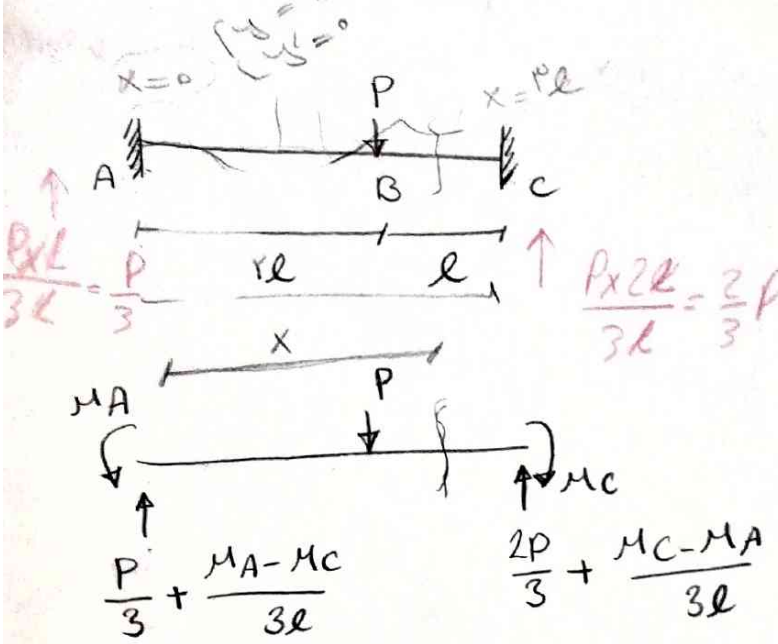
مثال اول

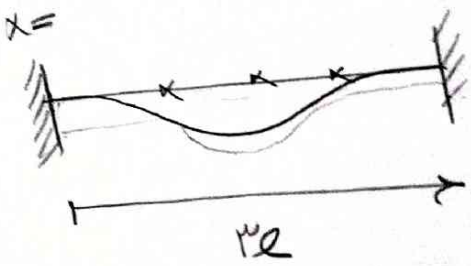


$$R \times 3\ell - M_C + M_A = 0$$

$$R = \frac{M_C - M_A}{3\ell}$$

$$\frac{P \times \ell}{3\ell} = \frac{P}{3} \qquad \frac{P \times 2\ell}{3\ell} = \frac{2}{3}P$$

$$\frac{P}{3} + \frac{M_A - M_C}{3\ell} \qquad \frac{2P}{3} + \frac{M_C - M_A}{3\ell}$$



$$M = EI\frac{d^2y}{dx^2} = EIy'' = M_A - \left(\frac{P}{۲} + \frac{M_A - M_C}{3\ell}\right)X + P(X - ۲\ell)$$

$$V = EIy' = M_A X - \left(\frac{P}{۲} + \frac{M_A - M_C}{3\ell}\right)\frac{X^2}{2} + P\frac{(X-۲\ell)^۲}{2} + A$$

$$\text{از } EIy = M_A\frac{X^2}{2} - \left(\frac{P}{3} + \frac{M_A - M_C}{3\ell}\right)\frac{X^3}{6} + P\frac{(X-۲\ell)^3}{6} + AX + B$$

$X = 0$, $y = 0$: $\quad 0 = 0 - 0 + B \Rightarrow B = 0$

از شرایط مرزی به دست می‌آید

$A = 0$

$X = 3\ell$, $y = 0$, $y' = 0$

از $y = 0$:

$$0 = (M_A(۲\ell)) - \left(\frac{P}{۲} + \frac{M_A - M_C}{۲\ell}\right)\frac{(3\ell)^2}{2} + \left(P\frac{(3\ell - 2\ell)^2}{2}\right) + (A)$$

$$0 = 3M_A\ell - \left(\frac{9P\ell^2}{8} + \frac{9M_A\ell^2}{8\ell} - \frac{9M_C\ell^2}{8\ell}\right) + \frac{P\ell^2}{2}$$

$$0 = \frac{9M_A\ell^2}{8\ell} + \frac{9M_C\ell^2}{8\ell} - \frac{8P\ell^2}{8} \Rightarrow \frac{9M_A\ell}{8} + \frac{9M_C\ell}{8} = P\ell^2$$

$x = 3\ell$, $y = 0$ از $y = 0$:

$$0 = \left(M_A\frac{9\ell^2}{2}\right) - \left(\frac{P}{3} + \frac{M_A - M_C}{3\ell}\right)\frac{27\ell^3}{6} + \left(P\frac{\ell^3}{6}\right) + 0$$

$$0 = \frac{9M_A\ell^2}{2} - \frac{27P\ell^3}{18} - \frac{27M_A\ell^3}{18\ell} + \frac{27M_C\ell^3}{18\ell} + \frac{P\ell^3}{6}$$

$$0 = \frac{54M_A\ell^2}{18\ell} + \frac{27M_C\ell^2}{18\ell} - \frac{24P\ell^3}{18} = \frac{0}{18}$$

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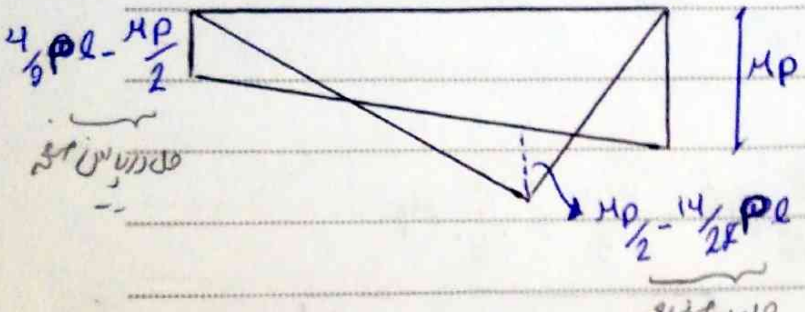
(ا) مقدار P و تنش Mp متناظر:

$M_C = M_p \qquad M_C = \frac{4}{9}Pl = M_p \rightarrow P = \frac{9}{4}\frac{M_p}{l}$



(بر حسب آوردن M_A):

$\begin{cases} x = 3l \\ M_C = M_p \end{cases} \xrightarrow{\text{معادله خمش در}} EIy = \frac{1}{2}M_A x^2 - \left(\frac{P}{3} + \frac{M_A - M_C}{3l}\right)\frac{x^3}{6} + \frac{P}{6}(x-2l)^3$

$0 = \frac{1}{2}M_A(3l)^2 - \left(\frac{P}{3} + \frac{M_A - M_p}{3l}\right)\frac{(3l)^3}{6} + \frac{P}{6}(3l-2l)^3$

$\xrightarrow{\text{ساده‌تر}} 0 = \frac{9}{2}M_A l^2 - \left(\frac{P}{3}\right)\left(\frac{27l^3}{6}\right) - \left(\frac{M_A}{3l}\right)\left(\frac{27l^3}{6}\right) + \left(\frac{M_p}{3l}\right)\left(\frac{27l^3}{6}\right) + \frac{Pl^3}{6}$

$0 = \frac{9}{2}M_A l^2 - \frac{9}{2}Pl^3 - \frac{9}{2}M_A l^2 + \frac{9}{2}M_p l^2 + \frac{Pl^3}{6}$

$0 = 3M_A l^2 - \frac{8}{6}Pl^3 + \frac{9}{2}M_p l^2$

$\rightarrow 9M_A l^2 = \frac{4}{3}Pl^3 - \frac{9}{2}M_p l^2 \rightarrow \boxed{M_A = \frac{4}{9}Pl - \frac{1}{2}M_p}$

ادامه مثال اول

بدست آوردن M_B

معادله دیفرانسیل در ناحیه M : $EIy'' = M_A - \left(\frac{P}{3} + \frac{M_A - M_C}{3l}\right)x + P(x - 2l)$

$$\rightarrow M_B = \left(\frac{4}{9}Pl - \frac{M_p}{2}\right) - \left(\frac{2}{3}Pl - \frac{\frac{4}{9}Pl - M_p/2}{3l}\right) \times 2l + \left(\frac{M_p}{3l}\right)(2l) + P(2l - 2l)$$

$$\rightarrow M_B = \frac{4}{9}\omega l - \frac{M_p}{2} - \frac{2}{3}\omega l - \frac{8}{27}Pl + \frac{M_p}{3} + \frac{2}{3}M_p$$

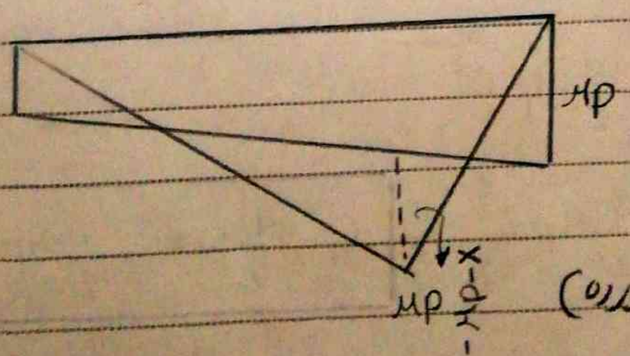
$$\rightarrow M_B = \frac{12 - 18 - 8}{27}Pl + \frac{M_p}{2} \rightarrow \boxed{M_B = \frac{M_p}{2} - \frac{14}{27}Pl}$$

که این علامت باید برعکس در بیاد (جهت رو باید عوض کنیم) (اشتباهاً توی شکل دست اشتباه بودم)

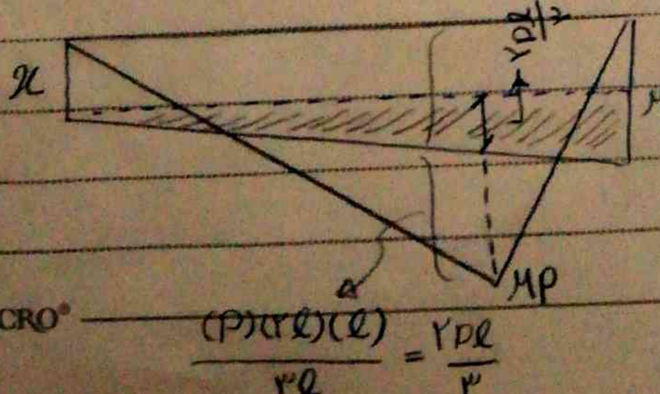
با افزایش بار، مفصل پلاستیک دوم در B تشکیل می‌شود.

