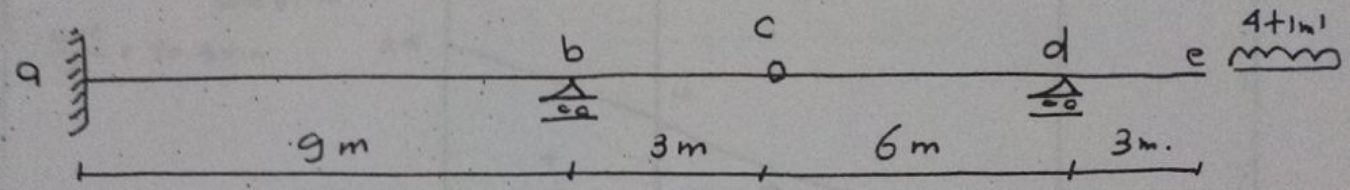
Moving load.

Exam 2015

a) Draw The max & min Curves of S.f and B.M dueto l.l equal 4t/m'.

b) Calculate The maximum negatine and max positine deflection at Point c due to The Ginen l.l only, use The virtual work Method

Take ($EI = 10000\ m^2.t$)



← Sol →

* في البداية يتم عمل ٣ حالات تحميل وهي :

a ⟶ b (Case (1)).

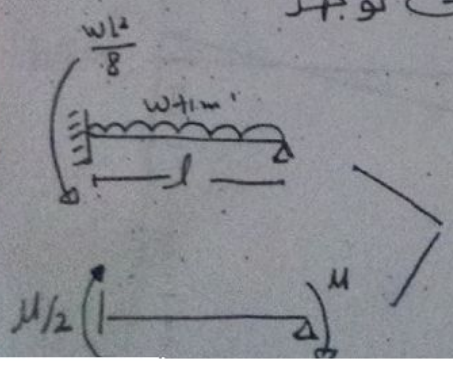
b ⟶ d (Case (2)).

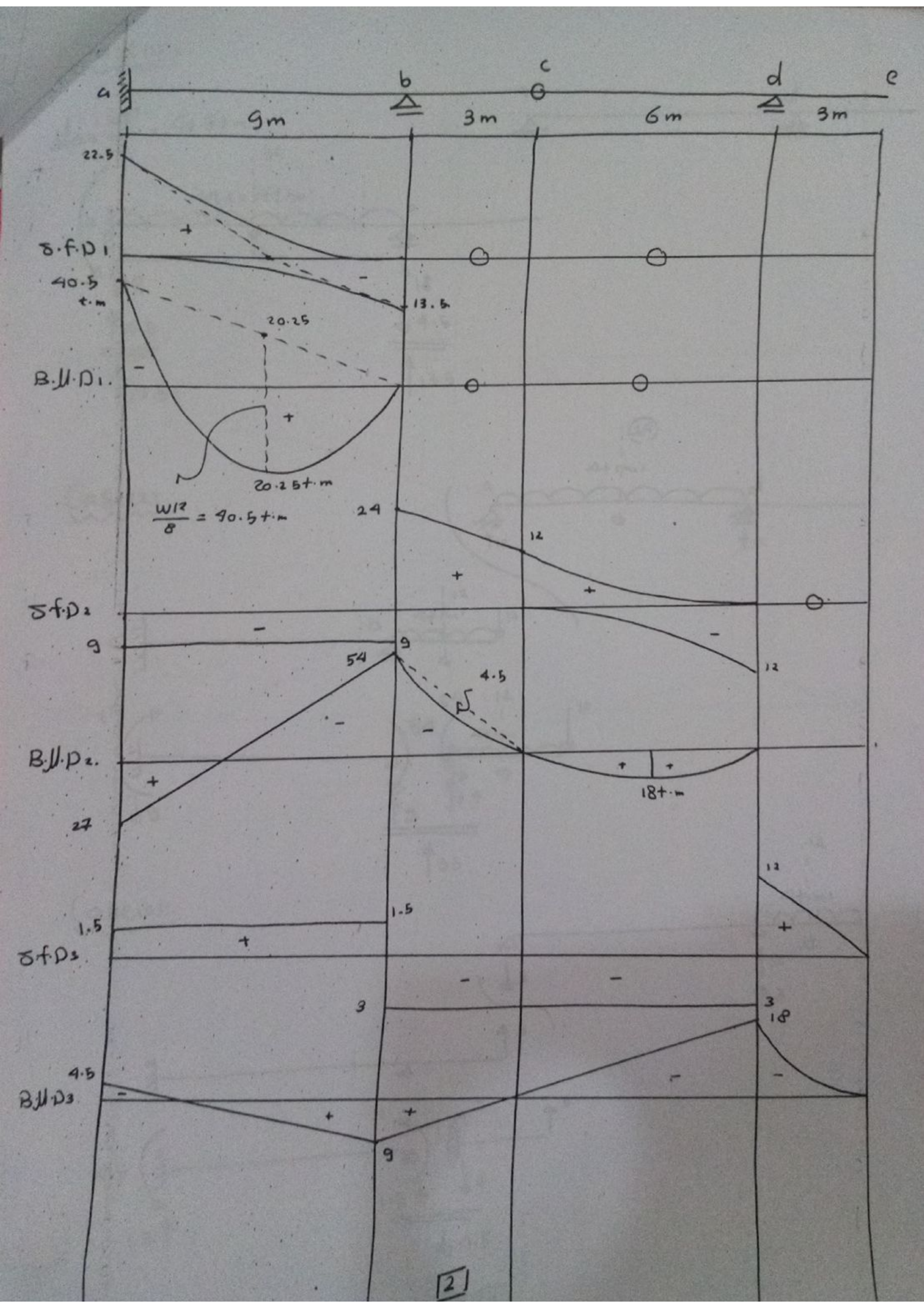
d ⟶ e (Case (3)).

