Analyze Structures by using Moment distribution Method

تستخدم هذه الطريقة لتحليل المنشاءات غير المحددة أستاتيكياً من عتبات وهياكل فقط .

يكون أسلوب الحل بهذه الطريقة على هيئة جدول بحيث نهاية هذا الجدول هي نهاية الحل . أي أن قيم العزوم تكون معلومة .

مكتب القمة
طباعة عامة - استنساخ
باب المعظم مجاور كلية الهندسة

1Z

[redacted] Structure [redacted]

[redacted]

[redacted]

4/5/2010

اليمين عن الدوران

$$M^F_{AB} = \frac{-2EI\theta}{\ell}$$

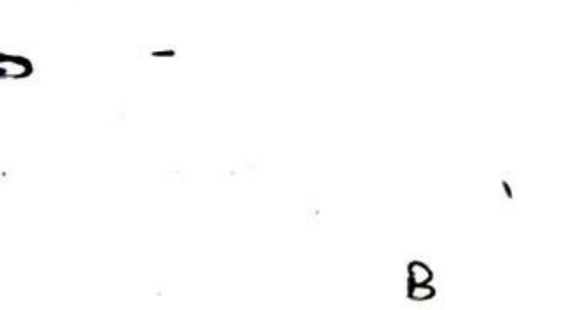
اليسار عن الدوران

$$M_{BA} = \frac{-4EI\theta}{\ell}$$

$$M^F_{AB} = \frac{2EI\theta}{\ell}$$

$$M^F_{BA} = \frac{4EI\theta}{\ell}$$

هنا الدوران عكس عقرب الساعة لذلك القرم سالب



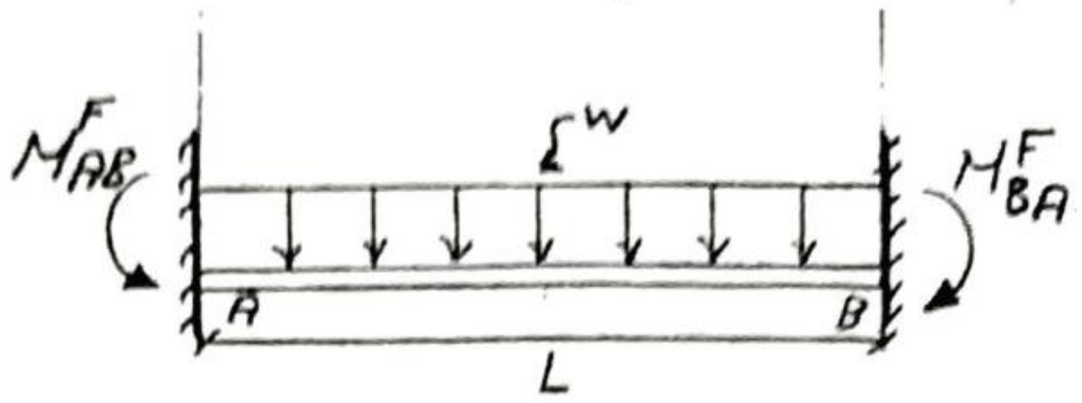
هنا الدوران مايلاه عقرب الساعة لذلك القرم موجب

⑥ - أحسب (Fixed-end-Moment) (M^F)

وذلك حسب الحالات التالية :

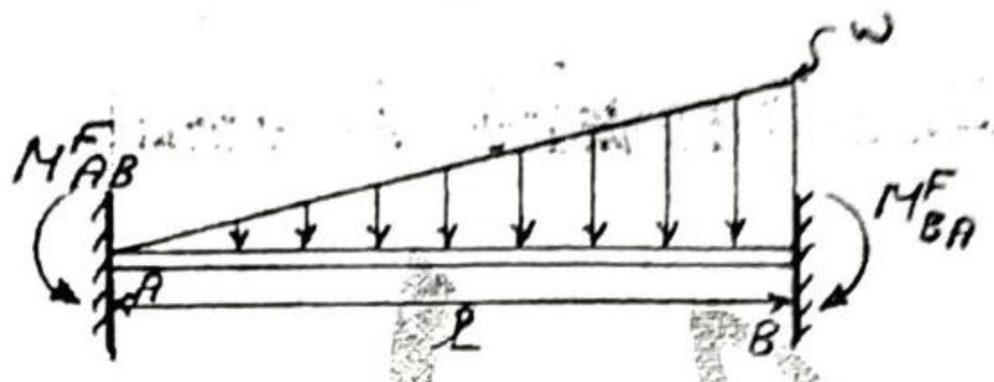
$$M^F_{AB} = -\frac{wl^2}{12}$$

$$M^F_{BA} = +\frac{wl^2}{12}$$



$$M^F_{AB} = -\frac{wl^2}{30}$$

$$M^F_{BA} = +\frac{wl^2}{20}$$

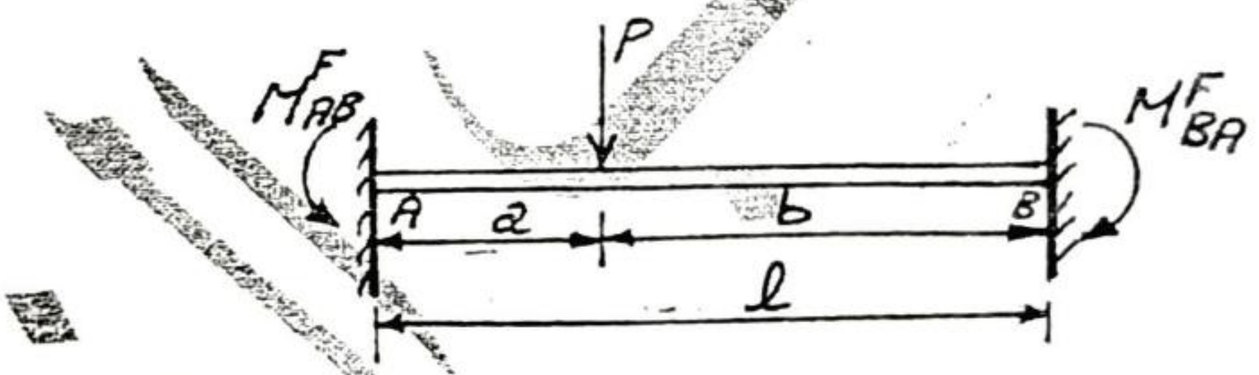


$$M^F_{AB} = -\frac{Pl}{8}$$

$$M^F_{BA} = +\frac{Pl}{8}$$

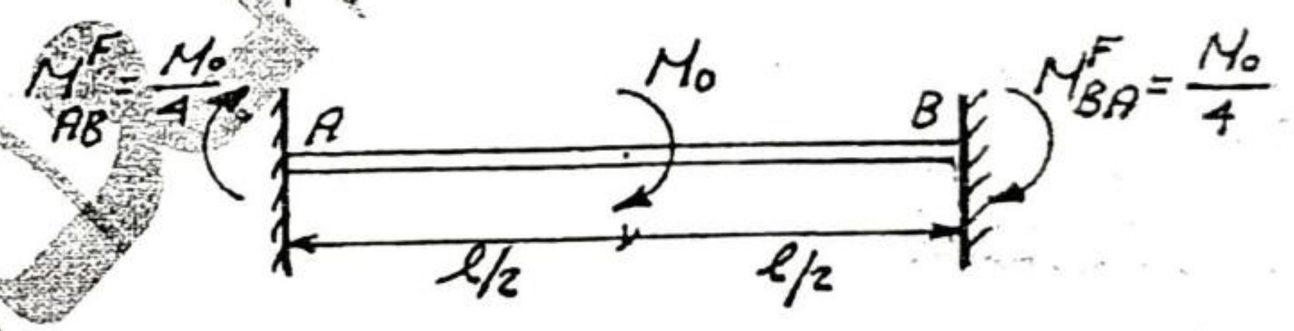
$$M^F_{AB} = -\frac{P*a*b^2}{l^2}$$

$$M^F_{BA} = +\frac{P*b*a^2}{l^2}$$



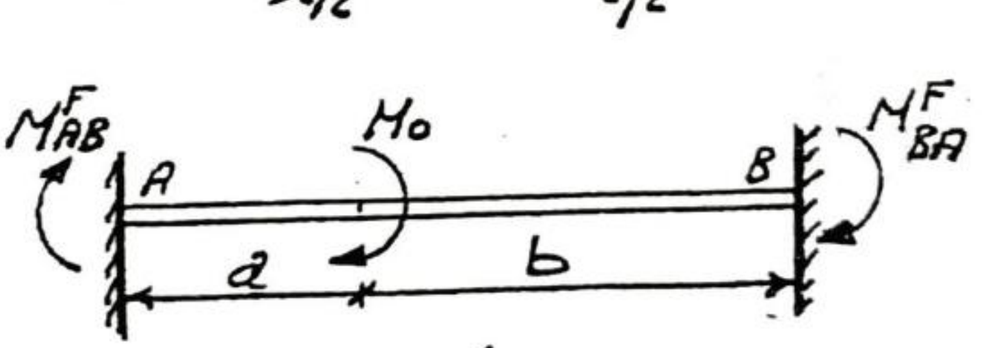
$$M^F_{AB} = +\frac{M_o}{4}$$

$$M^F_{BA} = +\frac{M^o}{4}$$



$$M^F_{AB} = +\frac{M_o * a(2b-a)}{l^2}$$

$$M^F_{BA} = +\frac{M_o * b(2a-b)}{l^2}$$



* دائماً (M^F) يكون ضعف عدد الفضاءات ونقصد بالفضاء هو المسافة بين مسندين .