$M_C = M_B = M_p$ $\left(\frac{14}{27}Pl - \frac{M_p}{2}\right) = M_p \rightarrow \frac{14}{27}Pl = \frac{3}{2}M_p$

$$\rightarrow P = \frac{81}{28}\frac{M_p}{l}$$



تشابه مثلث‌ها می‌نویسیم: (مربوط به قسمت‌های هاشور خورده) طبق شکل زیر



$$\frac{M_p - x}{3l} = \frac{2Pl/3 - M_p - x}{2l}$$

$$\frac{(P)(2l)(l)}{3l} = \frac{2Pl}{3}$$

$$2Pl - 3M_p - 3x = 2M_p - 2x$$

$$\rightarrow \boxed{x = 2Pl - 5M_p = M_A}$$

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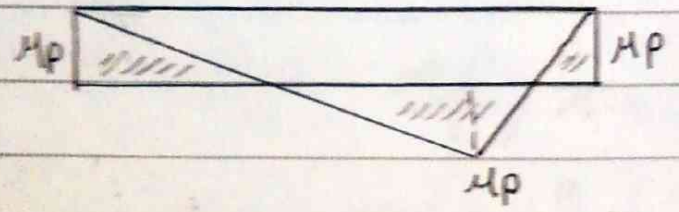
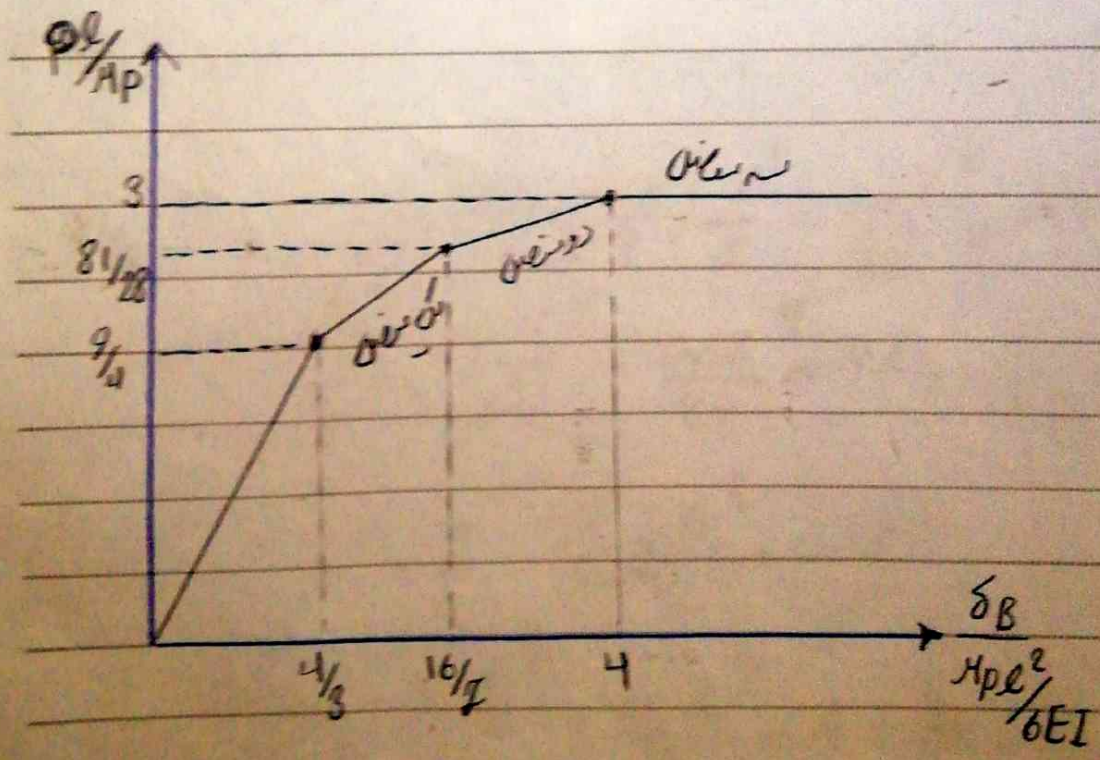
با افزایش مجدد بار، لنگر سوم در نقطه A تشکیل می‌شود

$$M_A = M_B = M_C = M_p$$

$$\text{اول} \quad 5M_p = M_p \rightarrow 2pl = 6M_p \rightarrow p = \frac{3M_p}{l}$$



سایر این ...



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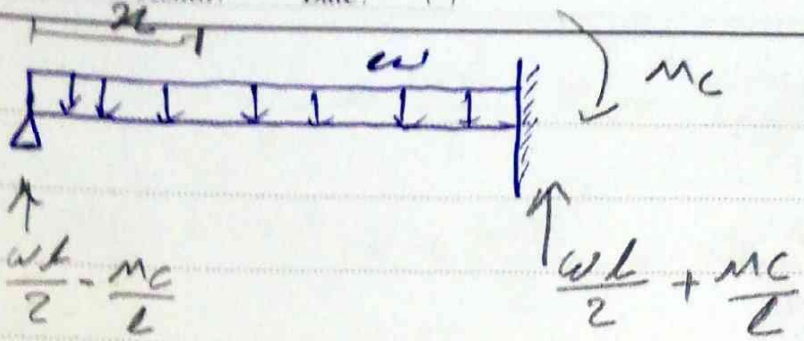
مثال دوم



$$EIy'' = -\left(\frac{wL}{2} - \frac{M_C}{L}\right)x + \frac{wx^2}{2}$$

$$EIy' = \left(\frac{M_C}{L} - \frac{wL}{2}\right)\frac{x^2}{2} + \frac{wx^3}{6} + A$$

$$EIy = \left(\frac{M_C}{L} - \frac{wL}{2}\right)\frac{x^3}{6} + \frac{wx^4}{24} + Ax + B$$

$x = 0 \quad y = 0 \rightarrow B = 0$

$$x = L \quad y = 0 \rightarrow \left(\frac{M_C}{L} - \frac{wL}{2}\right)\frac{L^3}{6} + \frac{wL^4}{24} + AL = 0$$

$$\frac{M_C L^2}{6} - \frac{wL^4}{12} + \frac{wL^4}{24} + AL = 0 \Rightarrow \boxed{A + \frac{M_C L}{6} = \frac{wL^3}{24}}$$

$$x = L \quad y' = 0 \rightarrow \left(\frac{M_C}{L} - \frac{wL}{2}\right)\frac{L^2}{2} + \frac{wL^3}{6} + A = 0$$

$$\frac{M_C L}{2} - \frac{wL^3}{4} + \frac{wL^3}{6} + A \Rightarrow \boxed{A + \frac{M_C L}{2} = \frac{wL^3}{12}}$$

$$\begin{cases} A + \frac{M_C L}{6} = \frac{wL^3}{24} \\ A + \frac{wL}{2} = \frac{wL^3}{12} \end{cases} \times -1 \qquad \begin{cases} A + \frac{M_C L}{6} = \frac{wL^3}{24} \\ -A - \frac{wL}{2} = -\frac{wL^3}{12} \end{cases}$$

$$-\frac{M_C L}{3} = -\frac{wL^3}{24} \qquad M_L = \frac{wL^2}{8}$$

ادامه مثال دوم

$$EI\,y'' = \left(\frac{M_C}{L} + \frac{wL}{2}\right)x + \frac{wx^2}{2}$$

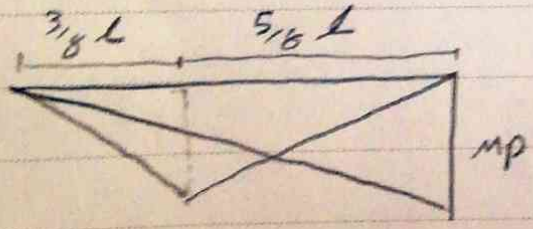
$$\left(\frac{wL}{8} - \frac{wL}{2}\right)x + \frac{wx^2}{2} = \frac{wx^2}{2} - \frac{3wLx}{8}$$

برای بدست آوردن x_{max} و M_{max} مشتق می‌گیریم

$$wx - \frac{3wL}{8} = 0 \qquad wx = \frac{3wL}{8} \Rightarrow x = \frac{3}{8}L$$

$$M_B = \left(\frac{w}{2}\right)\left(\frac{9}{64}L^2\right) - \left(\frac{3wL}{8}\right)\left(\frac{3}{8}L\right)$$

$$\frac{9wL^2}{128} - \frac{3wL^2}{64} = \frac{9 - 18}{128}wL^2 = \frac{-9wL^2}{128} = -0.07wL$$



$$M_C = M_P = \frac{wL^2}{8} \longleftarrow M_C = M_P$$

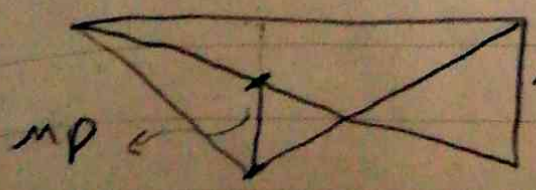
فرض اول

$$M_B = \left(\frac{M_P}{L} - \frac{wL}{2}\right)\left(\frac{3}{8}L\right) + \frac{w}{2}\left(\frac{3}{8}L\right)^2$$

$$M_B = \frac{3}{8}M_P - \frac{3}{16}wL^2 + \frac{9wL^2}{128} = \frac{3}{8}M_P - \frac{15wL^2}{128}$$

$$M_C = M_B = M_P$$

فرض دوم



$$M_B = \frac{3}{8}M_P - \frac{15wL^2}{128} = M_P$$

$$\rightarrow \frac{5}{8}M_P = -\frac{15wL^2}{128} \rightarrow M_P = \frac{3}{16}wL^2$$

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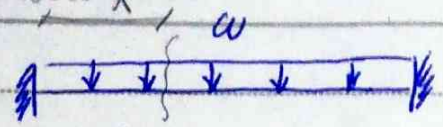
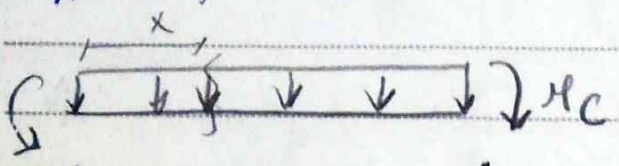
(1)





$\frac{wl}{2} + \frac{M_A - M_C}{l}$ $\qquad$ $\frac{wl}{2} + \frac{M_C - M_A}{l}$

$\sum M_A = 0 \rightarrow M_A - M_C + R_C l = 0 \rightarrow R_C = \frac{M_C - M_A}{l}$

M

$EIy'' = M_A - (\frac{wl}{2} + \frac{M_A - M_C}{l})x + \frac{wx^2}{2}$ $\quad wx \times \frac{x}{2}$

شیب $EIy' = M_A x - (\frac{wl}{2} + \frac{M_A - M_C}{l})\frac{x^2}{2} + \frac{wx^3}{6} + A$

خیز $EIy = M_A \frac{x^2}{2} - (\frac{wl}{2} + \frac{M_A - M_C}{l})\frac{x^3}{6} + \frac{wx^4}{24} + Ax + B$

A $\begin{cases} y = 0 \\ y' = 0 \end{cases} \rightarrow B = 0 \quad A = 0$

C $\begin{cases} y = 0 \\ y' = 0 \end{cases} \rightarrow$ $0 = M_A \frac{l^2}{2} - (\frac{wl}{2} + \frac{M_A - M_C}{l})\frac{l^3}{6} + \frac{wl^4}{24}$

$M_A \frac{l^2}{2} - \frac{wl^4}{12} - M_A \frac{l^2}{6} + M_C \frac{l^2}{6} + \frac{wl^4}{24}$

$$M_A \frac{l^2}{3} + M_C \frac{l^2}{6} = \frac{wl^4}{24}$$

$\times 8$

$$8M_A + 4M_C = wl^2$$

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$y'=0 \quad 0 = M_A l - \left(\frac{wl}{2} + \frac{M_A - M_C}{l}\right)\frac{l^2}{2} + \frac{wl^3}{6}$

$M_A l - \frac{wl^3}{4} - \frac{M_A l}{2} + \frac{M_C l}{2} + \frac{wl^3}{6} = 0$

$\frac{M_A l}{2} + \frac{M_C l}{2} = \frac{wl^3}{4} - \frac{wl^3}{6} = \frac{wl^3}{12}$

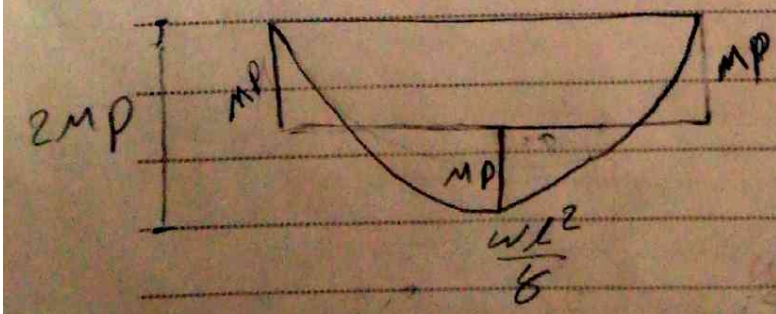
$M_A + M_C = \frac{wl^2}{6}$

$6M + 6M_C = wl^2$

$\begin{cases} (8M_A + 4M_C = wl^2) \times 6 \\ (6M_A + 6M_C = wl^2) \times (-8) \end{cases}$

