



CE 3213

9th May, 2020

UNIT LOAD METHOD/FRAME

Dr. Md. Shafiqul ISLAM

Professor, CE, RUET



PROBLEM

12

Rotational Deflection

Given

$$E = 200 \times 10^6 \text{ kN/m}^2$$

$$I = 160 \times 10^{-6} \text{ m}^4$$

Findings

$$\theta_A, \theta_B, \theta_C, \theta_D$$

$$\sum M_A = 0$$

$$48 \times 4.5 + 96 \times 3 = R_D \times 6$$

$$\sum f_y = 0$$

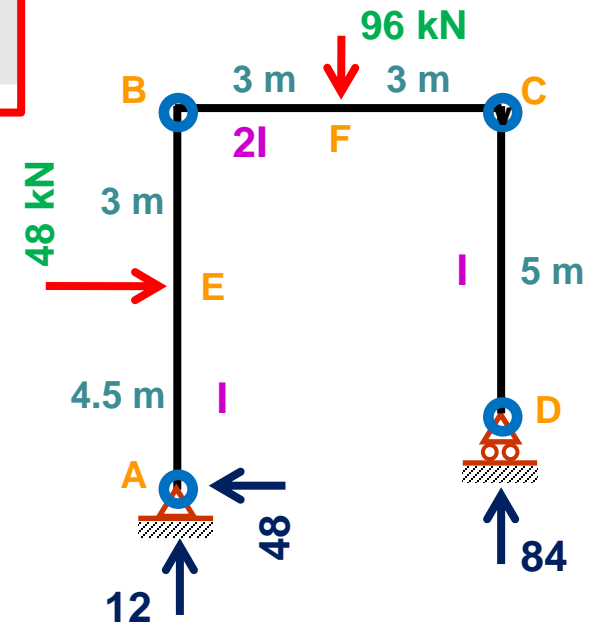
$$R_A + 84 = 96$$

$$\sum f_x = 0$$

$$H_A = 48$$

$$R_D = 84$$

$$R_A = 12$$





Unit Load Method/Frame

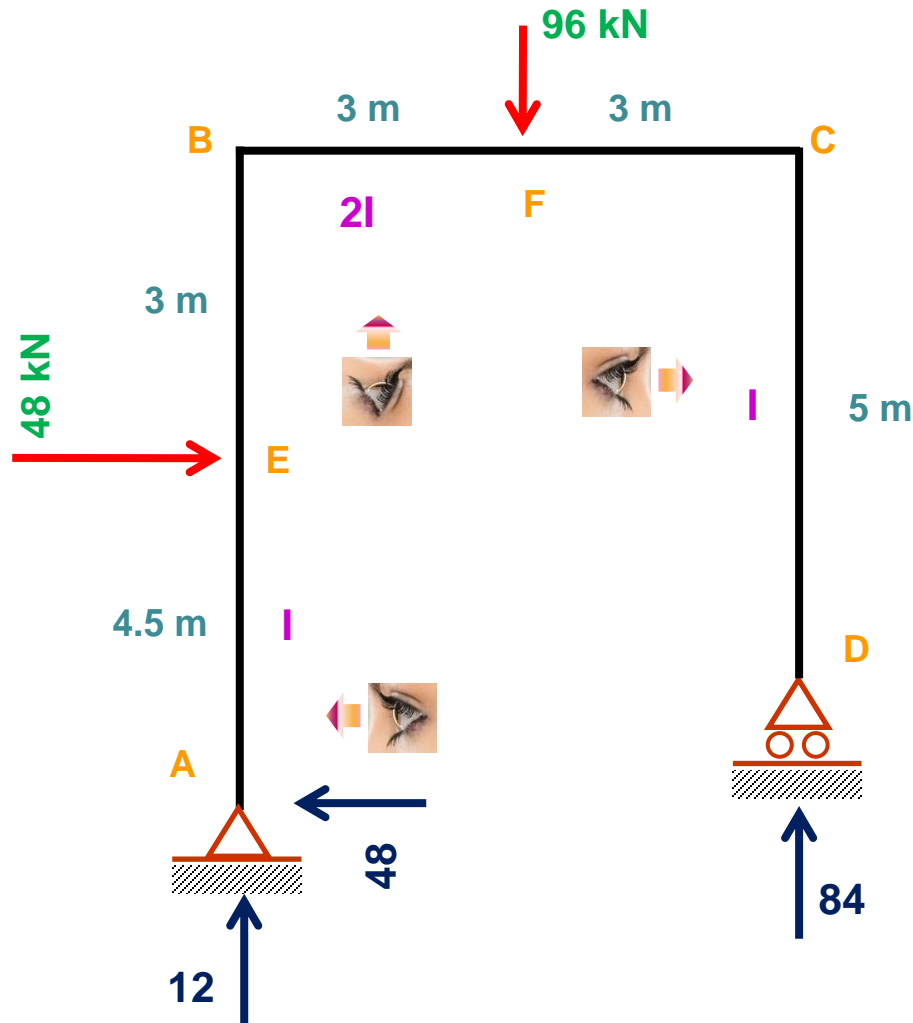
9th May, 2020

Portion	AE	BE	BF	CF	CD
Origin	A	B	B	C	C
Limit	0-4.5	0-3	0-3	0-3	0-5
I	1	1	2	2	1
M			?		
$m_{\theta A}$?		
$m_{\theta B}$?		
$m_{\theta C}$?		
$m_{\theta D}$?		

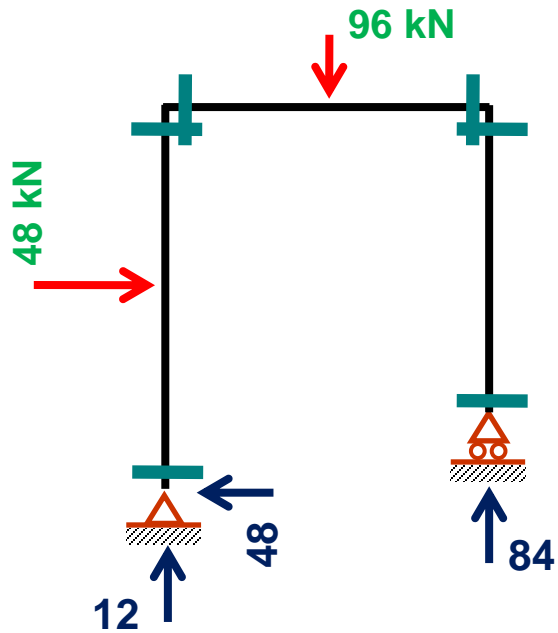


PROBLEM

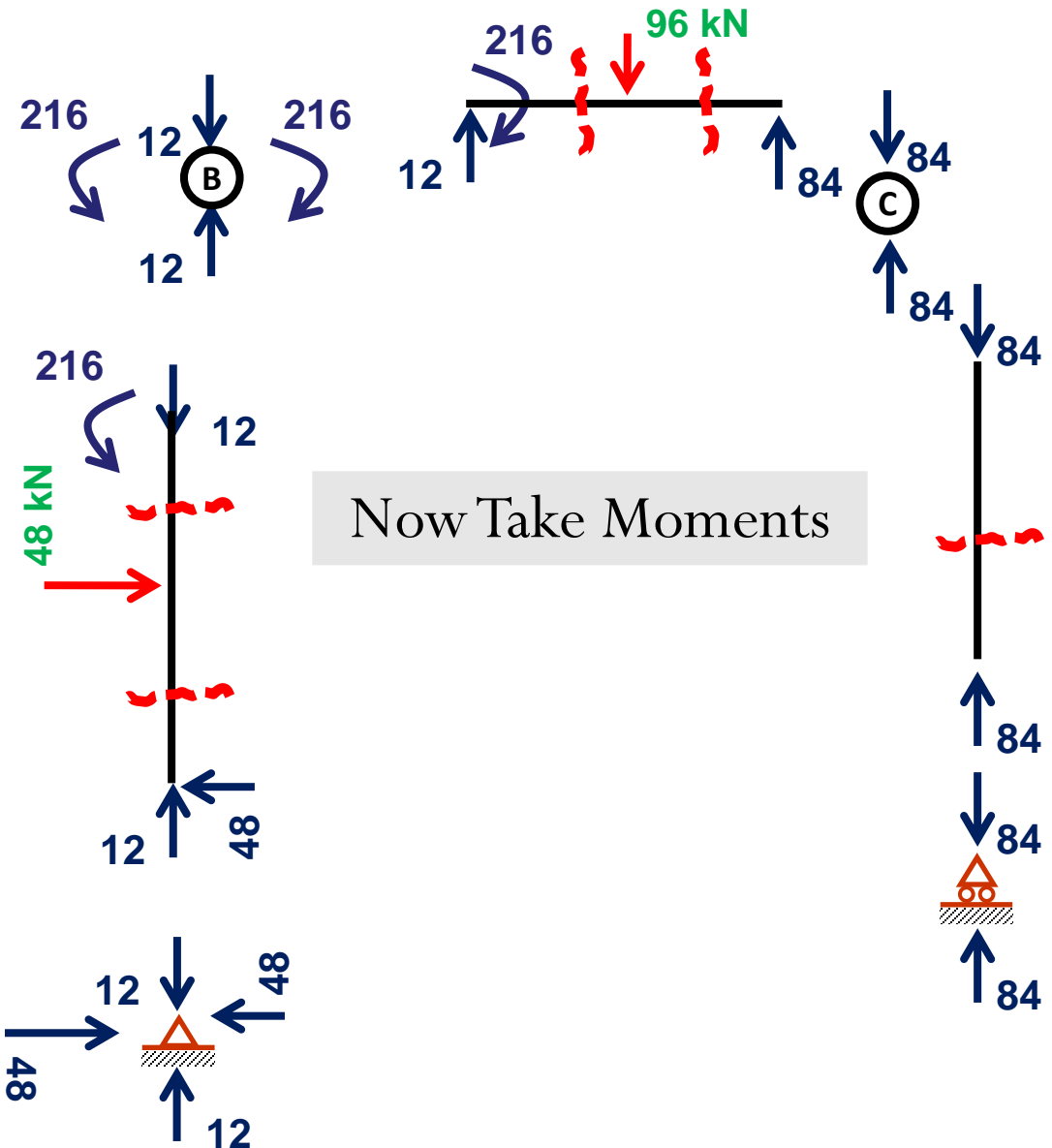
Direction of Vision At the Time of Moment Calculation



Free Body Diagram
For **Applied Load**



Assure **Joints** and
Members Equilibrium



Now Take Moments



Unit Load Method/Frame

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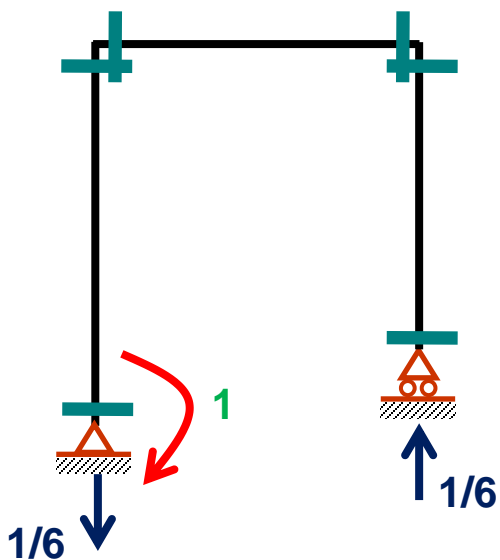
Portion	AE	BE	BF	CF	CD
Origin	A	B	B	C	C
Limit	0-4.5	0-3	0-3	0-3	0-5
I	1	1	2	2	1
M	48x	216	12x+216	84x	0
$m_{\theta A}$?		
$m_{\theta B}$?		
$m_{\theta C}$?		
$m_{\theta D}$?		



Unit Load Method/Frame

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Free Body Diagram
For **Rotation at A**

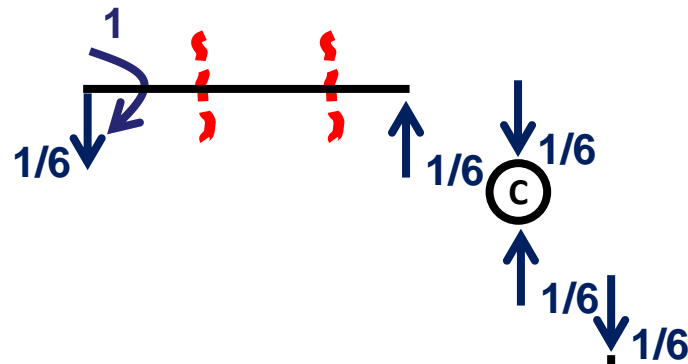
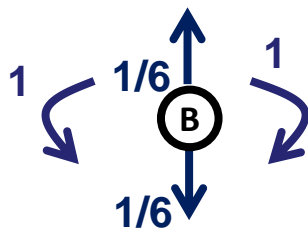


$$\sum M_A = 0$$

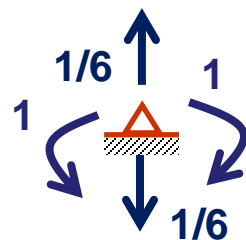
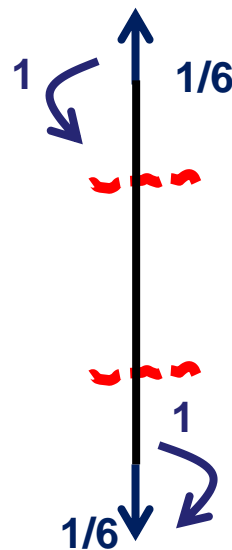
$$R_D = 1/6$$

$$\sum f_y = 0$$

$$R_A = 1/6$$



Now Take Moments





Unit Load Method/Frame

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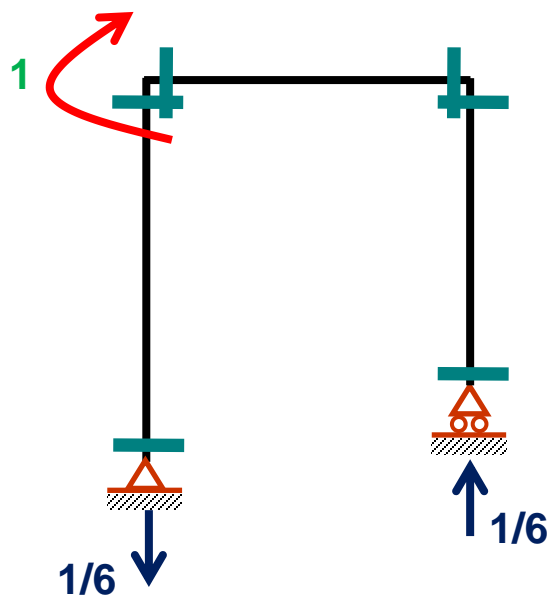
Portion	AE	BE	BF	CF	CD
Origin	A	B	B	C	C
Limit	0-4.5	0-3	0-3	0-3	0-5
I	1	1	2	2	1
M	48x	216	12x+216	84x	0
$m_{\theta A}$	1	1	$1-(x/6)$	$x/6$	0
$m_{\theta B}$?		
$m_{\theta C}$?		
$m_{\theta D}$?		



Unit Load Method/Frame

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Free Body Diagram
For **Rotation at B**

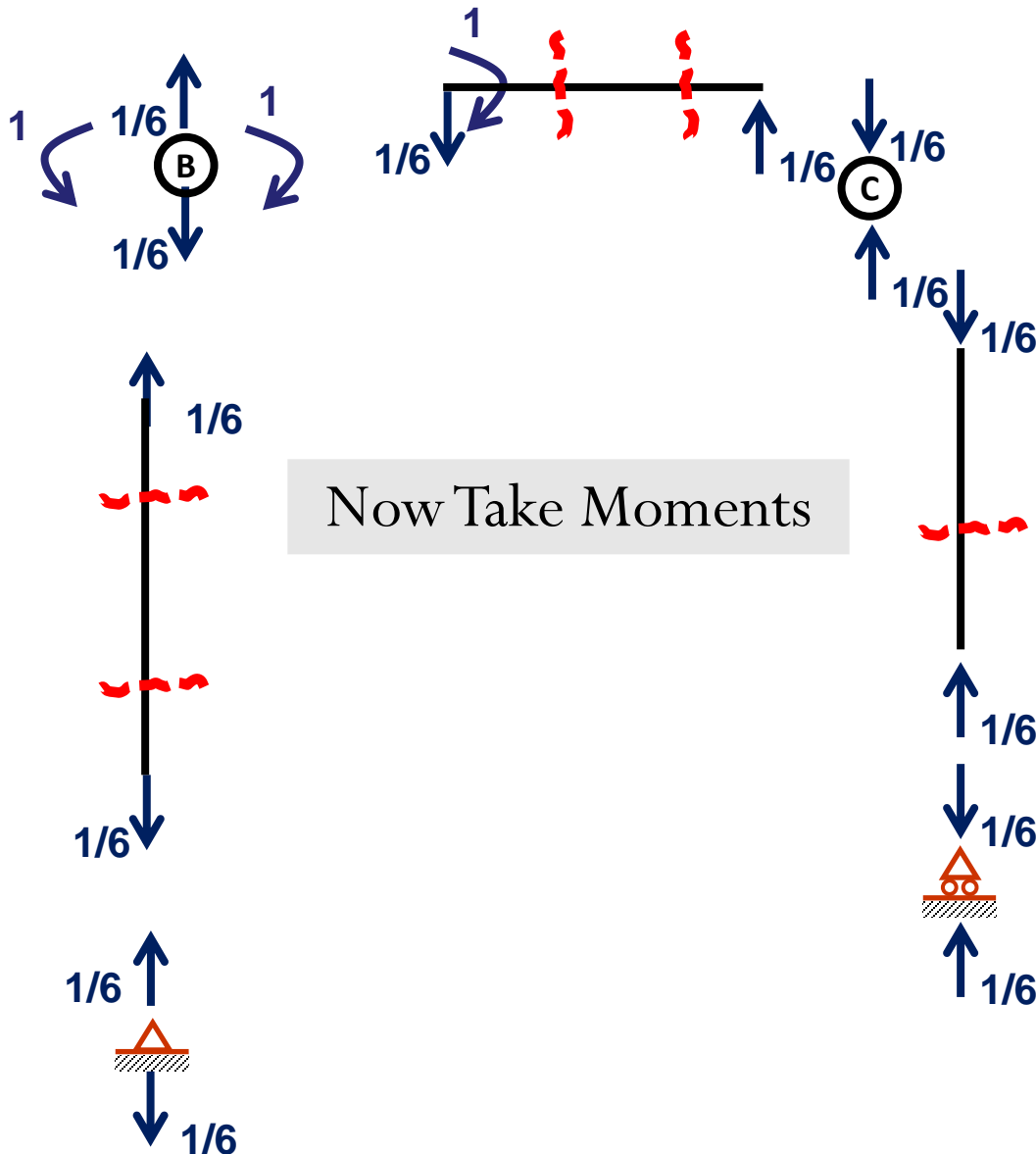


$$\sum M_A = 0$$

$$R_D = 1/6$$

$$\sum f_y = 0$$

$$R_A = 1/6$$





Unit Load Method/Frame

9th May, 2020

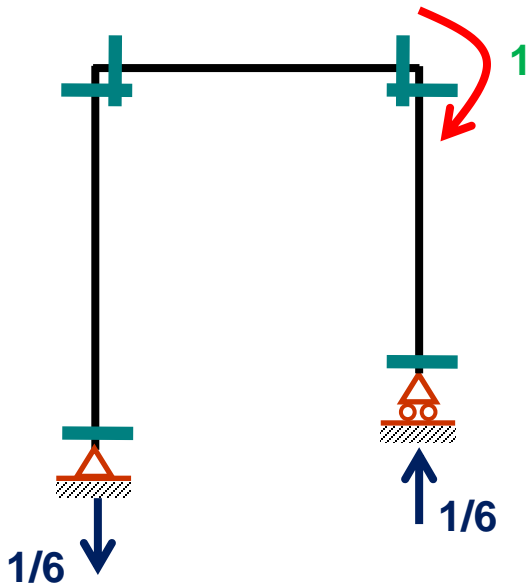
Portion	AE	BE	BF	CF	CD
Origin	A	B	B	C	C
Limit	0-4.5	0-3	0-3	0-3	0-5
I	1	1	2	2	1
M	48x	216	12x+216	84x	0
$m_{\theta A}$	1	1	$1-(x/6)$	$x/6$	0
$m_{\theta B}$	0	0	$1-(x/6)$	$x/6$	0
$m_{\theta C}$?		
$m_{\theta D}$?		



