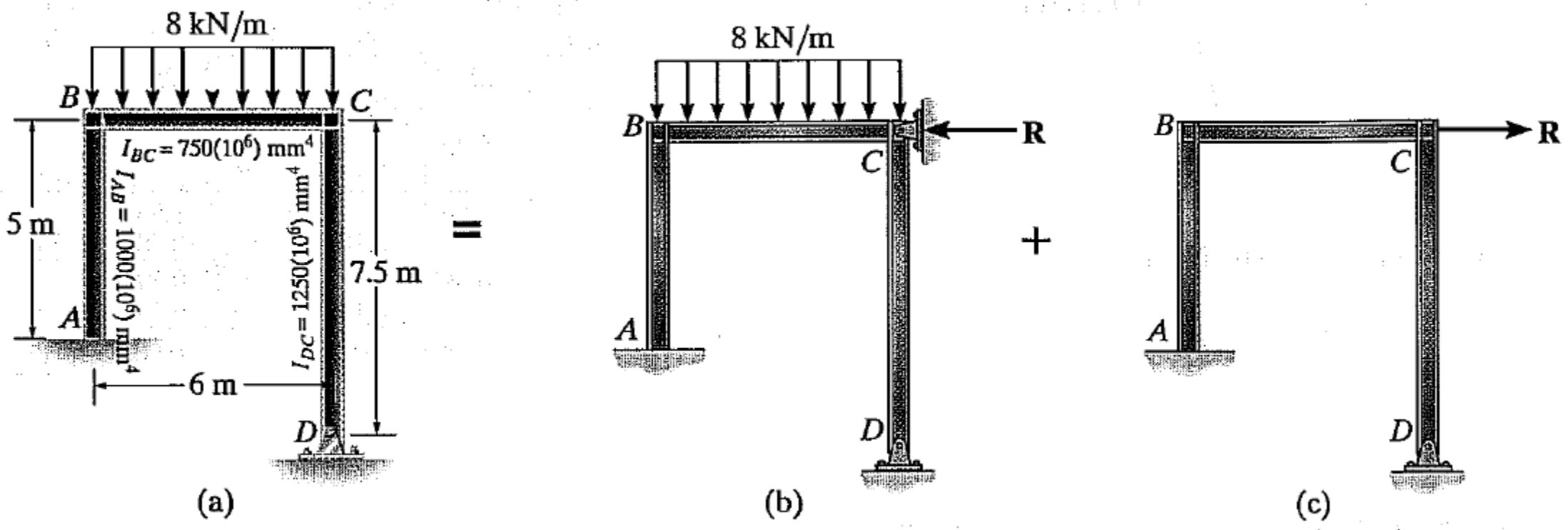
Moment distribution method – sway frames

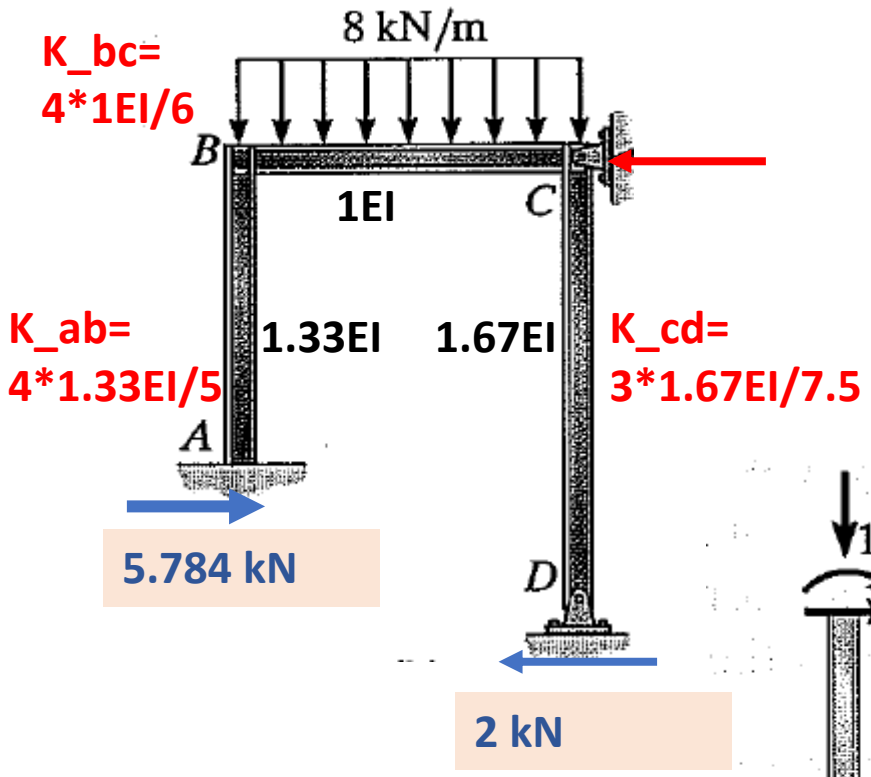
Sway frames: principle of superposition



- Actual system
- Non-Sway system (applied loading)
- Sway system (only swaying forc)