* وفي كل الحالات نتبع احدى حالات التحميل لاختلاف توزيع الحمل بطريقتين :

1) 3.M. equation.

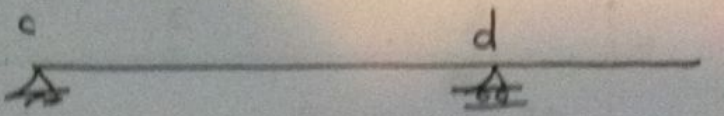
2) القوانين المحفوظة :

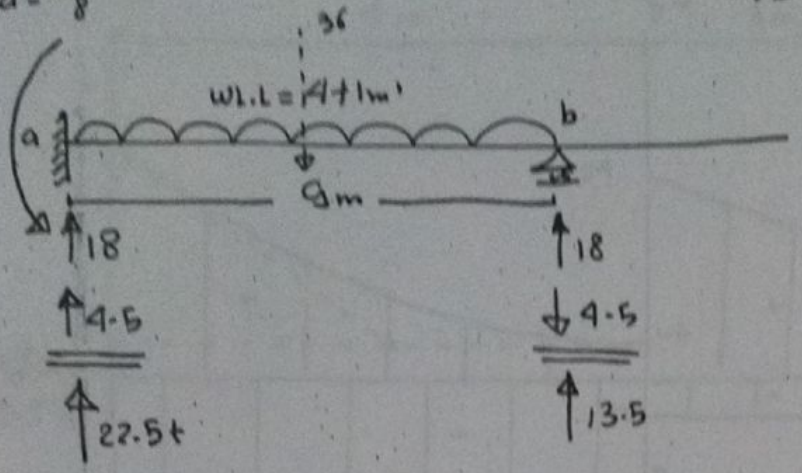



a
b
c
d
e
9m
3m
6m
3m
22.5
S.F.D1
40.5
t·m
13.5
20.25
B.M.D1
20.25 t·m
$\frac{WL^2}{8}$ = 40.5 t·m
24
12
S.F.D2
9
9
54
4.5
12
B.M.D2
18 t·m
27
12
1.5
1.5
S.F.D3
3
3
18
4.5
B.M.D3
9
2

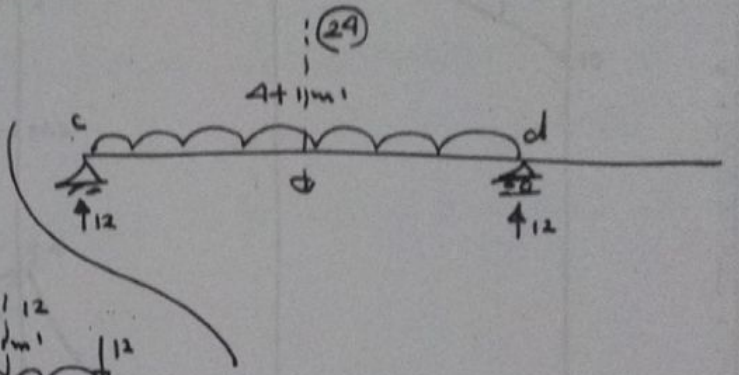
Case (1) :-

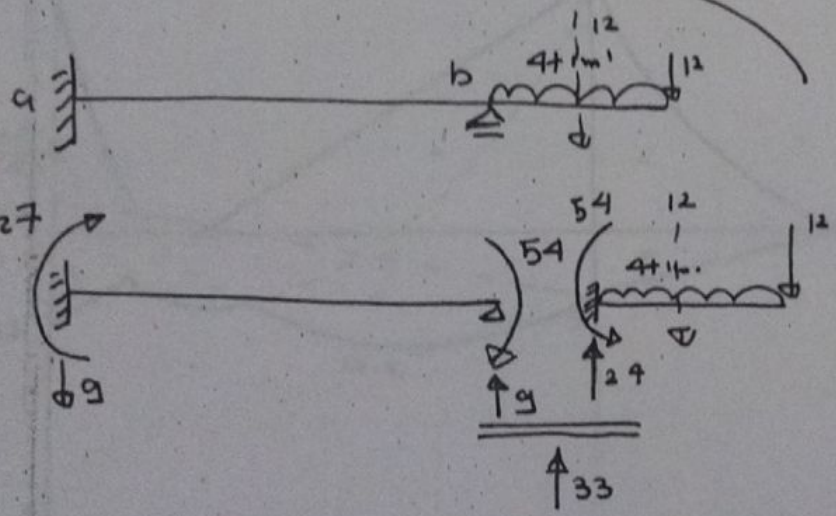
$M_a = \frac{wl^2}{8} = 40.5 \text{ t-m}$