$$M = -\frac{6EI\Delta}{l^2}$$

$$M^F_{AB} = \frac{6EI\Delta}{l^2}$$

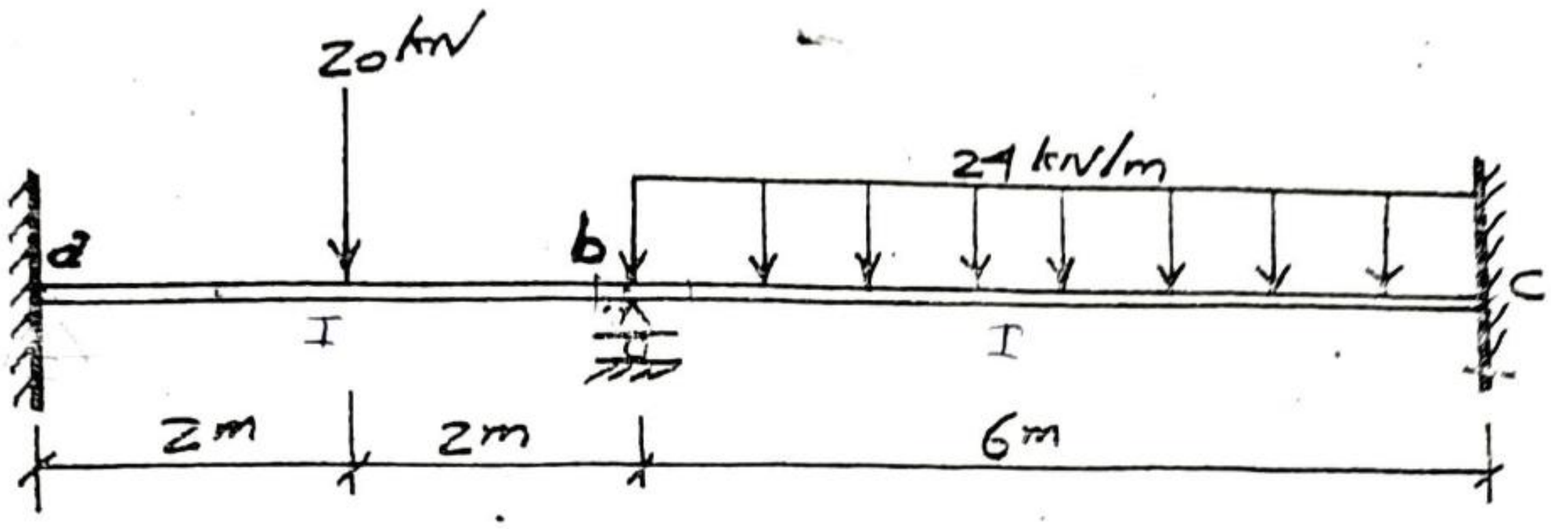
$$M^F_{BA} = \frac{6EI\Delta}{l^2}$$

$$M^F_{AB} = -\frac{6EI\Delta}{l^2}$$

$$M^F_{BA} = -\frac{6EI\Delta}{l^2}$$

دوران ال beam باتجاه عقرب الساعة لذلك Δ موجب والقانون سالب = سالب

Ex:- Analyze the beam shown in fig. EI = Constant.



Sol.

① - Find D.f:

Joint a : D.f) ab = 0

Joint c : D.f) cb = 0

Joint b:

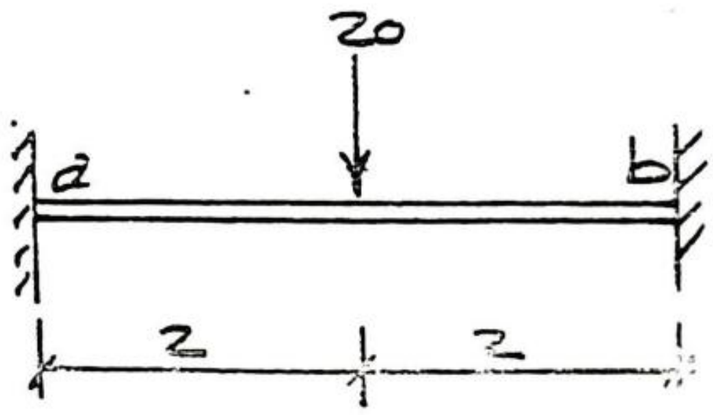
$k_{ba} = \frac{I}{4}$; $k_{bc} = \frac{I}{6}$

$\Sigma k = \frac{5}{12} I$

$D.f)_{ba} = \frac{\frac{I}{4}}{\frac{5}{12} I} = \frac{3}{5}$; $D.f)_{bc} = \frac{\frac{I}{6}}{\frac{5}{12} I} = \frac{2}{5}$