$-24M_C = -2wl^2 \rightarrow M_C = \frac{wl^2}{12} = M_P \Rightarrow W = 12\frac{M_P}{l^2}$

$M_A = \frac{wl^2}{12} = M_P \Rightarrow W = 12\frac{M_P}{l^2}$

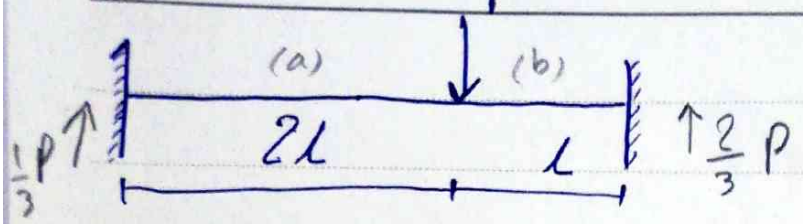


$2M_P = \frac{wl^2}{8}$

$M_P = \frac{wl^2}{16} \Rightarrow W = 16\frac{M_P}{l^2}$

MICRO

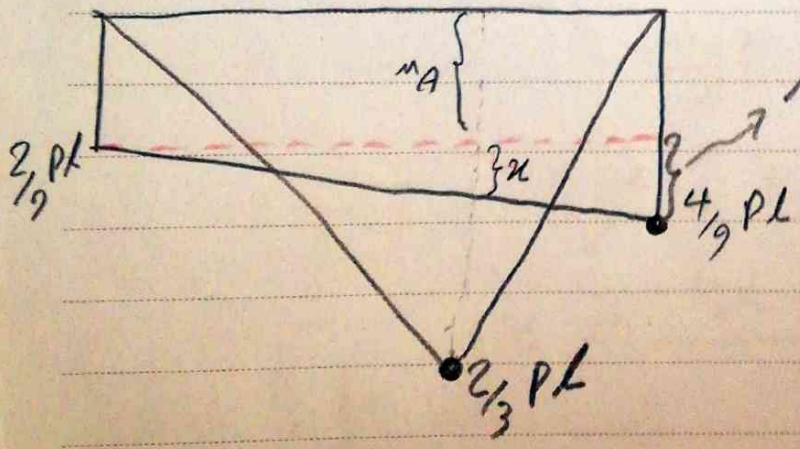
مثال ۲۱



$$M_A = \frac{Pab}{L} \times \frac{b}{L} \qquad M_C = \frac{Pab}{L} \times \frac{a}{L}$$

$$M_A = \frac{P \times 2L \times L}{3L} \times \frac{L}{3L} \Rightarrow M_A = \frac{2}{9} PL$$

$$M_C = \frac{P \times 2L \times L}{3L} \times \frac{2L}{3L} \Rightarrow M_C = \frac{4}{9} PL$$



$$M_C - M_A = \frac{2}{9} PL \times \frac{2}{3}$$

$\frac{2L}{3L}$

$$\frac{x}{\frac{2}{9}PL} = \frac{2L}{3L}$$

$$x = \frac{\frac{2}{9}PL \times 2L}{3L} = \boxed{\frac{4}{27} PL}$$

$$\frac{2}{9} PL + \frac{4}{27} + M_B = \frac{2}{3} PL$$

$$M_B = \frac{2}{3} PL - \frac{10}{27} PL$$

$$M_A = \frac{2}{9} PL$$

$$M_B = \frac{6}{27} PL$$

$$M_C = \frac{4}{9} PL \checkmark$$

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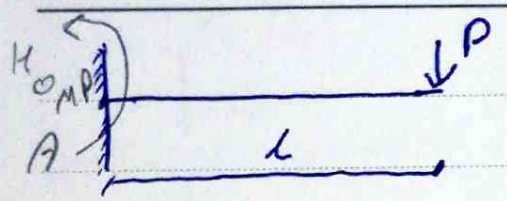
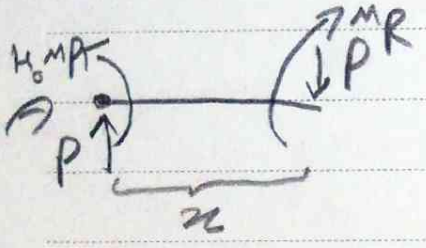
مثال پنجم — نمودار بار تغییر مکان را بیابید P



$$\Sigma M_A = 0 \Rightarrow M_0 - Pl = 0 \Rightarrow \boxed{P = \frac{M_0}{l}}$$



$$\Sigma M_A = 0 \Rightarrow M_0 - M_R - Px$$

$$\Rightarrow M_R = M_0 - Px$$

$$M_R = M_0 - \left(\frac{M_0}{l}\right)x = M\left(1 - \frac{x}{l}\right)$$

ذوزنقه ← $\boxed{M_R = M\left(1 - \frac{1}{3}\alpha^2\right)}$

$$M_R = M_R \Rightarrow M\left(1 - \frac{x}{l}\right) = M\left(1 - \frac{1}{3}\alpha^2\right)$$

$$1 - \frac{x}{l} = 1 - \frac{1}{3}\alpha^2$$

$$\frac{x}{l} = 1 - 1 + \frac{1}{3}\alpha^2$$

$$x = \frac{l - l + \frac{1}{3}l\alpha^2}{1}$$

$$dx = \frac{2}{3}\frac{l\alpha}{1}\,d\alpha \longrightarrow \text{مثلث}$$

$$\boxed{y' = \int_0^x \frac{\sigma_0}{E\alpha d}\,dx} \longrightarrow \text{دوران}$$

$$y' = \int_{\alpha_0}^{\alpha} \frac{\sigma_0}{E\alpha d} \times \frac{2}{3}\frac{l\alpha}{1}\,d\alpha$$

$$y' = \frac{\sigma_0 \times 2 \times l}{E d \times 3} \int 1\,dx = \frac{2\sigma_0 \times l}{E d} (\alpha - \alpha_0)$$

$$y = \int \frac{2\sigma_0 \times l}{E d}(\alpha - \alpha_0)\,dx \Rightarrow y = \int_{\alpha_0}^{\alpha} \frac{2\sigma_0 \times l}{3 E d}(\alpha - \alpha_0) \times \frac{2}{3}\frac{l\alpha}{1}\,d\alpha$$

PAPCO

$$\frac{2 \times 2\sigma_0 l^2}{3 \times 3 d} \int (\alpha - \alpha_0)\,\alpha\,d\alpha$$

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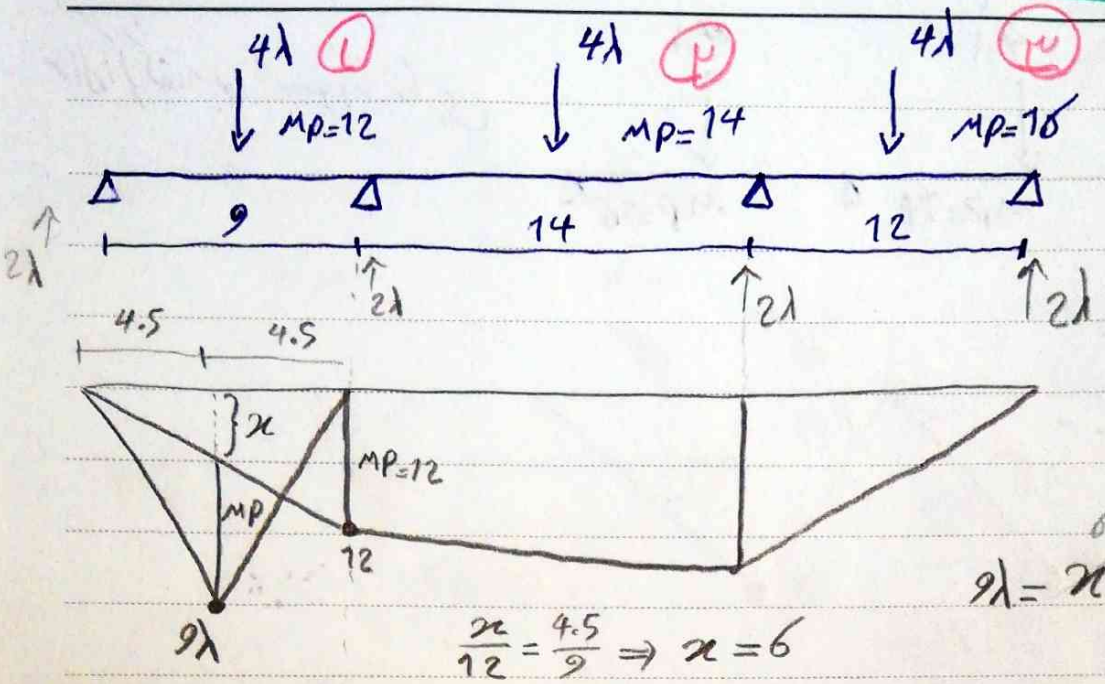
مثال ششم در دو حالت