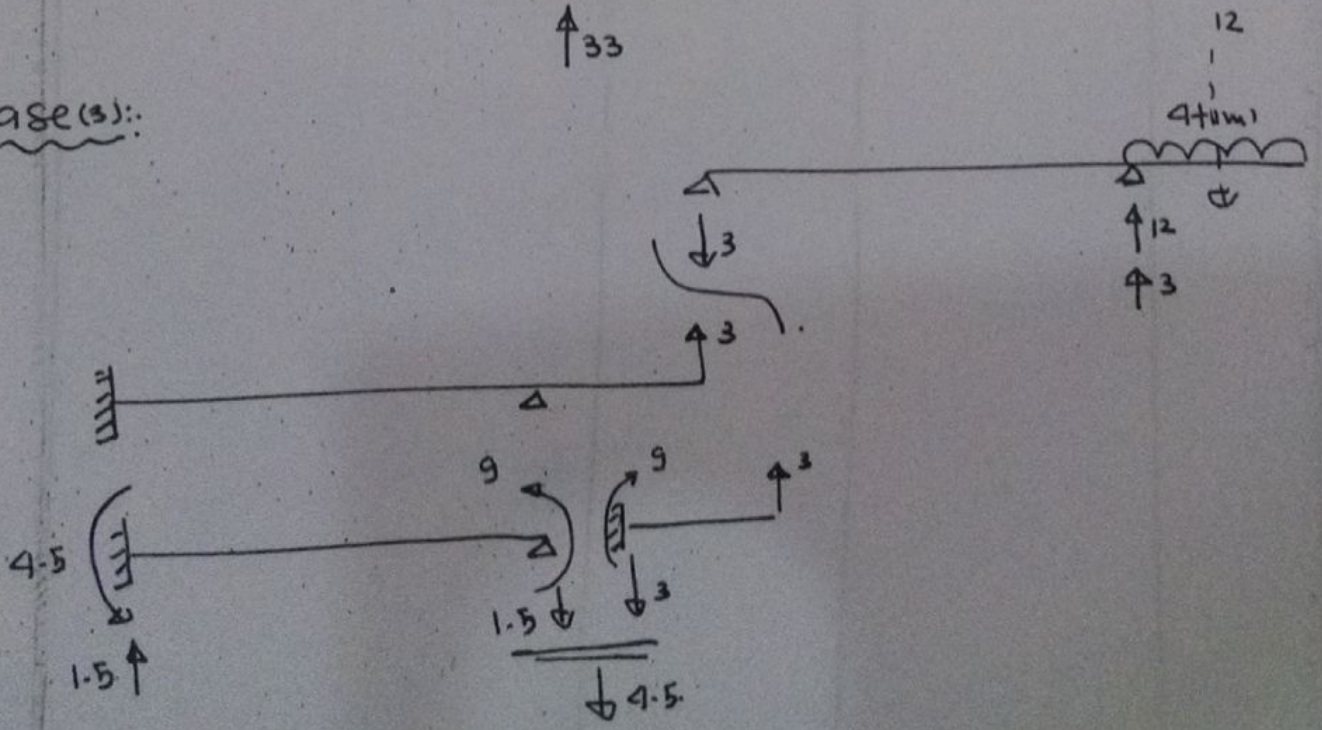


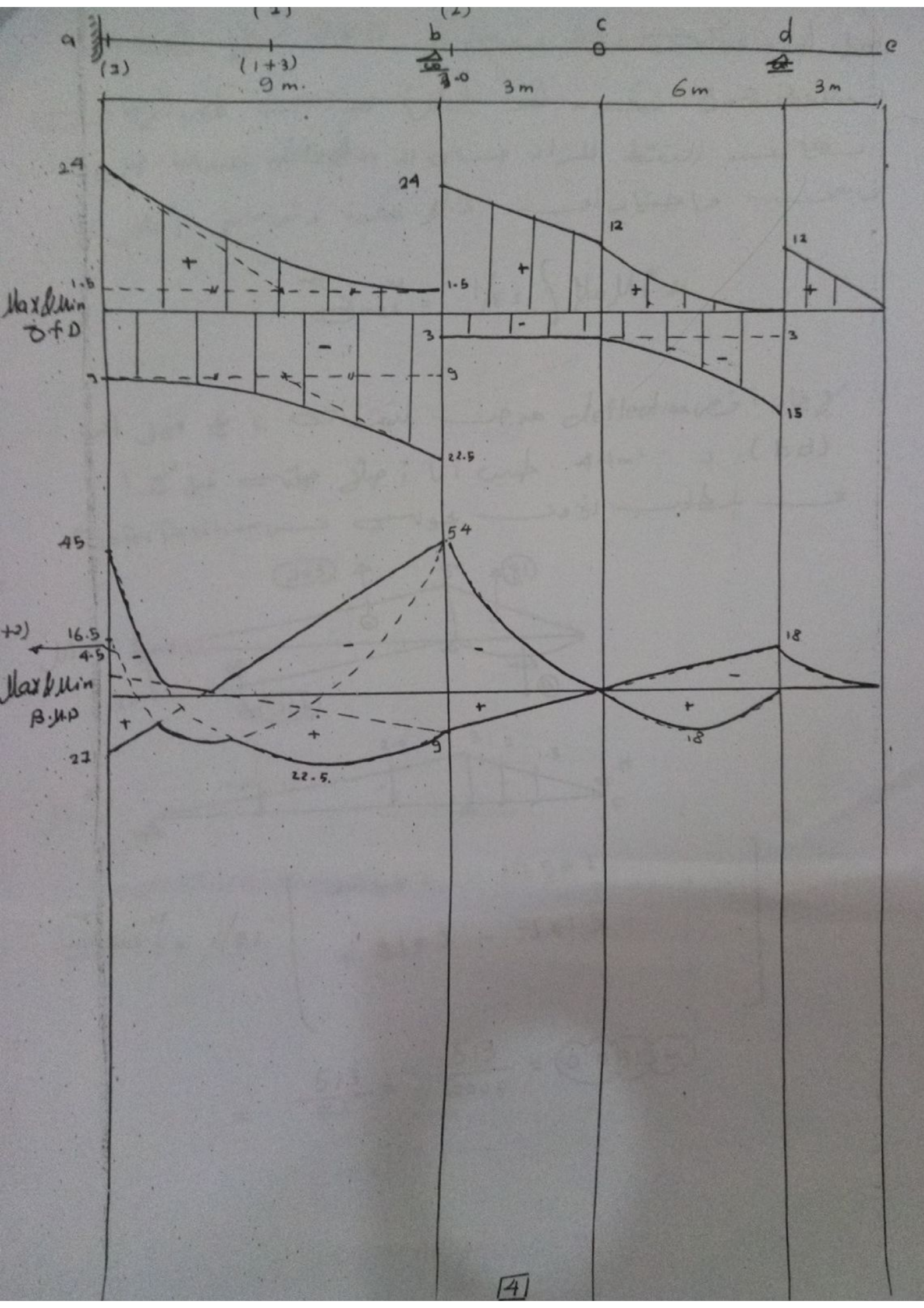
Case (2) :-





Case (3) :-

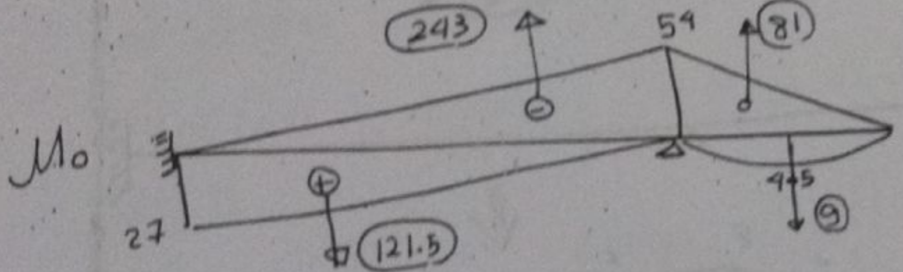


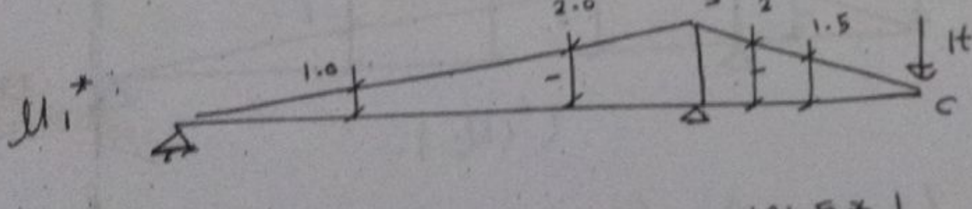

a
b
c
d
e
(2)
(1+3)
9 m.
3m
6m
3m
24
1.5
12
Max & Min
B.M.D
3
9
15
22.5
45
54
16.5
4.5
18
27
22.5.

* لإيجاد أقصى deflection موجب داخل باكية معينة يتم تحميل هذه الباكية فقط و رسم ال B.M.D لها بحيث ال Superposition فيكون هو (Mo) بعد ذلك نلغي الحمولات ونضع عند النقطة المراد حساب ال deflection عندها حمل 1t رأسي واختيار أي s.d للشكل ونرسم (M1*)

$$\therefore \delta_{max}^{+ve} = \frac{1}{EI} \int M_o M_1^* \, dx$$