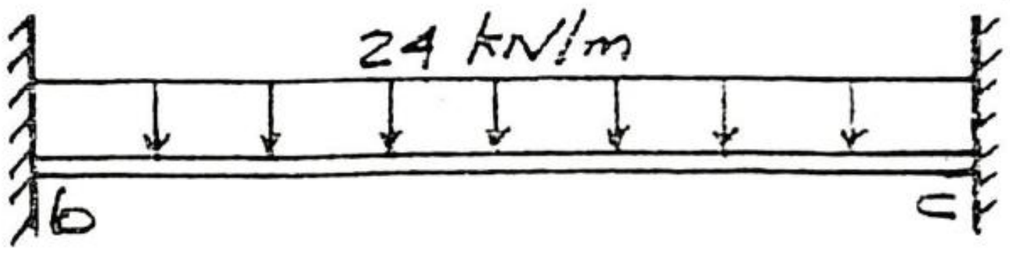
② :- F.E.M

$M^F_{ab} = -\frac{20(4)}{8} = -10 \text{ kN.m}$



$M^F_{ba} = +\frac{20(4)}{8} = +10 \text{ kN.m}$

$M^F_{bc} = -\frac{24(6)^2}{12} = -72 \text{ kN.m}$



$M^F_{cb} = +\frac{24(6)^2}{12} = +72 \text{ kN.m}$

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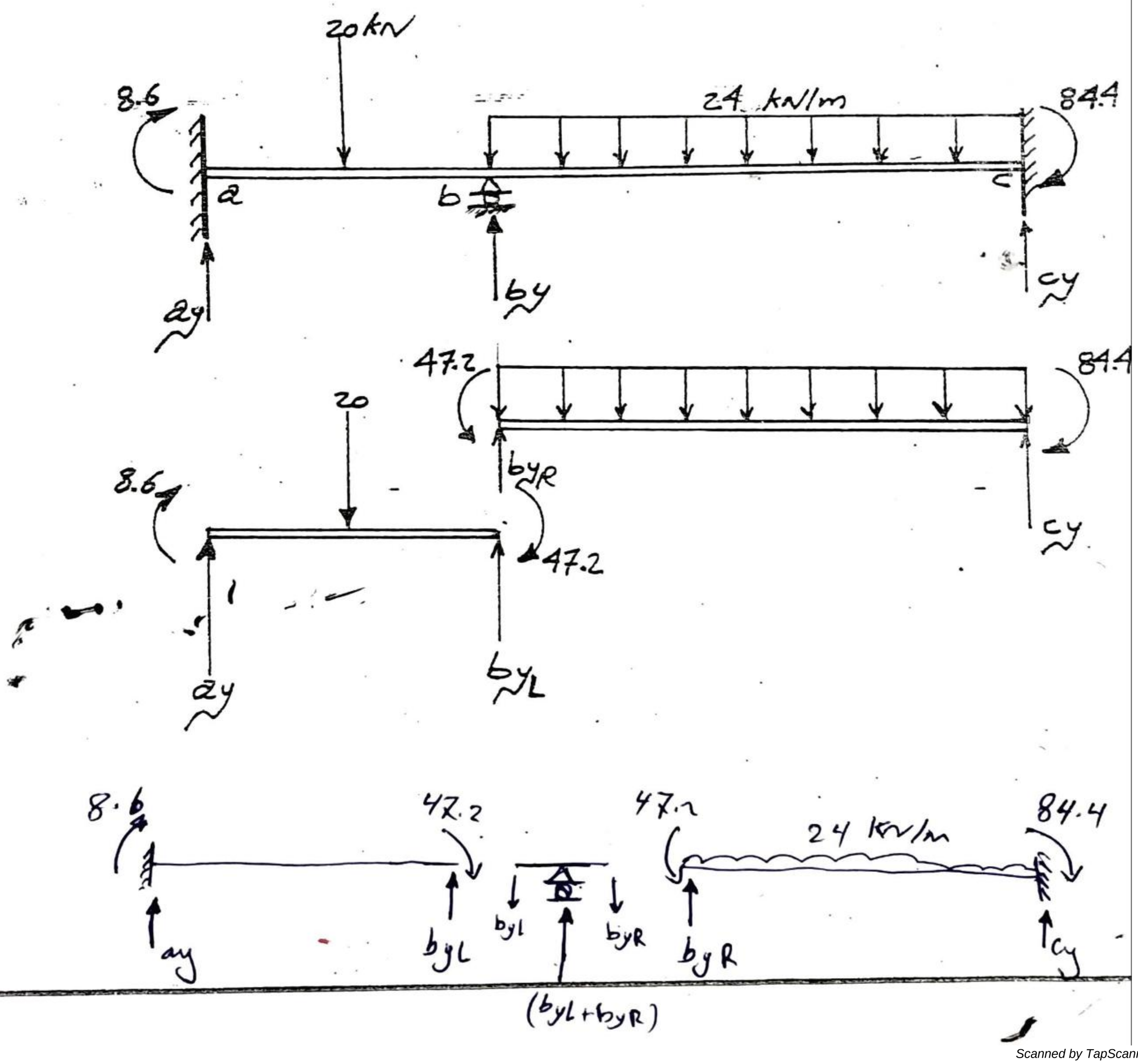
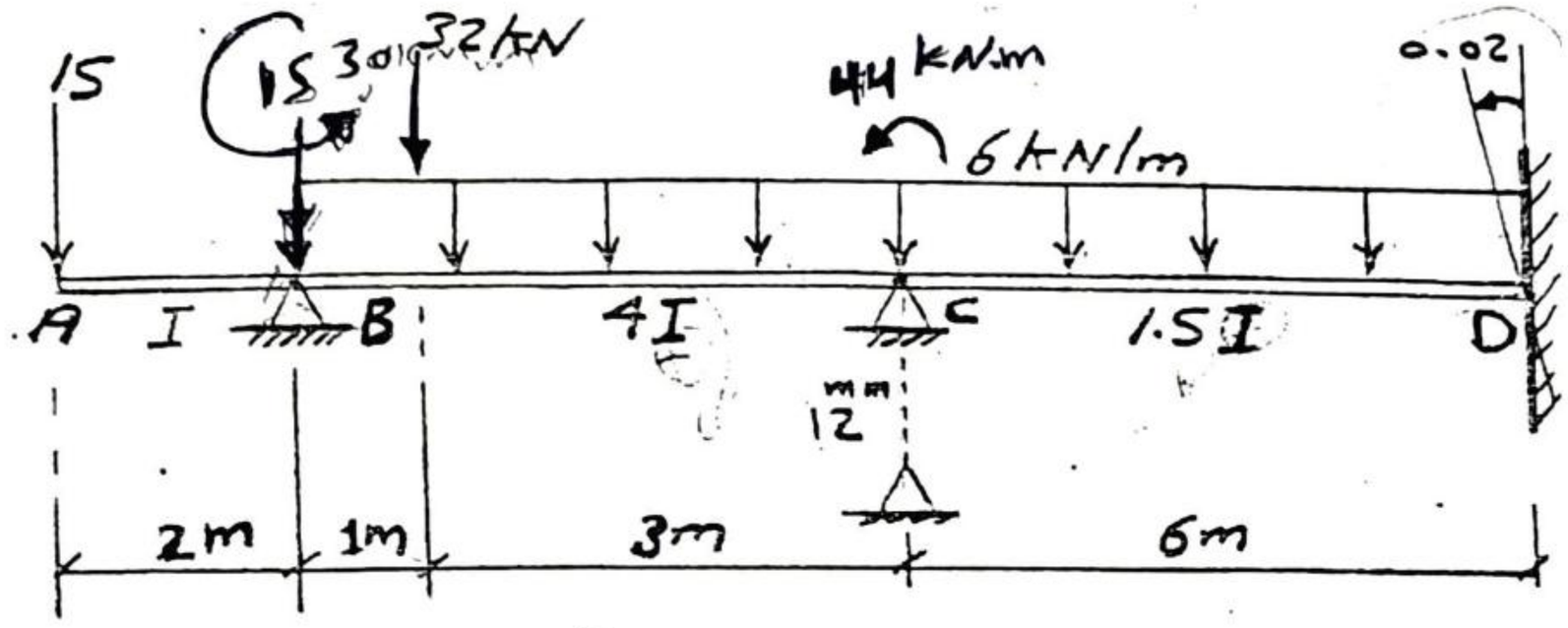
Joint	a	b		c	cycle
mem.	ab	ba	bc	cb	
D.f	0	$\frac{3}{5}$	$\frac{2}{5}$	0	
F.E.M	-10	+10	-72	+72	①
D.M	0	37.2	24.8	0	
C.o.M	18.6	0	-0	12.4	②
D.M	0	0	0	0	
ΣM	+8.6	47.2	-47.2	84.4	



Ex:- Analyze the beam shown in fig. $EI = 10^4\ kN.m^2$.



Sol.

① - Find D.f:

$$D.f) = \frac{K}{\Sigma k}$$

Joint B : $D.f)_{BC} = 1$ (pin)

Joint D : $D.f)_{DC} = 0$ (Fixed)

Joint C :

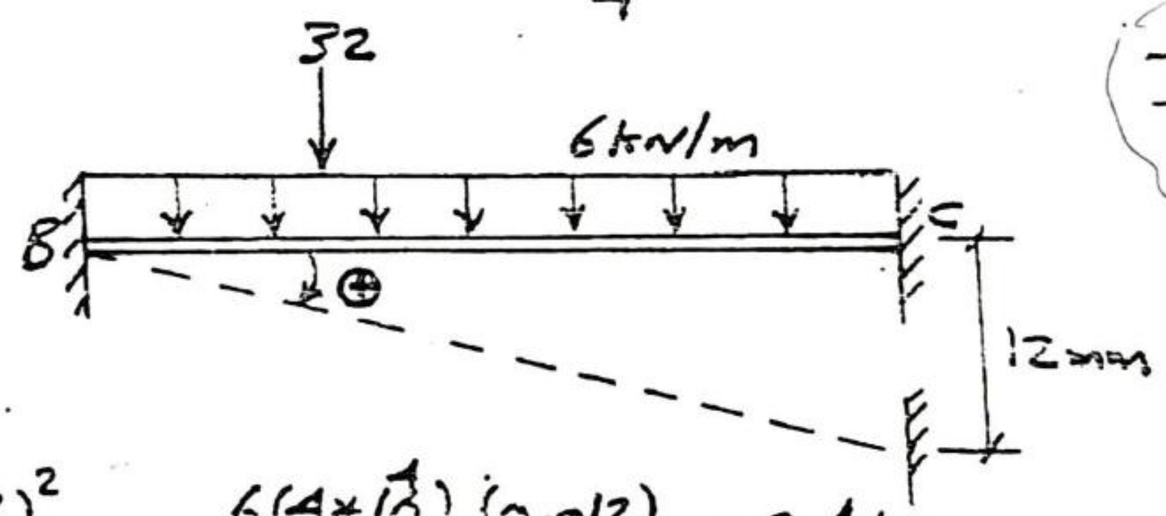
$$k_{CB} = \frac{4I}{4} = I \quad ; \quad k_{CD} = \frac{1.5I}{6} = \frac{1}{4}I$$

$$\Sigma k = I + \frac{1}{4}I = \frac{5}{4}I$$

$$D.f)_{CB} = \frac{I}{\frac{5}{4}I} = \frac{4}{5}, \quad D.f)_{CD} = \frac{\frac{1}{4}I}{\frac{5}{4}I} = \frac{1}{5}$$