حالت اول

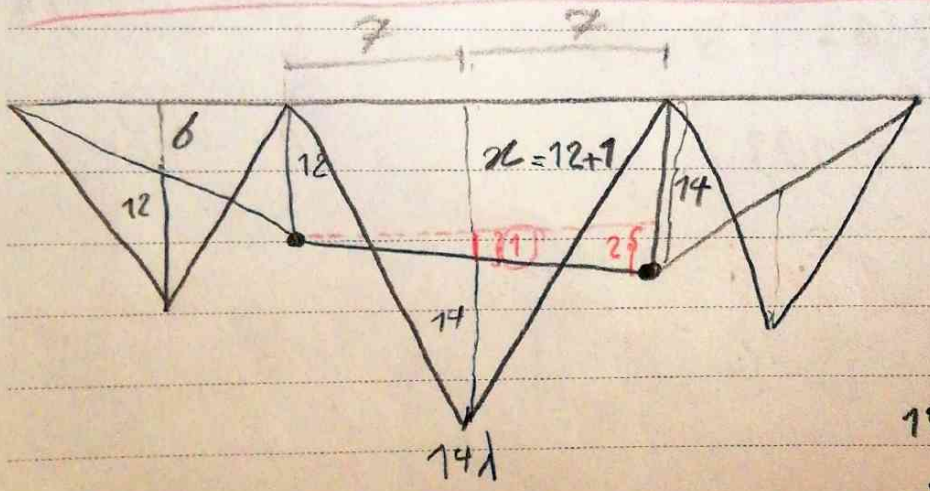


قسمت اول

$9\lambda = x + MP \Rightarrow 9\lambda = 18$

$\lambda = 2$

$\frac{x}{12} = \frac{4.5}{9} \Rightarrow x = 6$

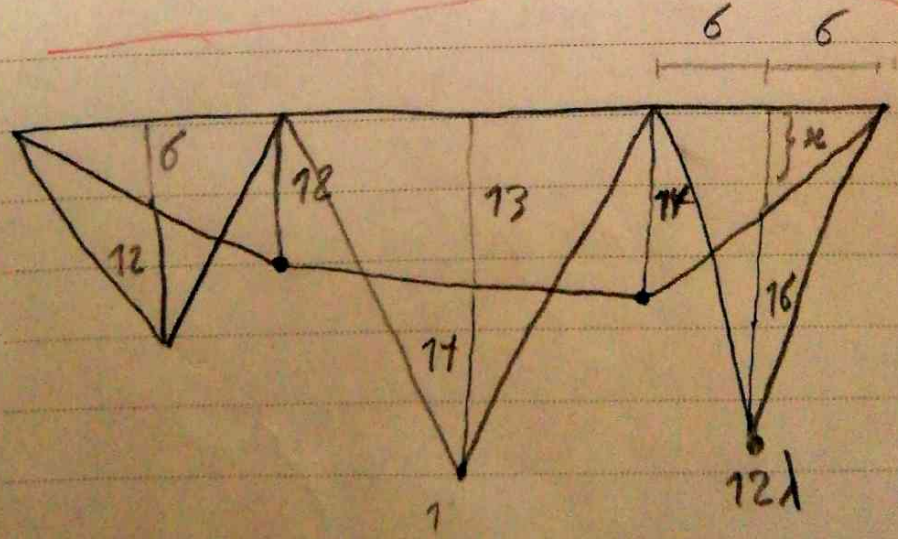


قسمت دوم

$\frac{x}{2} = \frac{7}{14}$ $2x = 2$ $x = 1$

$13 + 14 = 14\lambda$

$\lambda = \frac{27}{14} = 1.93$



قسمت سوم

$\frac{x}{14} = \frac{6}{12}$ $x = 7$

$12\lambda = 16 + 7$

$\lambda = 1.91$

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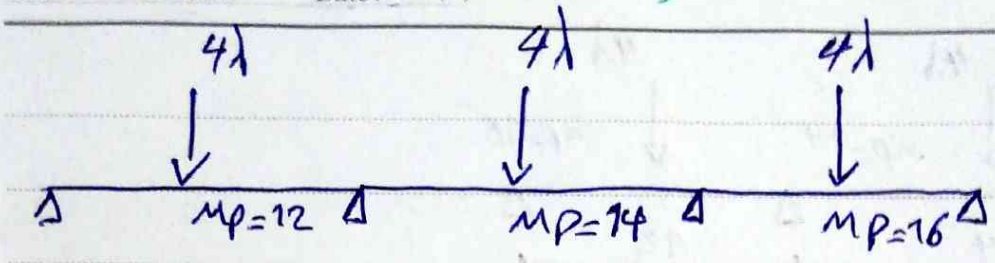
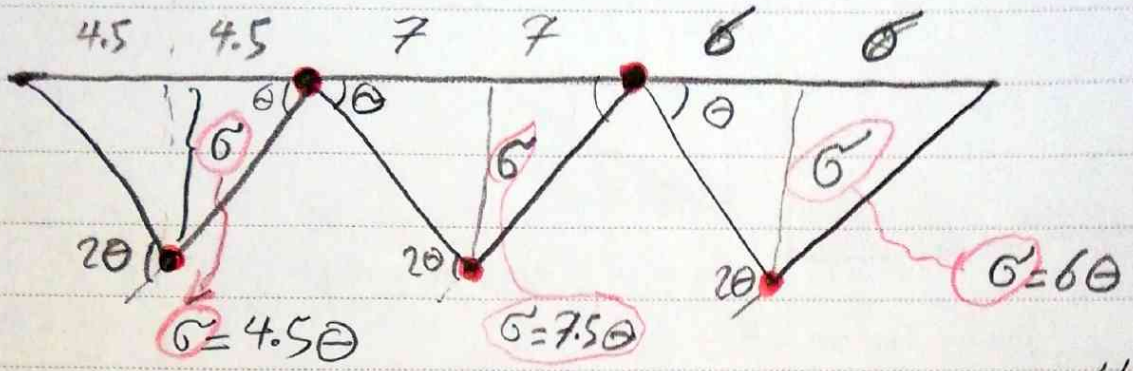
مثال ششم حالت دوم (کار مجازی)



حال اگر گفته بود؟ روش کار مجازی



$4\lambda \times 4.5\theta = 12 \times 3\theta$

$\lambda = 2$

$4\lambda \times 7.5\theta = 14 \times 3\theta + 12\theta$

$\lambda = 1.93$

$4\lambda 6\theta = (16 \times 3\theta) + (14 \times$

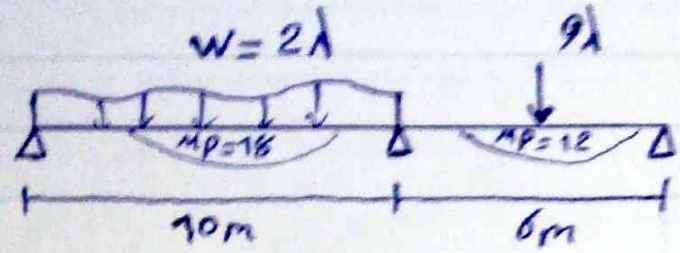
$\lambda = 1.92$

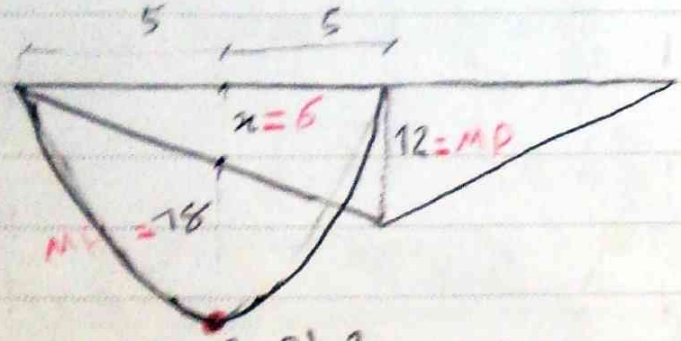
مفصل در تیر ضعیف تر یعنی MP کمتر تشکیل می شود

Subject:
Year Month Date

مثال صفحه دو حالته

مقدار λ را در هر دو حالت بیابید؟



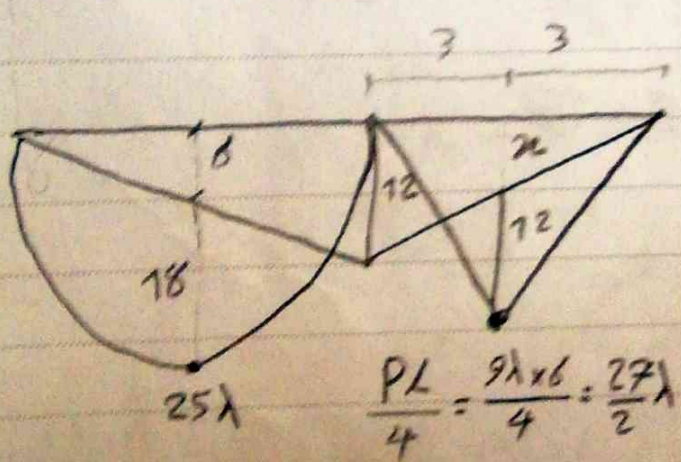


$\frac{wL^2}{8} = \frac{2\lambda \times 100}{8} = 25\lambda$

$\frac{x}{12} = \frac{5}{10}$ $\quad x=6$

$6+18 = 25\lambda$

$\lambda = 0.96$ ✓ جواب درست

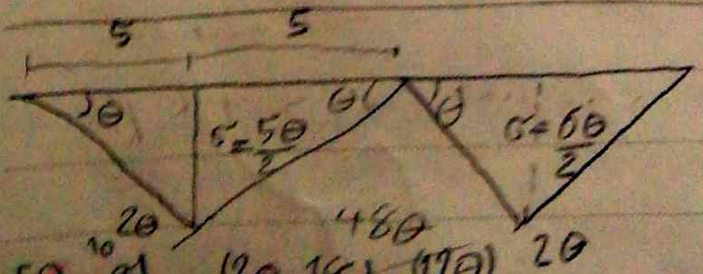


$\frac{PL}{4} = \frac{9\lambda \times 6}{4} = \frac{27}{2}\lambda$

$\frac{x}{12} = \frac{3}{6}$ $\quad x=6$

$6+12 = \frac{27}{2}\lambda$

$\lambda = 1.33$



$\frac{5\theta}{2} \times 25\lambda = (20\times 18) + (12\theta)$

$50\theta\lambda = 96\theta$

$\lambda = 0.96$

روش کار دوستی:

$54\theta\lambda \quad 36\theta$

$\frac{9\lambda \times 6\theta}{2} = 30\theta \times 12$

$\lambda = 1.33$

PAPCO

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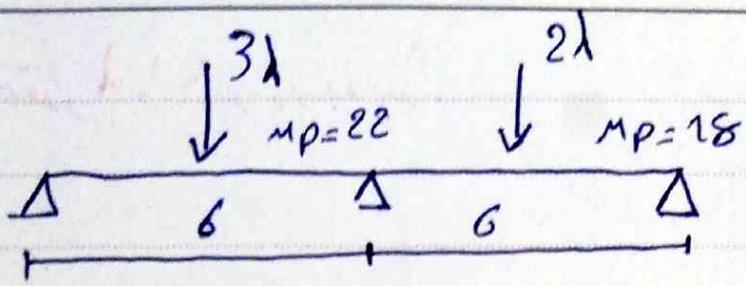
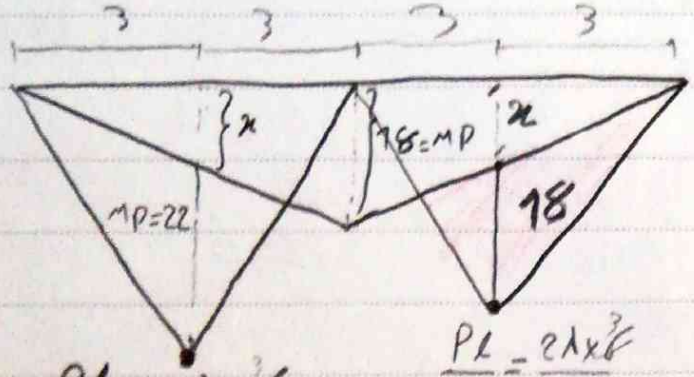
مثال صفحه (دو حالته)





$\frac{PL}{4} = \frac{3\lambda \times 6}{4}$

$\frac{3}{2}\lambda$

$\frac{PL}{4} = \frac{2\lambda \times 6}{4}$

3λ

$\frac{x}{18} = \frac{3}{6} \quad x = 9$

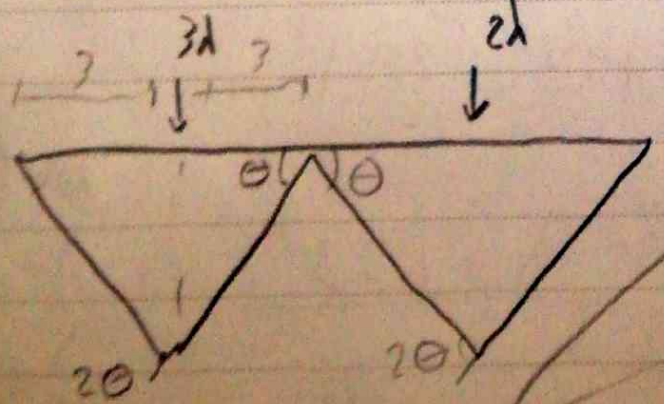
$\frac{3}{2}\lambda = 9 + 22$

$\lambda = 6.89$ ✓ بار غیر مجاز

$\frac{x}{18} = \frac{3}{6} \quad x = 9$

$3\lambda = 9 + 18$

$\lambda = 8$ روش کارمندی:



$3\lambda \times 3\theta = (22 \times 2\theta) + (18 \times \theta)$

$2\lambda \times 3\theta = 18 \times 3\theta$

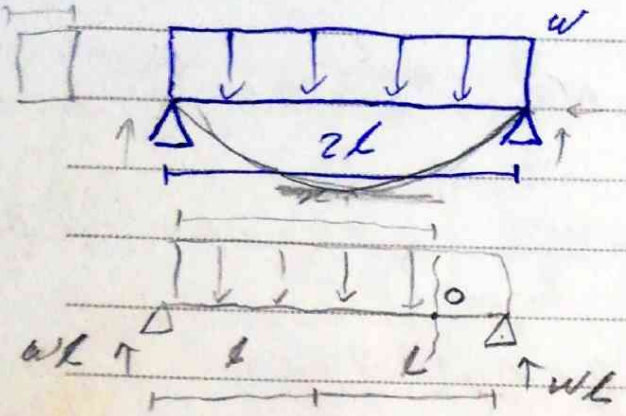
$\lambda = 6.89$

$\lambda = 9$

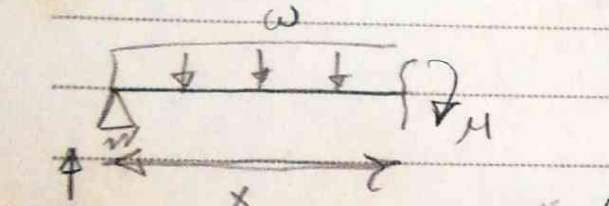
$2d-(d-\alpha d)$ $(d+\alpha d)$ $d(1+\alpha)$ $M_R = M_P(1-\frac{1}{3}\alpha^2)$

Subject: Date

مثال ۳



$$\sum M_O = (-wL \times x) + (w_x \times \frac{x}{2})$$



$$EIy'' = -wLx + \frac{wx^2}{2}$$

$$EIy' = -wL\frac{x^2}{2} + \frac{wx^3}{6} + A$$

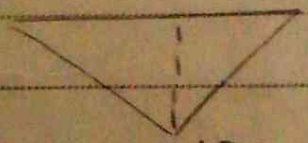
$$EIy = -wL\frac{x^3}{6} + \frac{wx^4}{24} + Ax + B$$

$x=0$, $y=0$ $\quad EIy = 0+0+0+B \Rightarrow B=0$

$x=2L$, $y=0$ $\quad EIy = -\frac{8wL^4}{6} + \frac{16wL^4}{24} + 2AL$

$$\frac{-32wL^4+16wL^4}{24} = -2AL$$

$$-\frac{16wL^4}{24} = -2AL \Rightarrow A = \frac{1}{3}wL^3$$



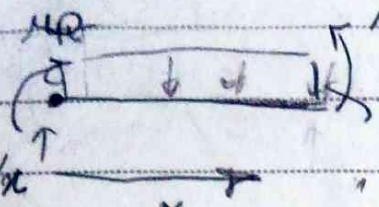
$$M_P = -wL(L) + \frac{wL^2}{2}$$

$$-wL^2 + \frac{wL^2}{2} = -\frac{wL^2}{2}$$

$$M_P = -\frac{wL^2}{2} \Rightarrow w = -\frac{2M_P}{L^2}$$

Subject: ادامه مثال نهم

Data:



$$Mp - MR - wx^2 + \frac{wx^2}{2} = 0$$

$$MR = Mp - \frac{wx^2}{2} \Rightarrow MR = Mp + \frac{2MP}{L^2}\frac{x^2}{2}$$

$$MR = Mp + \frac{MPx^2}{L^2} \Rightarrow MR = Mp\left(1 + \frac{x^2}{L^2}\right)$$

Subject:
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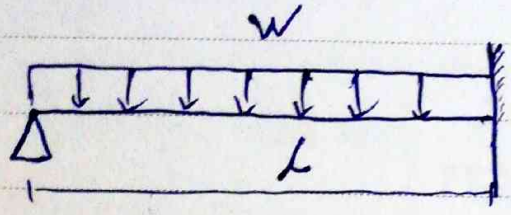
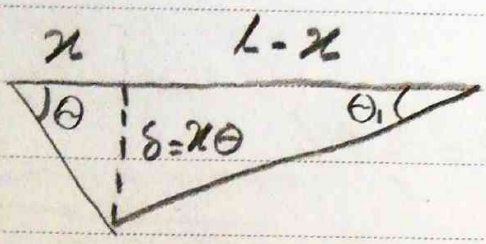
مثال > جمع

بار فروریزش تیر زیر را بیابید. (به روش معادله کار)





$$tg\theta_1 = \frac{x\theta}{(L-x)} \Rightarrow \theta_1 = \frac{x\theta}{(L-x)}$$

$$W \times \tfrac{1}{2} x\theta = Mp\theta + Mp\theta_1 + Mp\theta_1$$

$$W \times \tfrac{1}{2} x\theta = Mp\theta + 2Mp\frac{x\theta}{L-x}$$

$$W \times \frac{1}{2} x = \frac{Mp(L-x) + 2Mp\,x}{L-x} = \frac{MpL + Mpx}{L-x}$$

$$W = \frac{2MpL + 2Mpx}{(L-x)}$$

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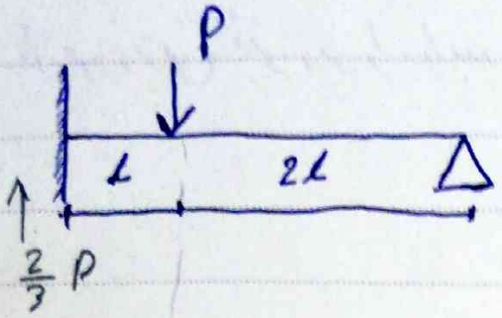
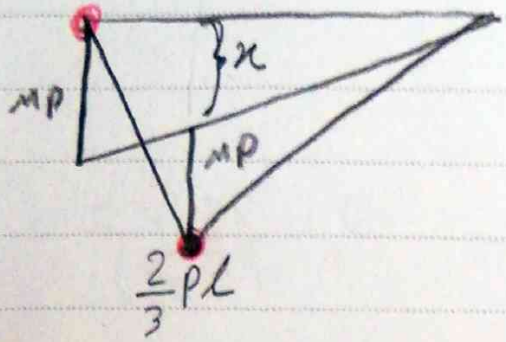
مثال یازدهم

بار خرابی تیر مقابل را حساب کنید.



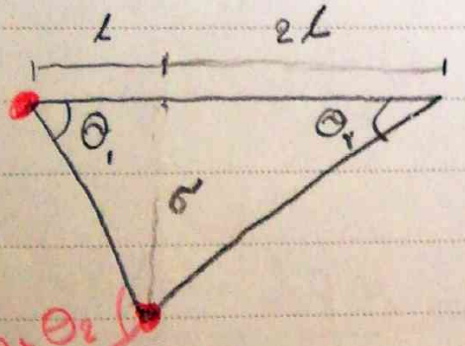
$$\frac{x}{MP} = \frac{2l}{3l} \Rightarrow x = \frac{2}{3}MP$$



$\frac{5}{3}MP$

$$\frac{2}{3}MP + \frac{3}{3}MP = \frac{2}{3}Pl$$

$$\frac{5}{2}\frac{15}{6}MP = Pl \Rightarrow P = \frac{5}{2}\frac{MP}{l}$$



به روش کار:
نکته: در یک کار مفصل MP تشکیل می شود

$$\theta_1 = \frac{\delta}{l} \Rightarrow \delta = l\theta_1$$

$$\theta_2 = \frac{\delta}{2l} \Rightarrow \delta = 2l\theta_2$$

$$l\theta_1 = 2l\theta_2$$

$$\theta_1 = 2\theta_2$$

$$P \times 2l\theta_2 = MP\theta_1 + MP\theta_2 + MP\theta_2$$

$$P \times 2l\theta_2 = 2MP\theta_2 + 3MP\theta_2$$

$$2Pl = 5MP \Rightarrow P = \frac{5}{2}\frac{MP}{l}$$

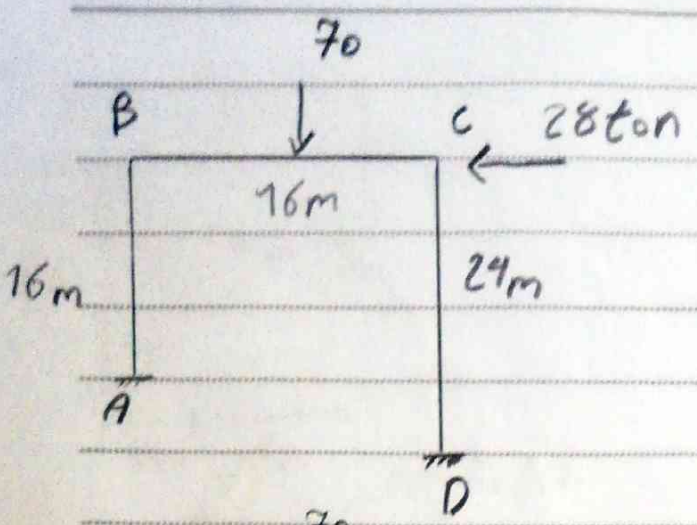
$$Pl = \frac{7}{2}MP$$

PqPCO

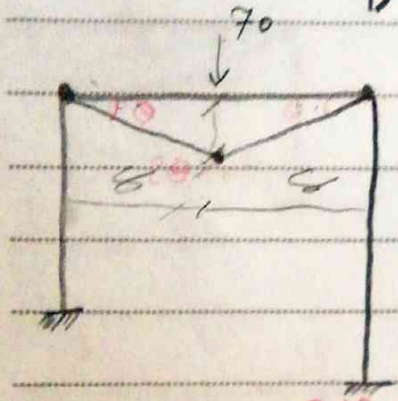
قاب ها

Subject : Date

مثال اول



گام اول) بدست آوردن مکانیزم تیرها



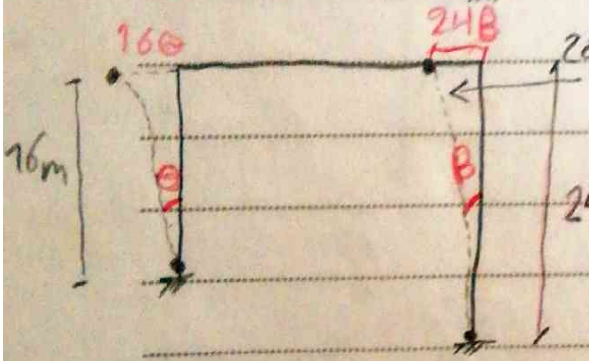
کار خارجی = کار داخلی

$$80\theta \times 70 = 40\theta \times Mp$$

مکانیزم تیری

$$\Rightarrow Mp = 140\ ton.m$$

گام دوم) بدست آوردن مکانیزم ستون ها

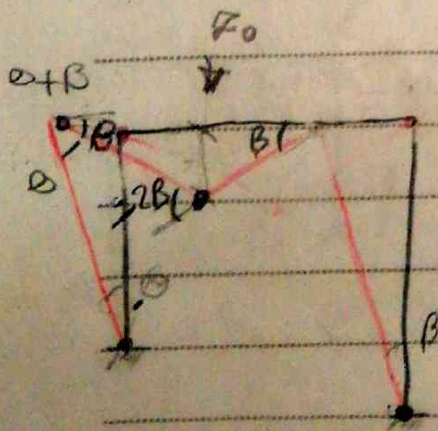


کار خارجی

$$24B \times 28 = (2B + 2\theta)Mp$$

$$B = \frac{16\theta}{24} \Rightarrow B = \frac{2}{3}\theta$$

$$\Rightarrow \frac{48}{3}\theta \times 28 = \left(\frac{4}{3}\theta + 2\theta\right)Mp$$



$$Mp = 134.4$$

$$(28 \times 24B) + (80\theta \times 70) = (4B + 2\theta)Mp$$

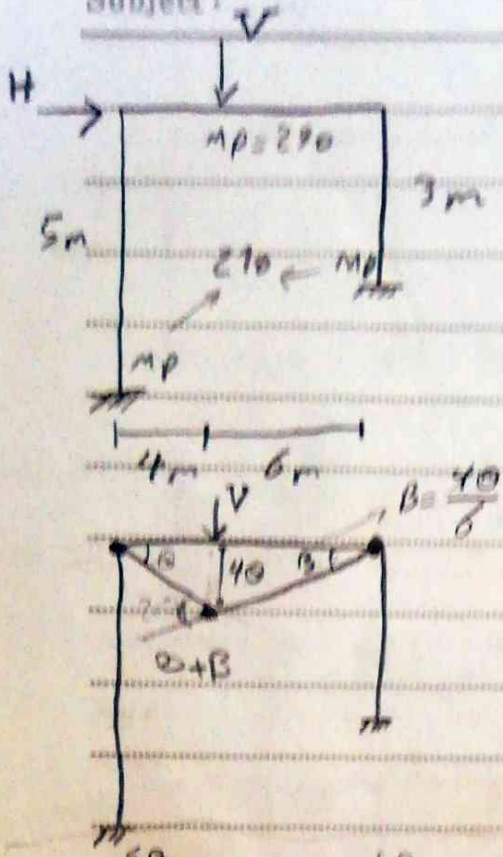
$$1680\theta + 560\theta = \frac{14}{3}\theta\, Mp$$

$$Mp = 156\ ton.m$$

Subject :