Moment = M_I + $(R/R')\ M_{II}$

Non-sway

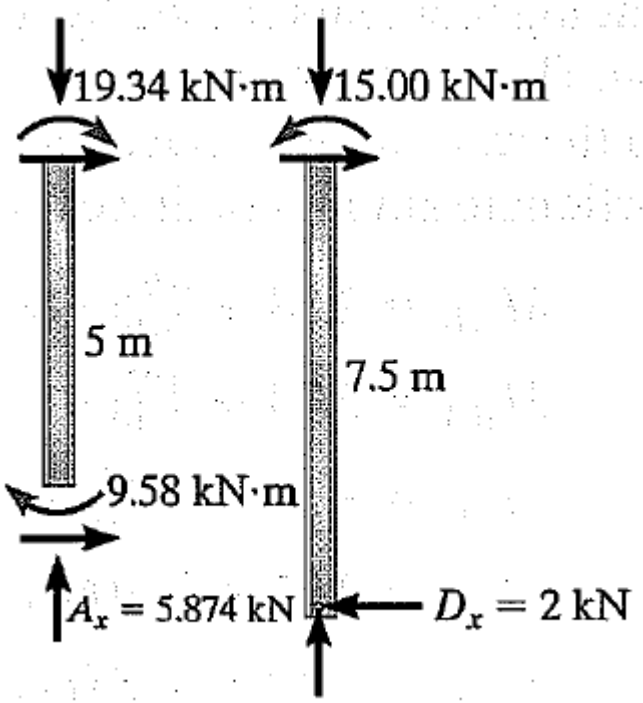


K_bc= 4*1EI/6

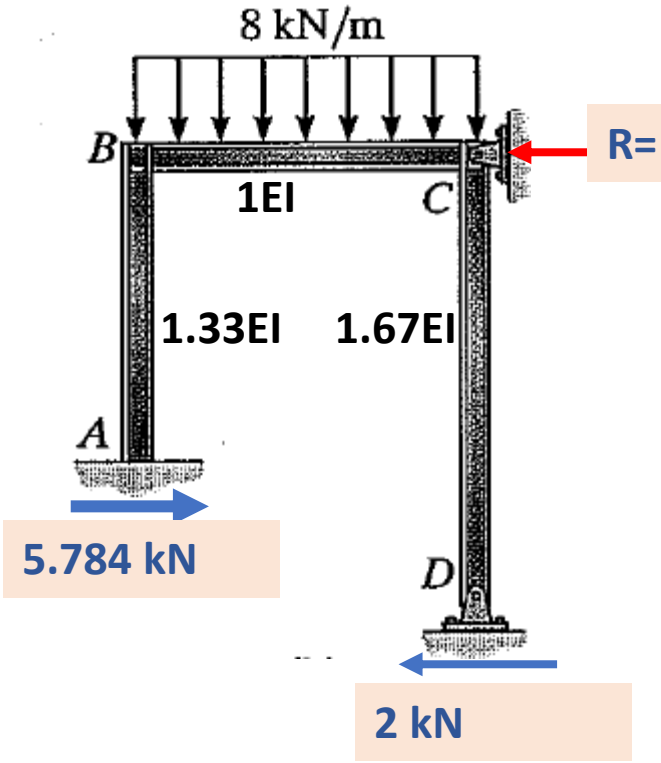
K_ab= 4*1.33EI/5

K_cd= 3*1.67EI/7.5

Joint	A	B		C		D
Member	AB	BA	BC	CB	CD	DC
DF	0	0.615	0.385	0.5	0.5	1
FEM			−24	24		
Dist.		14.76	9.24	−12	−12	
CO	7.38		−6	4.62		
Dist.		3.69	2.31	−2.31	−2.31	
CO	1.84		−1.16	1.16		
Dist.		0.713	0.447	−0.58	−0.58	
CO	0.357		−0.29	0.224		
Dist.		0.18	0.11	−0.11	−0.11	
ΣM	9.58	19.34	−19.34	15.00	−15.00	0