Settlement حالة

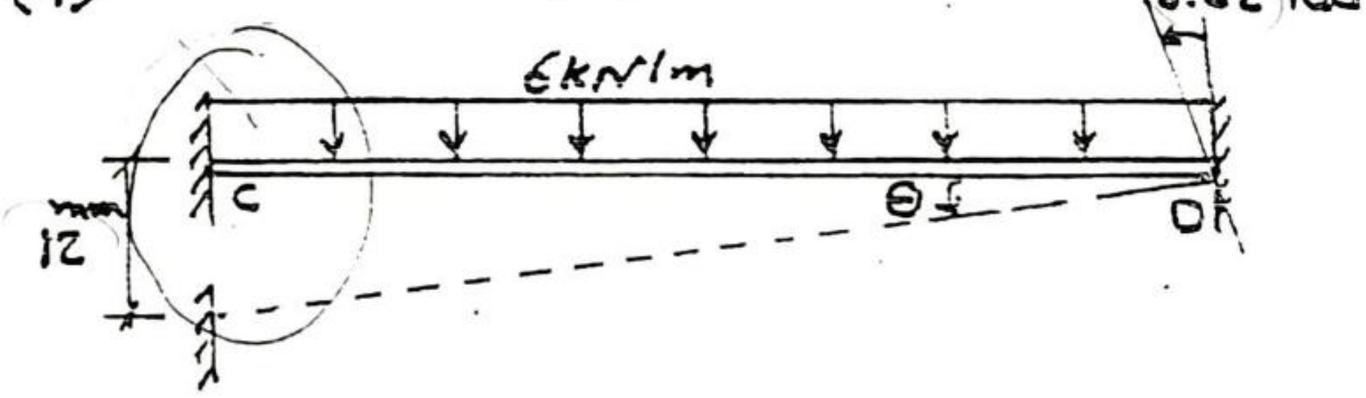
$$\frac{-6EI\Delta}{\ell^2}$$



② - F.E.M

$$M^F_{BC} = -\frac{6(4)^2}{12} - \frac{32(1)(3)^2}{(4)^2} - \frac{6(4*10^4)(0.012)}{(4)^2} = -206\ kN.m$$

$$M^F_{CB} = +\frac{6(4)^2}{12} + \frac{32(3)(1)^2}{(4)^2} - \frac{6(4*10^4)(0.012)}{(4)^2} = -166\ kN.m$$



$$M^F_{CD} = -\frac{6(6)^2}{12} + \frac{6(1.5*10^4)(0.012)}{(6)^2} - \frac{2(1.5*10^4)(0.02)}{6} = -88$$

$$M^F_{DC} = +\frac{6(6)^2}{12} + \frac{6(1.5*10^4)(0.012)}{(6)^2} - \frac{4(1.5*10^4)(0.02)}{6} = -152$$

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	+30	+44		
Joint	B	C		D
mem.	Bc	cB	cD	Dc
D.f	1	$\frac{4}{5}$	$\frac{1}{5}$	0
F.E.M	-206	-166 +(240)	-88	-152
D.M	+176	168	42	0
C.o.M	84	88	0.	21
D.M	-84	-70.4	-17.6	0
C.o.M	-35.2	-42	0	-8.8
D.M	35.2	33.6	8.4	0
C.o.M	16.8	17.6	0	4.2
D.M	-16.8	-14.08	-3.52	0
C.o.M	-7.04	-8.4	0	-1.76
D.M	+7.04	6.72	1.68	0
C.o.M				

cycle

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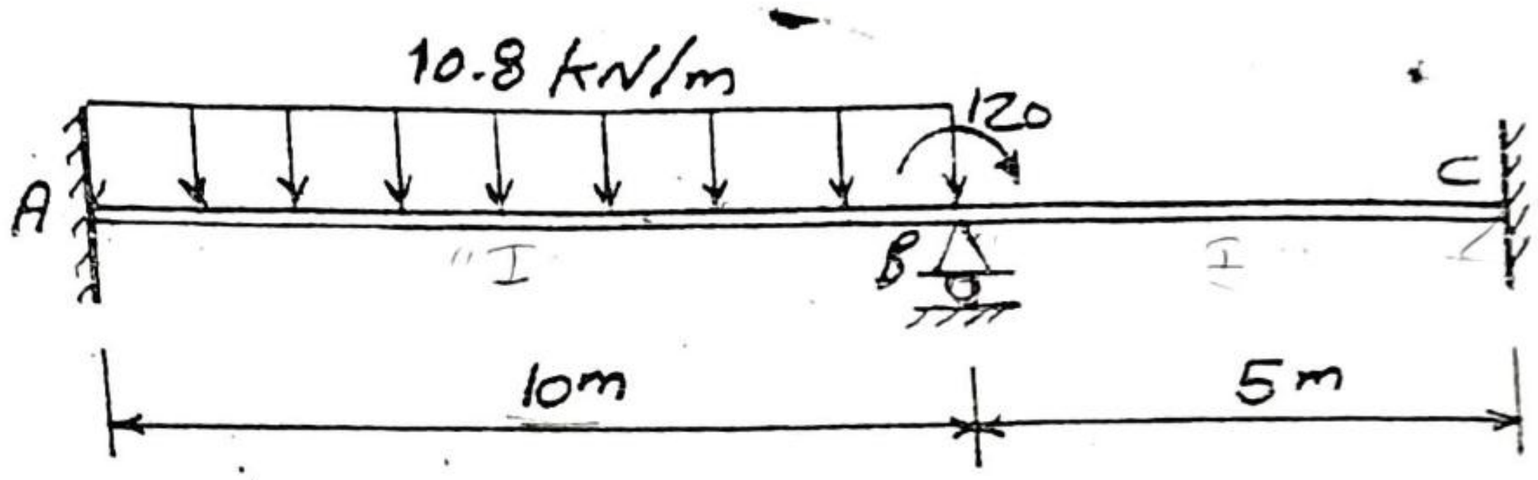
Ex:- Draw B.M.D for the beam shown. EI = Const.



Sol.

① - Find D.f:

Joint A: $D.f)_{AB} = 0$

Joint C: $D.f)_{CB} = 0$

Joint B:

$k_{BA} = \frac{I}{10}$, $k_{BC} = \frac{I}{5}$

$\Sigma k = \frac{3}{10} I$

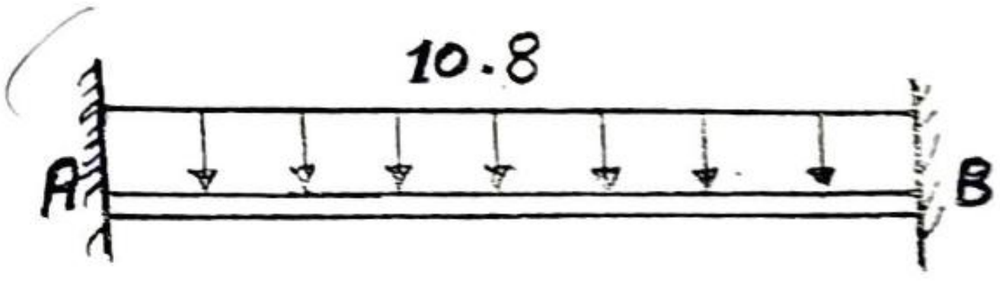
$D.f)_{BA} = \frac{k_{BA}\ \frac{I}{10}}{\Sigma k\ \ \frac{3}{10} I} = \frac{1}{3}$

$D.f)_{BC} = \frac{k_{BC}\ \ \frac{I}{5}}{\Sigma k\ \ \frac{3}{10} I} = \frac{2}{3}$

② - F.E.M

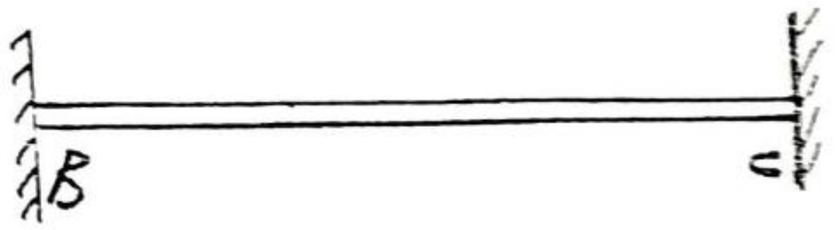
$M^F_{AB} = \frac{-10.8(10)^2}{12} = -90\ kN.m$