∴ لإيجاد أقصى deflection موجب للنقطة c يتم تحميل الجزء (bd) بـ 4 t/m' . حيث إنا حلينا قبل كدا في المطلوب الأول نحول بس Superposition

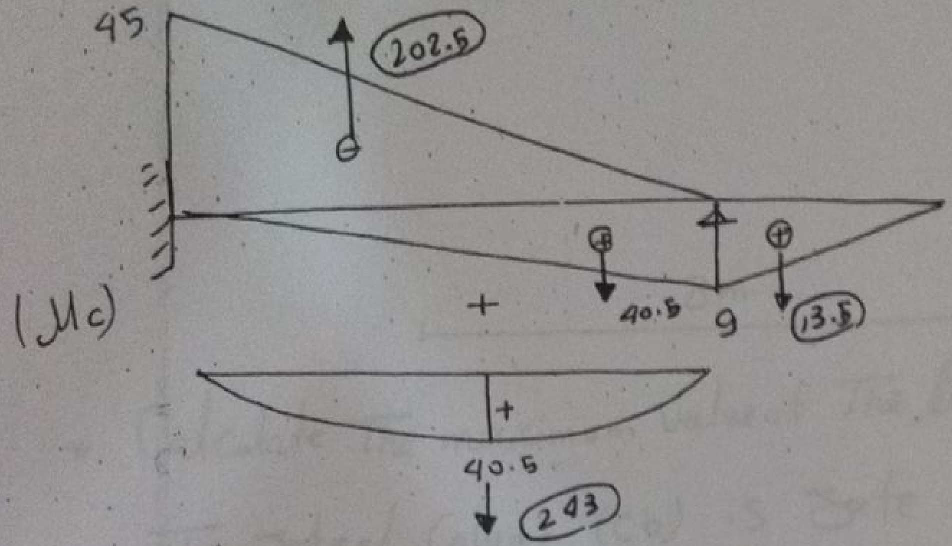


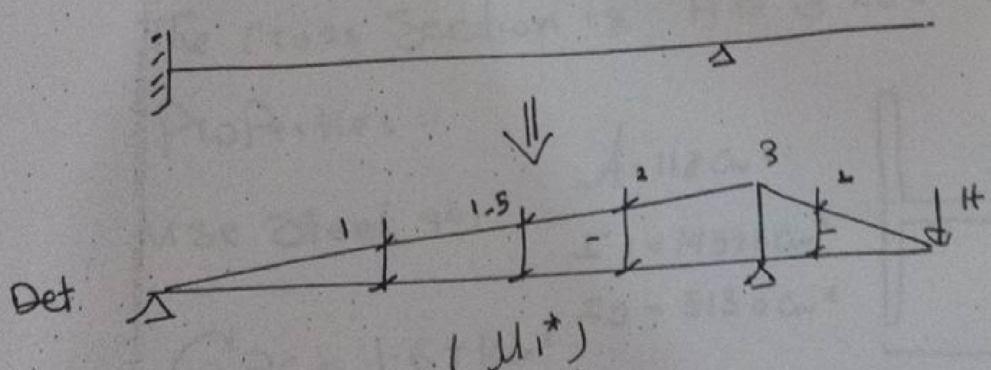


$$\delta_{max\ c}^{+ve} = \frac{1}{EI} \left[243 * 2 - 121.5 * 1 + 81 * 2 - 9 * 1.5 \right]$$

$$= \frac{513}{EI} = \frac{513}{10000} = 0.0513 \text{ m}$$

* لإيجاد أقصى deflection سالب داخل باكية معينة ⊖
نحمل عينيط وشالوطب 4t/m' ونرسم (Mo) ثابت
يتم جمع هنا الحالتين ① & ③ أو تحميلها معاً ونرسم
مساحة جديد. ونكامل Mo ده مع *M1 أيضاً نحصل
على الـ deflection السالب عند (C).