Finding R values and direction



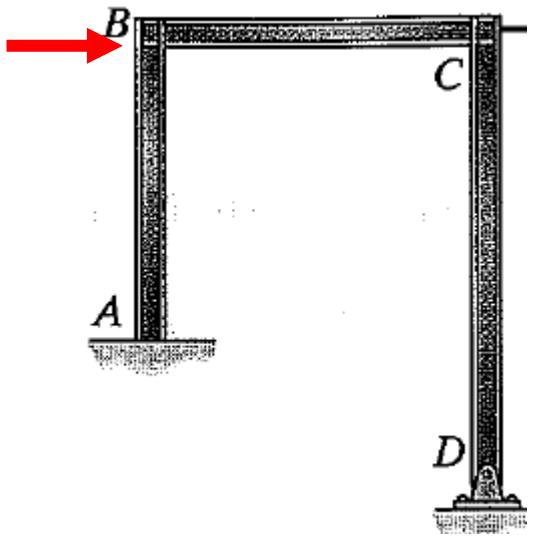
R= 3.784 kN

Propping force

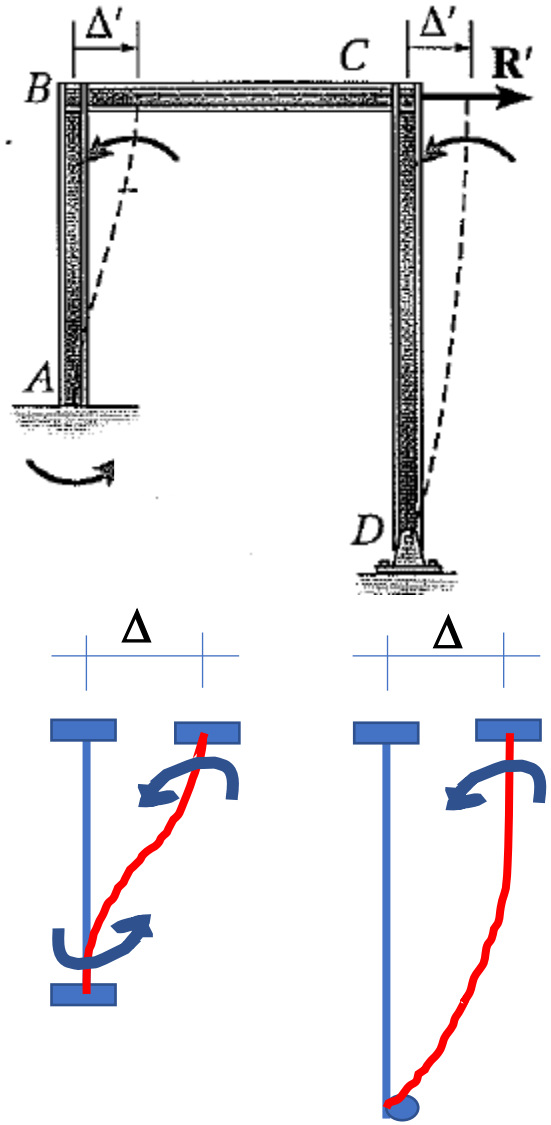
5.784 kN

2 kN

Swaying force



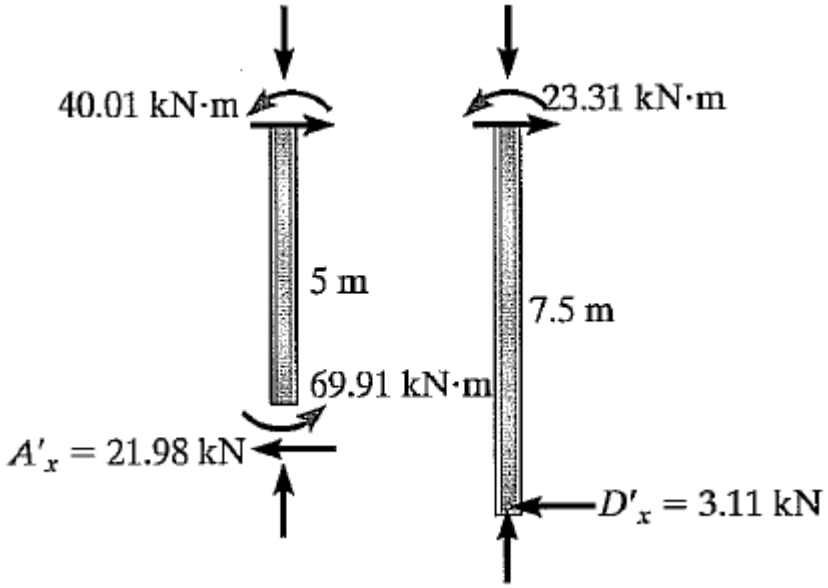
Sway Frame: Set of FEM due of drift following the compatibility conditions for the frame