Unit Load Method/Frame

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Free Body Diagram
For **Rotation at C**

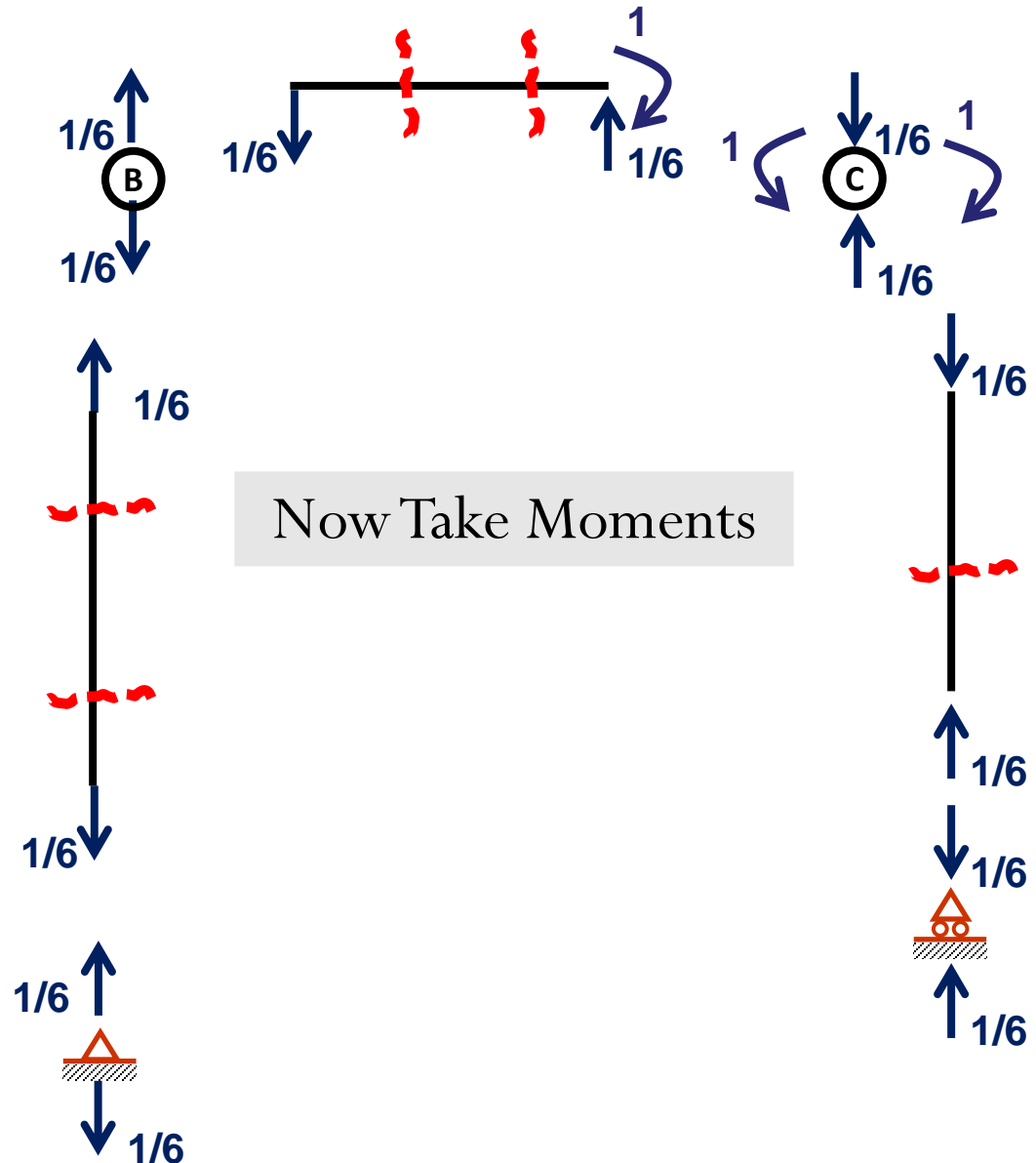


$$\sum M_A = 0$$

$$R_D = 1/6$$

$$\sum f_y = 0$$

$$R_A = 1/6$$





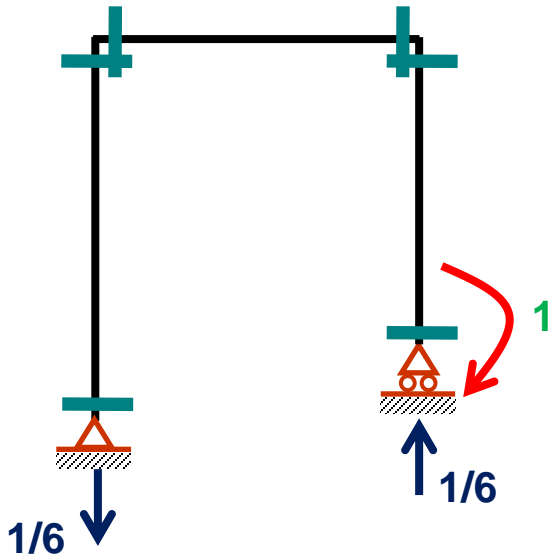
Unit Load Method/Frame

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Portion	AE	BE	BF	CF	CD
Origin	A	B	B	C	C
Limit	0-4.5	0-3	0-3	0-3	0-5
I	1	1	2	2	1
M	48x	216	12x+216	84x	0
$m_{\theta A}$	1	1	$1-(x/6)$	$x/6$	0
$m_{\theta B}$	0	0	$1-(x/6)$	$x/6$	0
$m_{\theta C}$	0	0	$-(x/6)$	$(x/6)-1$	0
$m_{\theta D}$?		



Free Body Diagram For Rotation at D

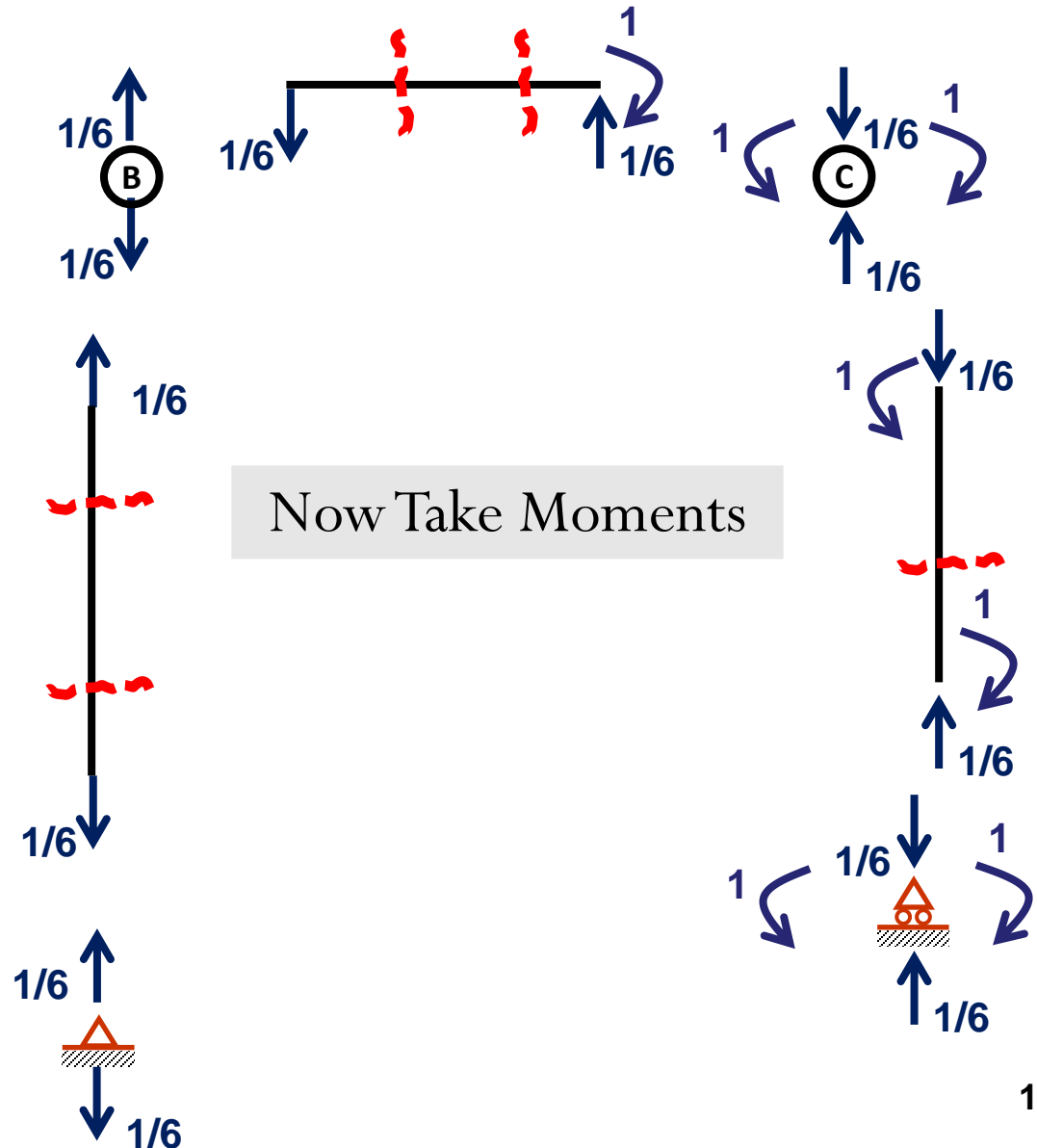


$$\sum M_A = 0$$

$$R_D = 1/6$$

$$\sum f_y = 0$$

$$R_A = 1/6$$





Unit Load Method/Frame

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Portion	AE	BE	BF	CF	CD
Origin	A	B	B	C	C
Limit	0-4.5	0-3	0-3	0-3	0-5
	1	1	2	2	1
<p>Now Integrate and Calculate....</p>					
$m_{\theta A}$	1	1	$1-(x/6)$	$x/6$	0
$m_{\theta B}$	0	0	$1-(x/6)$	$x/6$	0
$m_{\theta C}$	0	0	$-(x/6)$	$(x/6)-1$	0
$m_{\theta D}$	0	0	$-(x/6)$	$(x/6)-1$	-1



PROBLEM

13

Linear Deflection

Given

$$E = 200 \times 10^6 \text{ kN/m}^2$$

$$I = 160 \times 10^{-6} \text{ m}^4$$

Findings

$$\Delta_A, \Delta_B, \Delta_C, \Delta_D$$

$$\sum M_A = 0$$

$$48 \times 4.5 + 96 \times 3 = R_D \times 6$$

$$\sum f_y = 0$$

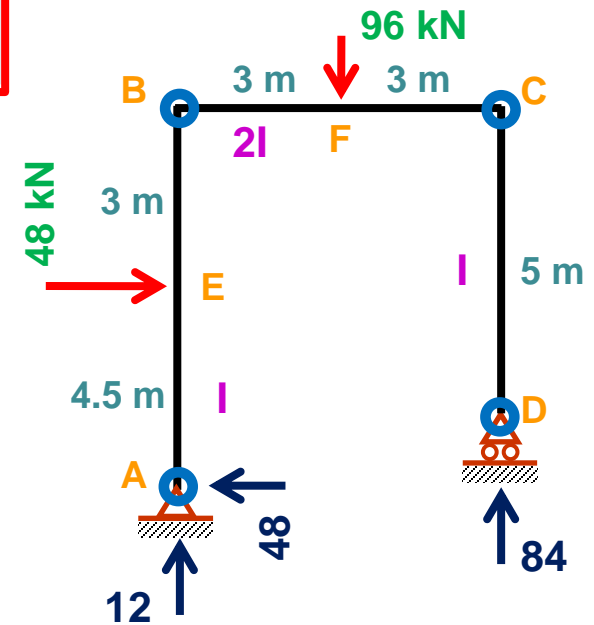
$$R_A + 84 = 96$$

$$\sum f_x = 0$$

$$H_A = 48$$

$$R_D = 84$$

$$R_A = 12$$



$$\Delta_A = 0$$



Unit Load Method/Frame

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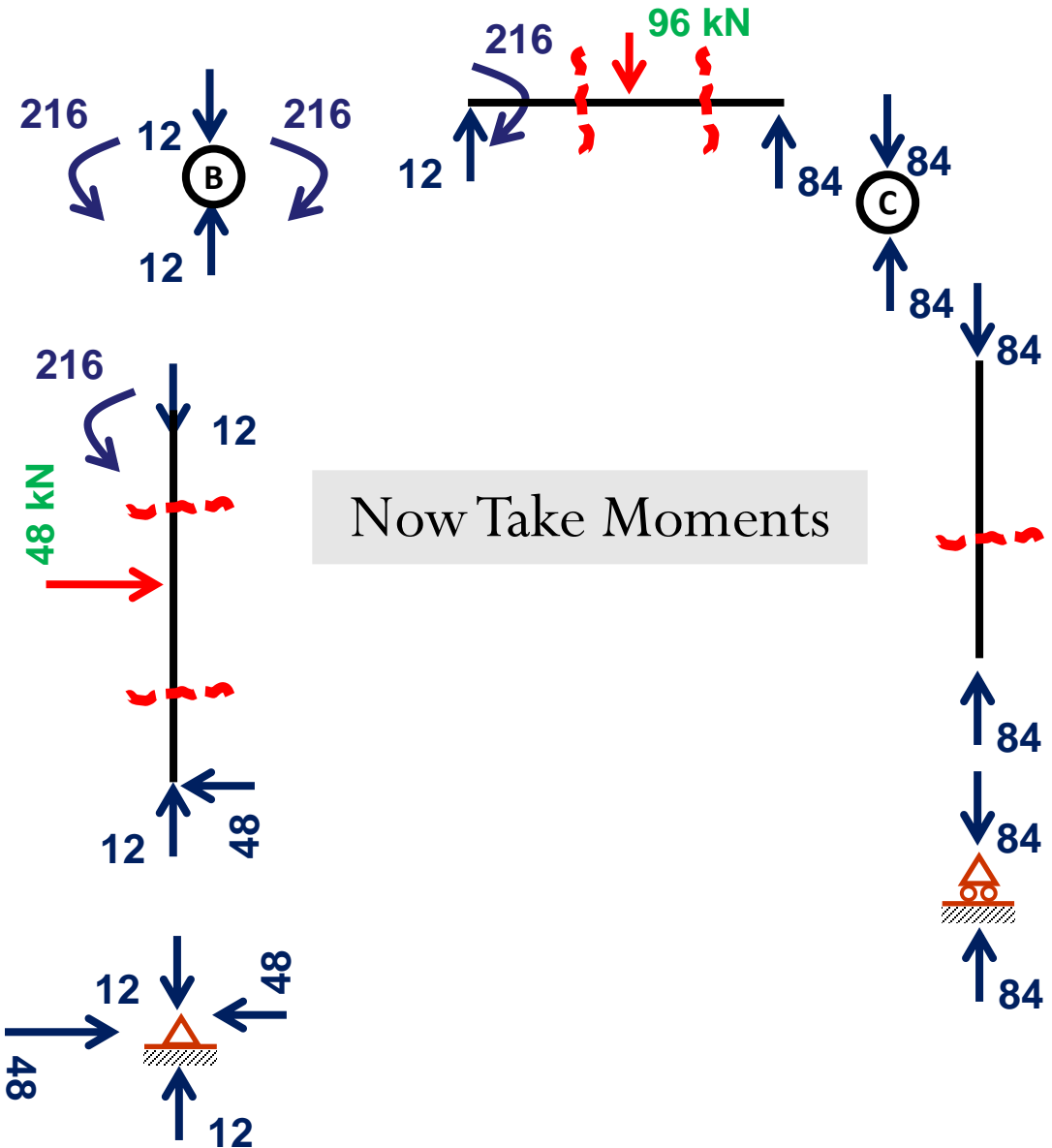
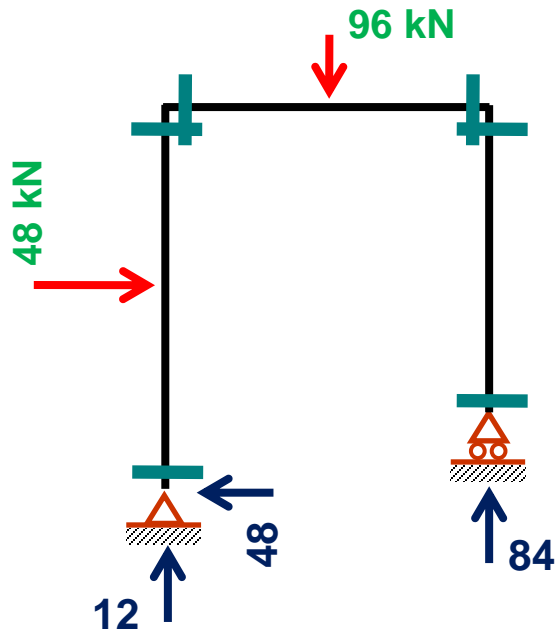
Portion	AE	BE	BF	CF	CD
Origin	A	B	B	C	C
Limit	0-4.5	0-3	0-3	0-3	0-5
I	1	1	2	2	1
M			?		
$m_{\Delta B}$?		
$m_{\Delta C}$?		
$m_{\Delta D}$?		



Unit Load Method/Frame

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Free Body Diagram
For **Applied Load**





Unit Load Method/Frame

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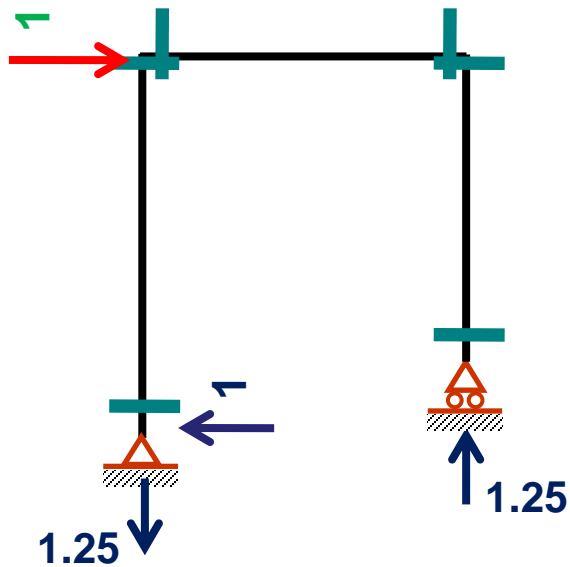
Portion	AE	BE	BF	CF	CD
Origin	A	B	B	C	C
Limit	0-4.5	0-3	0-3	0-3	0-5
I	1	1	2	2	1
M	48x	216	12x+216	84x	0
$m_{\Delta B}$?		
$m_{\Delta C}$?		
$m_{\Delta D}$?		



Unit Load Method/Frame

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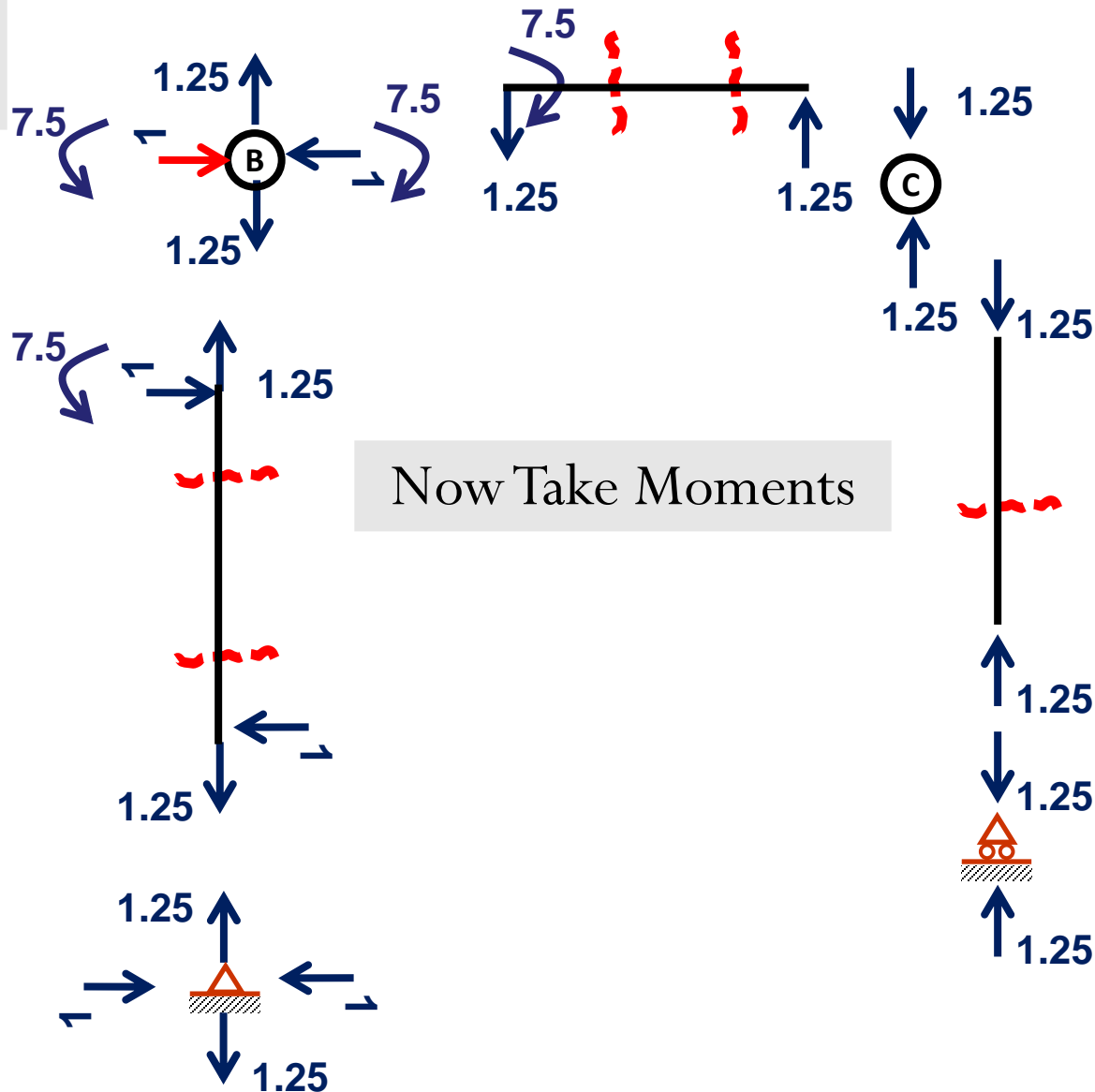
Free Body Diagram
For **Unit Load at B**



$$\sum M_A = 0 \quad R_D = 1.25$$

$$\sum f_y = 0 \quad R_A = 1.25$$

$$\sum f_x = 0 \quad H_A = 1$$



Now Take Moments



Unit Load Method/Frame

9th May, 2020

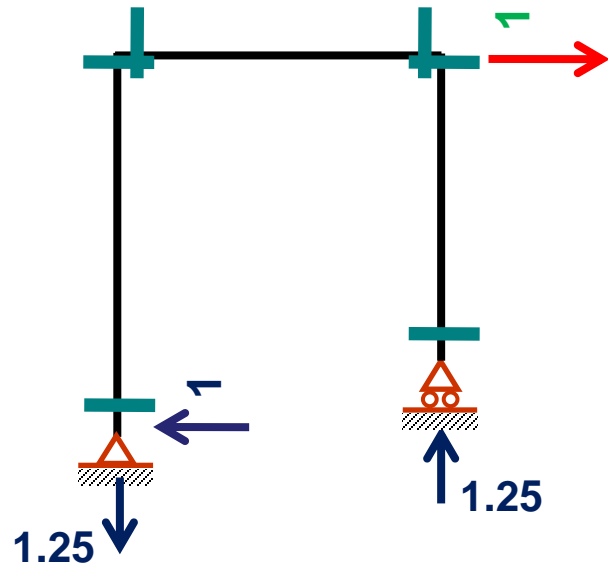
Portion	AE	BE	BF	CF	CD
Origin	A	B	B	C	C
Limit	0-4.5	0-3	0-3	0-3	0-5
I	1	1	2	2	1
M	48x	216	12x+216	84x	0
$m_{\Delta B}$	x	7.5-x	7.5-1.25x	1.25x	0
$m_{\Delta C}$?		
$m_{\Delta D}$?		