$M^F_{BA} = +\frac{10.8(10)^2}{12} = +90\ kN.m$



$M^F_{BC} = 0$

$M^F_{CB} = 0$



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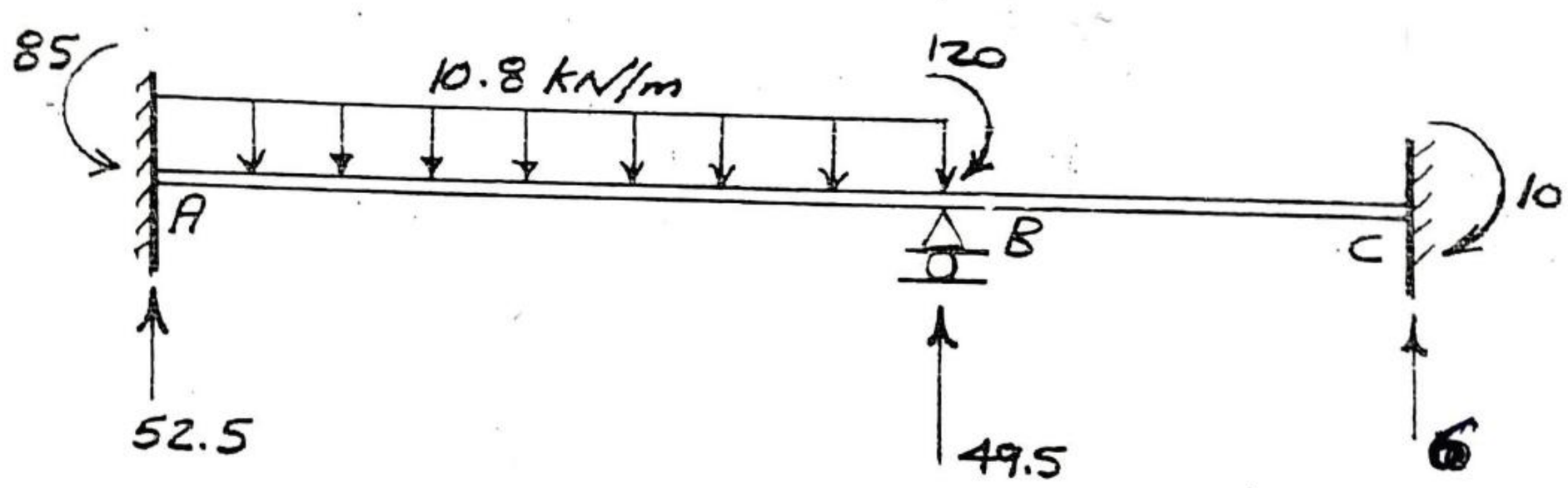
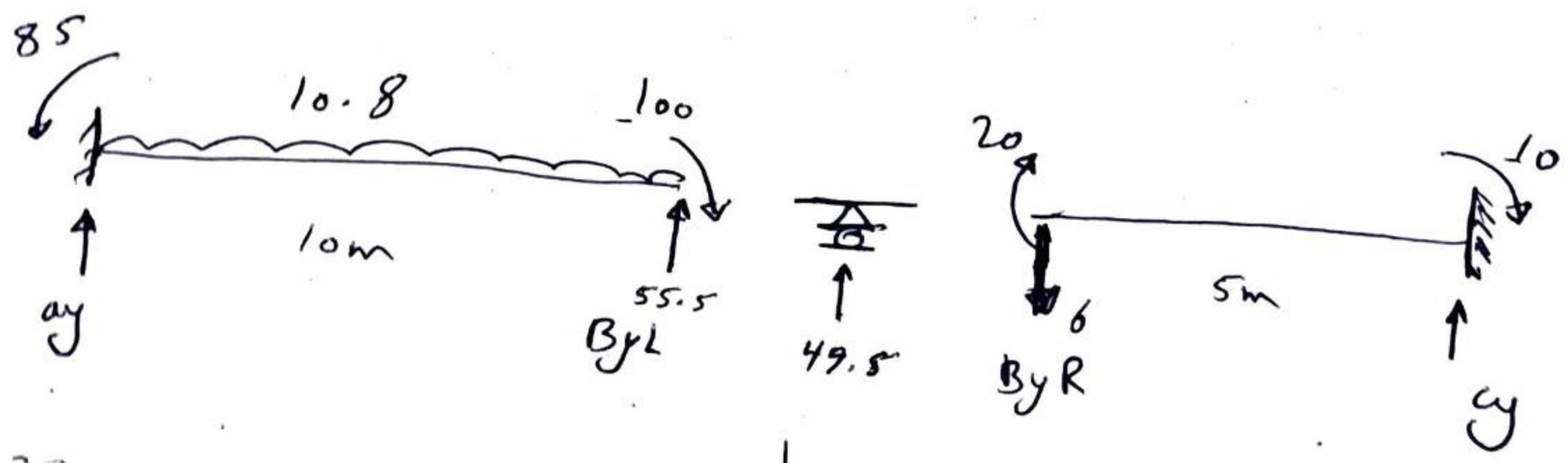
-120

Joint	A	B		C
mem.	AB	BA	Bc	cB
D.f	0	$\frac{1}{3}$	$\frac{2}{3}$	0
F.E.M	-90	+90	+30 = 0	0
D.M	0	+10	+20	0
C.o.M	5	0	0	10
D.M	-0	0	0	0
ΣM	-85	+100	+20	+10





$\curvearrowleft \Sigma M_a = 20$

$-85 + 100 + (10.8 * \frac{10^2}{2}) - ByL * 10 = 20$

$ByL = 55.5\ kN \uparrow$

$\Sigma F_y = 20$

$ay = 52.5\ kN \uparrow$

$\curvearrowleft \Sigma M_c = 0 \Rightarrow 20 + 10 + ByR * 5$

$ByR = 6\ kN \downarrow$

$\Sigma F_y = 0$

$cy = 6\ kN \uparrow$

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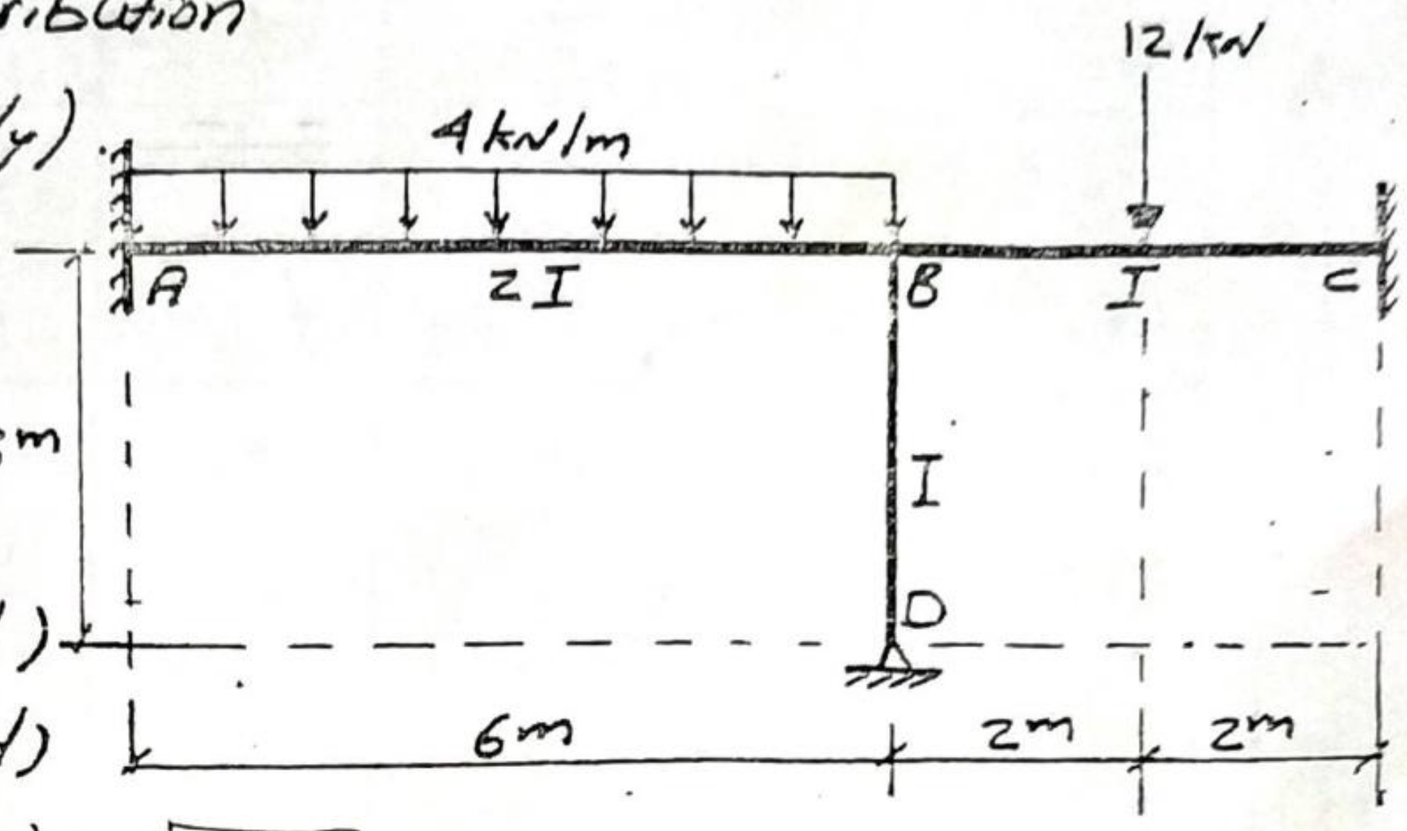
Ex:- Analyze the frame shown in fig.

use the moment Distribution method. (3 cycles only)



Sol.