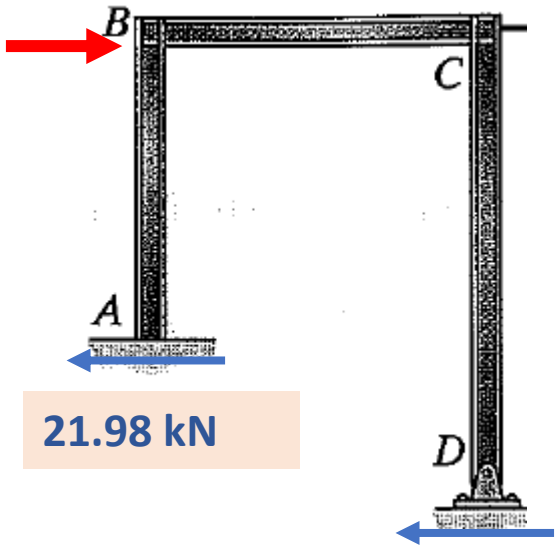
FEM_ab	:	FEM_ba	:	FEM_cd
6EI * Δ/(Lab)^2	:	6EI * Δ /(Lab)^2	:	3EI * Δ/(Lcd)^2
0.3192	:	0.3192	:	0.0891
1	:	1	:	0.2778
100	:	100	:	27.78
c.c.w.	:	c.c.w.	:	c.c.w.

Joint	A	B		C		D
Member	AB	BA	BC	CB	CD	DC
DF	0	0.615	0.385	0.5	0.5	1
FEM	−100	−100			−27.78	
Dist.		61.5	38.5	13.89	13.89	
CO	30.75		6.94	19.25		
Dist.		−4.27	−2.67	−9.625	−9.625	
CO	−2.14		−4.81	−1.34		
Dist.		2.96	1.85	0.67	0.67	
CO	1.48		0.33	0.92		
Dist.		−0.20	−0.13	−0.46	−0.46	
ΣM	−69.91	−40.01	40.01	23.31	−23.31	0

Calculation of R’ and finding end moments



R’ = 21.98+3.1=25.1



21.98 kN

3.1 kN

Actual end-moments of the system

$$M_{AB} = 9.58 + \left(\frac{3.78}{25.1}\right)(-69.91) = -0.948 \text{ kN} \cdot \text{m}$$

$$M_{BA} = 19.34 + \left(\frac{3.78}{25.1}\right)(-40.01) = 13.3 \text{ kN} \cdot \text{m}$$

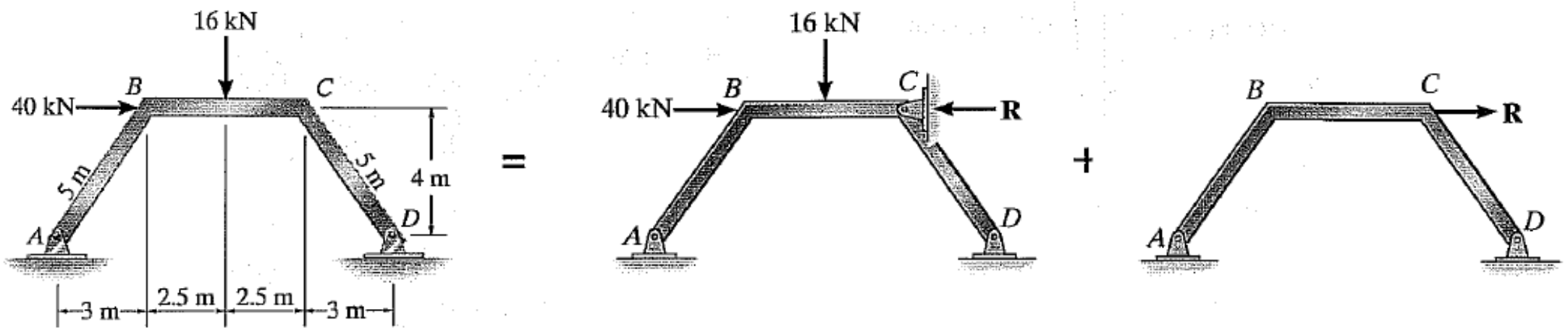
$$M_{BC} = -19.34 + \left(\frac{3.78}{25.1}\right)(40.01) = -13.3 \text{ kN} \cdot \text{m}$$

$$M_{CB} = 15.00 + \left(\frac{3.78}{25.1}\right)(23.31) = 18.5 \text{ kN} \cdot \text{m}$$

$$M_{CD} = -15.00 + \left(\frac{3.78}{25.1}\right)(-23.31) = -18.5 \text{ kN} \cdot \text{m}$$