Unit Load Method/Frame

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Free Body Diagram
For Unit Load at C



$$\sum M_A = 0$$

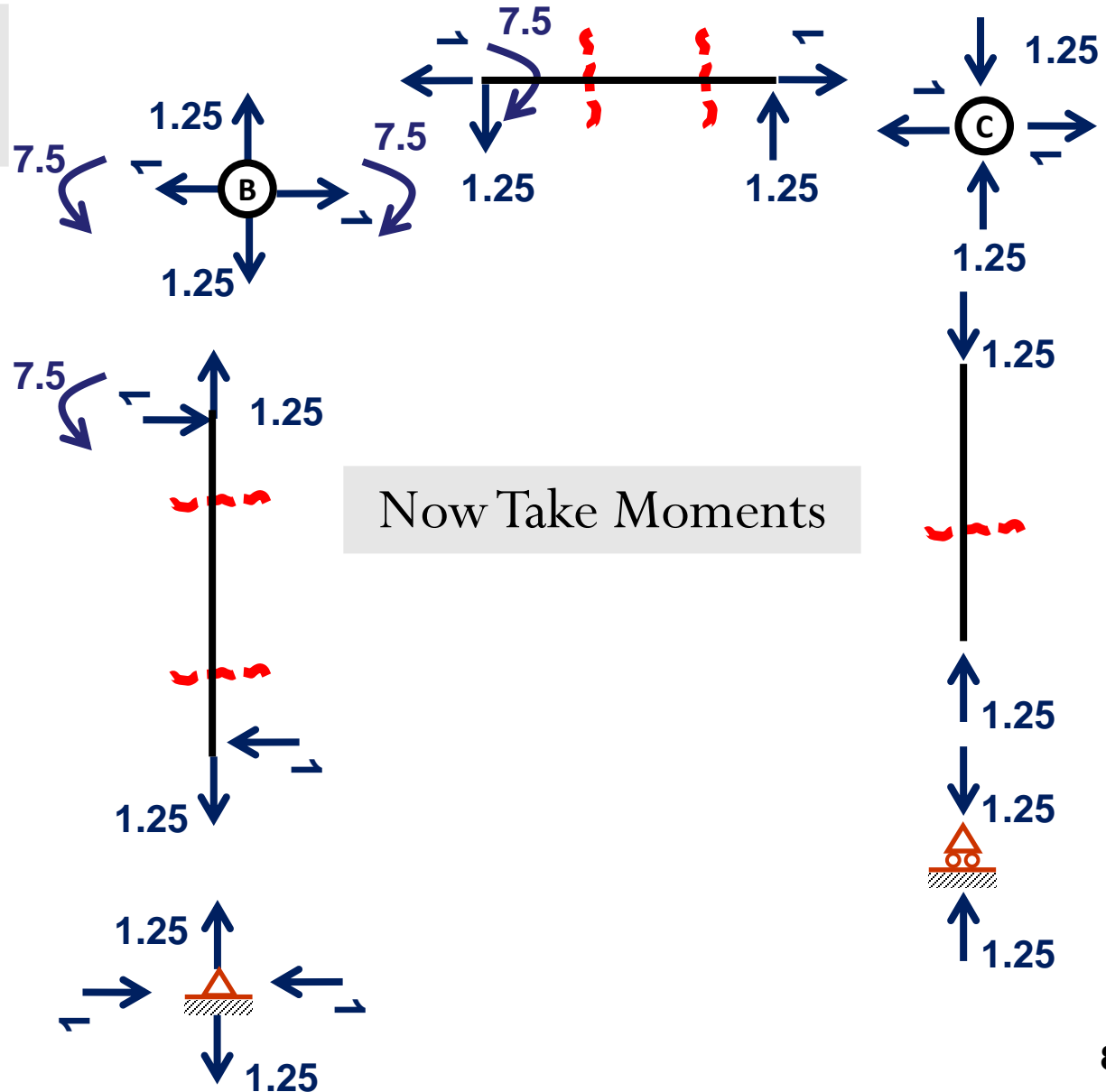
$$R_D = 1.25$$

$$\sum f_y = 0$$

$$R_A = 1.25$$

$$\sum f_x = 0$$

$$H_A = 1$$



Now Take Moments



Unit Load Method/Frame

9th May, 2020

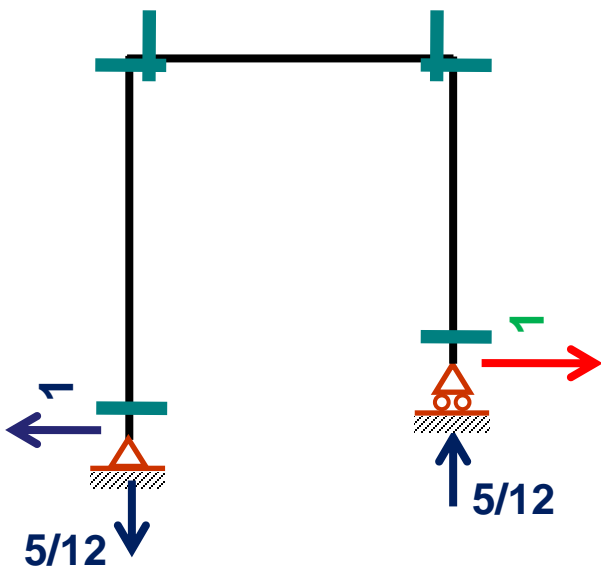
Portion	AE	BE	BF	CF	CD
Origin	A	B	B	C	C
Limit	0-4.5	0-3	0-3	0-3	0-5
I	1	1	2	2	1
M	48x	216	12x+216	84x	0
$m_{\Delta B}$	x	7.5-x	7.5-1.25x	1.25x	0
$m_{\Delta C}$	x	7.5-x	7.5-1.25x	1.25x	0
$m_{\Delta D}$?		



Unit Load Method/Frame

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Free Body Diagram
For **Unit Load at D**



$$\sum M_A = 0$$

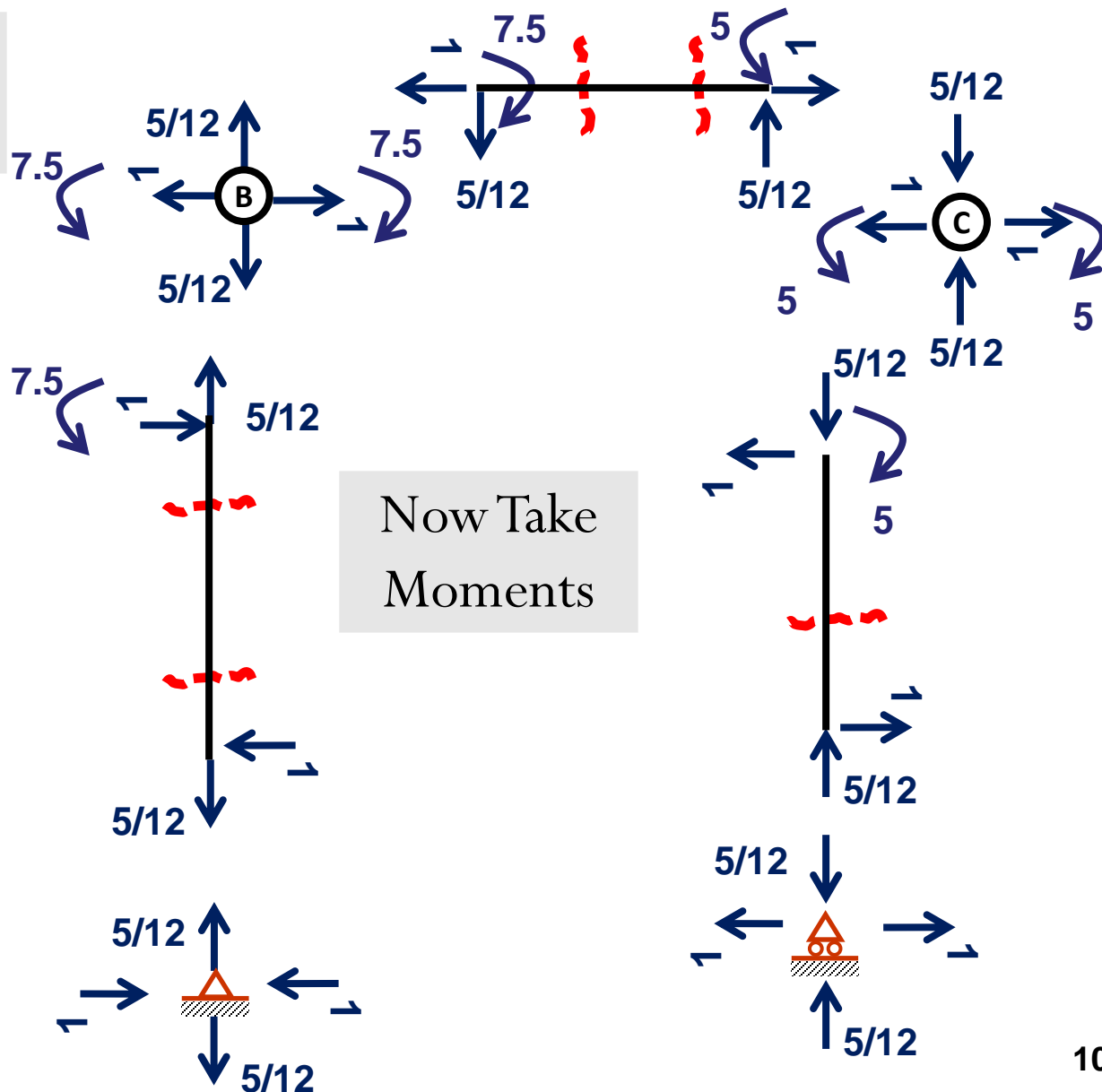
$$R_D = \frac{5}{12}$$

$$\sum f_y = 0$$

$$R_A = \frac{5}{12}$$

$$\sum f_x = 0$$

$$H_A = 1$$



Now Take
Moments



Unit Load Method/Frame

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Portion	AE	BE	BF	CF	CD
Origin	A	B	B	C	C
Limit	0-4.5	0-3	0-3	0-3	0-5
<h2 style="color: magenta;">Now Integrate and Calculate....</h2>					
M	48x	216	12x+216	84x	0
$m_{\Delta B}$	x	7.5-x	7.5-1.25x	1.25x	0
$m_{\Delta C}$	x	7.5-x	7.5-1.25x	1.25x	0
$m_{\Delta D}$	x	7.5-x	7.5-(5/12)x	5+(5/12)x	5-(1.x)



PROBLEM

14

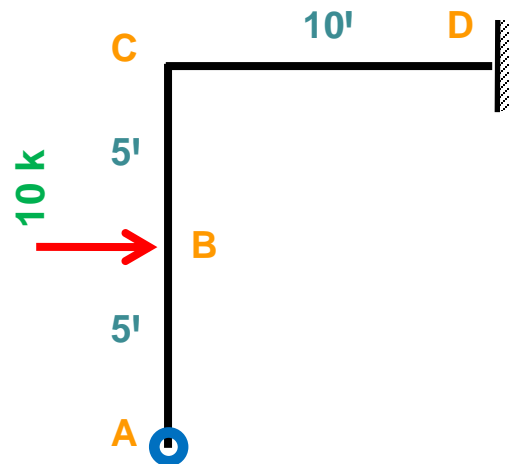
Linear/Rotational Deflection

Given

$E = 30000 \text{ ksi}$
 $I = 1000 \text{ in}^4$

Findings

$\Delta_{AH}, \Delta_{AV}, \theta_A$

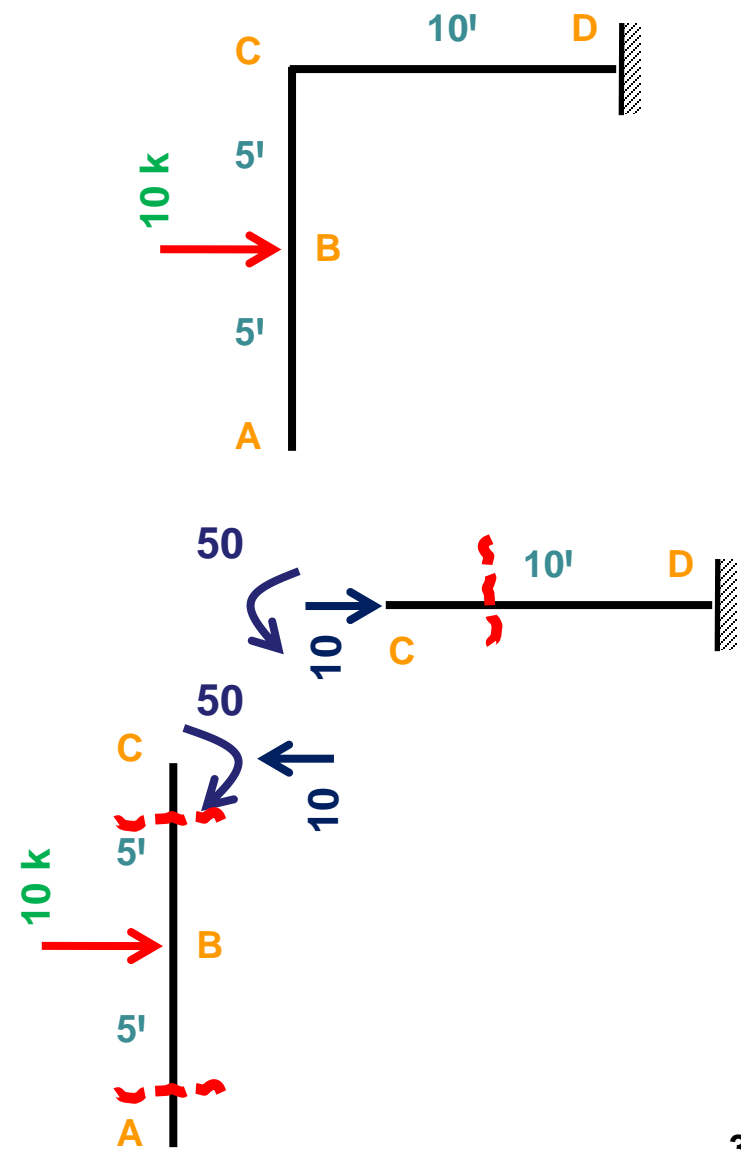




Unit Load Method/Frame

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Portion	AB	BC	CD
Origin	A	B	C
Limit	0-5	0-5	0-10
M	0	-10x	-50
$m_{\Delta AH}$?	
$m_{\Delta AV}$?	
$m_{\theta A}$?	

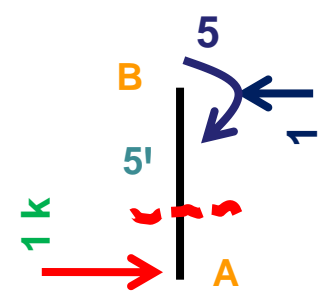
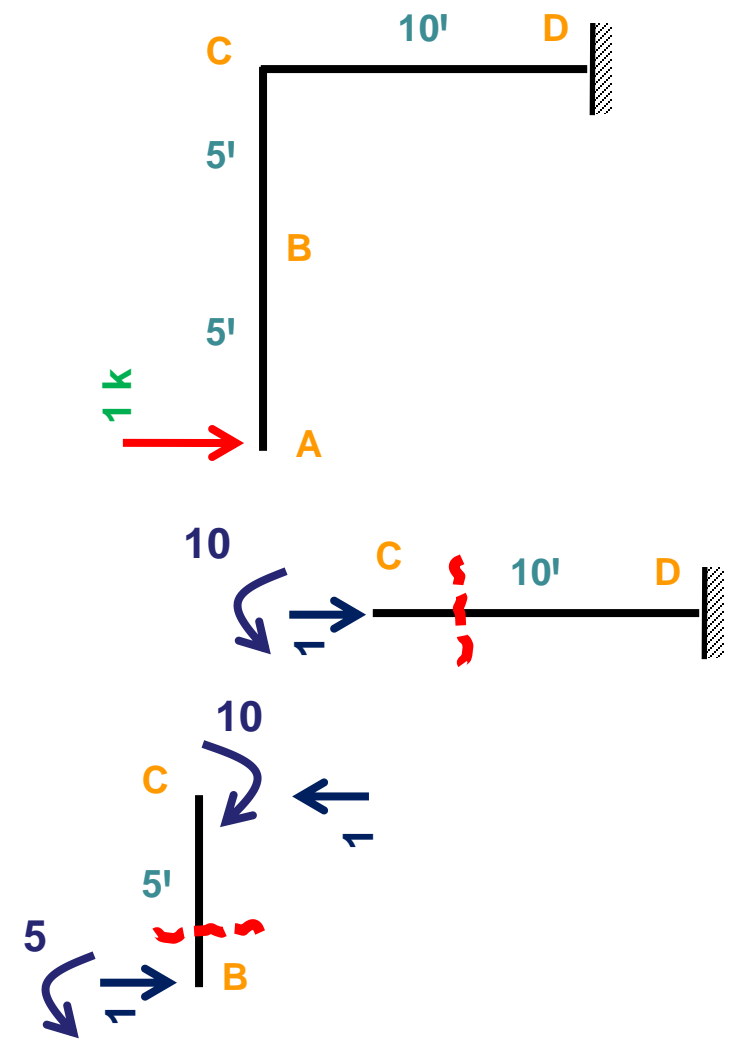




Unit Load Method/Frame

9th May, 2020

Portion	AB	BC	CD
Origin	A	B	C
Limit	0-5	0-5	0-10
M	0	-10x	-50
$m_{\Delta AH}$	-1.x	-1.x-5	-10
$m_{\Delta AV}$?	
$m_{\theta A}$?	

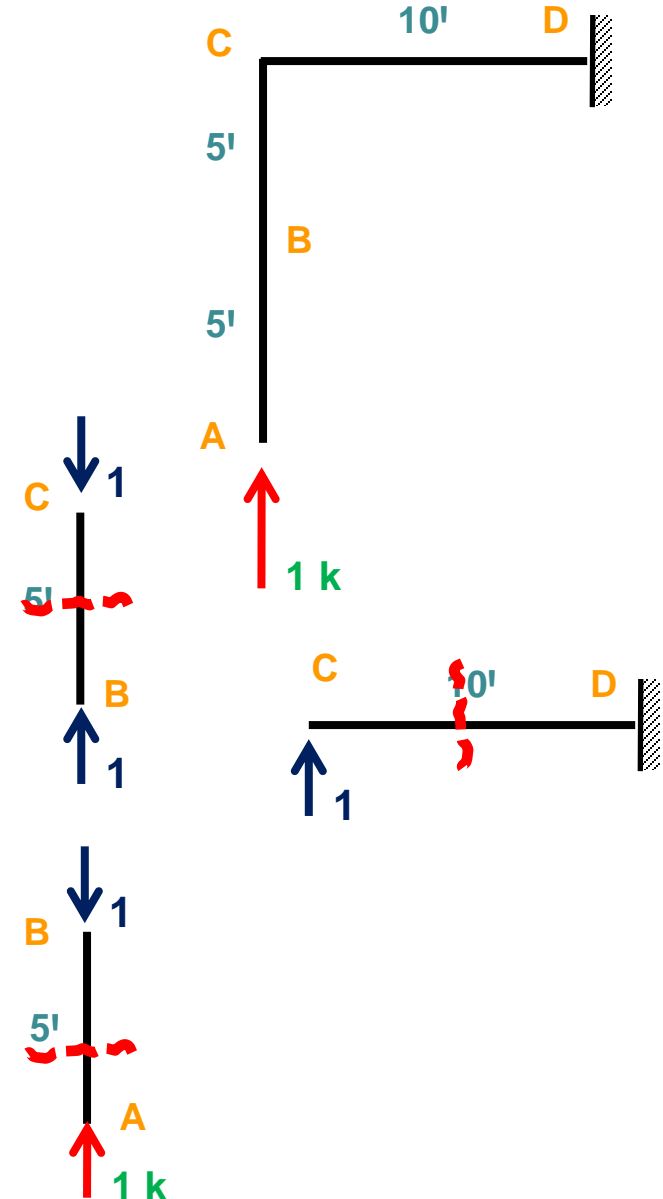




Unit Load Method/Frame

9th May, 2020

Portion	AB	BC	CD
Origin	A	B	C
Limit	0-5	0-5	0-10
M	0	-10x	-50
$m_{\Delta AH}$	-1.x	-1.x-5	-10
$m_{\Delta AV}$	0	0	1.x
$m_{\theta A}$?	

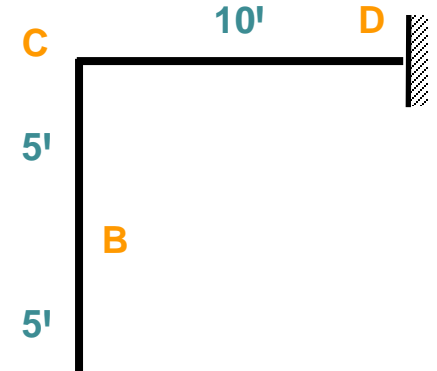




Unit Load Method/Frame

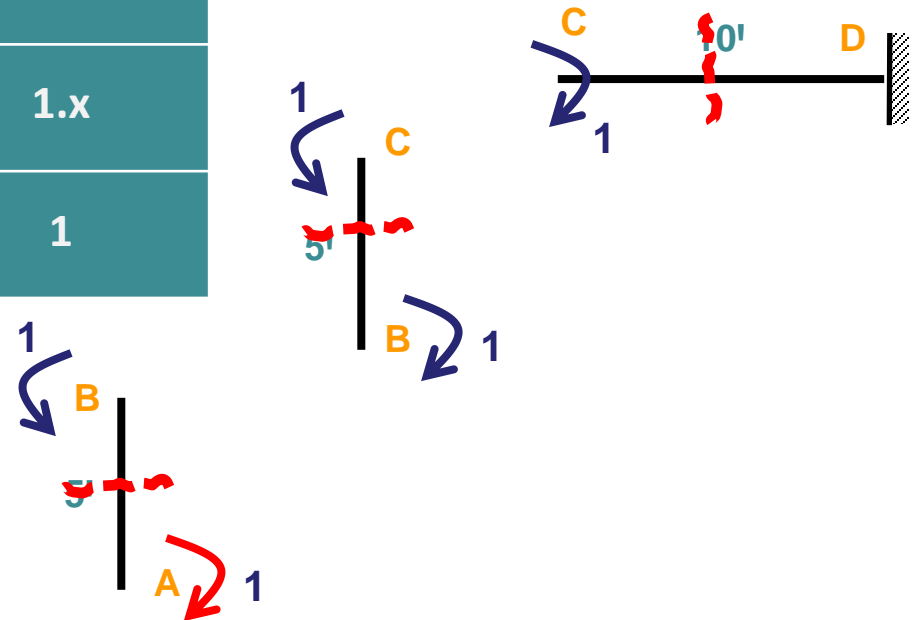
9th May, 2020

Portion	AB	BC	CD
Origin	A	B	C
Limit	0-5	0-5	0-10



Now Integrate and Calculate....