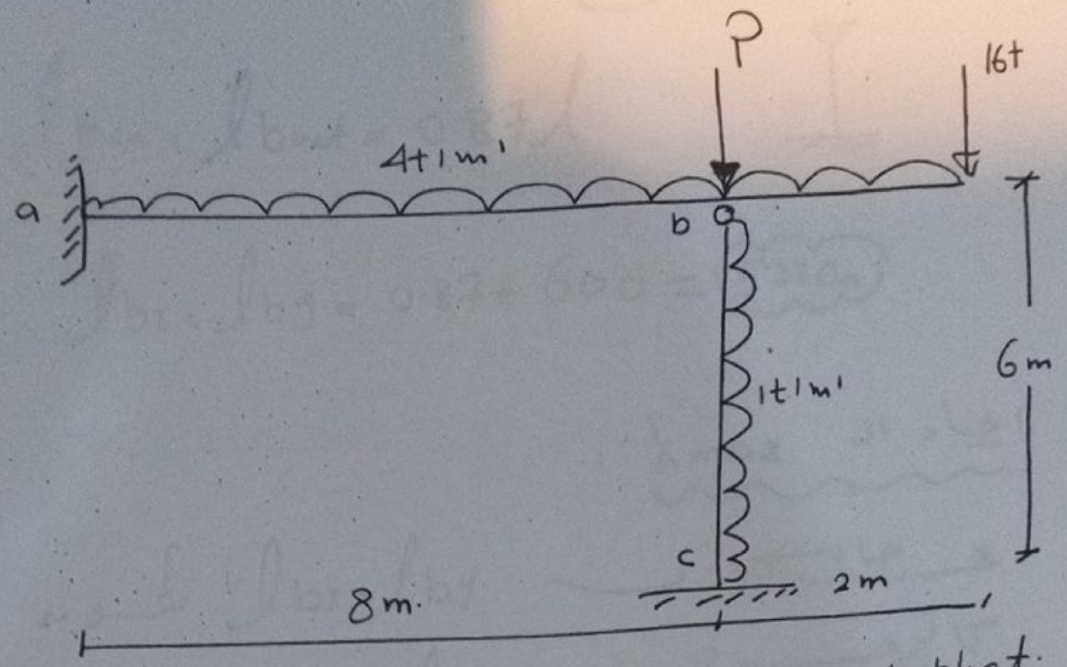


$$\delta_c^{-ve} = \frac{1}{EI}\left[(202.5*1) - (40.5*2) - (243*1.5) - (13.5*2)\right]$$

$$= \frac{-270}{10000} = -0.027\,m$$

Buckling of Column

Exam 2015



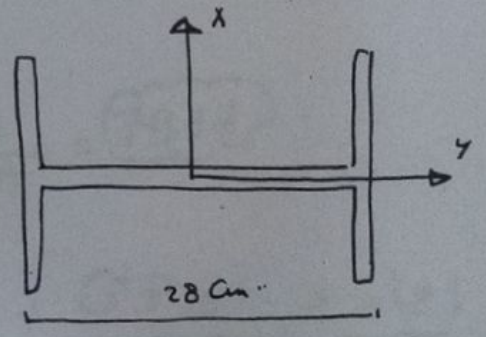
* Calculate the maximum value of the load P such that the steel column (Cb) is safe due to buckling the cross section is H.E.B 280 with the given properties:

use steel 44:

$A = 118\ cm^2$

$I_x = 14920\ cm^4$

$I_y = 5130\ cm^4$



$\sigma_{P.C} = 1.6\ t/cm^2$.

$$\sigma_{P.b} = \begin{cases} 1.6 - 0.000085(\lambda)^2, & \text{For } \lambda < 100. \\ \dfrac{7500}{\lambda^2}, & \lambda > 100. \end{cases}$$

١ تحديد الـ buckling length :

$$l_{bin} = l_{bout} = 0.87 l$$

$$\therefore l_{bx} = l_{by} = 0.87 * 600 = \boxed{522 cm}$$

٢ إيجاد الـ λ_{max} :

في حالة : $l_{bx} = l_{by}$ تكون λ_{max}

كالآتي :

$$\lambda_{max} = \frac{l_b}{i_{min}} \quad , \quad i_{min} = \sqrt{\frac{I_{min}}{A}}$$

$$\therefore i_{min} = \sqrt{\frac{5130}{118}} = 6.59 cm$$

$$\therefore \lambda_{max} = \frac{522}{6.59} = \boxed{79.17}$$

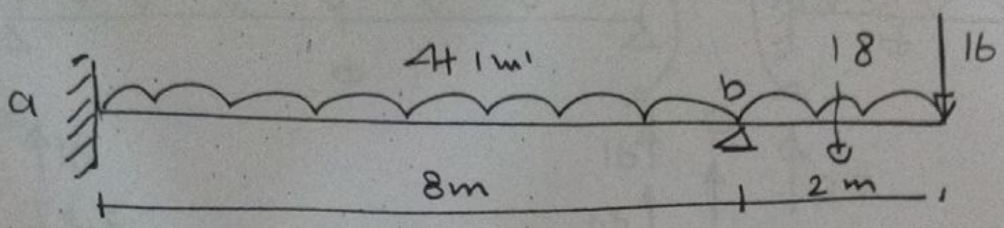
٣ إيجاد الـ $G_{P.b}$:

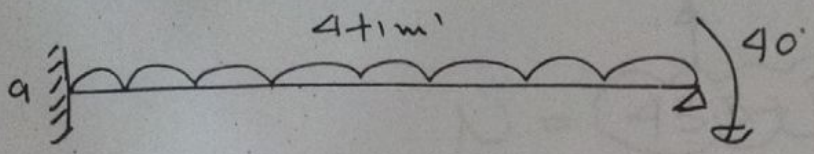
$$\lambda_{max} = 79.17 < 100$$

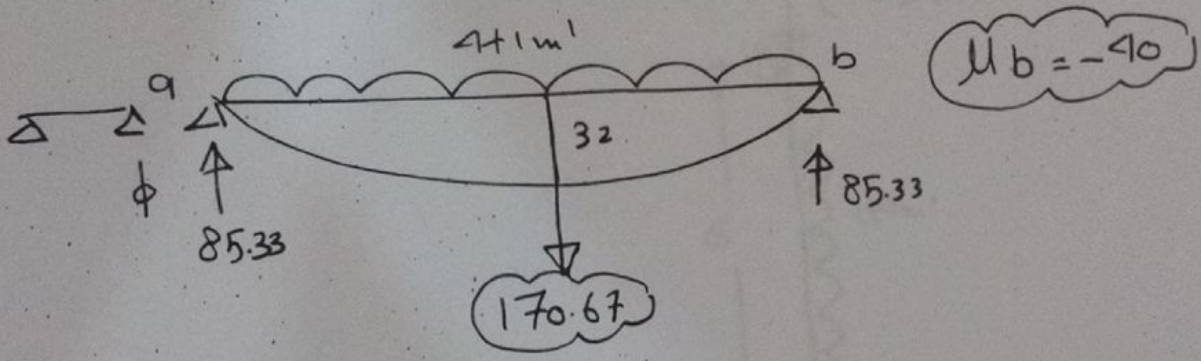
$$\therefore G_{P.b} = 1.6 - 0.000085 (79.17)^2 = \boxed{1.067 t/cm^2}$$

$$G_{P.c} = 1.6 t/cm^2 \quad (Given).$$

∴ M & N إيجاد لـ ... (P) بدلالة لـ





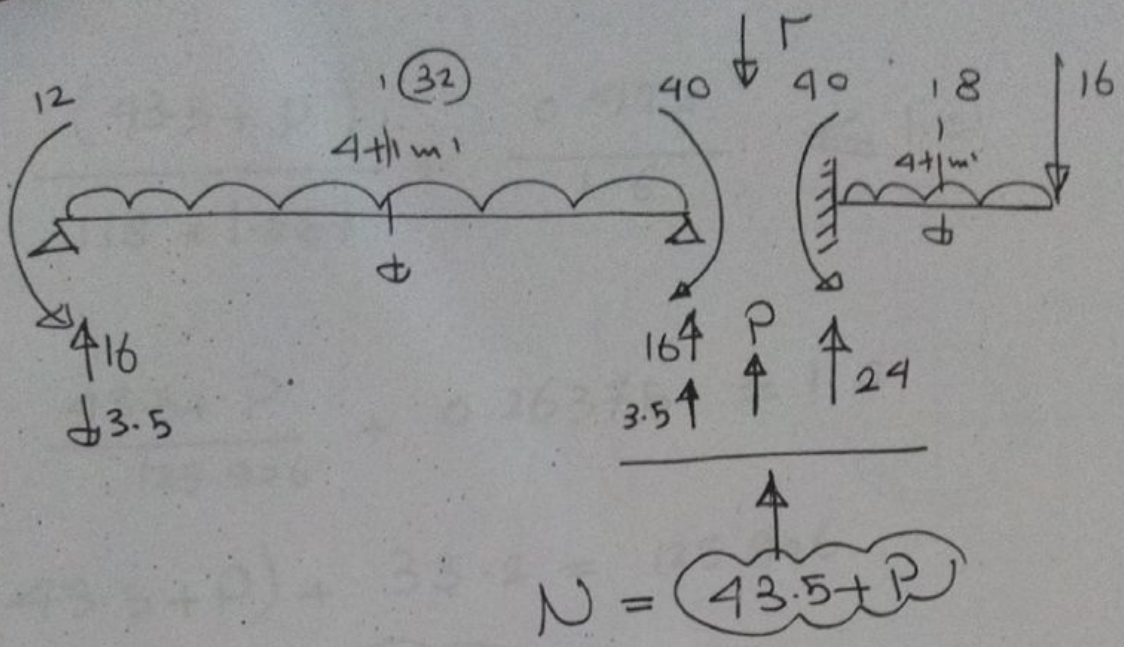


3. Mata::

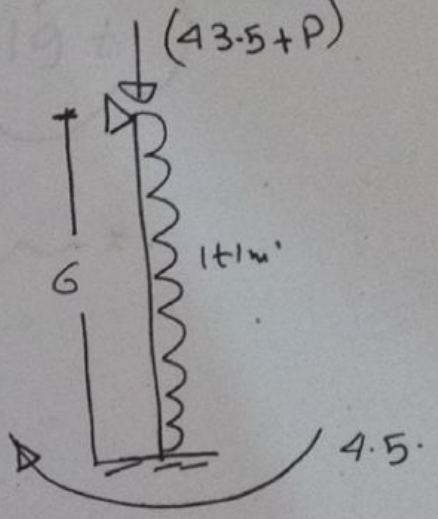
$$0.0 + 2Ma(0+8) - 40(8) = -6\left[0 + 85.33\right]$$

$$16Ma - 320 = -512$$

$$\therefore Ma = \frac{-192}{16} = -12\ t.m$$



$N = (43.5+P)$



$\therefore \quad N = (43.5+P)$

$M_x = 4.5 \times 100 = \boxed{450\ t\cdot m}$

$$\sigma_c = \frac{N}{A} = \frac{(43.5+P)}{118}$$

$$\sigma_{b.x} = \frac{M_x}{I_x} \cdot y = \frac{450}{14920} * 14 = \boxed{0.422}\ t/cm^2$$