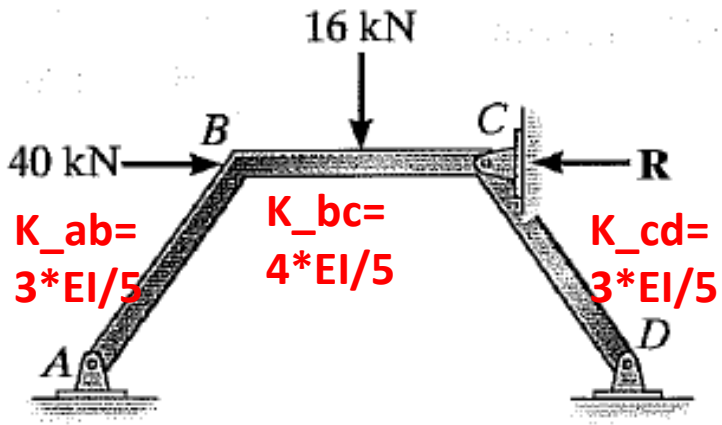
Assignment: **find the reaction forces of the frame system and draw shear and bending moment diagrams indicating key values and sketch deformed shape**

Analysis of swaying Frame with inclined columns



Moment = M_I + $(R/R')\ M_{II}$

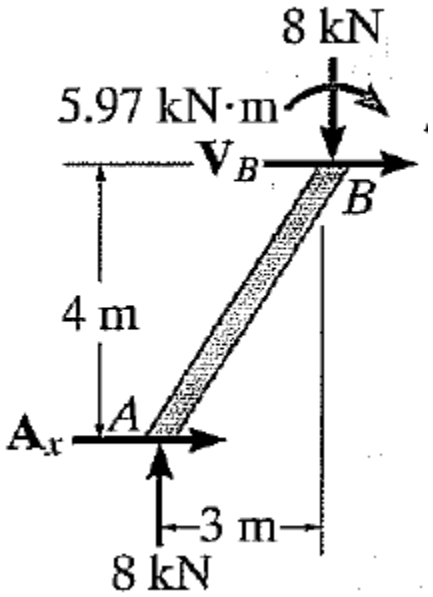
Non-sway



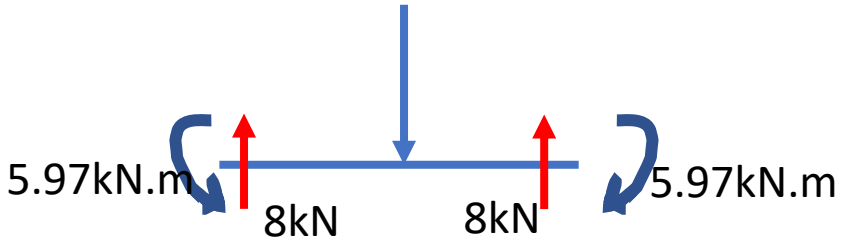
Joint	A	B		C		D
Member	AB	BA	BC	CB	CD	DC
DF	1	0.429	0.571	0.571	0.429	1
FEM			−10	10		
Dist.		4.29	5.71	−5.71	−4.29	
CO			−2.86	2.86		
Dist.		1.23	1.63	−1.63	−1.23	
CO			−0.82	0.82		
Dist.		0.35	0.47	−0.47	−0.35	
CO			−0.24	0.24		
Dist.		0.10	0.13	−0.13	−0.10	
ΣM	0	5.97	−5.97	5.97	−5.97	0

Finding R

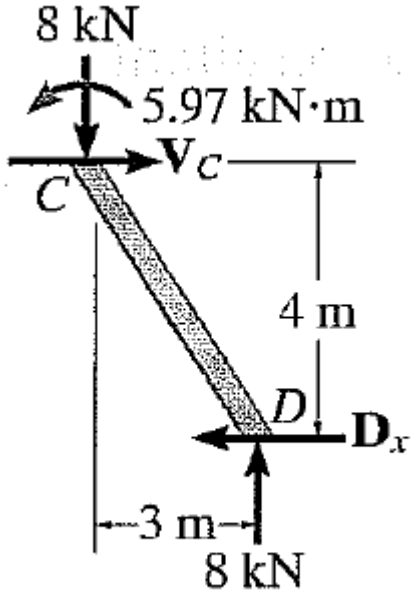
Step Two: shear in the beam is vertical loading on column