$m_{\Delta AH}$	$-1.x$	$-1.x-5$	-10
$m_{\Delta AV}$	0	0	$1.x$
$m_{\theta A}$	1	1	1





PROBLEM

15

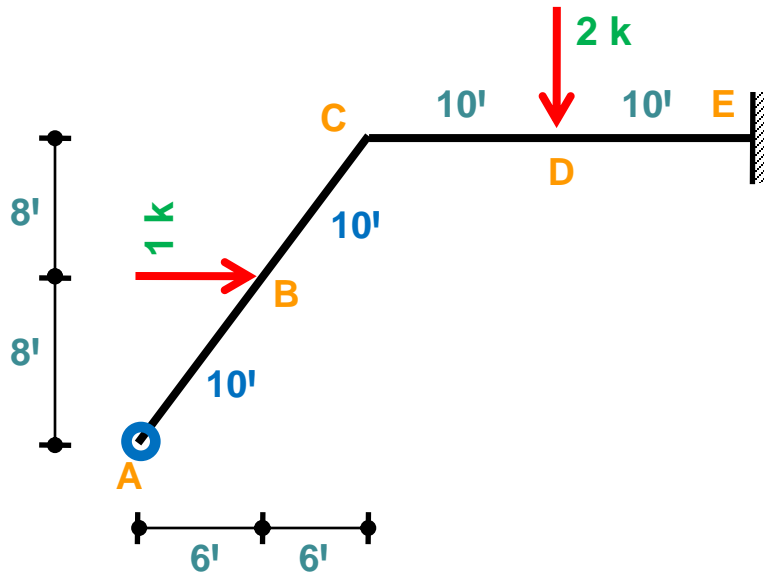
Linear/Rotational Deflection

Given

$E = 30000 \text{ ksi}$
 $I = 1000 \text{ in}^4$

Findings

$\Delta_{AH}, \Delta_{AV}, \theta_A$



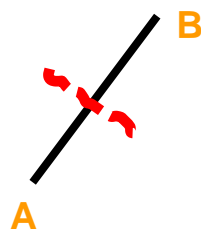
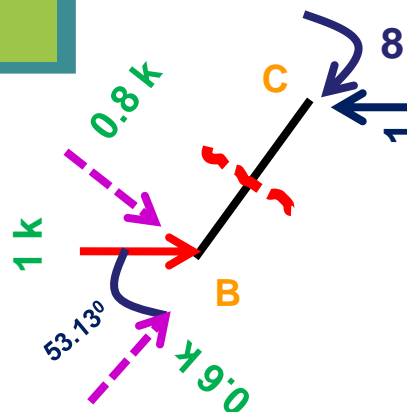
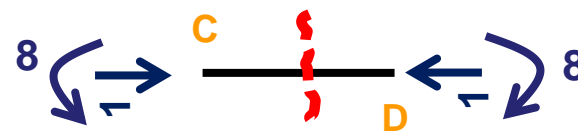
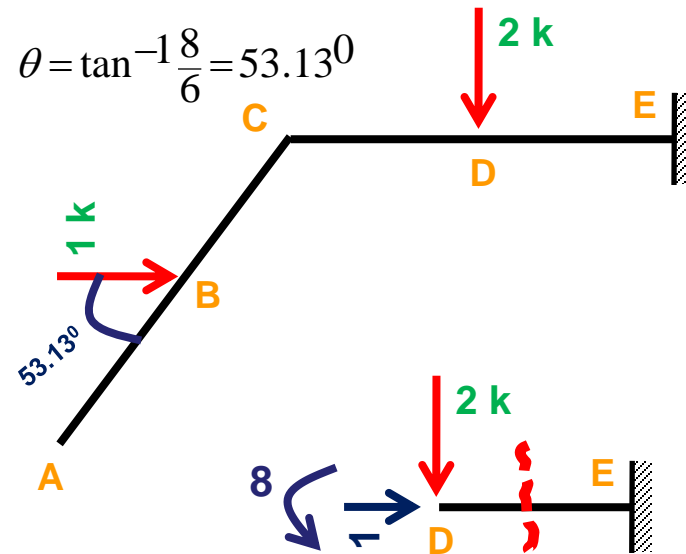
$$AB = BC = \sqrt{6^2 + 8^2} = 10$$



Unit Load Method/Frame

9th May, 2020

Portion	AB	BC	CD	DE
Origin	A	B	C	D
Limit	0-10	0-10	0-10	0-10
M	0	-0.8x	-8	-8-2x
$m_{\Delta AH}$?	
$m_{\Delta AV}$?	
$m_{\theta A}$?	

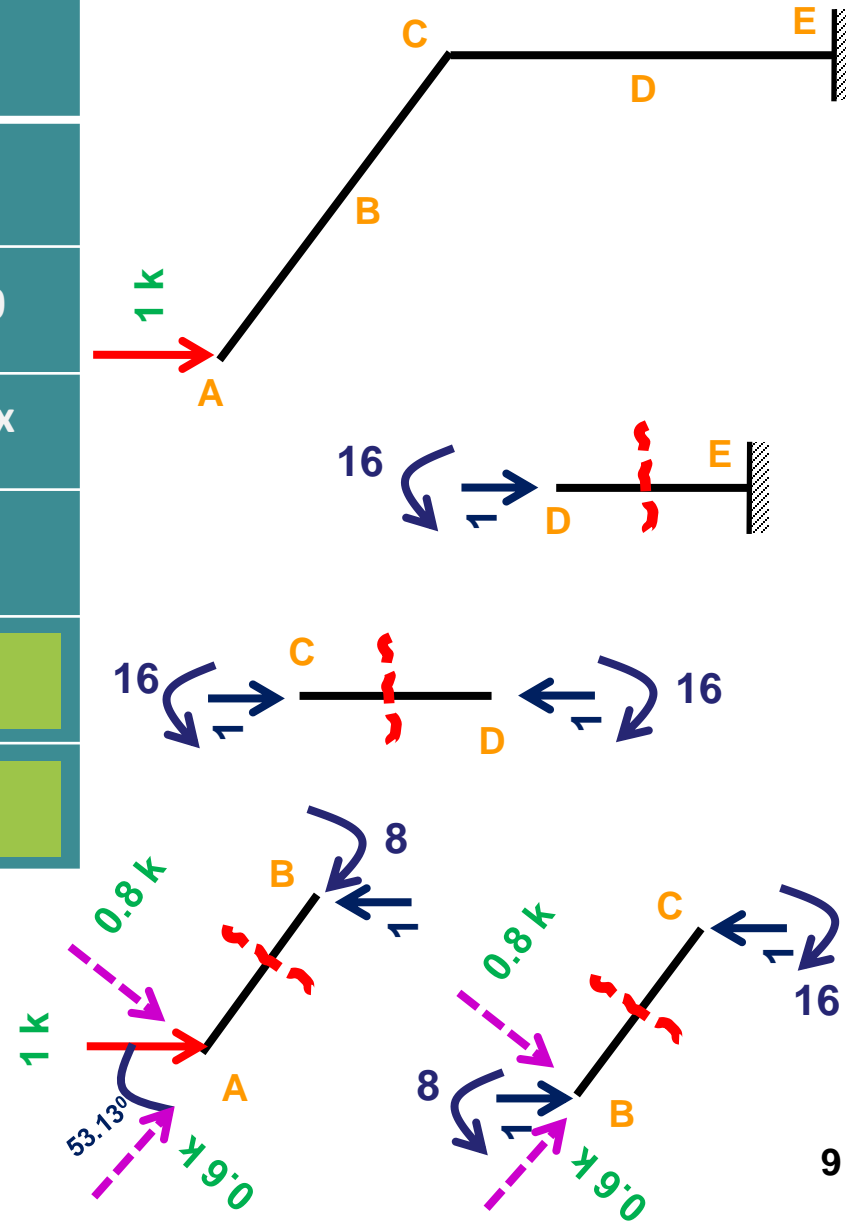




Unit Load Method/Frame

9th May, 2020

Portion	AB	BC	CD	DE
Origin	A	B	C	D
Limit	0-10	0-10	0-10	0-10
M	0	$-0.8x$	-8	$-8-2x$
$m_{\Delta AH}$	$-0.8x$	$-0.8x-8$	-16	-16
$m_{\Delta AV}$?	
$m_{\theta A}$?	

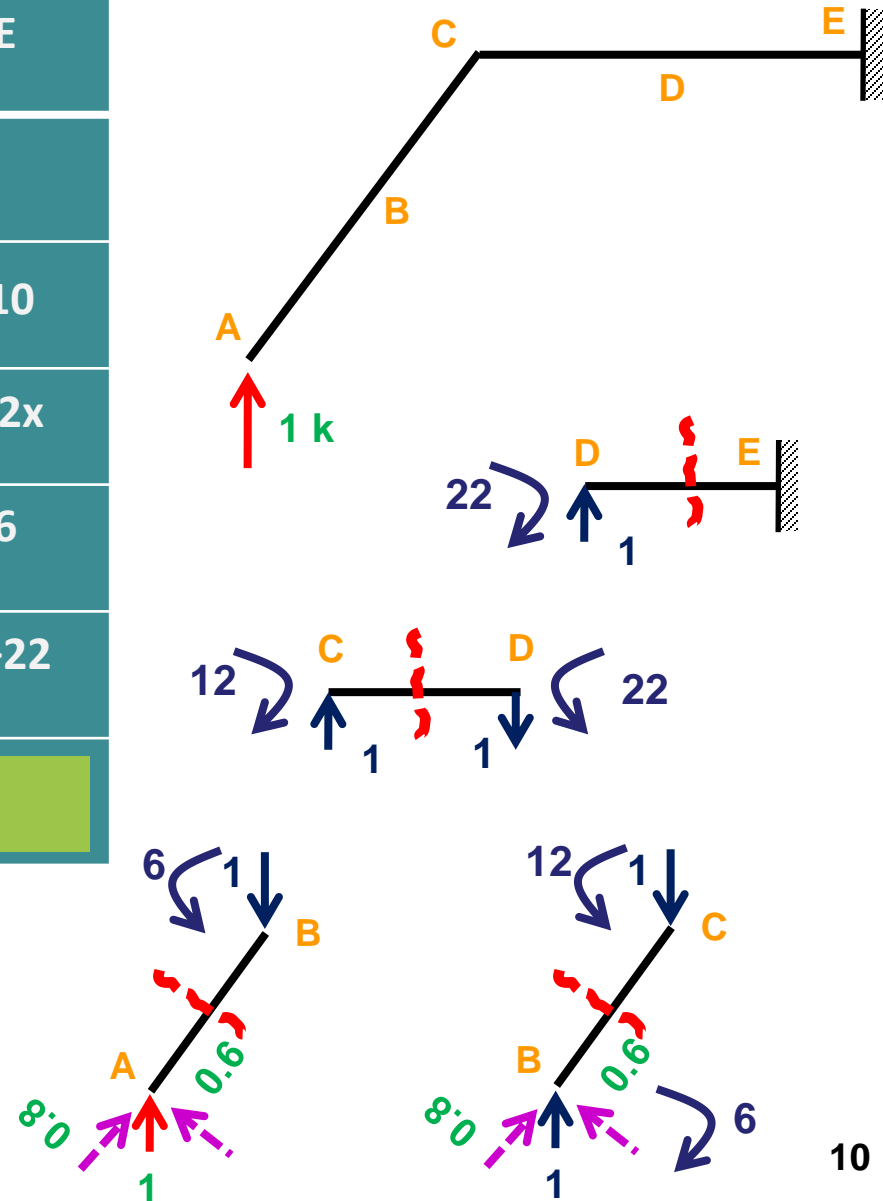




Unit Load Method/Frame

9th May, 2020

Portion	AB	BC	CD	DE
Origin	A	B	C	D
Limit	0-10	0-10	0-10	0-10
M	0	$-0.8x$	-8	$-8-2x$
$m_{\Delta AH}$	$-0.8x$	$-0.8x-8$	-16	-16
$m_{\Delta AV}$	$0.6x$	$0.6x+6$	$1.x+12$	$1.x+22$
$m_{\theta A}$?	

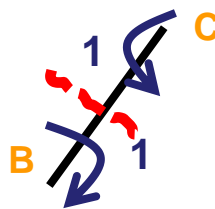
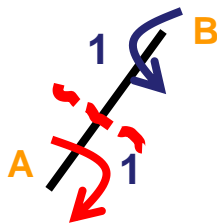
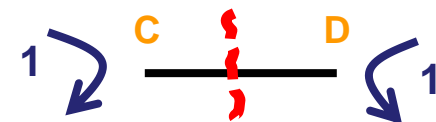
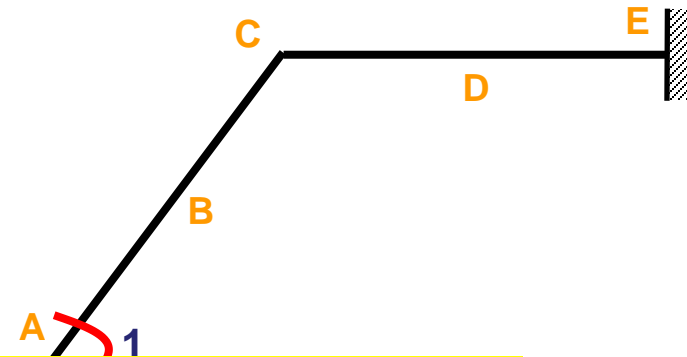




Unit Load Method/Frame

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Portion	AB	BC	CD	DE
Origin	A	B	C	D
Limit	0-10	0-10	0-10	0-10
M	Now Integrate and Calculate....			
$m_{\Delta AH}$	-0.8x	-0.8x-8	-16	-16
$m_{\Delta AV}$	0.6x	0.6x+6	1.x+12	1.x+22
$m_{\theta A}$	1	1	1	1





CE 3213

9th May, 2020

UNIT LOAD METHOD/TRUSS

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Professor, CE, RUET



Basic Formula

$$\Delta = \sum udL$$

$$dL = \frac{PL}{AE} = \frac{SL}{AE}$$

S = Axial Force in Member

A = Cross sectional Area of Member

L = Length of the Member

$$\Delta = \sum \frac{SuL}{AE}$$



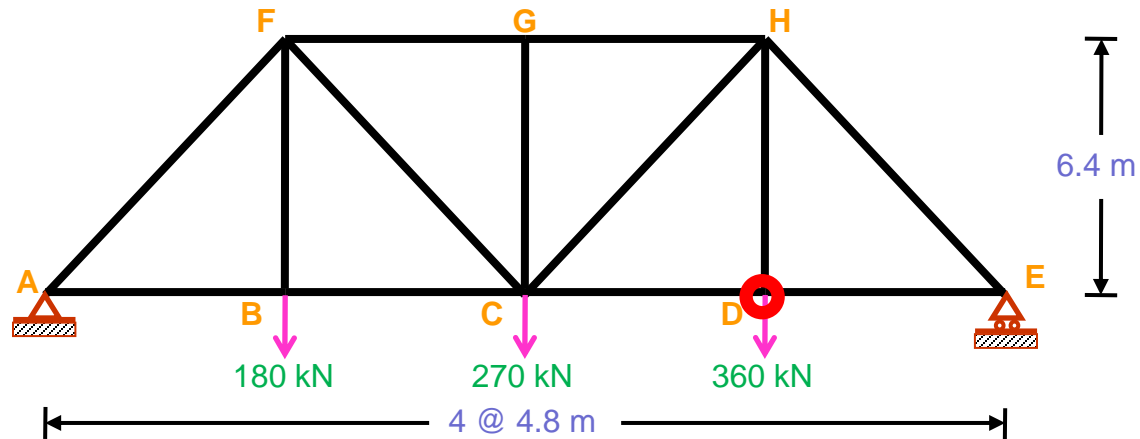
Unit Load/Truss/Horizontal- Vertical Deflection

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PROBLEM

16

Linear Deflection



Given

$$A = 5 \times 10^{-3} \text{ m}^2$$
$$E = 200 \times 10^6 \text{ kN/m}^2$$

Findings

$$\Delta_{HD} \quad \Delta_{VD}$$



Unit Load/Truss/Horizontal- Vertical Deflection

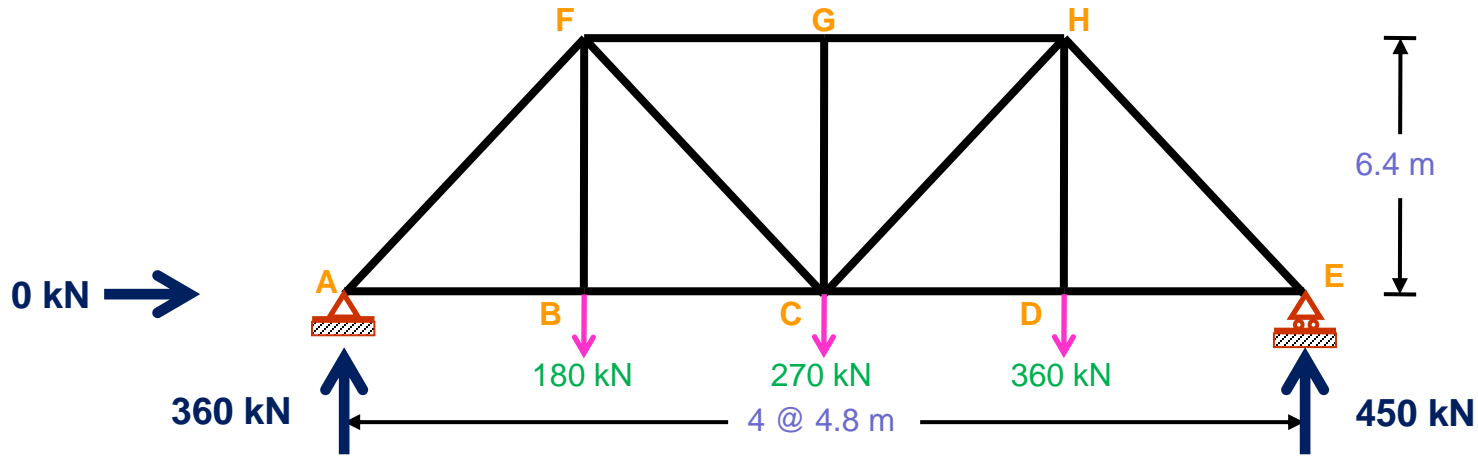
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Member	Length [m]	S [kN]	u_{VD} [kN]	u_{HD} [kN]	$Su_{VD}L/AE$	$Su_{HD}L/AE$
AF	8				----	----
FG	4.8				----	----
GH	4.8				----	----
HE	8				----	----
AB	4.8				----	----
BC	4.8				----	----
CD	4.8	?	?	?	----	----
DE	4.8				----	----
BF	6.4				----	----
CF	8				----	----
CG	6.4				----	----
CH	8				----	----
DH	6.4				----	----



Unit Load/Truss/Horizontal-Vertical Deflection

9th May, 2020



For S = ????/ Exists Applied Load

$$\sum M_A = 0 \quad 180 \times 4.8 + 270 \times 4.8 \times 2 + 360 \times 4.8 \times 3 = R_E \times 4.8 \times 4 \quad R_E = 450$$

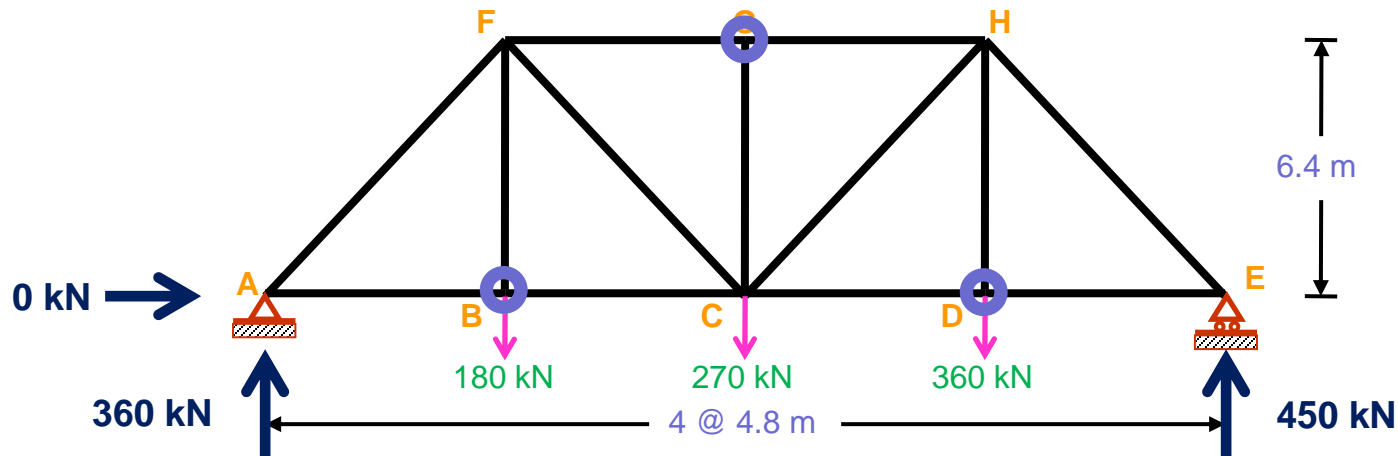
$$\sum f_y = 0 \quad R_A + R_E = 180 + 270 + 360 \quad R_A = 360$$

$$\sum f_x = 0 \quad H_A = 0$$



Unit Load/Truss/Horizontal- Vertical Deflection

9th May, 2020



Attack the
weak/Easy part

$$\text{joint } B, \sum f_y = 0$$

$$BF = +180$$

$$\text{joint } D, \sum f_y = 0$$

$$DH = +360$$

$$\text{joint } G, \sum f_y = 0$$

$$CG = 0$$



Unit Load/Truss/Horizontal- Vertical Deflection

9th May, 2020

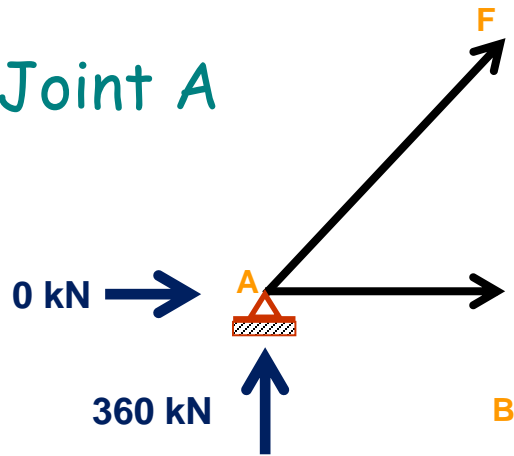
Member	Length [m]	S [kN]	u_{VD} [kN]	u_{HD} [kN]	$Su_{VD}L/AE$	$Su_{HD}L/AE$
AF	8				----	----
FG	4.8				----	----
GH	4.8				----	----
HE	8				----	----
AB	4.8				----	----
BC	4.8				----	----
CD	4.8				----	----
DE	4.8				----	----
BF	6.4	180			----	----
CF	8				----	----
CG	6.4	0			----	----
CH	8				----	----
DH	6.4	360			----	----



Unit Load/Truss/Horizontal-Vertical Deflection

9th May, 2020

Joint A



$$\text{joint A, } \sum f_y = 0$$

$$V_{AF} + 360 = 0$$

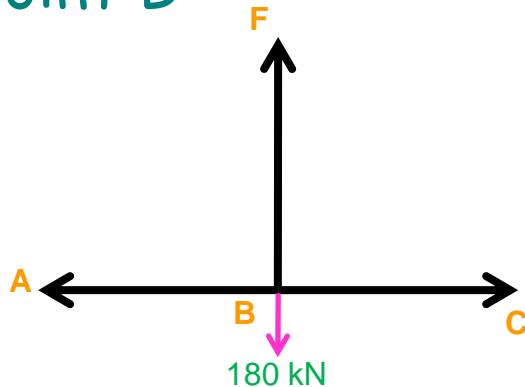
$$AF = -360 \times \frac{8}{6.4} = -450$$

$$\text{joint A, } \sum f_x = 0$$

$$AB = H_{AF}$$

$$AB = 450 \times \frac{4.8}{8} = 270$$

Joint B



$$\text{joint B, } \sum f_x = 0$$

$$AB = BC = 270$$



Unit Load/Truss/Horizontal- Vertical Deflection

9th May, 2020

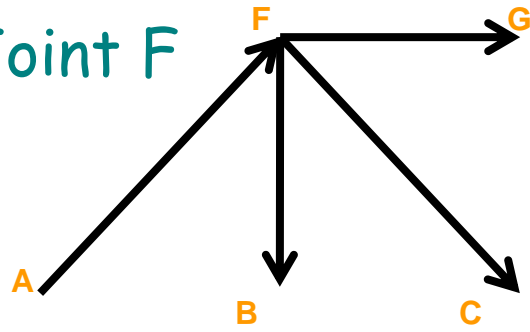
Member	Length [m]	S [kN]	u_{VD} [kN]	u_{HD} [kN]	$Su_{VD}L/AE$	$Su_{HD}L/AE$
AF	8	-450			----	----
FG	4.8				----	----
GH	4.8				----	----
HE	8				----	----
AB	4.8	270			----	----
BC	4.8	270			----	----
CD	4.8				----	----
DE	4.8				----	----
BF	6.4	180			----	----
CF	8				----	----
CG	6.4	0			----	----
CH	8				----	----
DH	6.4	360			----	----