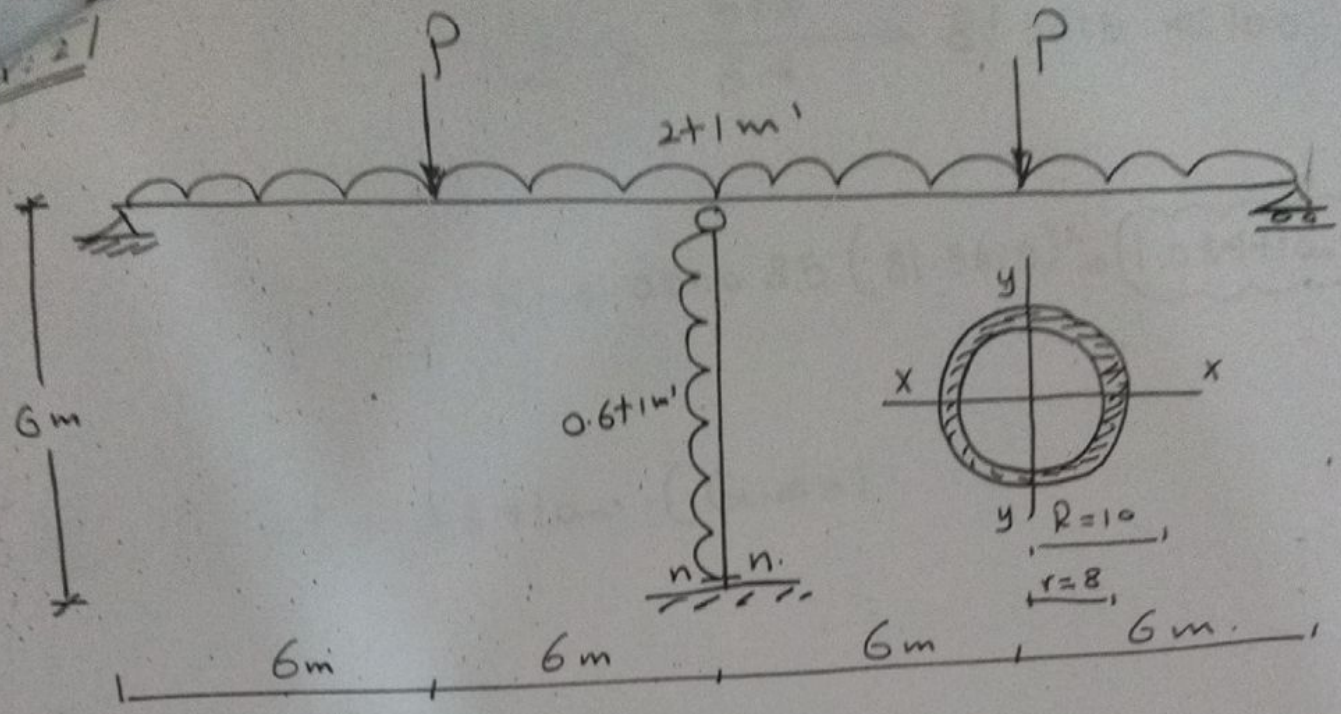
$$\frac{(43.5+P)}{118 * 1.067} + \frac{0.422}{1.6} \leq 1.0$$