Step One: shear in the beam



Step Two: shear in the beam is vertical loading on column

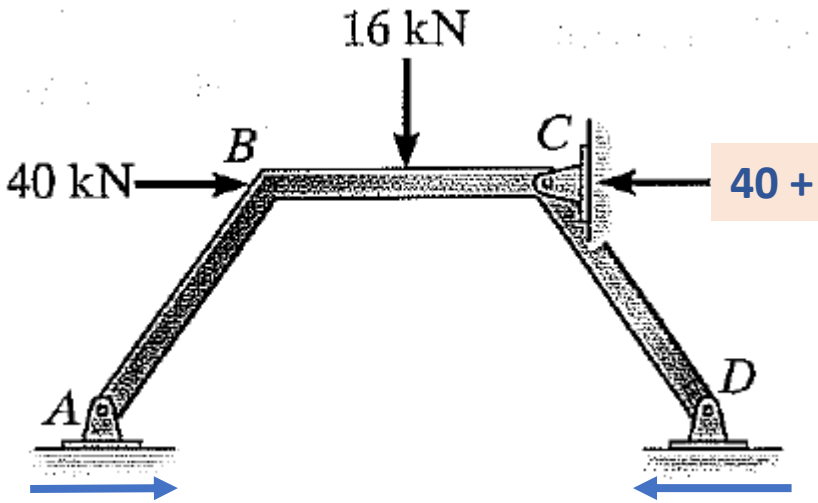


Σ Fy=0 -------- Ay=8kN

Σ M at B = 0 -----8*3+5.97=Ax(4) ---------Ax=7.49kN

In the same way

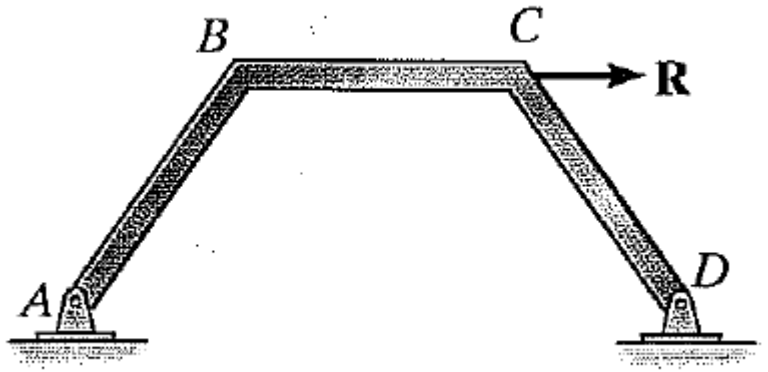
Σ M at C = 0 ----- Cy*3+Mcd = Dx (4) -----Dx=7.49kN