Unit Load/Truss/Horizontal-Vertical Deflection

9th May, 2020

Joint F



$$\text{joint } F, \sum f_y = 0$$

$$V_{AF} - BF - V_{CF} = 0$$

$$450 \times \frac{6.4}{8} - 180 - V_{CF} = 0$$

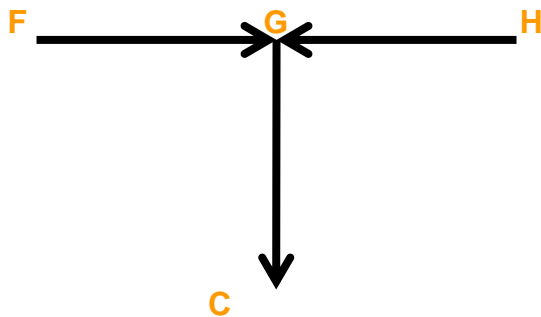
$$V_{CF} = 180$$

$$\text{joint } F, \sum f_x = 0$$

$$FG = -\left(H_{AF} + H_{CF}\right)$$

$$CF = 180 \times \frac{8}{6.4} = 225$$

$$FG = -\left(450 \times \frac{4.8}{8} + 225 \times \frac{4.8}{8}\right) = -405$$



$$\text{joint } G, \sum f_x = 0$$

$$FG = -405 = GH$$



Unit Load/Truss/Horizontal- Vertical Deflection

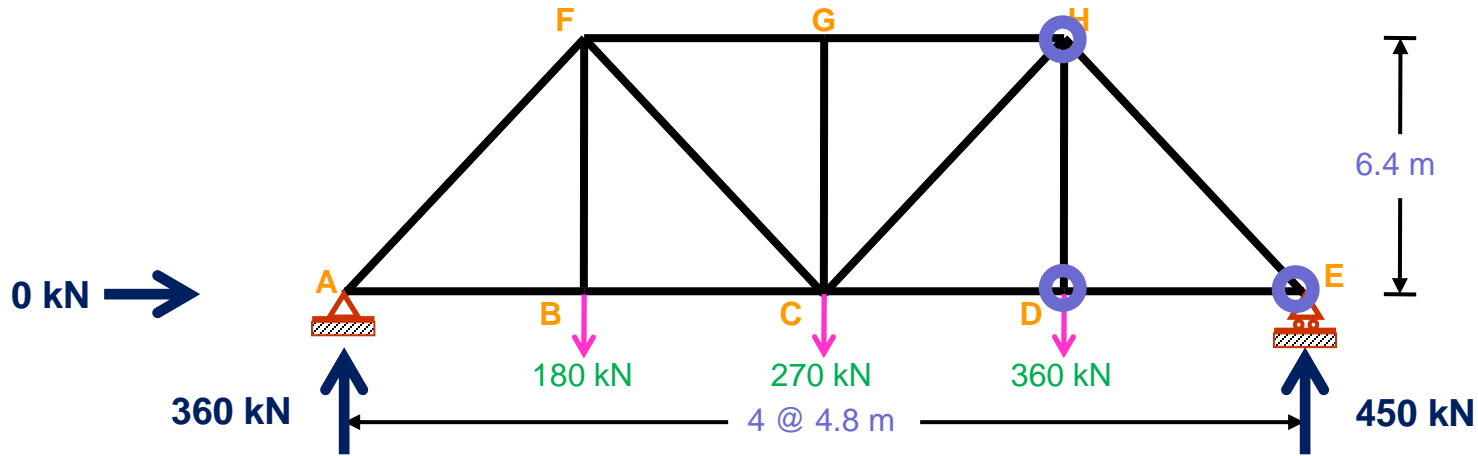
9th May, 2020

Member	Length [m]	S [kN]	u_{VD} [kN]	u_{HD} [kN]	$Su_{VD}L/AE$	$Su_{HD}L/AE$
AF	8	-450			----	----
FG	4.8	-405			----	----
GH	4.8	-405			----	----
HE	8				----	----
AB	4.8	270			----	----
BC	4.8	270			----	----
CD	4.8				----	----
DE	4.8				----	----
BF	6.4	180			----	----
CF	8	225			----	----
CG	6.4	0			----	----
CH	8				----	----
DH	6.4	360			----	----



Unit Load/Truss/Horizontal- Vertical Deflection

9th May, 2020



Taking joint E, joint D, joint H



Unit Load/Truss/Horizontal- Vertical Deflection

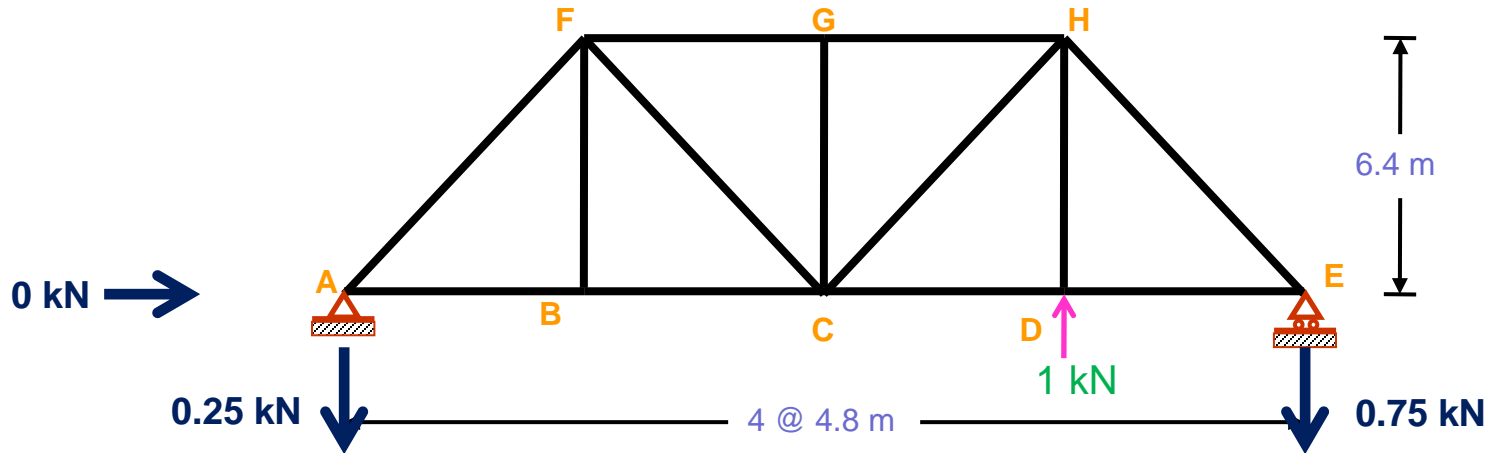
9th May, 2020

Member	Length [m]	S [kN]	u_{VD} [kN]	u_{HD} [kN]	$Su_{VD}L/AE$	$Su_{HD}L/AE$
AF	8	-450			----	----
FG	4.8	-405			----	----
GH	4.8	-405			----	----
HE	8	-562.5			----	----
AB	4.8	270			----	----
BC	4.8	270			----	----
CD	4.8	337.5			----	----
DE	4.8	337.5			----	----
BF	6.4	180			----	----
CF	8	225			----	----
CG	6.4	0			----	----
CH	8	112.5			----	----
DH	6.4	360			----	----



Unit Load/Truss/Horizontal-Vertical Deflection

9th May, 2020



For $u = \text{????}$ / Remove Applied Load/ Apply unit load

$$\sum M_A = 0$$

$$1 \times 4.8 \times 3 = R_E \times 4.8 \times 4$$

$$R_E = 0.75$$

$$\sum f_y = 0$$

$$R_A + R_E = 1$$

$$R_A = 0.25$$

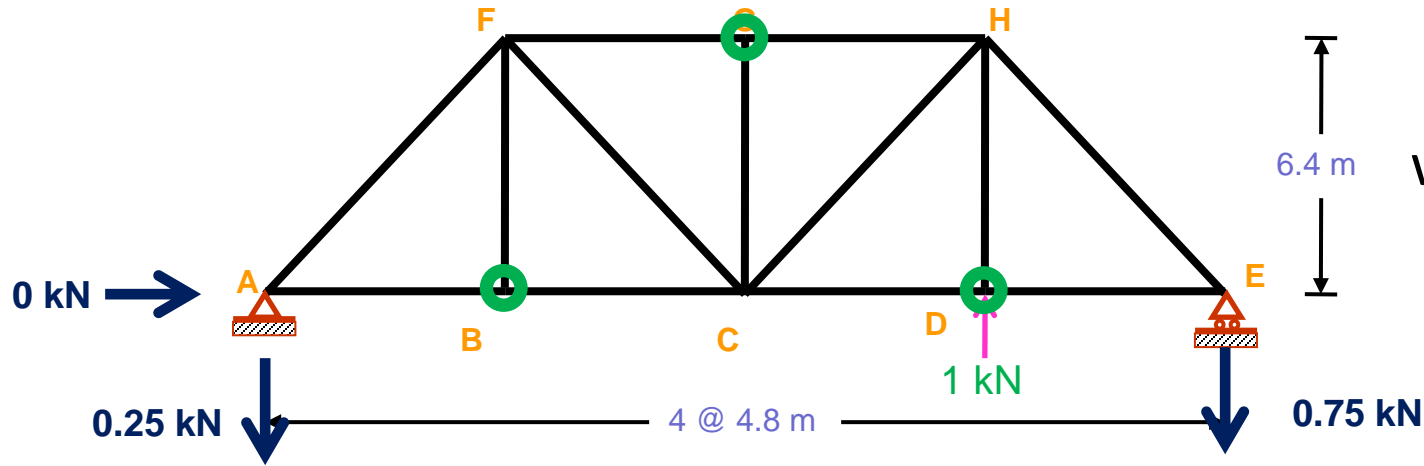
$$\sum f_x = 0$$

$$H_A = 0$$



Unit Load/Truss/Horizontal-Vertical Deflection

9th May, 2020



Attack the weak/Easy part

$$\text{joint } B, \sum f_y = 0$$

$$BF = 0$$

$$\text{joint } D, \sum f_y = 0$$

$$DH = -1$$

$$\text{joint } G, \sum f_y = 0$$

$$CG = 0$$



Unit Load/Truss/Horizontal- Vertical Deflection

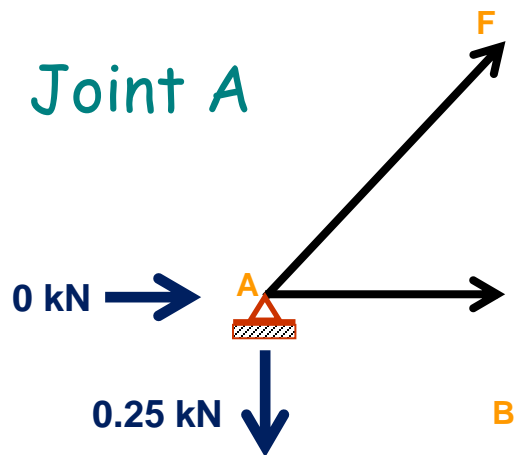
9th May, 2020

Member	Length [m]	S [kN]	u_{VD} [kN]	u_{HD} [kN]	$Su_{VD}L/AE$	$Su_{HD}L/AE$
AF	8	-450			----	----
FG	4.8	-405			----	----
GH	4.8	-405			----	----
HE	8	-562.5			----	----
AB	4.8	270			----	----
BC	4.8	270			----	----
CD	4.8	337.5			----	----
DE	4.8	337.5			----	----
BF	6.4	180	0		----	----
CF	8	225			----	----
CG	6.4	0	0		----	----
CH	8	112.5			----	----
DH	6.4	360	-1		----	----



Unit Load/Truss/Horizontal-Vertical Deflection

9th May, 2020



$$\text{joint A, } \sum f_y = 0$$

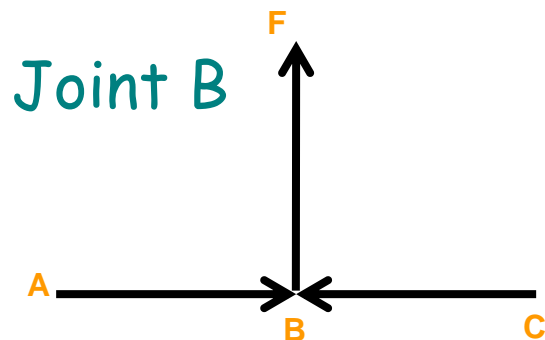
$$V_{AF} - 0.25 = 0$$

$$AF = 0.25 \times \frac{8}{6.4} = 0.3125$$

$$\text{joint A, } \sum f_x = 0$$

$$AB + H_{AF} = 0$$

$$AB = -0.3125 \times \frac{4.8}{8} = -0.1875$$



$$\text{joint B, } \sum f_x = 0$$

$$AB = BC = -0.1875$$



Unit Load/Truss/Horizontal- Vertical Deflection

9th May, 2020

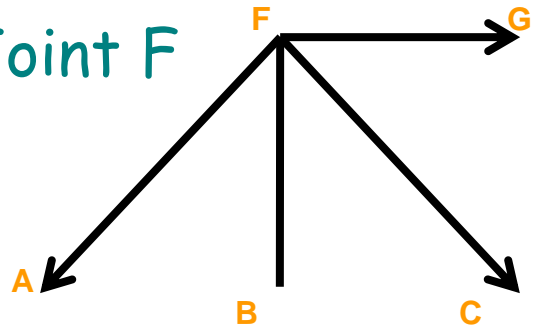
Member	Length [m]	S [kN]	u_{VD} [kN]	u_{HD} [kN]	$Su_{VD}L/AE$	$Su_{HD}L/AE$
AF	8	-450	0.3125		----	----
FG	4.8	-405			----	----
GH	4.8	-405			----	----
HE	8	-562.5			----	----
AB	4.8	270	-0.1875		----	----
BC	4.8	270	-0.1875		----	----
CD	4.8	337.5			----	----
DE	4.8	337.5			----	----
BF	6.4	180	0		----	----
CF	8	225			----	----
CG	6.4	0	0		----	----
CH	8	112.5			----	----
DH	6.4	360	-1		----	----



Unit Load/Truss/Horizontal-Vertical Deflection

9th May, 2020

Joint F



$$\text{joint } F, \sum f_y = 0$$

$$-V_{AF} - V_{CF} = 0$$

$$-0.3125 \times \frac{6.4}{8} - V_{CF} = 0$$

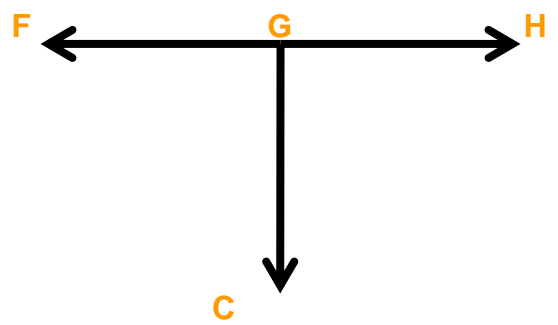
$$V_{CF} = -0.25$$

$$\text{joint } F, \sum f_x = 0$$

$$FG = (H_{AF} + H_{CF})$$

$$CF = -0.25 \times \frac{8}{6.4} = -0.3125$$

Joint G



$$FG = \left(0.3125 \times \frac{4.8}{8} + 0.3125 \times \frac{4.8}{8} \right) = 0.375$$

$$\text{joint } G, \sum f_x = 0$$

$$FG = 0.375 = GH$$



Unit Load/Truss/Horizontal- Vertical Deflection

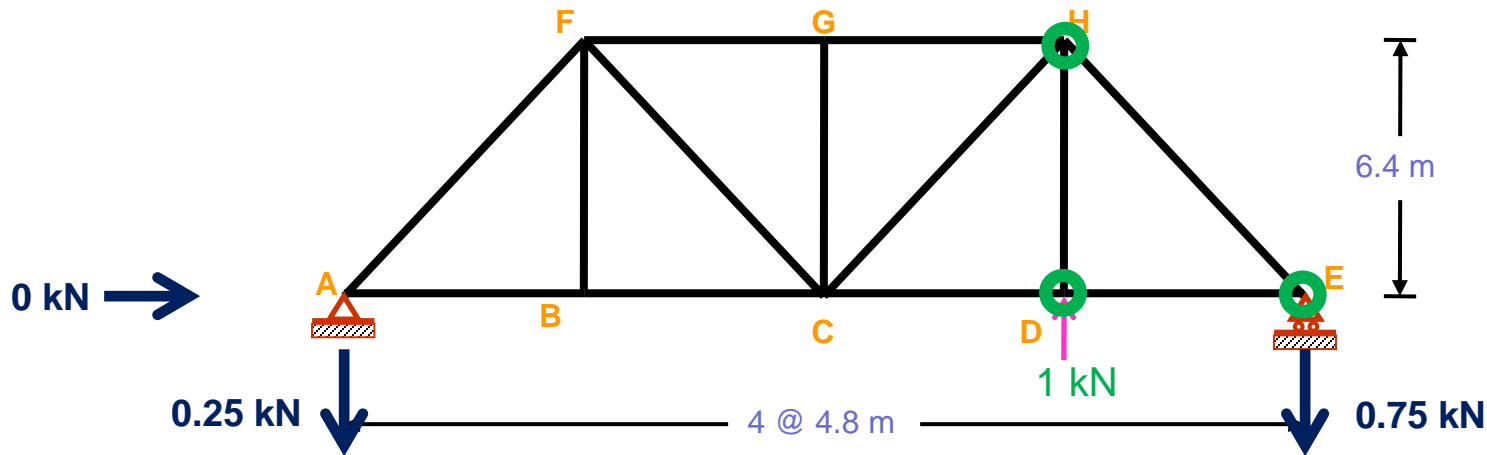
9th May, 2020

Member	Length [m]	S [kN]	u_{VD} [kN]	u_{HD} [kN]	$Su_{VD}L/AE$	$Su_{HD}L/AE$
AF	8	-450	0.3125		----	----
FG	4.8	-405	0.375		----	----
GH	4.8	-405	0.375		----	----
HE	8	-562.5			----	----
AB	4.8	270	-0.1875		----	----
BC	4.8	270	-0.1875		----	----
CD	4.8	337.5			----	----
DE	4.8	337.5			----	----
BF	6.4	180	0		----	----
CF	8	225	-0.3125		----	----
CG	6.4	0	0		----	----
CH	8	112.5			----	----
DH	6.4	360	-1		----	----



Unit Load/Truss/Horizontal- Vertical Deflection

9th May, 2020



Taking joint E, joint D, joint H



Unit Load/Truss/Horizontal- Vertical Deflection

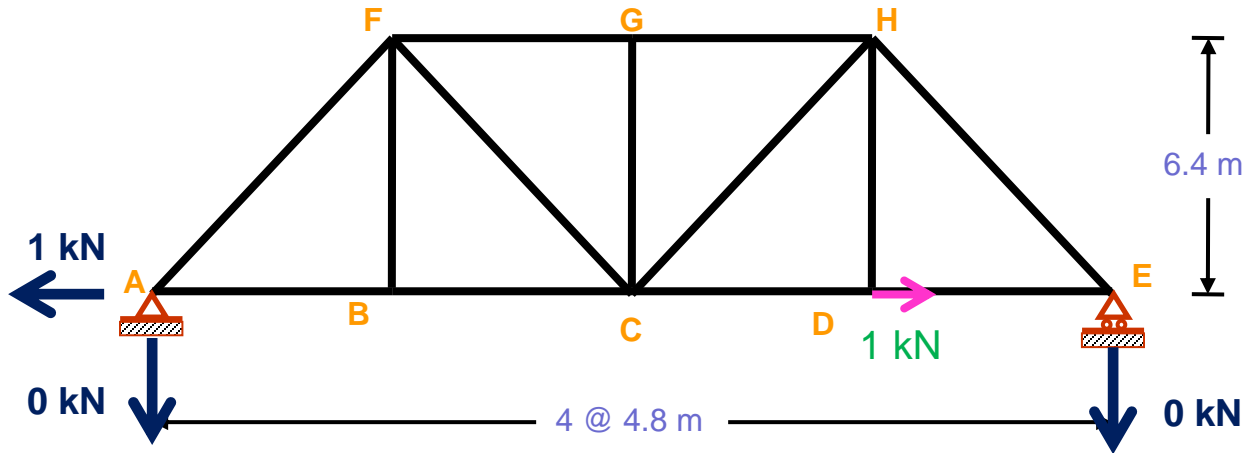
9th May, 2020

Member	Length [m]	S [kN]	u_{VD} [kN]	u_{HD} [kN]	$Su_{VD}L/AE$	$Su_{HD}L/AE$
AF	8	-450	0.3125		----	----
FG	4.8	-405	0.375		----	----
GH	4.8	-405	0.375		----	----
HE	8	-562.5	0.9375		----	----
AB	4.8	270	-0.1875		----	----
BC	4.8	270	-0.1875		----	----
CD	4.8	337.5	-0.5625		----	----
DE	4.8	337.5	-0.5625		----	----
BF	6.4	180	0		----	----
CF	8	225	-0.3125		----	----
CG	6.4	0	0		----	----
CH	8	112.5	0.3125		----	----
DH	6.4	360	-1		----	----