① - Find D.f:

Joint A: D.f)$_{AB}$ = 0 (fixed)

Joint C: D.f)$_{CB}$ = 0 (fixed)

Joint D: D.f)$_{DB}$ = 1 (pin) or roller = 1

Joint B:

$$k_{BA} = \frac{2I}{6} = \frac{I}{3}, \quad k_{BD} = \frac{I}{3}, \quad k_{BC} = \frac{I}{4}$$

$$\Sigma k = k_{BA} + k_{BD} + k_{BC} = \frac{I}{3} + \frac{I}{3} + \frac{I}{4} = \frac{11}{12} I$$

$$D.f_{BA} = \frac{k_{BA}}{\Sigma k} = \frac{\frac{I}{3}}{\frac{11}{12} I} = \frac{4}{11}$$

$$D.f)_{BD} = \frac{\frac{I}{3}}{\frac{11}{12} I} = \frac{4}{11}$$

$$D.f)_{BC} = \frac{\frac{I}{4}}{\frac{11}{12} I} = \frac{3}{11}$$

1 = pin D.f ∞

settlement rotation

② - F.E.M

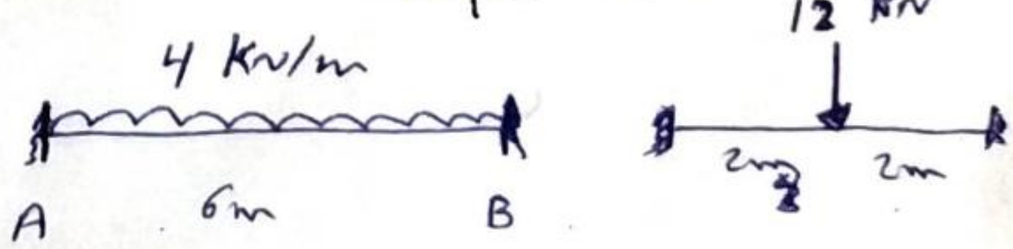
$$M^F_{BD} = M^F_{DB} = 0$$

$$M^F_{AB} = -\frac{4(6)^2}{12} = -12 \text{ kN.m}$$

$$M^F_{BA} = +\frac{4(6)^2}{12} = 12 \text{ kN.m}$$

$$M^F_{BC} = -\frac{12(4)}{8} = -6 \text{ kN.m}$$

$$M^F_{CB} = +\frac{12(4)}{8} = 6 \text{ kN.m}$$



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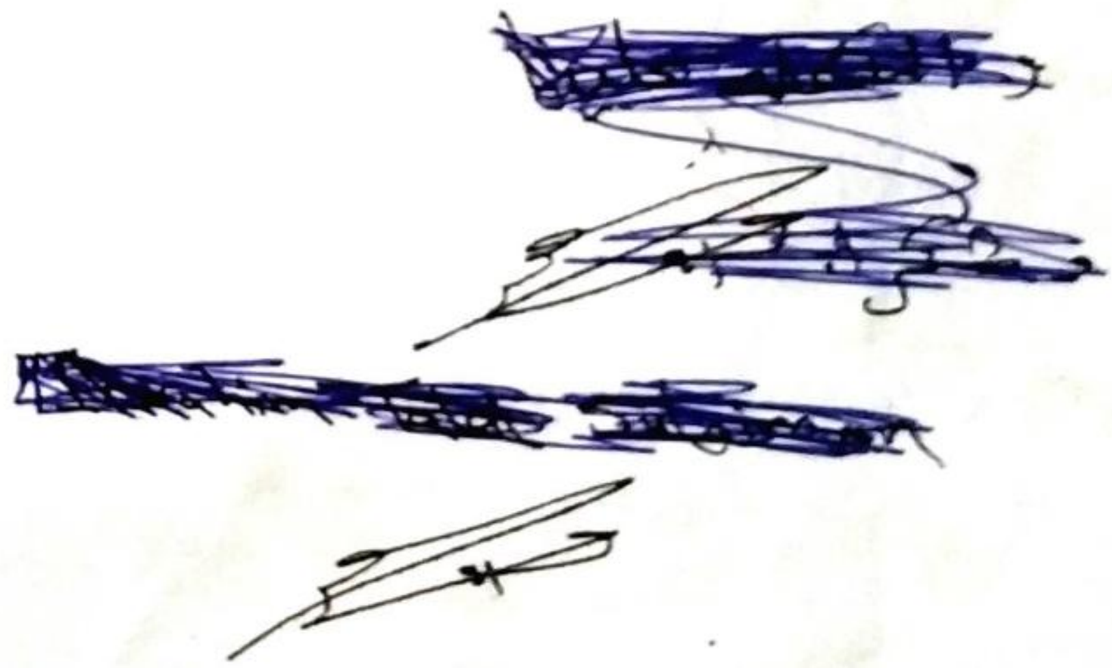
Joint	A	B			C	D	Cycle
mem.	AB	BA	BD	Bc	CB	DB	
D.f	0	$\frac{4}{11}$	$\frac{4}{11}$	$\frac{3}{11}$	0	1	
F.E.M	-12	12	0	-6	6	0	①
D.M	6	-2.1818	-2.1818	-1.636	0	0	
C.O.M	-1.0909	0	0	0	-0.818	-1.0909	②
Carry over D.M	0	0	0	0	0	1.0909	
C.O.M	0	0	0.545	0	0	0	③
D.M	0	-0.198	-0.198	-0.148	0	0	
ΣM	-13.0909	9.62	-1.834	-7.784	5.182	0	



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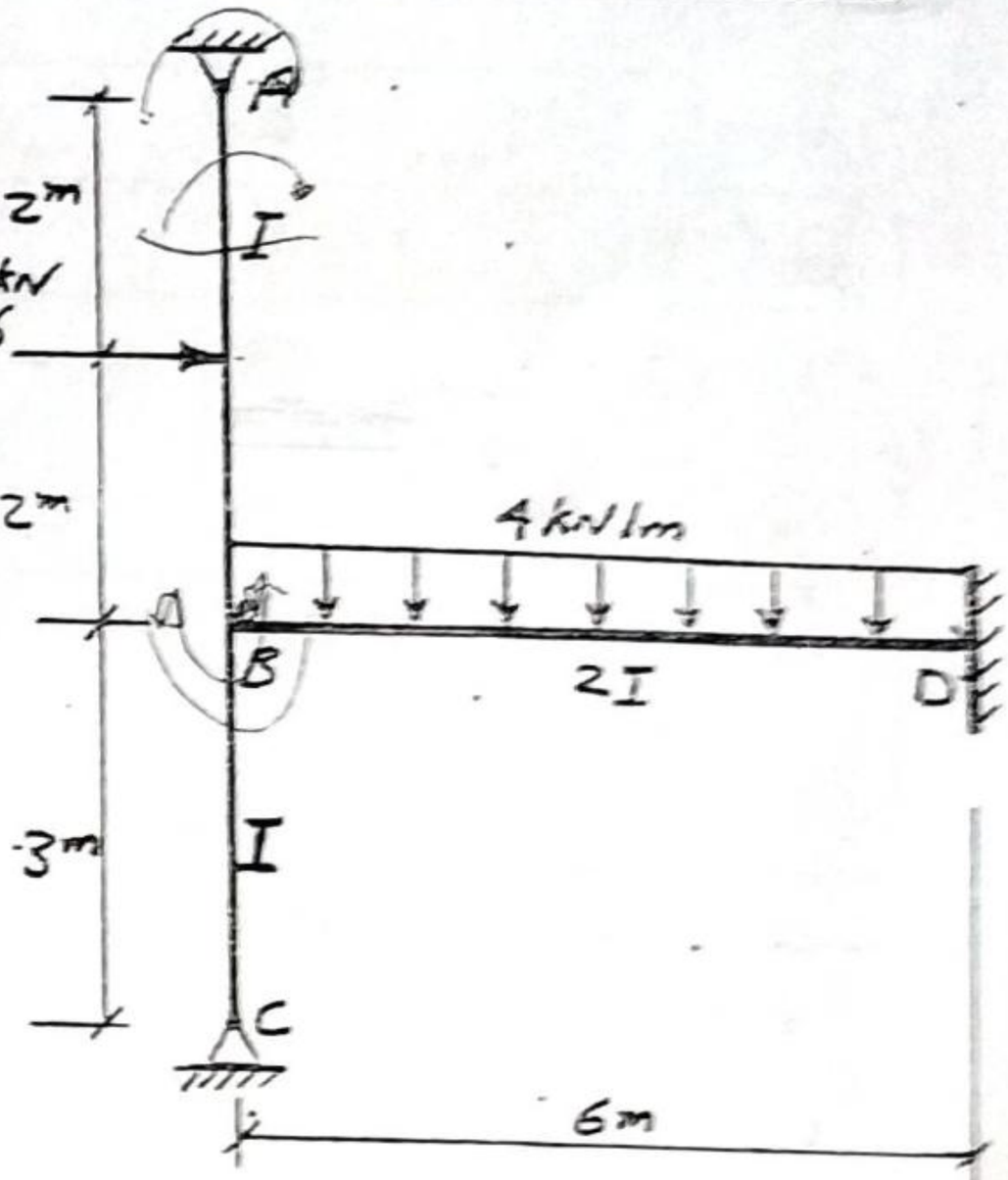
Ex:- For the frame shown in fig. use moment distribution to find Reaction at D (RD).