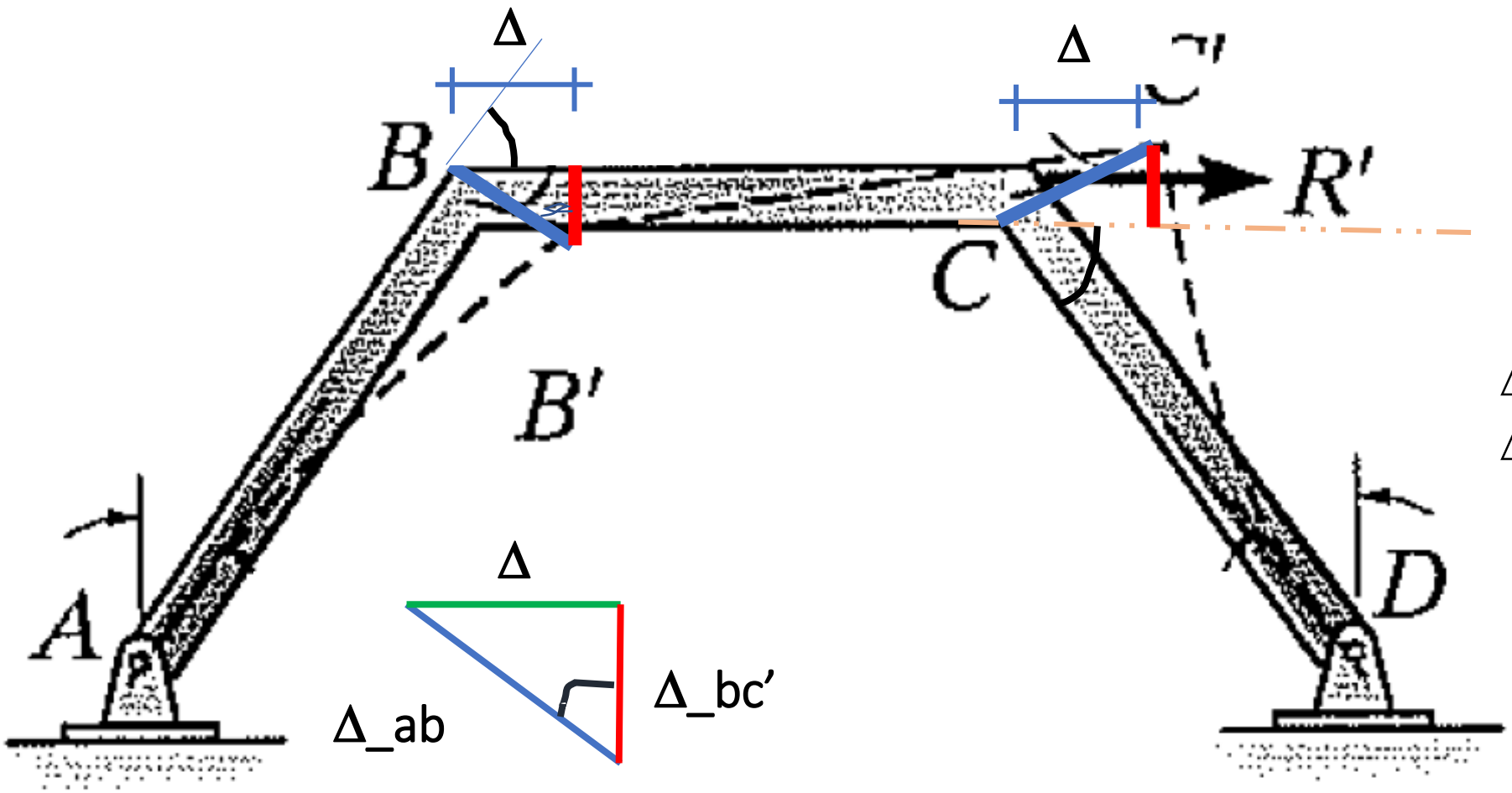


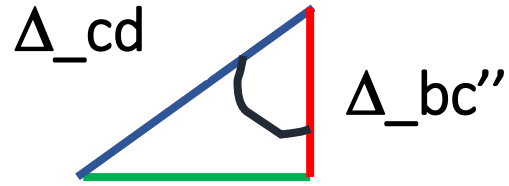
40 + 7.49 - 7.49 = 40 kN

7.49 kN

7.49 kN







$\Delta\_cd = \Delta/\sin(\beta) = 5/4\ \Delta$

$\Delta\_bc'' = \Delta/\tan(\beta) = 3/4\ \Delta$

$\Delta\_ab = \Delta/\sin(\alpha) = 5/4\ \Delta$

$\Delta\_bc' = \Delta/\tan(\alpha) = 3/4\ \Delta$

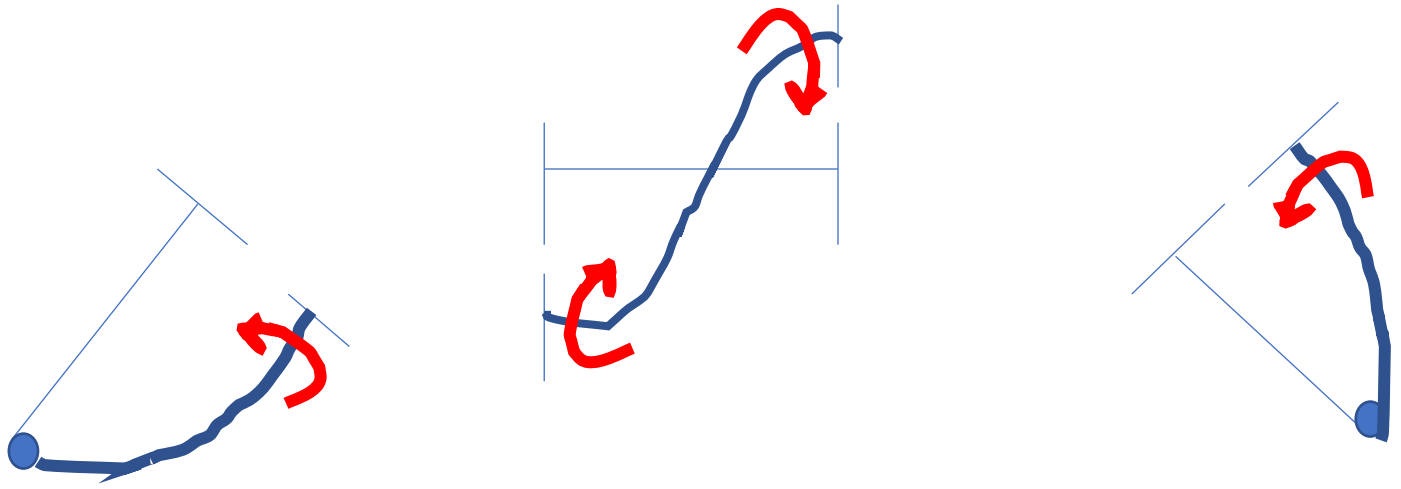
$\Delta\_ab = 1.25\ \Delta$

$\Delta\_bc = \Delta\_bc' + \Delta\_bc'' = 1.5\ \Delta$

$\Delta\_cd = 1.25\ \Delta$

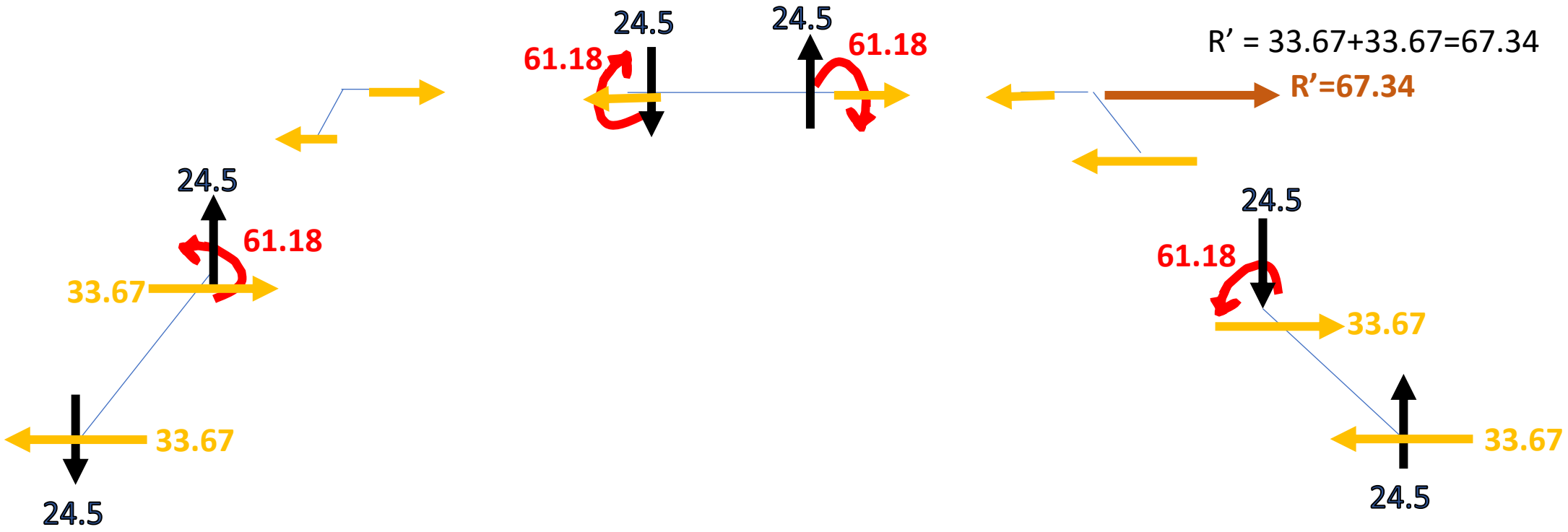
Sway: Set of FEM

FEM_ba	:	FEM_bc	:	FEM_cb	:	FEM_cd
3EI *Δ_ab/(Lab)^2	:	6EI * Δ_bc /(Lcb)^2	:	6EI * Δ_bc/(Lcb)^2	:	3EI *Δ_cd/(Lcd)^2
0.15	:	0.36	:	0.36	:	0.15
0.417	:	1	:	1	:	0.417
41.7	:	100	:	100	:	41.7
c.c.w.	:	c.w.	:	c.w.	:	c.c.w



joint	A	B		C		D
end-moment	AB	BA	BC	CB	CD	DC
DF	1	0.429	0.571	0.571	0.429	1
FEM	0	-41.7	100	100	-41.7	0
Dist	0	-25	-33.31	-33.31	-25	0
CO	0		-16.65	-16.65		0
Dist	0	7.143	9.507	9.507	7.143	0
CO	0		4.753	4.753		0
Dist	0	-2.04	-2.71	-2.71	-2.04	0
CO	0		-1.36	-1.36		0
Dist	0	0.582	0.776	0.776	0.582	0
CO	0		0.388	0.388		0
Dist	0	-0.17	-0.22	-0.22	-0.17	0
	0	-61.18	61.18	61.18	-61.18	0

Finding R’ and final values of end moments



Actual end-moments of the system

End moment	AB	BA	BC	CB	CD	DC
MI	0	5.97	-5.97	5.97	-5.97	0
MII * (R/R’)	0	-36.34	36.34	36.34	-36.34	0
MI+ (R/R’)MII	0	-30.4	30.4	42.3	-42.3	0

Assignment:

Analyze the following frame system, draw shear and bending moment diagrams indicating key values and draw the deformed shape