Date

مثال (1)



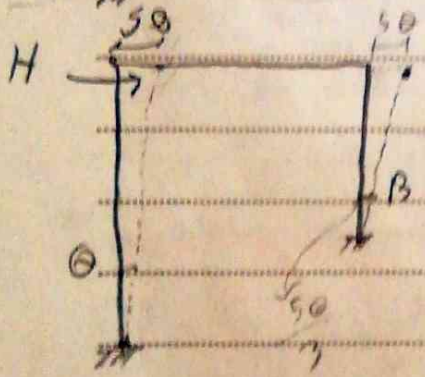
$\left(\frac{10}{3}\theta\right)290$

$\frac{5}{3}\theta + \frac{4}{3}\theta$

B 290

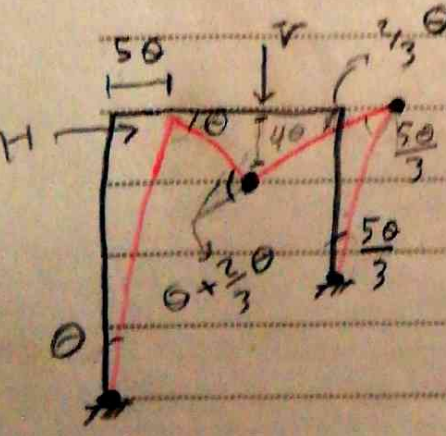
$V \times 4\theta = \left(\theta + \theta + \frac{2}{3}\theta + \frac{2}{3}\theta\right) Mp$

$4V = 290 \times \frac{10}{3} \Rightarrow V = 241.67$



$5H\theta = \left(\theta + \theta + \frac{5}{3}\theta + \frac{5}{3}\theta\right) Mp$

$-5H\theta = \frac{16}{3}\theta \times 290 \Rightarrow H = 224\ t.m$



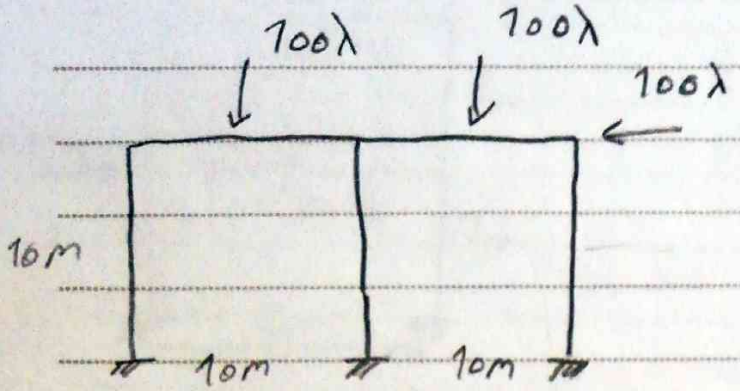
$(H \times 5\theta) + (V \times 4\theta) = \left(\theta + \frac{2}{3}\theta \times 290\right) +$

$+ \frac{5}{3}\theta \times 110 + \frac{5}{3}\theta \times 210 + \frac{2}{3}\theta \times 290$

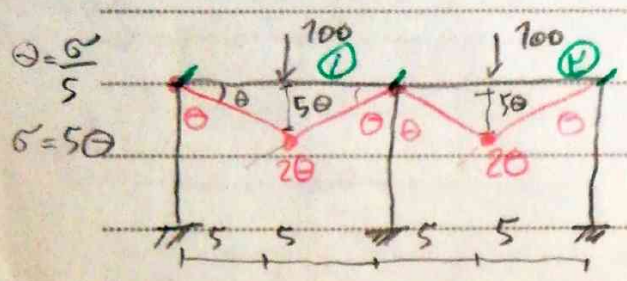
$+ \theta \times 210$

Subject : Date

مثال سوم $M_P = 250$



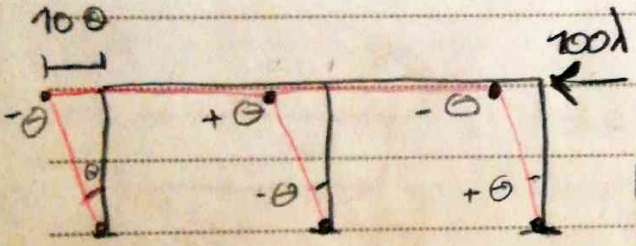
گام اول) مکانیزم خرابی را بدست می‌آوریم.



تیر ① $100 \times 5\theta = 4\theta M_P \Rightarrow \lambda = 2$ ✓

تیر ② $100 \times 5\theta = 4\theta M_P \Rightarrow \lambda = ?$ ✓

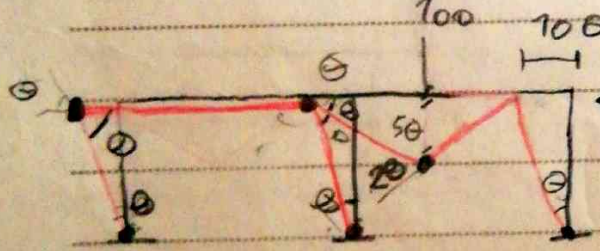
گام دوم) مکانیزم ستون‌ها را بدست می‌آوریم.



$(100\lambda \times 10\theta) = 6\theta \times M_P$

$\lambda = 1.5$

گام سوم) مکانیزم ترکیبی را بدست می‌آوریم.



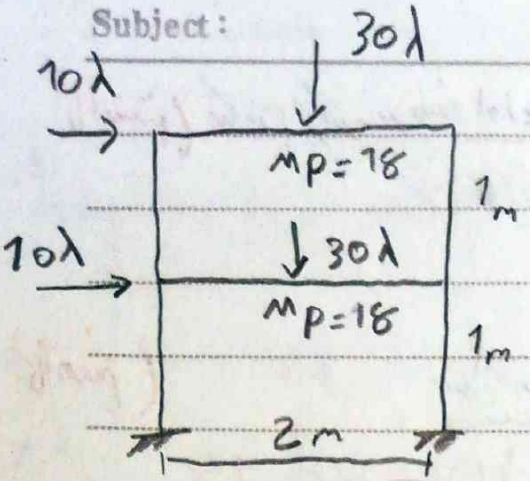
$(100\lambda \times 5\theta) + (1000\lambda \times 10\theta) =$

$8\theta \times 250 \Rightarrow \lambda = \frac{2000}{1500} = \frac{4}{3} = 1.33$

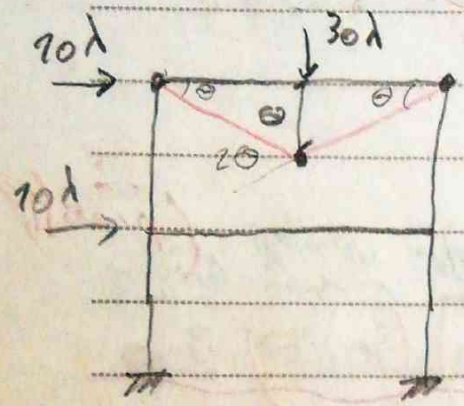
این λ را بدست خواهد آمد.

Subject : Date

مثال ۴ :

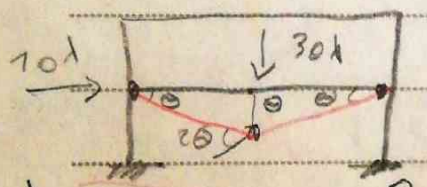


گام اول) بدست آوردن مکانیزم قید طبقه دوم



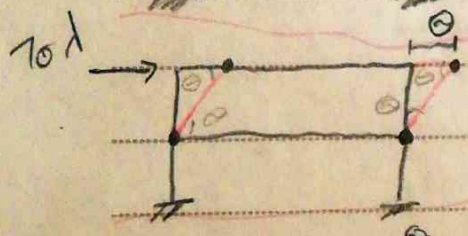
$30\lambda\theta = 4\theta(18) \Rightarrow \lambda = \frac{72}{30} = 2.4$

گام دوم) بدست آوردن مکانیزم قید طبقه اول



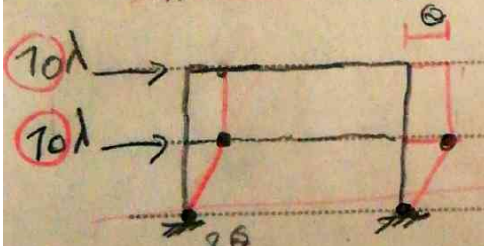
$30\lambda\theta = 4\theta(18) \Rightarrow \lambda = 2.4$

گام سوم) بدست آوردن مکانیزم ستون طبقه دوم



$10\lambda\theta = 4\theta(18) \Rightarrow \lambda = 7.2$

گام چهارم) بدست آوردن مکانیزم ستون طبقه اول



$20\lambda\theta = 4\theta(18) \Rightarrow \lambda = 3.6$

گام پنجم) مکانیزم ترکیبی ستون های طبقه اول و دوم

$30\lambda\theta$

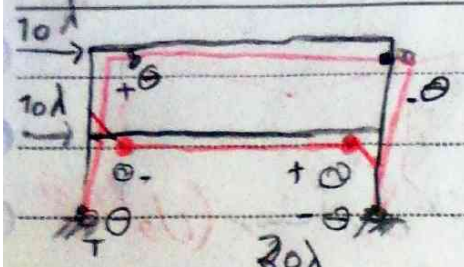
$10\lambda\theta + 10\lambda 2\theta = (4\theta 18) + (4\theta 18)$

ستون اول ستون دوم

$\lambda = 4.8$

۶

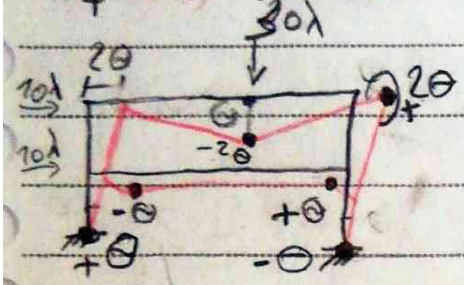
Subject: Data:



۵) مکانیزم ترکیبی تیر طبقه اول و دوم

$(10\lambda\theta)+(10\,2\theta)=6\theta\,18$

$\lambda=3.6$

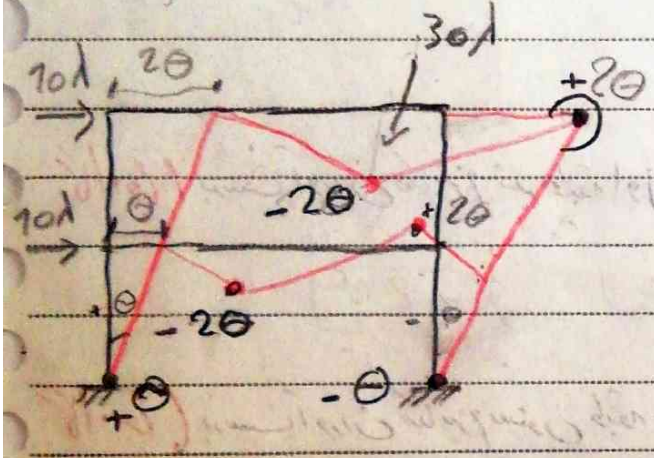


۶) مفصلی

تیر طبقه ۲ ستون طبقه ۲ ستون طبقه ۱

$(30\lambda\theta)+(10\lambda\,2\theta)+(10\lambda\theta)=8\theta\times18$

$\lambda=2.4$



۷) مفصلی

ستون طبقه ۲ ستون طبقه اول تیر طبقه اول تیر طبقه اول

$(10\lambda\,2\theta)+(10\lambda\theta)+(30\lambda\theta)+(30\theta)$

$=10\theta\,18$

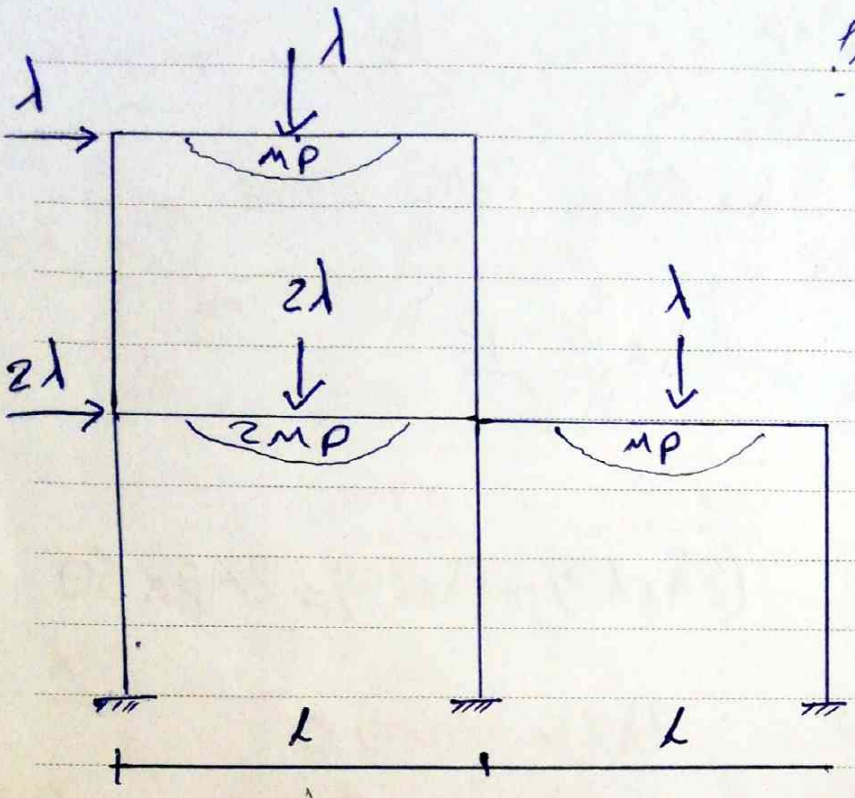
$\lambda=2$ ✓

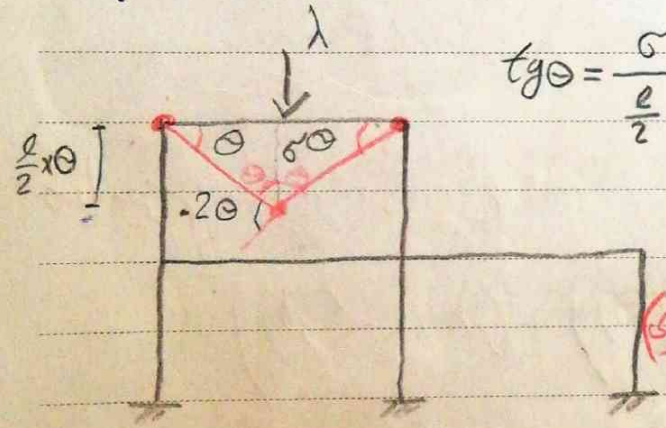
Subject :

Year . Month . Date . ( )

مکانیزم ترکیبی قابل قبول را بدست آورید!

(ستون ها همگی با هم MP و تیر با 2MP می باشد.)





$$tg\theta = \frac{\sigma}{\frac{l}{2}} \overset{tg}{\Rightarrow} \theta = \frac{\sigma}{\frac{l}{2}} \Rightarrow \sigma = \frac{l}{2}\theta$$

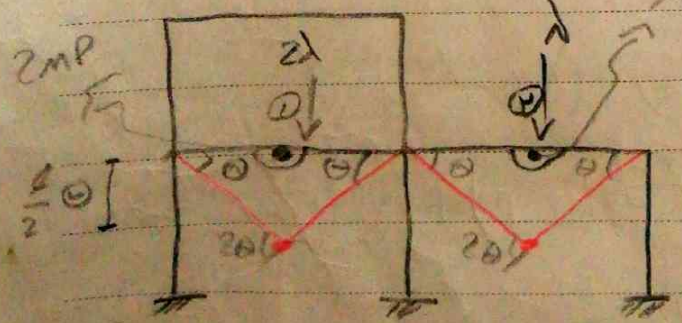
مکانیزم حمارلات تیر:

$$\sum P\sigma = \sum M_p\theta$$

(مجموع تیر و جابجایی) = (مجموع $M_p \times \theta$)

$$\lambda \times \left(\frac{l}{2} \times \theta\right) = M_p \times 4\theta$$

$$\lambda = \frac{2M_p}{l}$$



تیر ①:

$$2\lambda \times \frac{l}{2} \times \theta = 2M_p \times 4\theta$$

$$\lambda = \frac{4M_P}{l}$$

تیر ②:

$$\lambda \times \frac{l}{2} \times \theta = M_p \times 4\theta$$

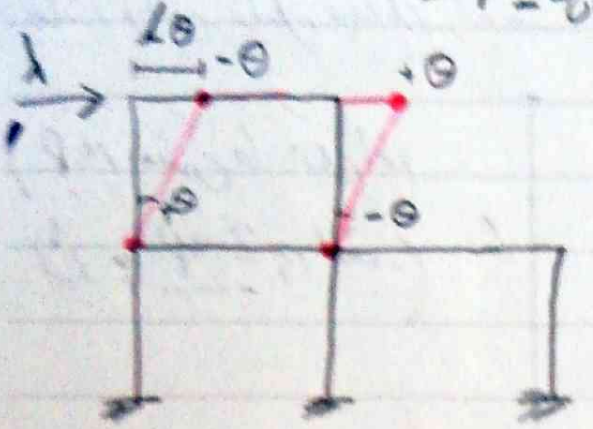
$$\lambda = \frac{2M_P}{l}$$

PAPCO

year Month Date ( )

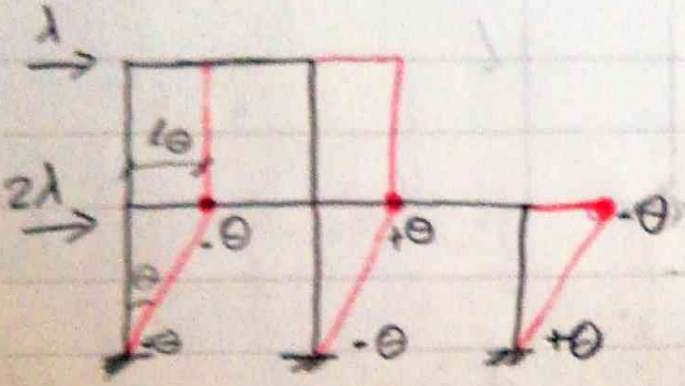
$2M_P$ = ظرفیت خمشی

مکانیزم معادل ستون ها (مکانیزم جانبی):



$$\lambda \times l\theta = 2M_P \times 4\theta$$

$$\lambda = \frac{8M_P}{l}$$



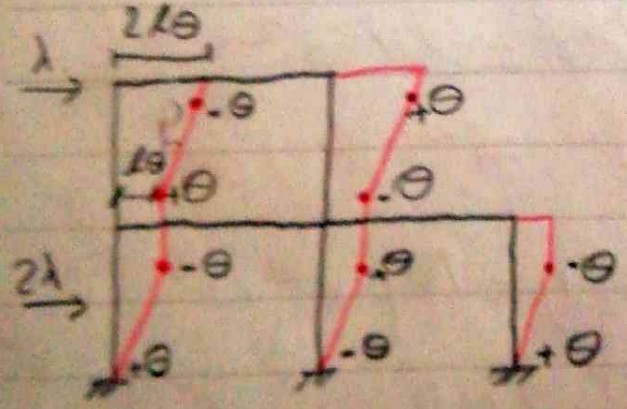
تیر طبقه اول — تیر طبقه بام

$$(2\lambda \times l\theta) + (\lambda \times l\theta) = 2M_P \times 6\theta$$

$$4\lambda l\theta = 20M_P\theta$$

$$\lambda = \frac{5M_P}{l}$$

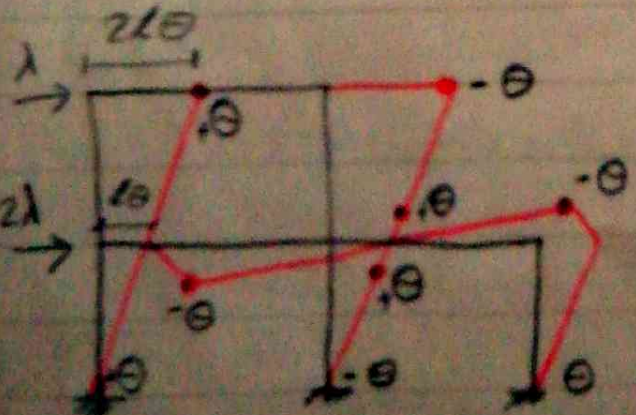
مکانیزم های ترکیبی:



$$(2\lambda \times l(\theta)) + (\lambda \times (2l\theta))$$

$$= 2M_P \times 10\,\theta$$

$$\Rightarrow 4\lambda l\theta = 20M_P\theta \Rightarrow \lambda = \frac{5M_P}{l}$$



$$(2\lambda \times l\theta) + (\lambda \times 2l\theta)$$

ستون ها — تیر — تیر

$$= (7\theta)(2M_P) + 2M_P\theta + M_P\theta$$

$$4\lambda l\theta = 17M_P\theta$$

$$\lambda = \frac{17M_P}{4l}$$

FaPCO

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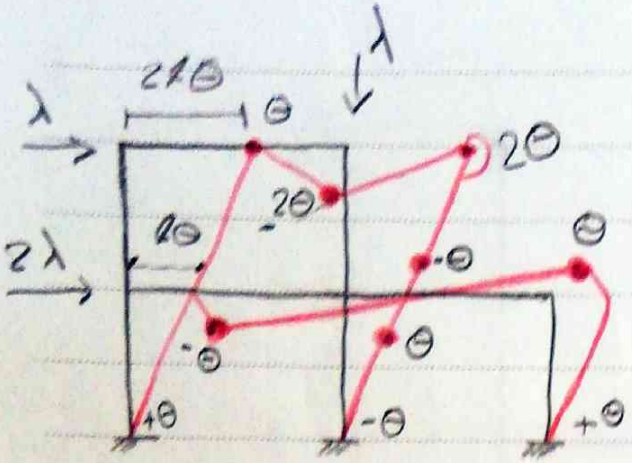