Sol.

① - Find D.f:

Joint A : D.f)$_{AB}$ = 1 (pin)

Joint C : D.f)$_{CB}$ = 1 (pin)

Joint D : D.f)$_{DB}$ = 0 (Fixed)

Joint B:

$$k_{BA} = \frac{I}{4}, \quad k_{BC} = \frac{I}{3}, \quad k_{BD} = \frac{2I}{6} = \frac{I}{3}$$

$$\Sigma k = k_{BA} + k_{BC} + k_{BD} = \frac{I}{4} + \frac{I}{3} + \frac{I}{3} = \frac{11}{12} I$$

$$D.f)_{BA} = \frac{\frac{I}{4}}{\frac{11}{12} I} = \frac{3}{11}$$

$$D.f)_{BC} = \frac{\frac{I}{3}}{\frac{11}{12} I} = \frac{4}{11}$$

$$D.f)_{BD} = \frac{\frac{I}{3}}{\frac{11}{12} I} = \frac{4}{11}$$

② - F.E.M

$$M^F_{BC} = M^F_{CB} = 0$$

$$M^F_{AB} = + \frac{96(4)}{8} = +48$$

$$M^F_{BA} = - \frac{96(4)}{8} = -48$$

$$M^F_{BD} = - \frac{4(6)^2}{12} = -12$$

$$M^F_{DB} = + \frac{4(6)^2}{12} = +12$$

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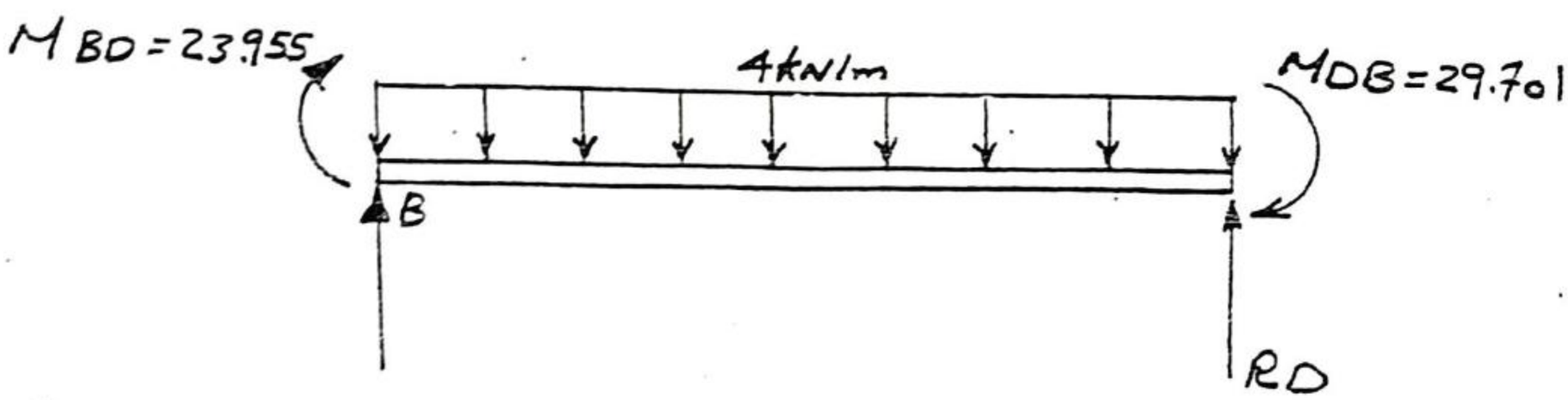
Joint	A	B			C	D	Cycle
mem.	AB	BA	BD	Bc	cB	DB	
D.f	1	$\frac{3}{11}$	$\frac{4}{11}$	$\frac{4}{11}$	1	0	
F.E.M	48	-48	-12	0	0	+12	①
D.M	-48	16.363	21.818	21.818	0	0	
C.O.M	8.1815	-24	0	0	10.909	10.909	②
D.M	-8.1815	6.545	8.727	8.727	-10.909	0	
C.O.M	3.272	-4.09	0	-5.454	4.363	4.363	③
D.M	-3272	2.603	3.47	3.47	-4.363	0	
C.O.M	1.3015	-1.636	0	-2.1815	1.735	1.735	④
D.M	-1.3015	1.041	1.388	1.388	-1.735	0	
C.O.M	0.5205	-0.6507	0	-0.8675	0.694	0.694	⑤
D.M	-0.5205	0.414	0.552	0.552	-0.694	0	
ΣM	0	-51.91	+23.955	+27.452	0	+29.701	



$\Sigma M_B = 0$ ↺

$23.955 + 29.701 + 4 * 6 * 3 - 6R_D = 0$

$R_D = 21\ kN$ ↑

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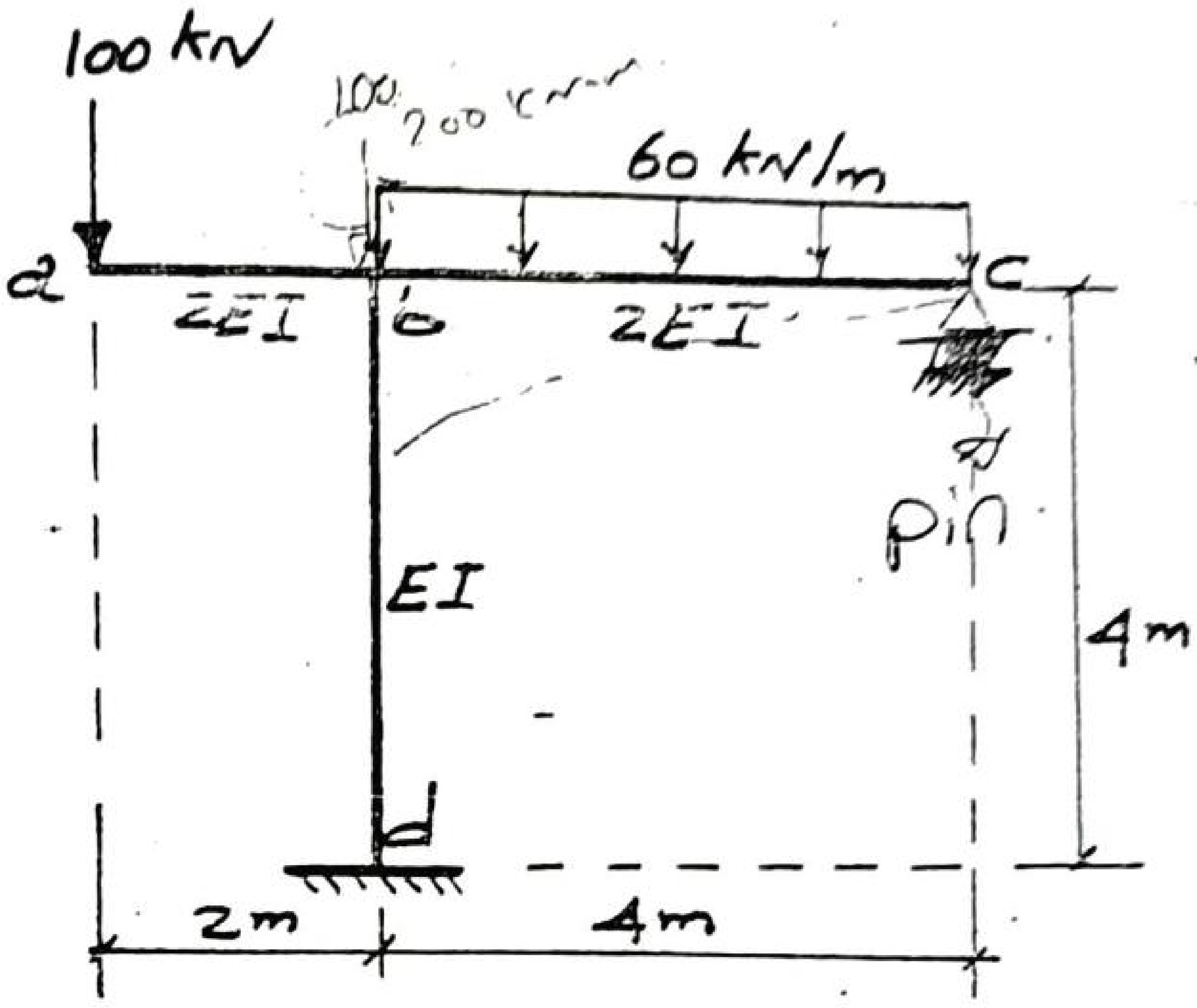
Ex:- For the frame shown in figure. Use the moment-distribution method to find the reaction at the supports if the joint (b) settles (3cm) downward.

$$EI = \frac{120 * 10^5 \ kN.mm^2}{(1000)^2} \rightarrow \boxed{kN.m}$$



Sol.