Unit Load/Truss/Horizontal-Vertical Deflection

9th May, 2020



For $u = \text{????}$ / Remove Applied Load/ Apply unit load

$$\sum M_A = 0$$

$$1 \times 0 = R_E \times 4.8 \times 4$$

$$R_E = 0$$

$$\sum f_y = 0$$

$$R_A + R_E = 0$$

$$R_A = 0$$

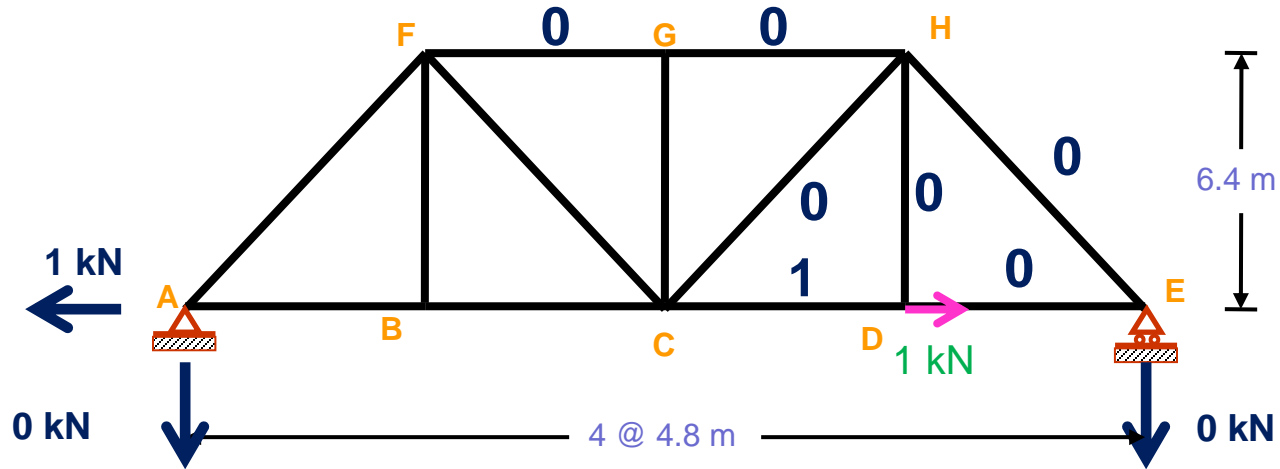
$$\sum f_x = 0$$

$$H_A = 1$$



Unit Load/Truss/Horizontal-Vertical Deflection

9th May, 2020



$$\text{joint } E, \sum f_y = 0$$

$$V_{EH} = 0$$

$$EH = 0$$

$$\text{joint } E, \sum f_x = 0$$

$$EH = 0$$

$$DE = 0$$

$$\text{joint } D, \sum f_y = 0$$

$$DH = 0$$

$$\text{joint } D, \sum f_x = 0$$

$$DE + 1 = CD$$

$$CD = 1$$

$$\text{joint } H, \sum f_y = 0$$

$$EH = 0$$

$$DH = 0$$

$$CH = 0$$

$$\text{joint } H, \sum f_x = 0$$

$$EH = 0$$

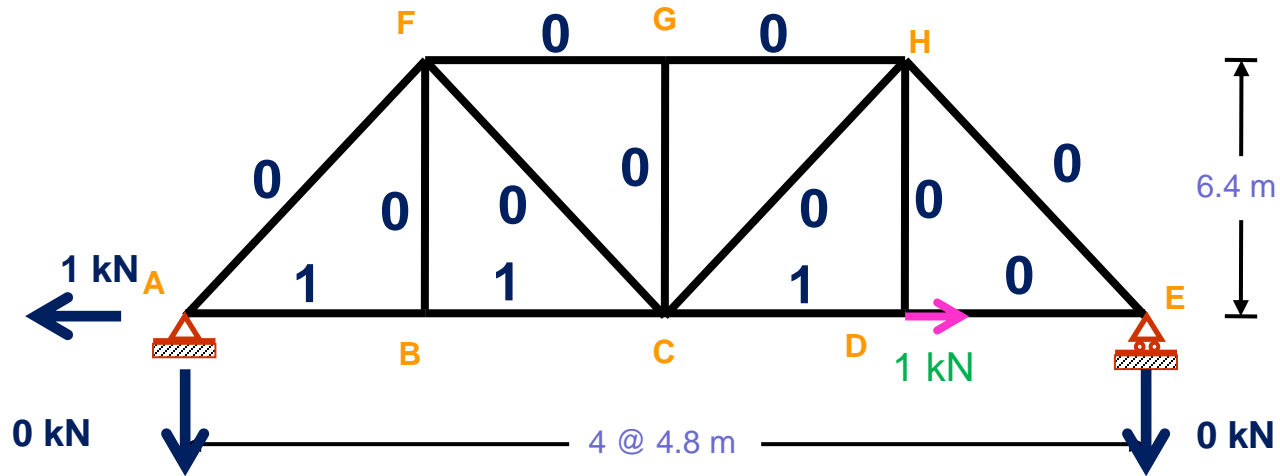
$$CH = 0$$

$$GH = 0 = FG$$



Unit Load/Truss/Horizontal-Vertical Deflection

9th May, 2020



joint A, $\sum f_y = 0$

$V_{AF} = 0$

$AF = 0$

joint A, $\sum f_x = 0$

$H_{AF} + AB = 1$

$AB = 1$

joint B, $\sum f_y = 0$

$BF = 0$

joint B, $\sum f_x = 0$

$AB = 1 = BC$

joint F, $\sum f_y = 0$

$AF = 0$

$BF = 0$

$CF = 0$

joint G, $\sum f_y = 0$

$CG = 0$



Unit Load/Truss/Horizontal- Vertical Deflection

9th May, 2020

Member	Length [m]	S [kN]	u_{VD} [kN]	u_{HD} [kN]	$Su_{VD}L/AE$	$Su_{HD}L/AE$
AF	8	-450	0.3125	0	----	----
FG	4.8	-405	0.375	0	----	----
GH	4.8	-405	0.375	0	----	----
HE	8	-562.5	0.9375	0	----	----
AB	4.8	270	-0.1875	1	----	----
BC	4.8	270	-0.1875	1	----	----
CD	4.8	337.5	-0.5625	1	----	----
DE	4.8	337.5	-0.5625	0	----	----
BF	6.4	180	0	0	----	----
CF	8	225	-0.3125	0	----	----
CG	6.4	0	0	0	----	----
CH	8	112.5	0.3125	0	----	----
DH	6.4	360	-1	0	----	----



Unit Load/Truss/Horizontal- Vertical Deflection

9th May, 2020

Member	Length [m]	S [kN]	u_{VD} [kN]	u_{HD} [kN]	$Su_{VD}L/AE$	$Su_{HD}L/AE$
AF	8	-450	0.3125	0	----	----
FG	4.8	-405	0.375	0	----	----
GH	4.8	-405	0.375	0	----	----
HE	8	-562.5	0.9375	0	----	----
AB	4.8	270	-0.1875	1	----	----
BC	4.8	270	-0.1875	1	----	----
CD	4.8	337.5	-0.5625	1	----	----
DE	4.8	337.5	-0.5625	0	----	----
BF	6.4	180	0	0	----	----
CF	8	225	-0.3125	0	----	----
CG	6.4	0	0	0	----	----
CH	8	112.5	0.3125	0	----	----
DH	6.4	360	-1	0	----	----
					$\Sigma() UD$	$\Sigma() RL$



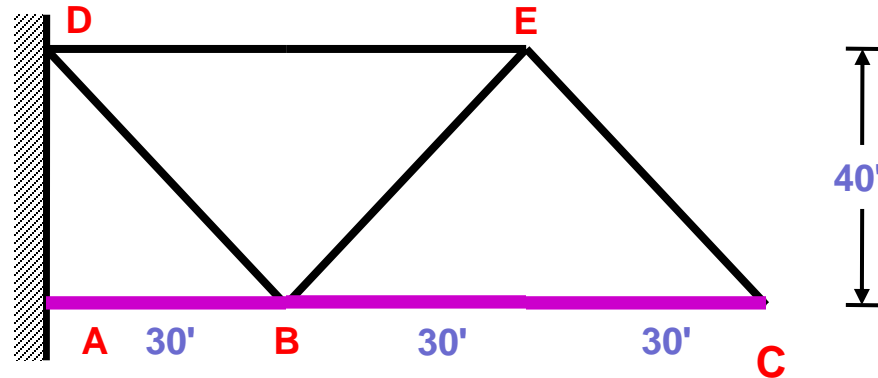
Unit Load/Truss/ Temperature Deflection

9th May, 2020

PROBLEM

17

Temperature Effect



Find deflection of **C** due to the rise of temperature 50°F in the **lower chord member** [$\alpha = 6.5 \times 10^{-6}/^{\circ}\text{F}$]



Unit Load/Truss/ Temperature Deflection

9th May, 2020

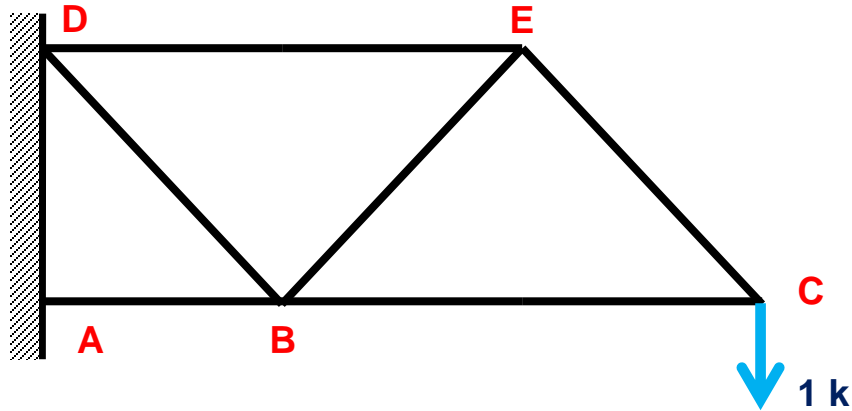
Member	Length [ft]	Δt [$^{\circ}F$]	u_{VC} [k]	u_{HC} [k]	$u_{VC}L\Delta t$	$u_{HC}L\Delta t$
AB	30	50	?	?	----	----
BC	60	50			----	----
DE	60	0			----	----
DB	50	0			----	----
BE	50	0			----	----
EC	50	0			----	----
					----	----



Unit Load/Truss/ Temperature Deflection

9th May, 2020

Apply Vertical Unit Load



Joint C

$$\text{joint } C, \sum f_y = 0$$

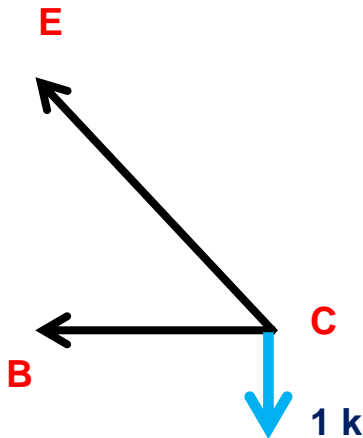
$$V_{CE} = 1$$

$$CE = 1 \times \frac{50}{40} = 1.25$$

$$\text{joint } C, \sum f_x = 0$$

$$BC = -H_{CE}$$

$$BC = -1.25 \times \frac{30}{50} = -0.75$$

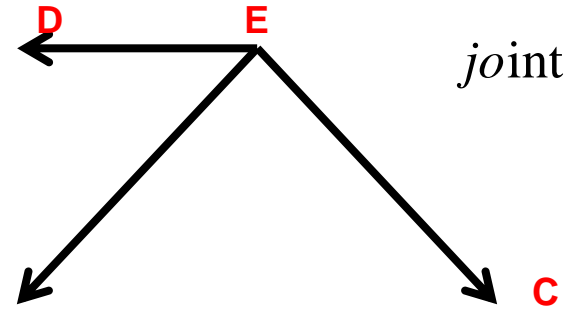




Unit Load/Truss/ Temperature Deflection

9th May, 2020

Joint E



$$\text{joint } E, \sum f_y = 0$$

$$-V_{BE} - V_{CE} = 0$$

$$V_{BE} = -1.25 \times \frac{40}{50} = -1$$

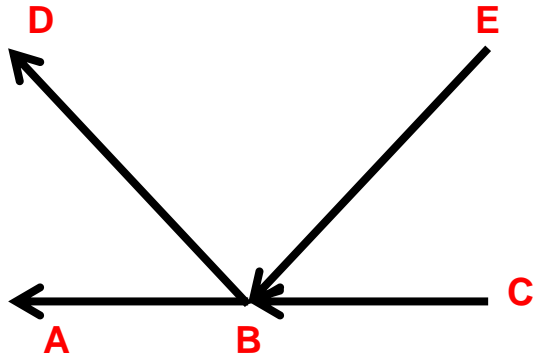
$$BE = -1 \times \frac{50}{40} = -1.25$$

$$\text{joint } E, \sum f_x = 0$$

$$DE = H_{CE} + H_{BE}$$

$$DE = 1.25 \times \frac{30}{50} + 1.25 \times \frac{30}{50} = 1.50$$

Joint B



$$\text{joint } B, \sum f_y = 0$$

$$-V_{BE} + V_{BD} = 0$$

$$BD = 1.25$$

$$\text{joint } B, \sum f_x = 0$$



$$AB = -\left(1.25 \times \frac{30}{50} + 1.25 \times \frac{30}{50} + 0.75\right) = -2.25$$



Unit Load/Truss/ Temperature Deflection

9th May, 2020

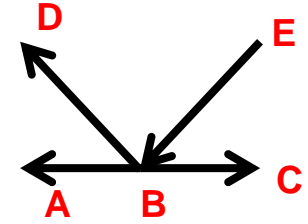
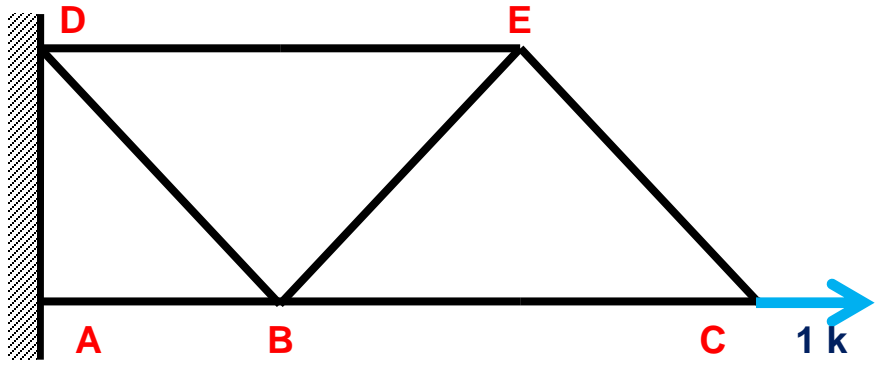
Member	Length [ft]	Δt [$^{\circ}F$]	u_{VC} [k]	u_{HC} [k]	$u_{VC}L\Delta t$	$u_{HC}L\Delta t$
AB	30	50	-2.25		----	----
BC	60	50	-0.75		----	----
DE	60	0	1.50		----	----
DB	50	0	1.25		----	----
BE	50	0	-1.25		----	----
EC	50	0	1.25		----	----



Unit Load/Truss/ Temperature Deflection

9th May, 2020

Apply Horizontal Unit Load

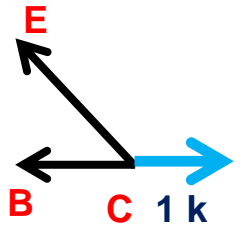


Joint B

$$\text{joint B, } \sum f_y = 0 \quad V_{BE} = 0 = V_{BD} \quad BD = 0$$

$$\text{joint B, } \sum f_x = 0 \quad AB = 1$$

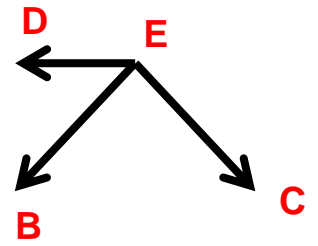
Joint C



$$\text{joint C, } \sum f_y = 0 \quad V_{CE} = 0 \quad CE = 0$$

$$\text{joint C, } \sum f_x = 0 \quad BC = 1$$

Joint E



$$\text{joint E, } \sum f_y = 0 \quad V_{CE} = 0 = V_{BE} \quad BE = 0$$

$$\text{joint E, } \sum f_x = 0 \quad H_{CE} = 0 = H_{BE} \quad DE = 0$$



Unit Load/Truss/ Temperature Deflection

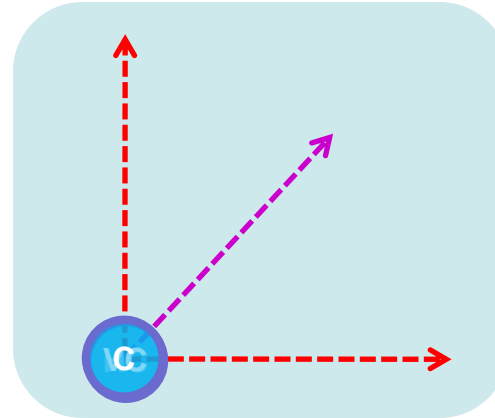
9th May, 2020

Member	Length [ft]	Δt [$^{\circ}F$]	u_{VC} [k]	u_{HC} [k]	$u_{VC}L\Delta t$	$u_{HC}L\Delta t$
AB	30	50	-2.25	1	-3375	1500
BC	60	50	-0.75	1	-2250	3000
DE	60	0	1.50	0	0	0
DB	50	0	1.25	0	0	0
BE	50	0	-1.25	0	0	0
EC	50	0	1.25	0	0	0
					-5625	4500



Unit Load/Truss/ Temperature Deflection

9th May, 2020



$$\Delta_{HC} = \alpha \sum u_{HC} L \Delta t = 6.5 \times 10^{-6} \times 4500 = 0.029$$

$$\Delta_{VC} = \alpha \sum u_{VC} L \Delta t = 6.5 \times 10^{-6} \times (-5625) = -0.036$$

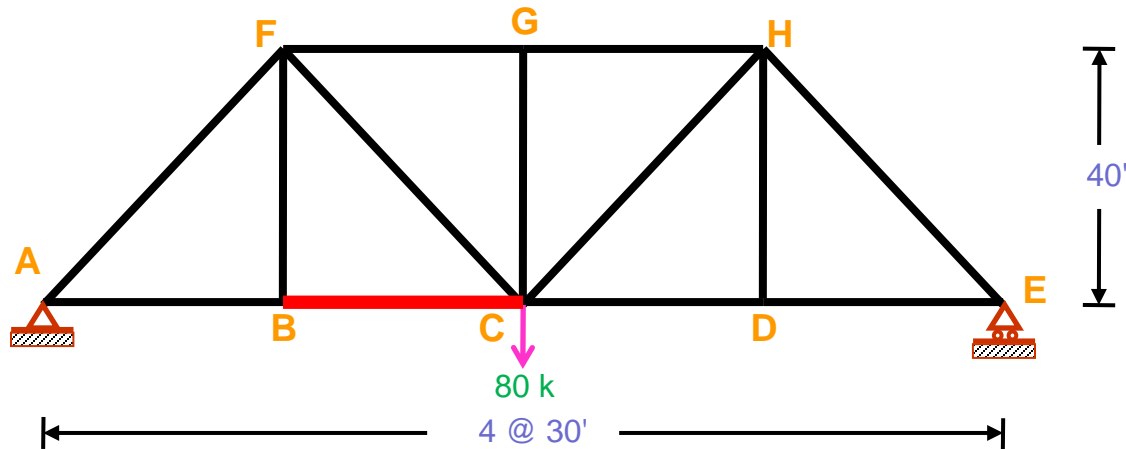
$$\Delta_C = \sqrt{(0.029)^2 + (-0.036)^2} = 0.0462 \text{ ft}$$



PROBLEM

18

Rotational Deflection



Given

$$A = 20 \text{ in}^2$$
$$E = 30 \times 10^3 \text{ ksi}$$

Findings

Rotation of BC



Unit Load/Truss/Rotational Deflection

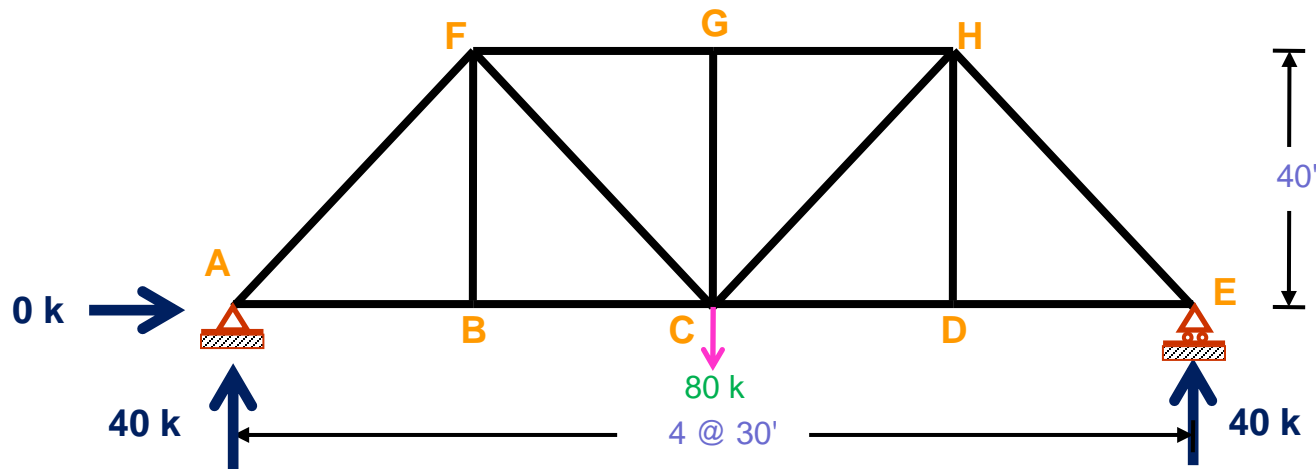
9th May, 2020

Member	Length [ft]	S [k]	u_{BC} [k]	$Su_{BC}L/AE$
AB	30			----
BC	30			----
CD	30			----
DE	30			----
FG	30			----
GH	30			----
AF	50	?	?	----
FC	50			----
BF	40			----
CG	40			----
CH	50			----
DH	40			----
EH	50			----