$$\frac{43.5+P}{125.906} + 0.26375 = 1.0$$

$$(43.5+P) + 33.2 = 125.906$$

$$\therefore P = 49.19\ t$$

* ~~~~ *



Required:

Find P so that the stresses will be safe. Taking into consideration buckling effect.

← sol →

1 Buckling length:

$$l_{bx} = l_{by} = 0.87\,l = 0.87 * 600 = 522\,cm$$

2 Properties of area:

$$A = \pi(10)^2 - \pi(8)^2 = 113.1\,cm^2$$

$$I_x = I_y = I_{min} = \frac{\pi}{4}\left[10^4 - 8^4\right] = 4636.99\,cm^4$$

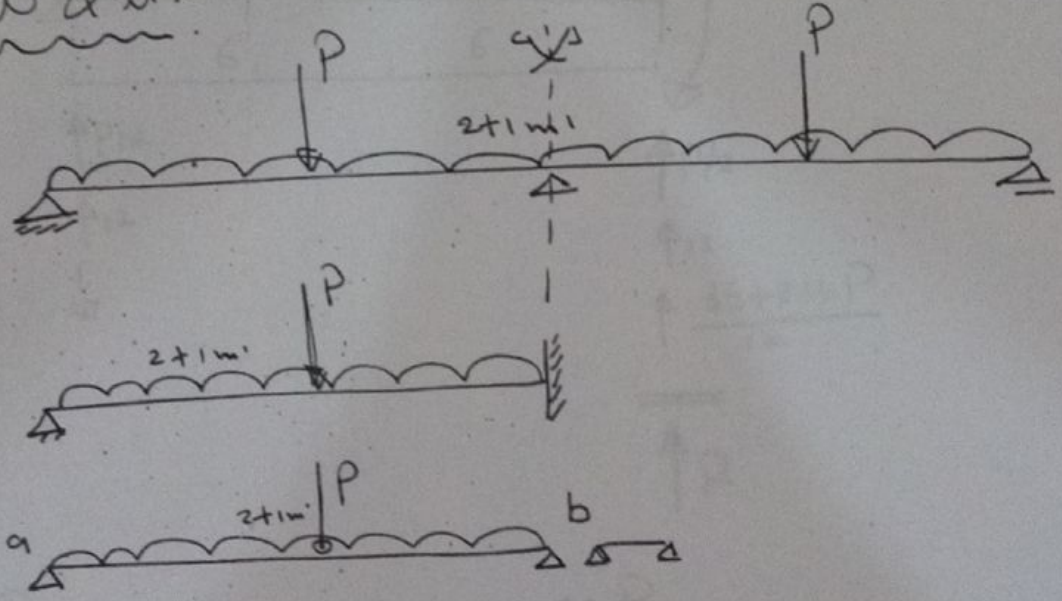
$$\therefore\ c_{min} = \sqrt{\frac{I_{min}}{A}} = \sqrt{\frac{4636.99}{113.1}} = 6.4\,cm$$

[3] $\lambda = \frac{l_b}{i_{min}} = \frac{522}{6.4} \rightarrow 81.5625 < 100$

[4] $\sigma_{P.b} = 1.6 - 0.000085 (81.5625)^2 = \boxed{1.034 \text{ t/cm}^2}$

[5] $\sigma_{P.C} = 1.6 \text{ t/cm}^2$ (Given).

[6] M & N:



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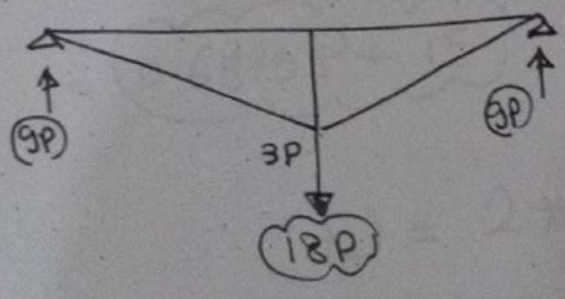

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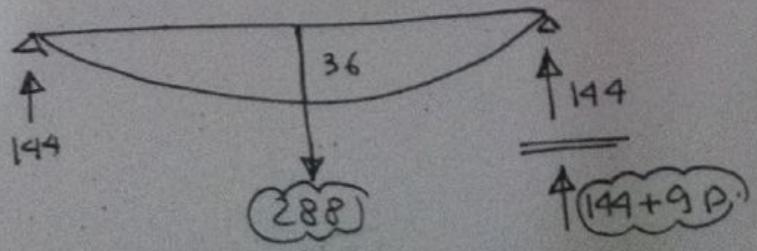


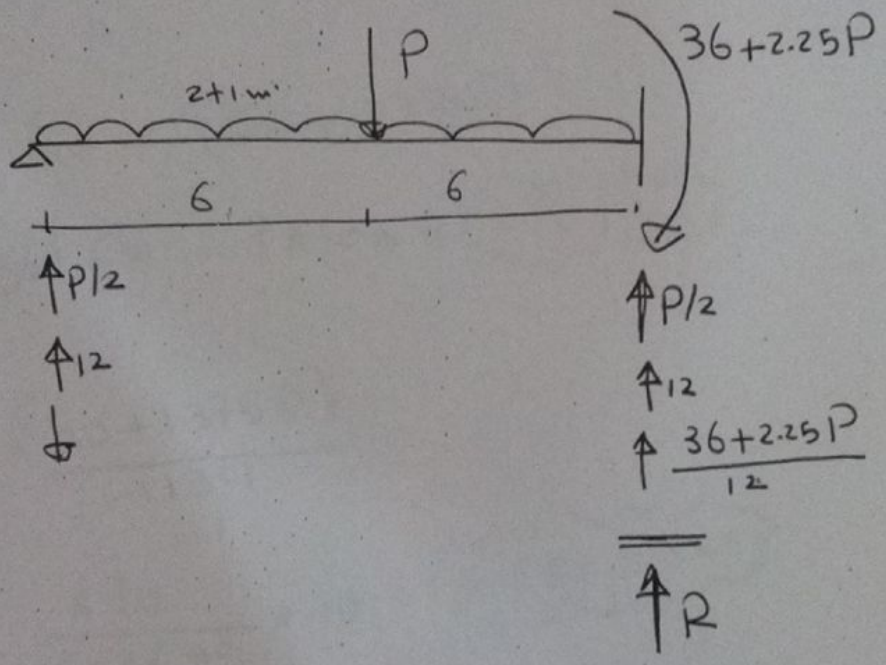
[7]

Mequat b:-

$$0.0 + 2Mb(12+0) + 0.0 = -6[144+9P]$$

$$24Mb = -864 - 54P \Rightarrow$$

$$Mb = -36 - 2.25P = \boxed{-(36+2.25P)}$$

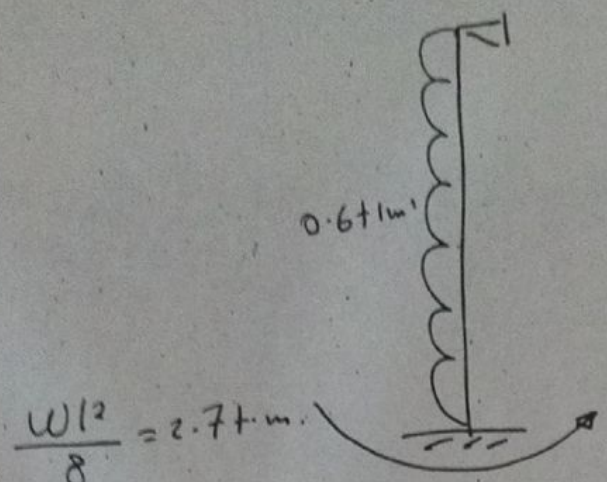


$$\therefore R = P/2 + 12 + 3 + 0.1875P$$

$$= \boxed{0.6875P + 15}$$

$$\therefore N = 2 * (0.6875P + 15)$$

$$= \boxed{30 + 1.375P}$$



$$\therefore N = (30 + 1.375P)$$

$$M_x = 2.7 * 100 = \boxed{270\ t.cm}$$

$$\sigma_c = \frac{(30 + 1.375P)}{113.1}$$

$$\sigma_{b.x} = \frac{270}{4636.99} * 10 = \boxed{0.582\ t/cm^2}$$

$$\frac{(30 + 1.375P)}{113.1 * 1.034} + \frac{0.582}{1.6} = 1.0$$

$$\frac{(30 + 1.375P)}{116.9454} + 0.5325 = 1.0$$

$$30 + 1.375P + 62.2734 = 116.9454$$

$$\therefore P = \frac{24.67}{1.375} = \boxed{17.94t}$$