① - Find D.f :

Joint d : $D.f)_{db} = 0$

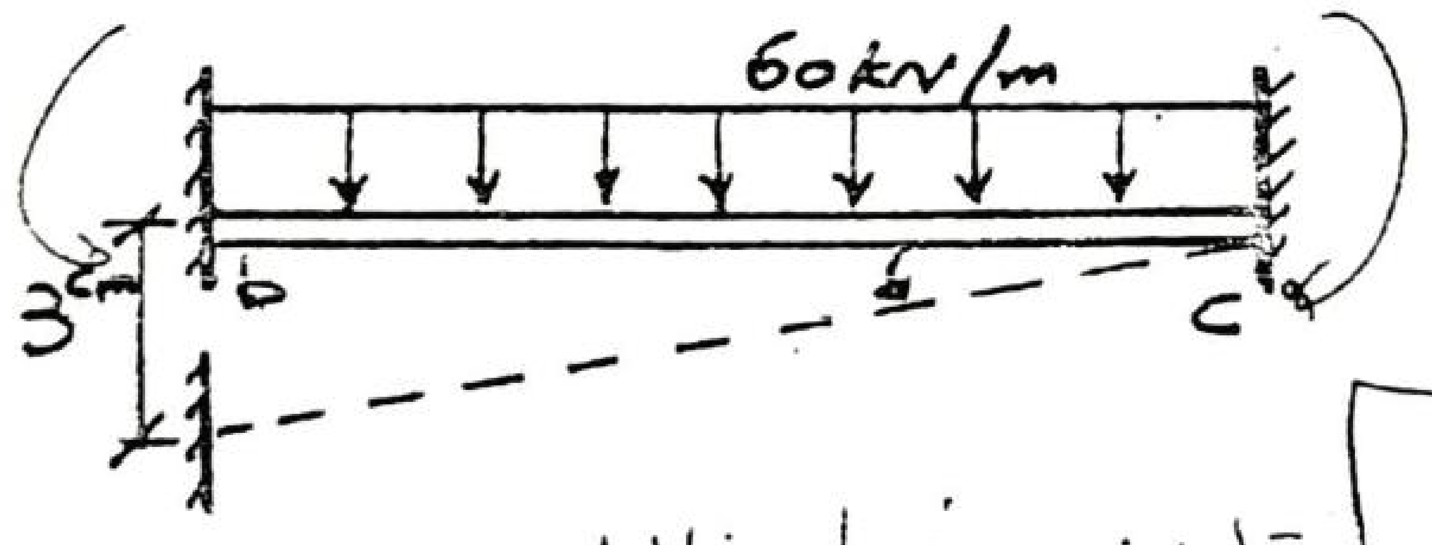
Joint c : $D.f)_{cb} = 1$

Joint b:

$k_{bd} = \frac{I}{4}$, $k_{bc} = \frac{2I}{4} = \frac{I}{2}$

$\sum k = \frac{I}{4} + \frac{I}{2} = \frac{3}{4} I$

$$D.f)_{bd} = \frac{\frac{I}{4}}{\frac{3}{4} I} = \frac{1}{3} \quad , \quad D.f)_{bc} = \frac{\frac{I}{2}}{\frac{3}{4} I} = \frac{2}{3}$$



ضغط

Sattlement قانون يحيـ $\boxed{\frac{-6EI\Delta}{l^2}}$

② - F.E.M

$M^F_{db} = M^F_{bd} = 0$

(−)(−) → (+)

$$M^F_{bc} = -\frac{60(4)^2}{12} + \frac{6(2*12)*0.03}{(4)^2} = -79.73 \ kN.m$$

$$M^F_{cb} = +\frac{60(4)^2}{12} + \frac{6(2*12)*0.03}{(4)^2} = 80.27 \ kN.m$$

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عوضنا عن X

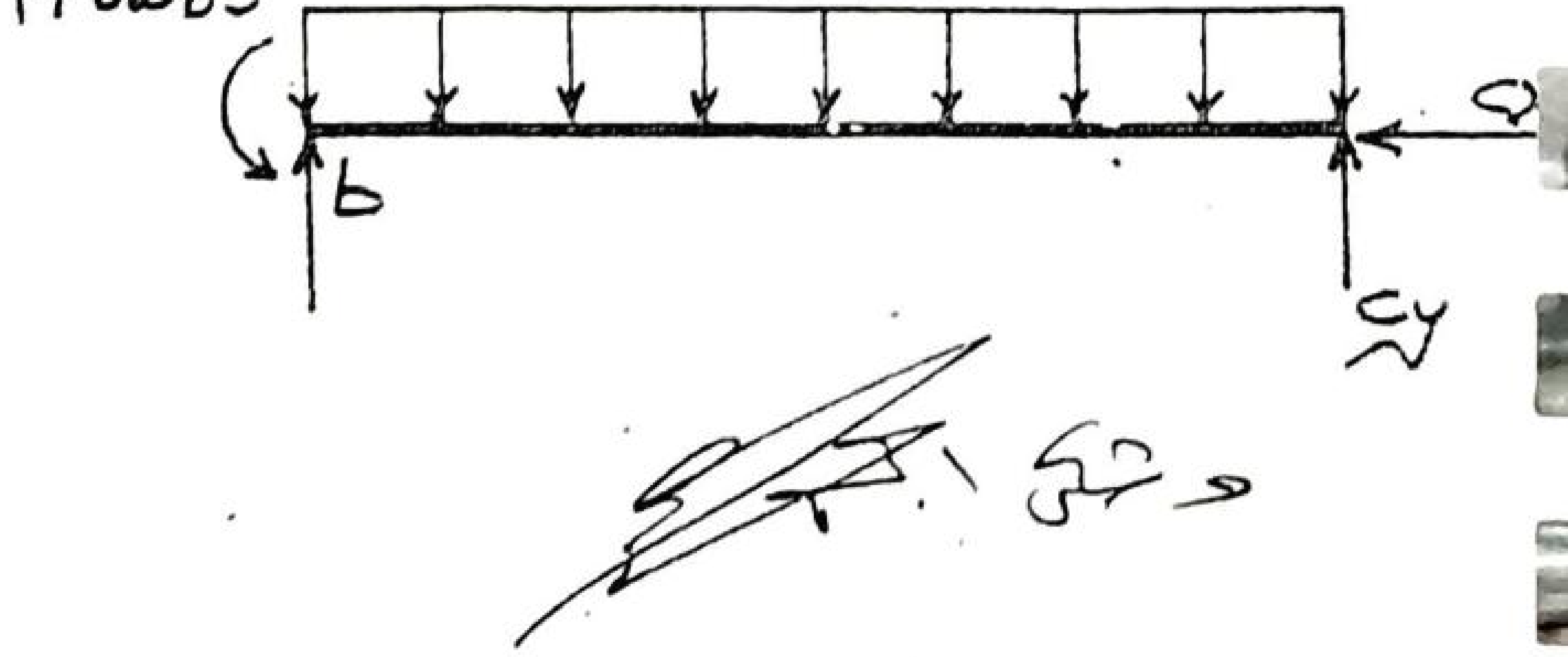
+200

من جدول سعي 0 + 200 - 79.73

Joint	d	b		c
mem.	db	bd	bc	cb
D.f	0	$\frac{1}{3}$	$\frac{2}{3}$	1
F.E.M	0	0	-79.73	80.27
D.M	0	-40.09	-80.18	-80.27
C.o.M	-20.045	0	-40.135	-40.09
D.M	0	13.378	26.756	40.09
C.o.M	6.689	0	20.045	13.378
D.M	0	-6.68	-13.363	-13.378
C.o.M	-3.34	0	-6.689	-6.68
D.M	0	2.229	4.459	6.68
C.o.M	1.1145	0	3.34	2.229
D.M	0	-1.113	-2.226	-2.229
C.o.M	-0.5565	0	-1.1145	-1.113
D.M	0	0.3715	0.743	1.113
C.o.M	0.185	0	0.5565	0.3715
D.M	0	0.1855	0.371	-0.3715
ΣM	-15.953	-31.719	-176.085	0

اذا هذكر سوي 5 حلقات ونكشفه

من تجمع المعقول ميدخل 200



$\Sigma M_b = 0 \Rightarrow c_y$

From whole frame.

$\Sigma M_d = 0 \Rightarrow c_x = \checkmark$

$\Sigma F_y = 0 \Rightarrow c_y = \checkmark$

$\Sigma F_x = 0 \Rightarrow c_x = \checkmark$