Unit Load/Truss/Rotational Deflection

9th May, 2020



For S = ????/ Exists Applied Load

$$\sum M_A = 0$$

$$80 \times 30 \times 2 = R_E \times 30 \times 4$$

$$R_E = 40$$

$$\sum f_y = 0$$

$$R_A + R_E = 80$$

$$R_A = 40$$

$$\sum f_x = 0$$

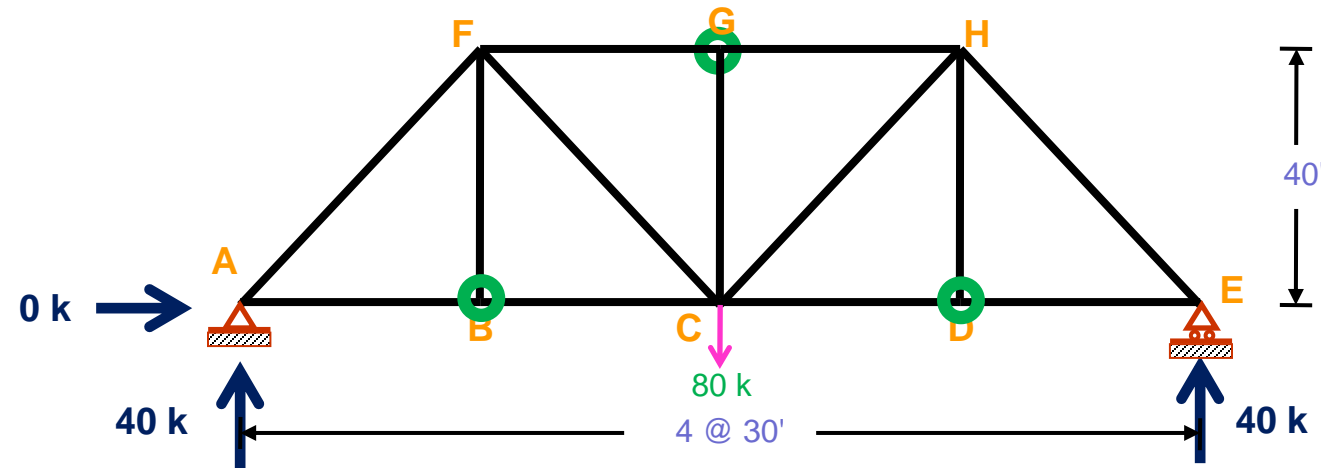
$$H_A = 0$$



Unit Load/Truss/Rotational Deflection

9th May, 2020

Attack the weak/Easy part



$$\text{joint } B, \sum f_y = 0$$

$$BF = 0$$

$$\text{joint } D, \sum f_y = 0$$

$$DH = 0$$

$$\text{joint } G, \sum f_y = 0$$

$$CG = 0$$



Unit Load/Truss/Rotational Deflection

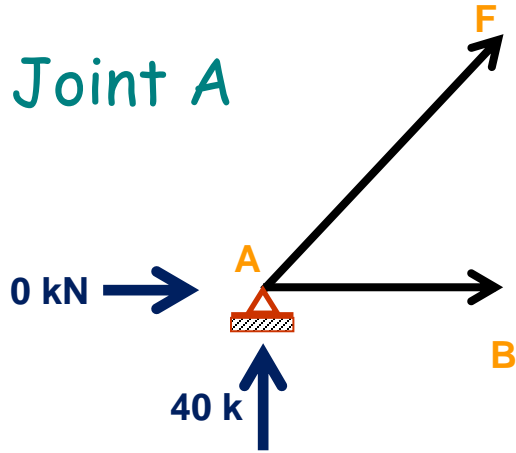
9th May, 2020

Member	Length [ft]	S [k]	u_{BC} [k]	$Su_{BC}L/AE$
AB	30			----
BC	30			----
CD	30			----
DE	30			----
FG	30			----
GH	30			----
AF	50			----
FC	50			----
BF	40	0		----
CG	40	0		----
CH	50			----
DH	40	0		----
EH	50			----



Unit Load/Truss/Rotational Deflection

9th May, 2020



$$\text{joint A, } \sum f_y = 0$$

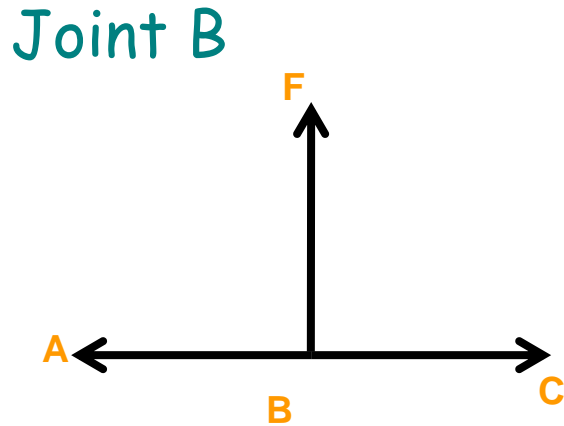
$$V_{AF} + 40 = 0$$

$$AF = -40 \times \frac{50}{40} = -50$$

$$\text{joint A, } \sum f_x = 0$$

$$AB = H_{AF}$$

$$AB = 50 \times \frac{30}{50} = 30$$



$$\text{joint B, } \sum f_x = 0$$

$$AB = BC = 30$$



Unit Load/Truss/Rotational Deflection

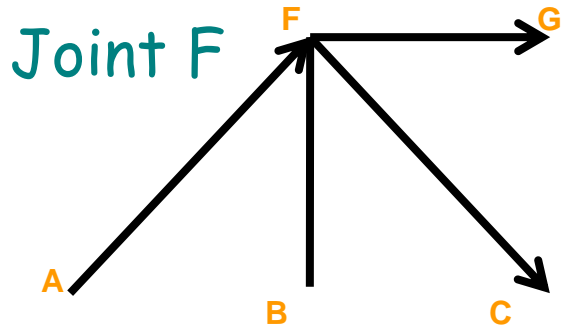
9th May, 2020

Member	Length [ft]	S [k]	u_{BC} [k]	$Su_{BC}L/AE$
AB	30	30		----
BC	30	30		----
CD	30			----
DE	30			----
FG	30			----
GH	30			----
AF	50	-50		----
FC	50			----
BF	40	0		----
CG	40	0		----
CH	50			----
DH	40	0		----
EH	50			----



Unit Load/Truss/Rotational Deflection

9th May, 2020



$$\text{joint } F, \sum f_y = 0$$

$$V_{AF} - V_{CF} = 0$$

$$50 \times \frac{40}{50} - V_{CF} = 0$$

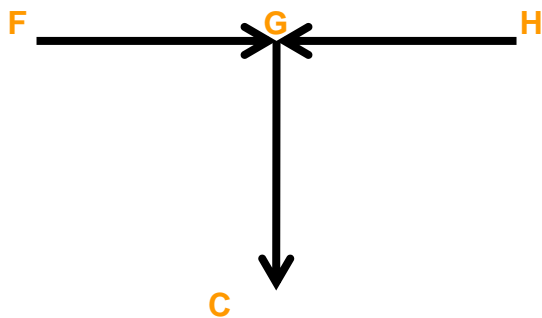
$$V_{CF} = 40$$

$$\text{joint } F, \sum f_x = 0$$

$$FG = -\left(H_{AF} + H_{CF}\right)$$

$$CF = 40 \times \frac{50}{40} = 50$$

Joint G



$$FG = -\left(50 \times \frac{30}{50} + 50 \times \frac{30}{50}\right) = -60$$

$$\text{joint } G, \sum f_x = 0$$

$$FG = -60 = GH$$



Unit Load/Truss/Rotational Deflection

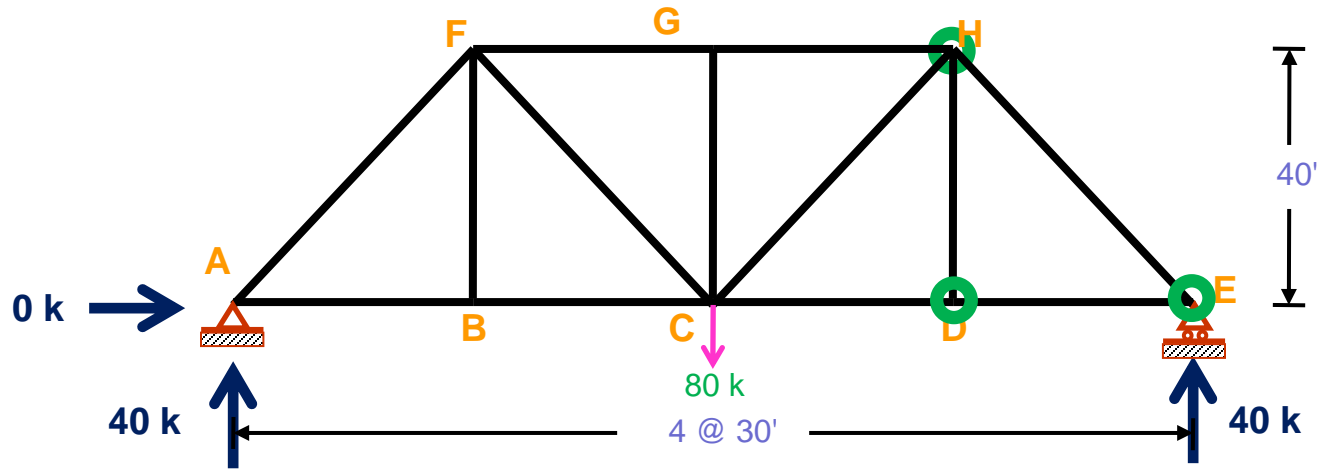
9th May, 2020

Member	Length [ft]	S [k]	u_{BC} [k]	$Su_{BC}L/AE$
AB	30	30		----
BC	30	30		----
CD	30			----
DE	30			----
FG	30	-60		----
GH	30	-60		----
AF	50	-50		----
FC	50	50		----
BF	40	0		----
CG	40	0		----
CH	50			----
DH	40	0		----
EH	50			----



Unit Load/Truss/Rotational Deflection

9th May, 2020



Taking joint E, joint D, joint H



Unit Load/Truss/Rotational Deflection

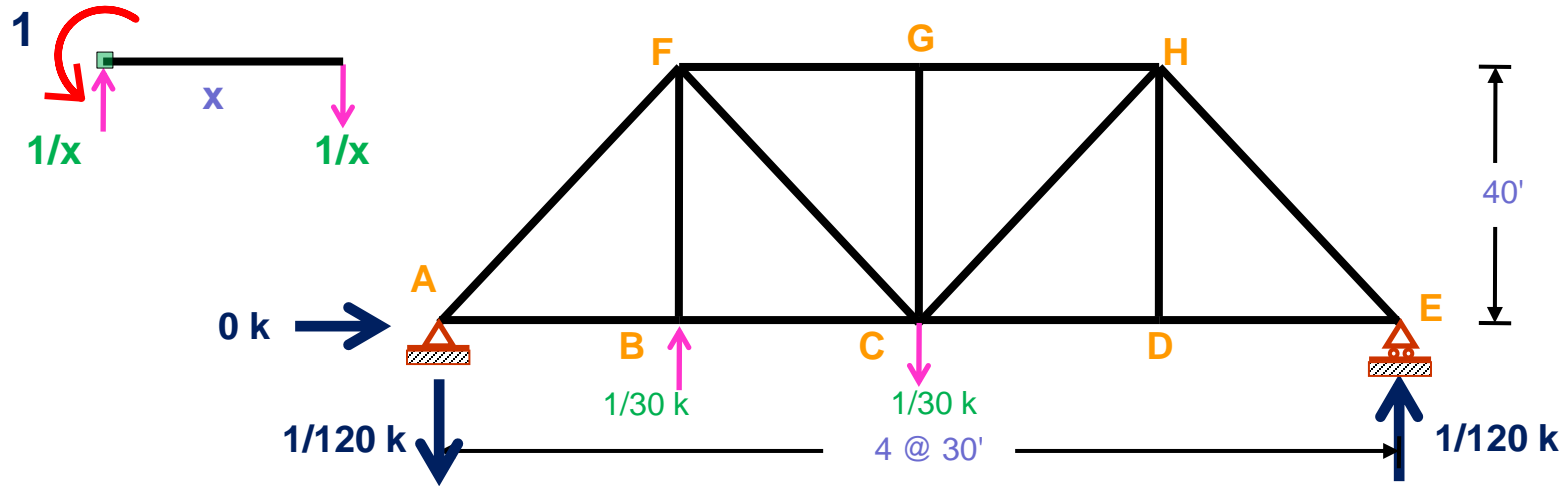
9th May, 2020

Member	Length [ft]	S [k]	u_{BC} [k]	$Su_{BC}L/AE$
AB	30	30		----
BC	30	30		----
CD	30	30		----
DE	30	30		----
FG	30	-60		----
GH	30	-60		----
AF	50	-50		----
FC	50	50		----
BF	40	0		----
CG	40	0		----
CH	50	50		----
DH	40	0		----
EH	50	-50		----



Unit Load/Truss/Rotational Deflection

9th May, 2020



For $u = \text{????}$ / Remove Applied Load / Apply unit rotation

$$\sum M_A = 0$$

$$R_E \times 30 \times 4 + \frac{1}{30} \times 30 \times 1 = \frac{1}{30} \times 30 \times 2$$

$$R_E = \frac{1}{120}$$

$$\sum f_y = 0$$

$$R_A + \frac{1}{30} = \frac{1}{120} + \frac{1}{30}$$

$$R_A = \frac{1}{120}$$

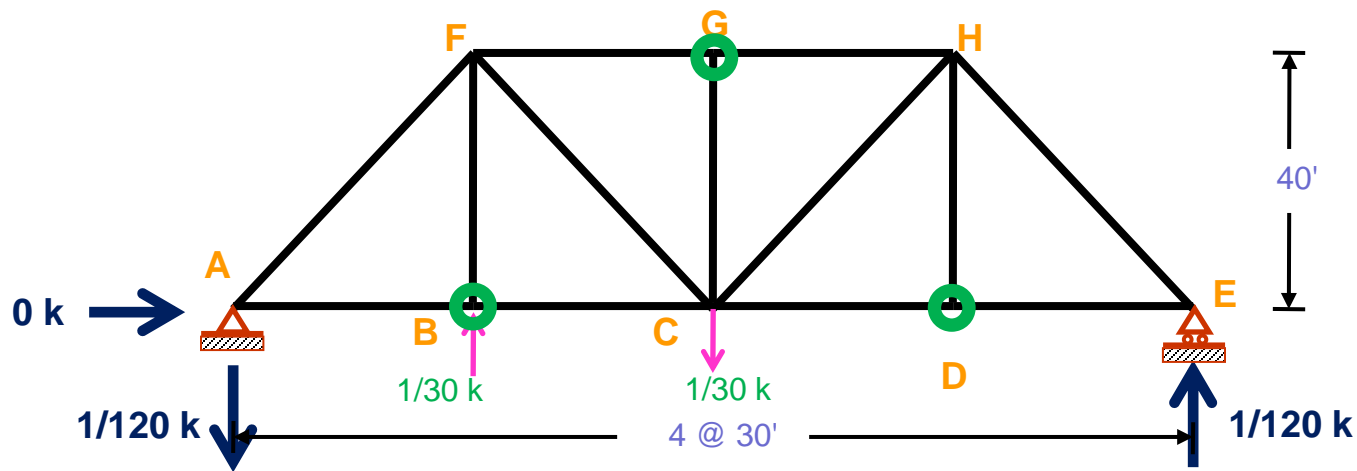
$$\sum f_x = 0$$

$$H_A = 0$$



Unit Load/Truss/Rotational Deflection

9th May, 2020



Attack the weak/Easy part

$$\text{joint } B, \sum f_y = 0 \qquad BF = -\frac{1}{30}$$

$$\text{joint } D, \sum f_y = 0 \qquad DH = 0$$

$$\text{joint } G, \sum f_y = 0 \qquad CG = 0$$



Unit Load/Truss/Rotational Deflection

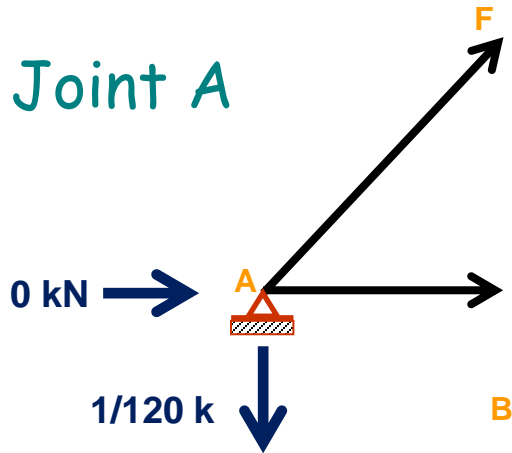
9th May, 2020

Member	Length [ft]	S [k]	u_{BC} [k]	$Su_{BC}L/AE$
AB	30	30		----
BC	30	30		----
CD	30	30		----
DE	30	30		----
FG	30	-60		----
GH	30	-60		----
AF	50	-50		----
FC	50	50		----
BF	40	0	-1/30	----
CG	40	0	0	----
CH	50	50		----
DH	40	0	0	----
EH	50	-50		----



Unit Load/Truss/Rotational Deflection

9th May, 2020



$$\text{joint A, } \sum f_y = 0$$

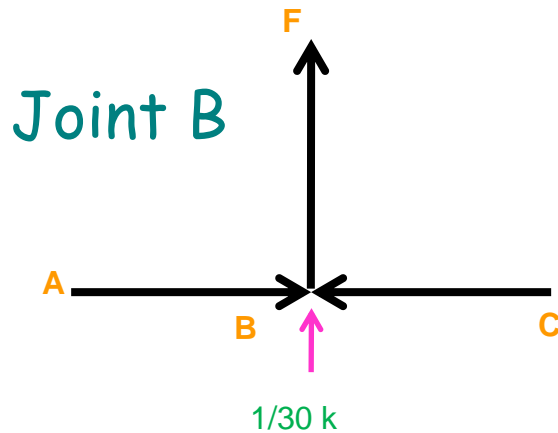
$$V_{AF} - \frac{1}{120} = 0$$

$$AF = \frac{1}{120} \times \frac{50}{40} = \frac{1}{96}$$

$$\text{joint A, } \sum f_x = 0$$

$$AB + H_{AF} = 0$$

$$AB = -\frac{1}{96} \times \frac{30}{50} = -\frac{1}{160}$$



$$\text{joint B, } \sum f_x = 0$$

$$AB = BC = -\frac{1}{160}$$



Unit Load/Truss/Rotational Deflection

9th May, 2020

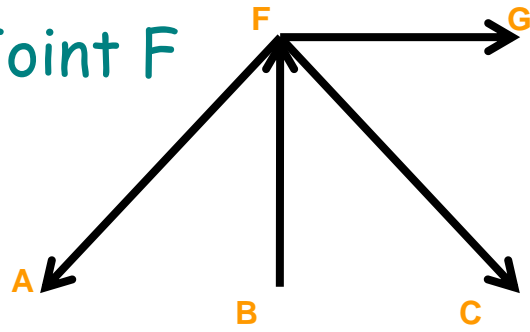
Member	Length [ft]	S [k]	u_{BC} [k]	$Su_{BC}L/AE$
AB	30	30	-1/160	----
BC	30	30	-1/160	----
CD	30	30		----
DE	30	30		----
FG	30	-60		----
GH	30	-60		----
AF	50	-50	1/96	----
FC	50	50		----
BF	40	0	-1/30	----
CG	40	0	0	----
CH	50	50		----
DH	40	0	0	----
EH	50	-50		----



Unit Load/Truss/Rotational Deflection

9th May, 2020

Joint F



$$\text{joint } F, \sum f_y = 0$$

$$-V_{AF} + BF - V_{CF} = 0$$

$$-\frac{1}{96} \times \frac{40}{50} + \frac{1}{30} - V_{CF} = 0$$

$$V_{CF} = \frac{1}{40}$$

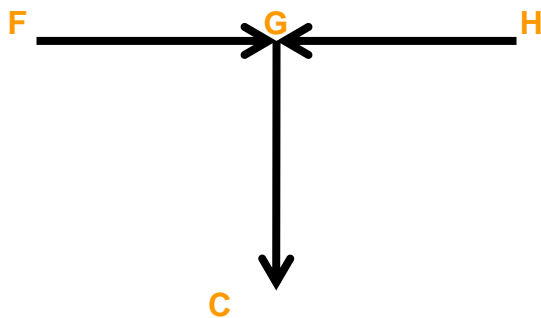
$$\text{joint } F, \sum f_x = 0$$

$$FG = (H_{AF} - H_{CF})$$

$$CF = \frac{1}{40} \times \frac{50}{40} = \frac{1}{32}$$

$$FG = \left(\frac{1}{96} \times \frac{30}{50} - \frac{1}{32} \times \frac{30}{50} \right) = -\frac{1}{80}$$

Joint G



$$\text{joint } G, \sum f_x = 0$$

$$FG = -\frac{1}{80} = GH$$



Unit Load/Truss/Rotational Deflection

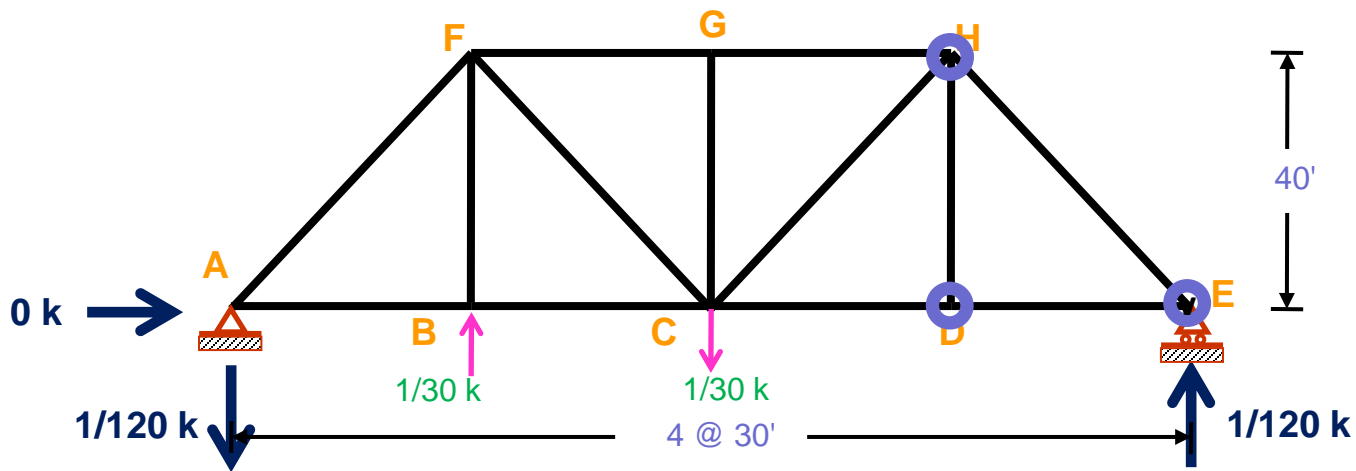
9th May, 2020

Member	Length [ft]	S [k]	u_{BC} [k]	$Su_{BC}L/AE$
AB	30	30	-1/160	----
BC	30	30	-1/160	----
CD	30	30		----
DE	30	30		----
FG	30	-60	-1/80	----
GH	30	-60	-1/80	----
AF	50	-50	1/96	----
FC	50	50	1/32	----
BF	40	0	-1/30	----
CG	40	0	0	----
CH	50	50		----
DH	40	0	0	----
EH	50	-50		----



Unit Load/Truss/Rotational Deflection

9th May, 2020



Taking joint E, joint D, joint H



Unit Load/Truss/Rotational Deflection

9th May, 2020

Member	Length [ft]	S [k]	u_{BC} [k]	$Su_{BC}L/AE$
AB	30	30	-1/160	----
BC	30	30	-1/160	----
CD	30	30	1/160	----
DE	30	30	1/160	----
FG	30	-60	1/80	----
GH	30	-60	1/80	----
AF	50	-50	1/96	----
FC	50	50	1/32	----
BF	40	0	-1/30	----
CG	40	0	0	----
CH	50	50	1/96	----
DH	40	0	0	----
EH	50	-50	-1/96	----