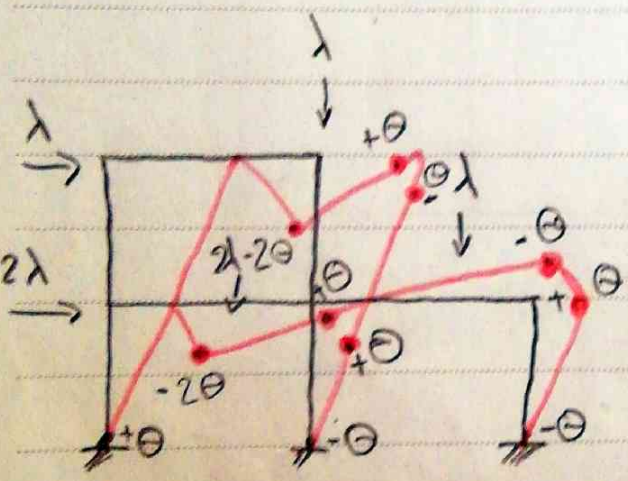
$$(2\lambda \times \ell\theta) + (2\lambda\, \ell\theta) + (\lambda \tfrac{\ell}{2}\theta)$$

سنون — نيم — 2θ

$$= (2Mp\,5\theta) + (Mp \times 4\theta) + (2Mp\theta)$$

$$\frac{9\lambda\ell\theta}{2} = 9Mp\theta$$

$$\boxed{2Mp = \lambda}$$



6Mpθ — 3Mpθ

$$(2\lambda\ell\theta) + (\lambda\, 2\ell\theta) = (2Mp\,6\theta) + (Mp\,3\theta)$$

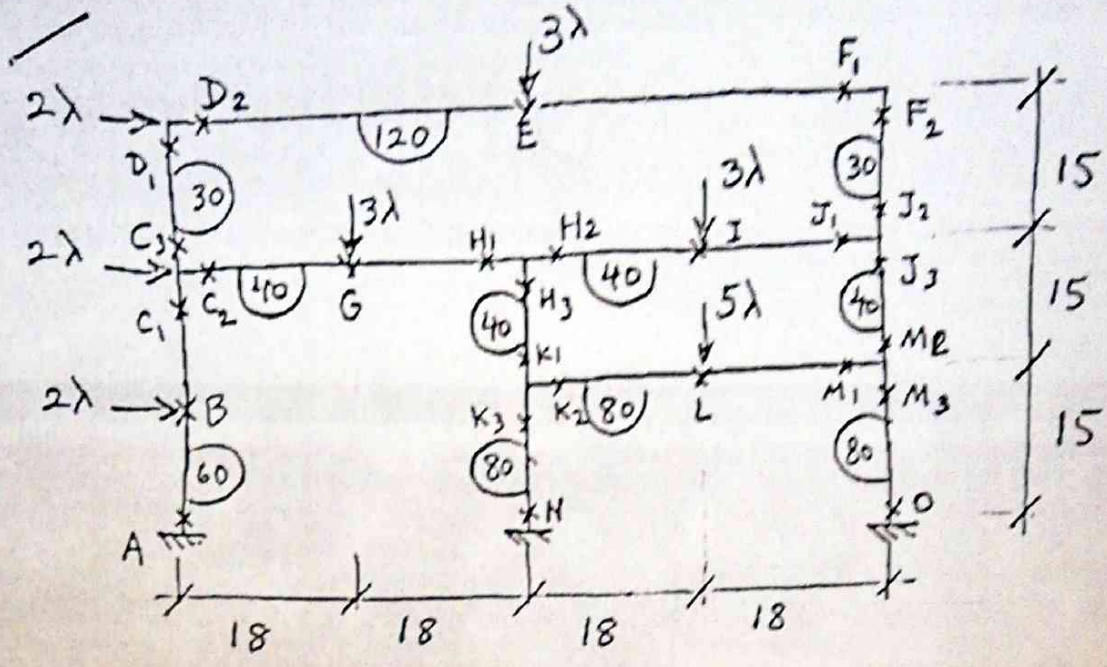
6Mpθ

$$+ (2Mp\,3\theta) + Mp\theta$$

$$4\lambda\ell\theta = 16Mp\theta \Rightarrow \boxed{\frac{4Mp}{\ell} = \lambda}$$

PAPCO

تمرین: مطلوب است محاسبه ضریب بار فروریزش برای قاب شکل. (مقاطع بحرانی در شکل مشخص شده است)



تعداد مقاطع بحرانی = 27

تعداد نامعینی = 12

15 مکانیسم مستقل

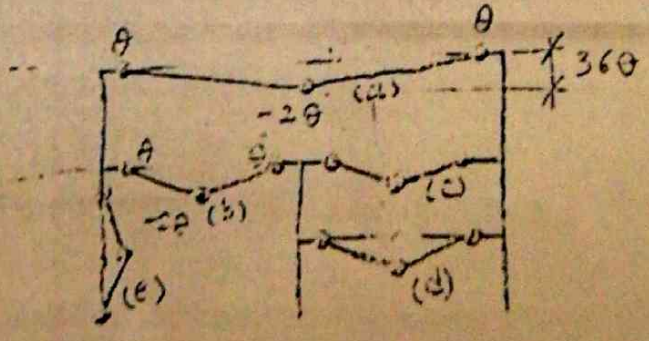
- 7 درجات آزادی

8 مکانیسم مستقل درجه

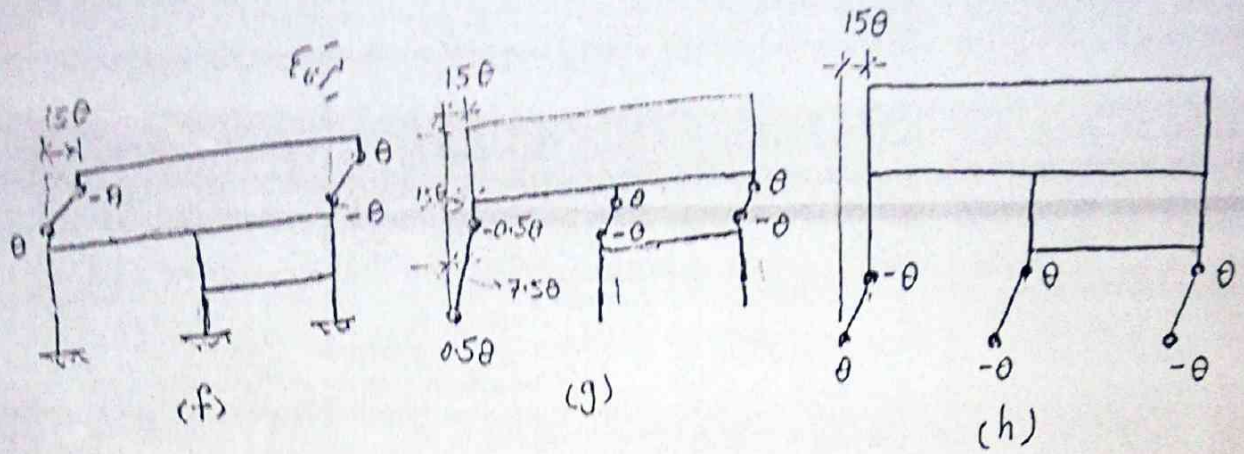
3 جابجایی

5 تیری

پنج مکانیزم تیری:



سه مکانیزم جانبی:



معادلات مکانیسم‌های تیری

(a) $(3\lambda)(36\theta) = (120)(4\theta) \longrightarrow 108\lambda = 480 \longrightarrow \lambda = 4.444$

(b) $(3\lambda)(18\theta) = (40)(4\theta) \longrightarrow 54\lambda = 160 \longrightarrow \lambda = 2.963$

(c) $(3\lambda)(18\theta) = (40)(4\theta) \longrightarrow 54\lambda = 160 \longrightarrow \lambda = 2.963$

(d) $(5\lambda)(18\theta) = (80)(4\theta) \longrightarrow 90\lambda = 320 \longrightarrow \lambda = 3.556$

(e) $(2\lambda)(15\theta) = (60)(4\theta) \longrightarrow 30\lambda = 240 \longrightarrow \lambda = 8$

معادلات مکانیسم‌های جانبی

(f) $(2\lambda)(15\theta) = (30)(4\theta) \longrightarrow 30\lambda = 120 \longrightarrow \lambda = 4$

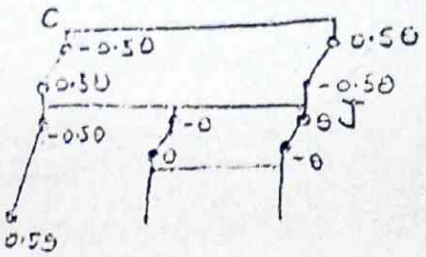
(g) $(2\lambda)(15\theta + 15\theta + 7.5\theta) = (60)(2\times 0.5\theta) + (40)(4\theta) \longrightarrow 75\lambda = 220 \longrightarrow \boxed{\lambda = 2.93}$

(h) $(2\lambda)(15\theta + 15\theta + 15\theta) = (60)(2\theta) + (80)(4\theta) \longrightarrow 90\lambda = 440 \longrightarrow \lambda = 4.889$

ترکیب مکانیزم ها:

چند حالت مختلف را با هم ترکیب کرده و مورد بررسی قرار می دهیم تا بتوانیم پاسخ ها را مقایسه کنیم. مشاهده خواهد شد که به مقادیر ضرایب پایین تری نیز خواهیم رسید.

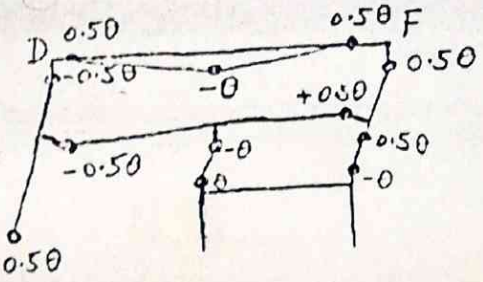
$$0.5(f) \quad 15\lambda = 60$$
$$(g) \quad 75\lambda = 220$$
$$90\lambda = 280$$



گره C حول 0.5θ لنگر $-(0.5\times30+0.5\times60)+0.5\times40=-25$

گره J حول 0.5θ لنگر $-(0.5\times20+0.5\times40)+0.5\times40=-15$

$$(i) \quad 90\lambda = 240 \longrightarrow \lambda = 2.667$$



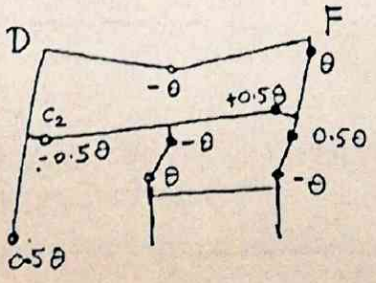
$$(i) \quad 90\lambda = 240$$
$$0.5(a) \quad 54\lambda = 240$$
$$144\lambda = 480$$

گره D حول 0.5θ لنگر $-(0.5\times30+0.5\times120)=-75$

گره F حول 0.5θ لنگر $-0.5\times120+0.5\times30=-45$

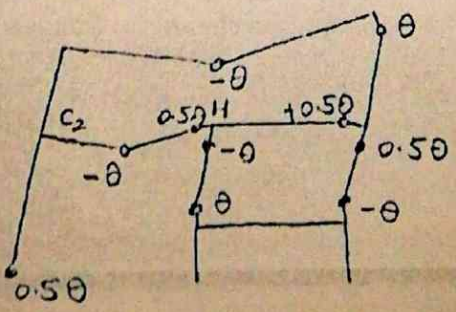
$$(j) \quad 144\lambda = 360 \longrightarrow 2.5$$

$$(j) \quad 144\lambda = 360$$
$$0.5(b) \quad 27\lambda = 80$$
$$171\lambda = 440$$



گره مفصل C_2 لنگر $-2\times0.5\times40=-40$

$$(K) \quad 171\lambda = 400 \longrightarrow \lambda = 2.339$$



$$(K) \quad 171\lambda = 400$$
$$(c) \quad 54\lambda = 160$$
$$225\lambda = 560$$

گره H حول θ لنگر $-40-40+40=-40$

$$225\lambda = 520 \longrightarrow \lambda = 2.311$$