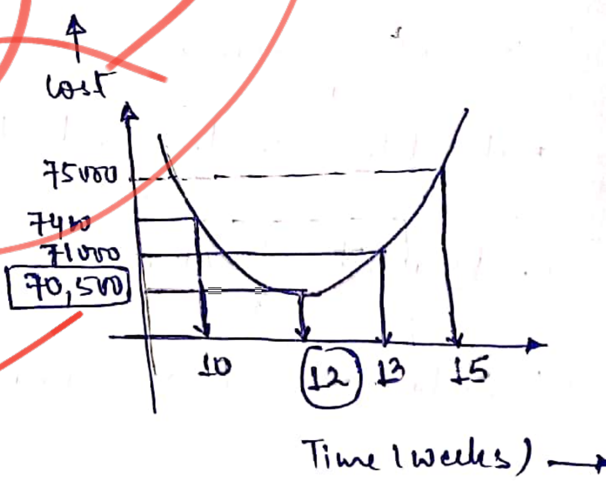
IVth stage crashing (Tn = 10 weeks)

crash activity (B, C and D by 1 week each)

∴ DC = 38000 + 1500 + 1000 + 3500 = 44000

IC = 3000×10 = 30,000 = 30,000

∴ TC = Rs 74000



∴ optimum Project duration = 12 days] (Ans)
Minimum cost = Rs 70,500

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Q-7-c) Flat slab: → Beams of great depth reduce due to construction of flat slab.

→ Flat slab are the thin ordinary reinforced slabs that are ~~worno~~ monolithically casted with columns and doesn't require any beam to support from base.

→ Column heads enlarged at the location where ~~sab~~ slab is present called as column heads or capitals and the slab is made usually thick at the interface called as drop panels.

→ Load transfer is flat slab directly takes place from slab to column.

Advantages of flat slab:

1) Construction of flat slab reduces clear height b/w the floor levels and thus reducing the ~~story~~ storey heights.

2) It resists fire better than ordinary slab.

3) Construction is faster as it eliminates the removal of formworks in case of beams.

4) Flat slabs resists point load better.

5) Dead weight of structure reduces greatly.

6) Concrete is more economically used in construction of flat slabs.