Unit Load/Truss/Rotational Deflection

9th May, 2020

Member	Length [ft]	S [k]	u_{BC} [k]	$Su_{BC}L/AE$
AB	30	30	-1/160	----
BC	30	30	-1/160	----
CD	30	30	1/160	----
DE	30	30	1/160	----
FG	30	-60	1/80	----
GH	30	-60	1/80	----
AF	50	-50	1/96	----
FC	50	50	1/32	----
BF	40	0	-1/30	----
CG	40	0	0	----
CH	50	50	1/96	----
DH	40	0	0	----
EH	50	-50	-1/96	----

$\Sigma()$ **C** **AC**



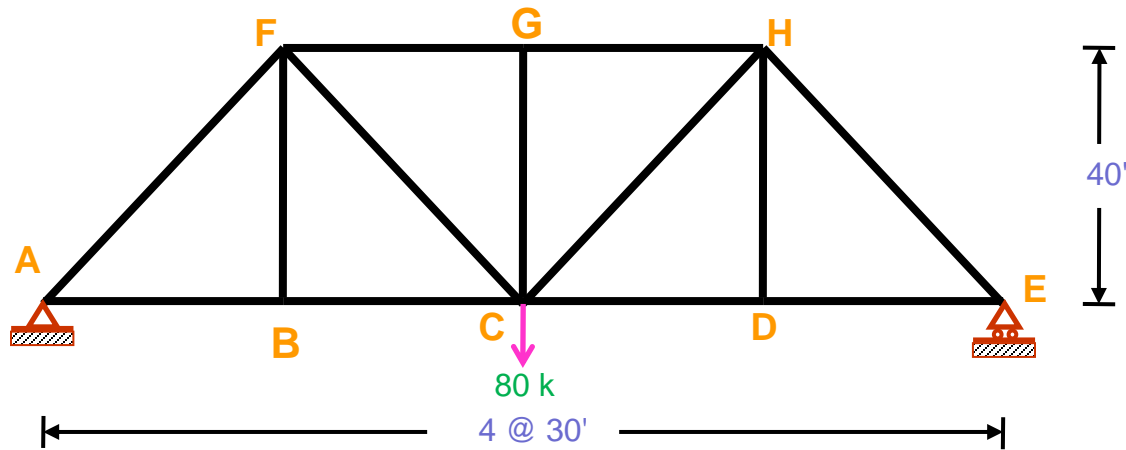
Unit Load/Truss/Relative Displacement

9th May, 2020

PROBLEM

19

Relative Displacement



Given

$$A = 20 \text{ in}^2$$
$$E = 30 \times 10^3 \text{ ksi}$$

Findings

Relative Displacement of BG



Unit Load/Truss/Relative Displacement

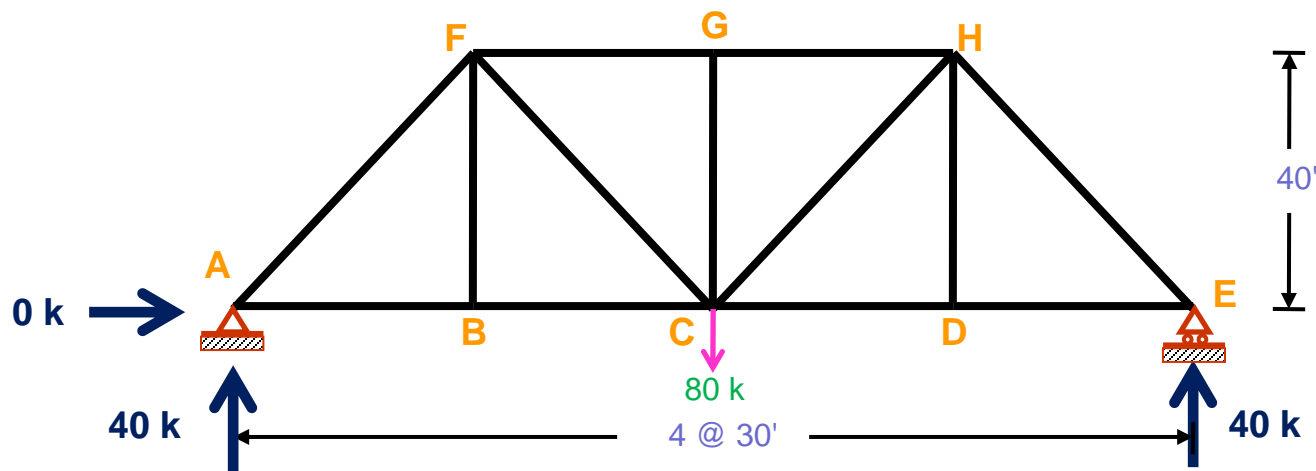
9th May, 2020

Member	Length [ft]	S [k]	u_{BG} [k]	$Su_{BG}L/AE$
AB	30			----
BC	30			----
CD	30			----
DE	30			----
FG	30			----
GH	30			----
AF	50	?	?	----
FC	50			----
BF	40			----
CG	40			----
CH	50			----
DH	40			----
EH	50			----



Unit Load/Truss/Relative Displacement

9th May, 2020



For S = ????/ Exists Applied Load

$$\sum M_A = 0$$

$$80 \times 30 \times 2 = R_E \times 30 \times 4$$

$$R_E = 40$$

$$\sum f_y = 0$$

$$R_A + R_E = 80$$

$$R_A = 40$$

$$\sum f_x = 0$$

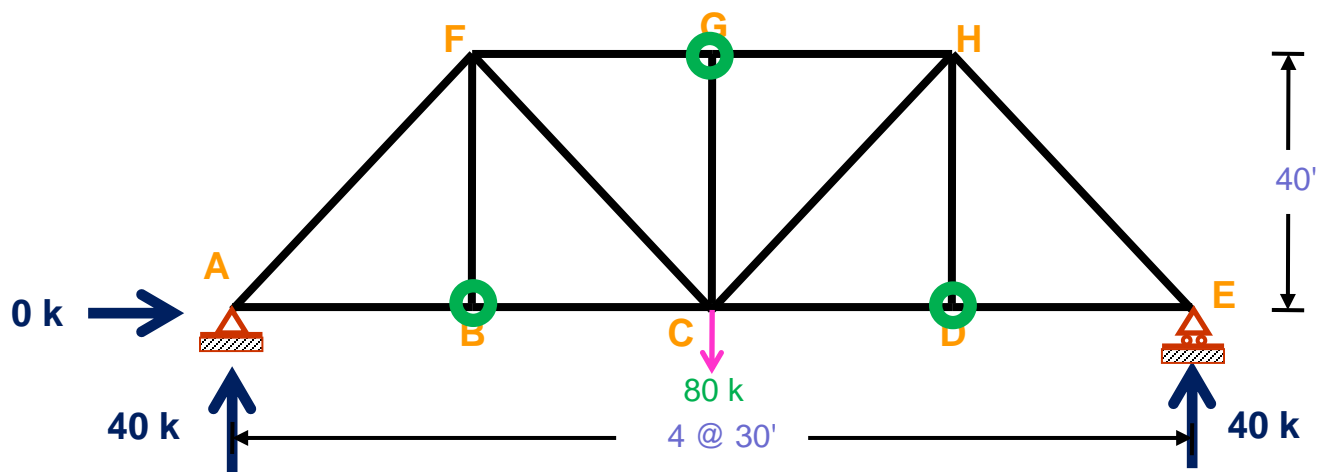
$$H_A = 0$$



Unit Load/Truss/Relative Displacement

9th May, 2020

Attack the weak/Easy part



$$\text{joint } B, \sum f_y = 0$$

$$BF = 0$$

$$\text{joint } D, \sum f_y = 0$$

$$DH = 0$$

$$\text{joint } G, \sum f_y = 0$$

$$CG = 0$$



Unit Load/Truss/Relative Displacement

9th May, 2020

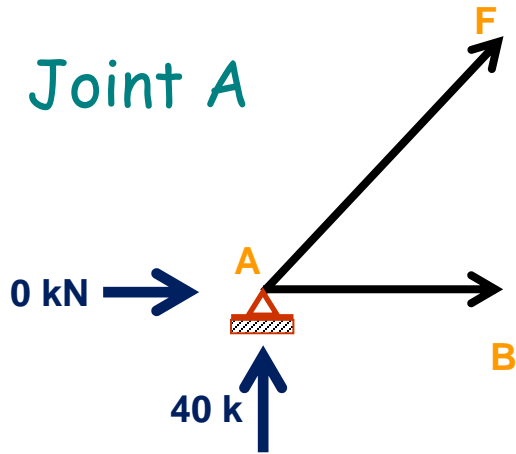
Member	Length [ft]	S [k]	u_{BG} [k]	$Su_{BG}L/AE$
AB	30			----
BC	30			----
CD	30			----
DE	30			----
FG	30			----
GH	30			----
AF	50			----
FC	50			----
BF	40	0		----
CG	40	0		----
CH	50			----
DH	40	0		----
EH	50			----



Unit Load/Truss/Relative Displacement

9th May, 2020

Joint A



$$\text{joint A, } \sum f_y = 0$$

$$V_{AF} + 40 = 0$$

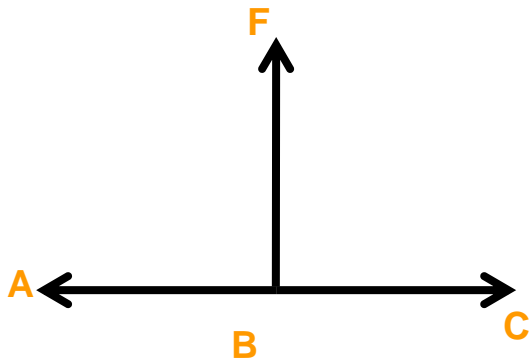
$$AF = -40 \times \frac{50}{40} = -50$$

$$\text{joint A, } \sum f_x = 0$$

$$AB = H_{AF}$$

$$AB = 50 \times \frac{30}{50} = 30$$

Joint B



$$\text{joint B, } \sum f_x = 0$$

$$AB = BC = 30$$



Unit Load/Truss/Relative Displacement

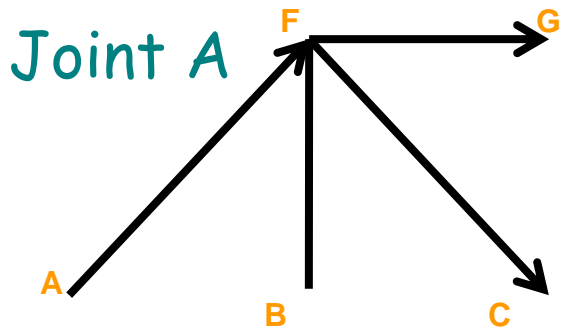
9th May, 2020

Member	Length [ft]	S [k]	u_{BG} [k]	$Su_{BG}L/AE$
AB	30	30		----
BC	30	30		----
CD	30			----
DE	30			----
FG	30			----
GH	30			----
AF	50	-50		----
FC	50			----
BF	40	0		----
CG	40	0		----
CH	50			----
DH	40	0		----
EH	50			----



Unit Load/Truss/Relative Displacement

9th May, 2020



$$\text{joint } F, \sum f_y = 0$$

$$V_{AF} - V_{CF} = 0$$

$$50 \times \frac{40}{50} - V_{CF} = 0$$

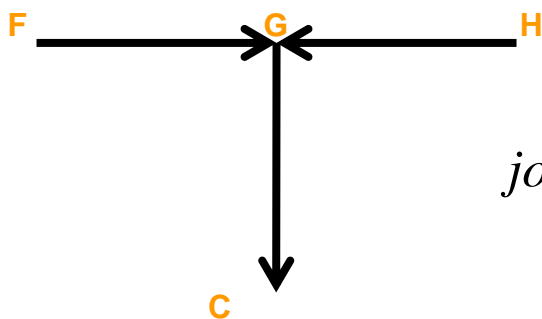
$$V_{CF} = 40$$

$$\text{joint } F, \sum f_x = 0$$

$$FG = -\left(H_{AF} + H_{CF}\right)$$

$$CF = 40 \times \frac{50}{40} = 50$$

Joint G



$$FG = -\left(50 \times \frac{30}{50} + 50 \times \frac{30}{50}\right) = -60$$

$$\text{joint } G, \sum f_x = 0$$

$$FG = -60 = GH$$



Unit Load/Truss/Relative Displacement

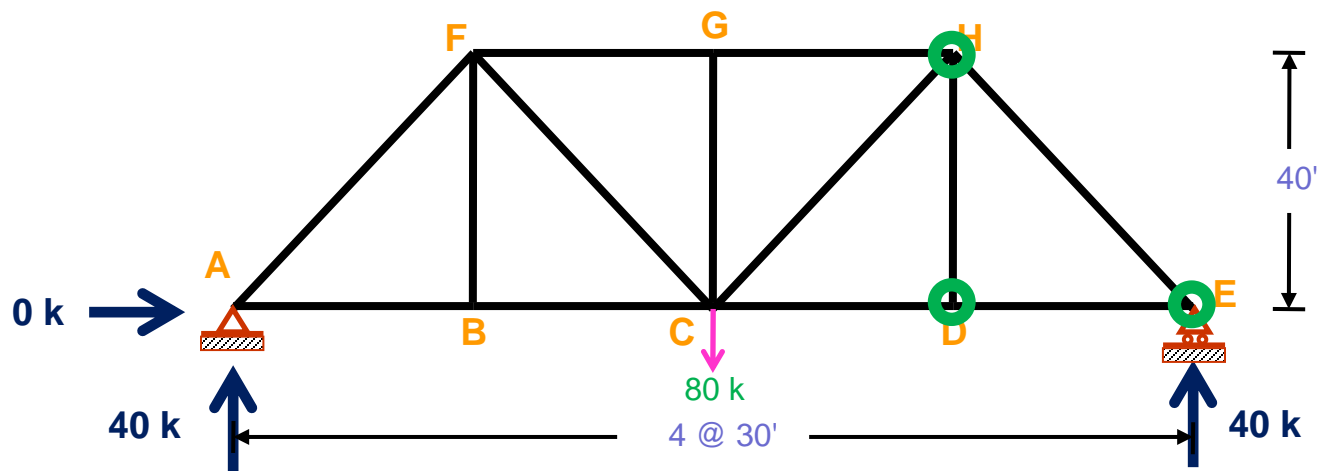
9th May, 2020

Member	Length [ft]	S [k]	u_{BG} [k]	$Su_{BG}L/AE$
AB	30	30		----
BC	30	30		----
CD	30			----
DE	30			----
FG	30	-60		----
GH	30	-60		----
AF	50	-50		----
FC	50	50		----
BF	40	0		----
CG	40	0		----
CH	50			----
DH	40	0		----
EH	50			----



Unit Load/Truss/Relative Displacement

9th May, 2020



Taking joint E, joint D, joint H



Unit Load/Truss/Relative Displacement

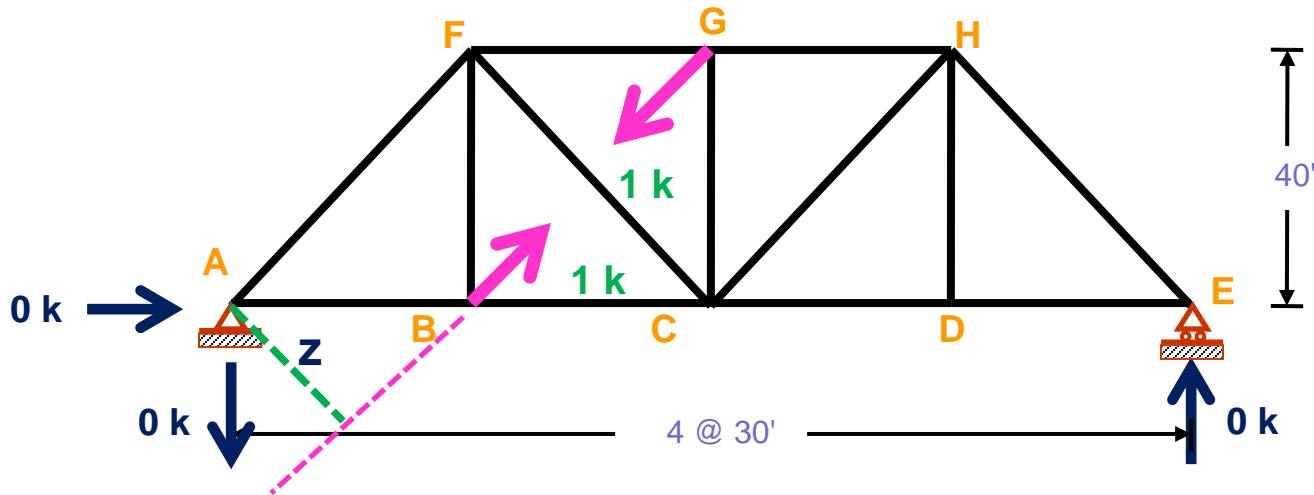
9th May, 2020

Member	Length [ft]	S [k]	u_{BG} [k]	$Su_{BG}L/AE$
AB	30	30		----
BC	30	30		----
CD	30	30		----
DE	30	30		----
FG	30	-60		----
GH	30	-60		----
AF	50	-50		----
FC	50	50		----
BF	40	0		----
CG	40	0		----
CH	50	50		----
DH	40	0		----
EH	50	-50		----



Unit Load/Truss/Relative Displacement

9th May, 2020



For $u = \text{????}$ / Remove Applied Load / Apply unit Load

$$\sum M_A = 0$$

$$1 \times z = 1 \times z + R_E \times 30 \times 4$$

$$R_E = 0$$

$$\sum f_y = 0$$

$$R_A = 0$$

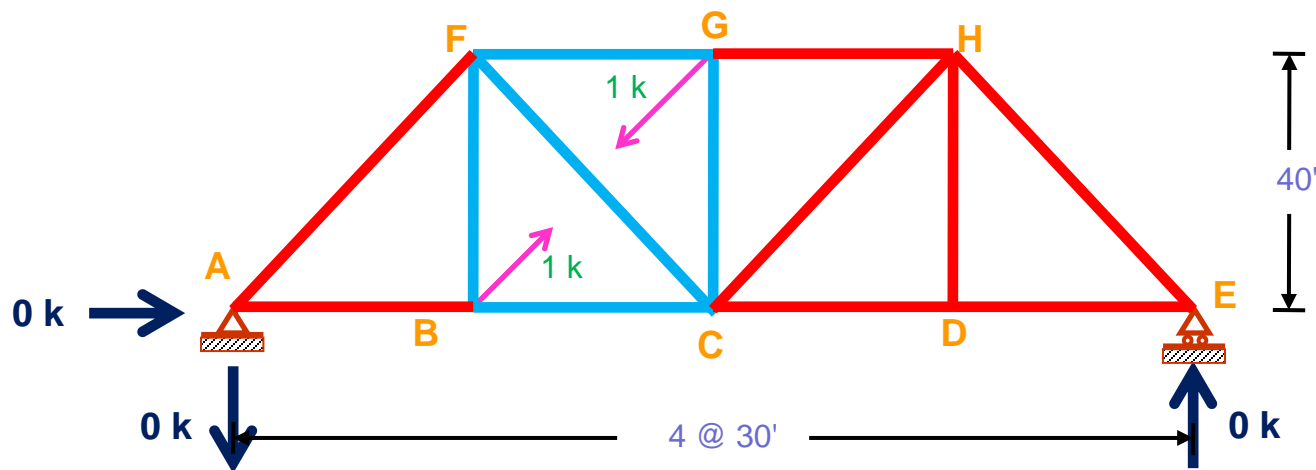
$$\sum f_x = 0$$

$$H_A = 0$$



Unit Load/Truss/Relative Displacement

9th May, 2020



BC, BF, CG, FG, CF
will have values

All other members
will have value of 0



Unit Load/Truss/Relative Displacement

9th May, 2020

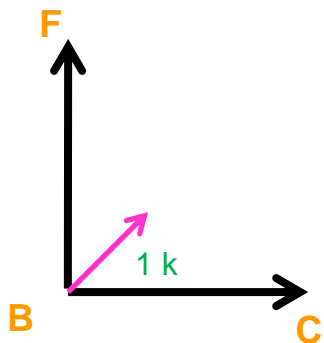
Member	Length [ft]	S [k]	u_{BG} [k]	$Su_{BG}L/AE$
AB	30	30	0	----
BC	30	30		----
CD	30	30	0	----
DE	30	30	0	----
FG	30	-60		----
GH	30	-60	0	----
AF	50	-50	0	----
FC	50	50		----
BF	40	0		----
CG	40	0		----
CH	50	50	0	----
DH	40	0	0	----
EH	50	-50	0	----



Unit Load/Truss/Relative Displacement

9th May, 2020

Joint B



$$\text{joint } B, \sum f_y = 0$$

$$BF + 1 \times \frac{40}{50} = 0$$

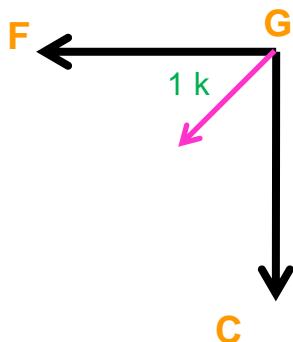
$$BF = -0.8$$

$$\text{joint } B, \sum f_x = 0$$

$$BC + 1 \times \frac{30}{50} = 0$$

$$BC = -0.6$$

Joint G



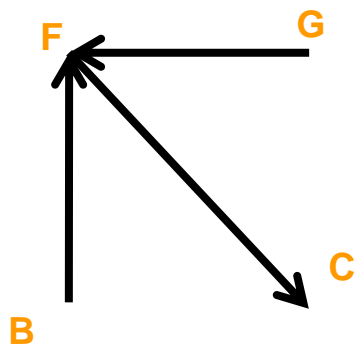
$$\text{joint } G, \sum f_y = 0$$

$$CG = -0.8$$

$$\text{joint } G, \sum f_x = 0$$

$$FG = -0.6$$

Joint F



$$\text{joint } F, \sum f_y = 0$$

$$CF = 0.8 \times \frac{50}{40} = 1$$



Unit Load/Truss/Relative Displacement

9th May, 2020

Member	Length [ft]	S [k]	u_{BG} [k]	$Su_{BG}L/AE$
AB	30	30	0	----
BC	30	30	-0.6	----
CD	30	30	0	----
DE	30	30	0	----
FG	30	-60	-0.6	----
GH	30	-60	0	----
AF	50	-50	0	----
FC	50	50	1	----
BF	40	0	-0.8	----
CG	40	0	-0.8	----
CH	50	50	0	----
DH	40	0	0	----
EH	50	-50	0	----



Unit Load/Truss/Relative Displacement

9th May, 2020

Member	Length [ft]	S [k]	u_{BG} [k]	$Su_{BG}L/AE$
AB	30	30	0	----
BC	30	30	-0.6	----
CD	30	30	0	----
DE	30	30	0	----
FG	30	-60	-0.6	----
GH	30	-60	0	----
AF	50	-50	0	----
FC	50	50	1	----
BF	40	0	-0.8	----
CG	40	0	-0.8	----
CH	50	50	0	----
DH	40	0	0	----
EH	50	-50	0	----

$\Sigma()$ IW OW