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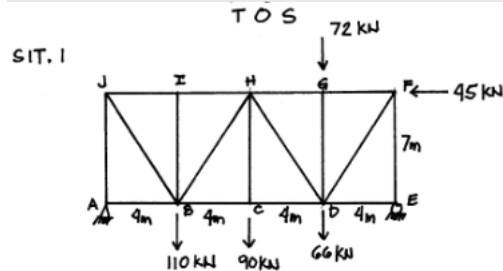
Question: Determine the following A and B use VIRTUAL WORK METHO...

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Determine the following

A and B use VIRTUAL WORK METHOD

C and D use CASTIGLIANO'S PRINCIPLE



• Sectional Properties:
 $E = 210 \text{ GPa}$ $I_x = 1,500 \times 10^6 \text{ mm}^4$
 $A = 15,010 \text{ mm}^2$

Det. the ff.:

a.) ΔF_x in mm > USE VWM
 b.) ΔF in mm > USE VWM

c.) Δc in mm > USE CP

d.) Δc_y in mm > USE CP

e.) Conserving all the loads & average stiffness of the truss members to be replaced by a uniformly distributed load by 0.009%, determine the vertical displacement @ C. Use VWM or CP. The top chord & web members are to be removed & replaced by an equivalent load as mentioned.

f.) ΔB in question e.)

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Expert Answer ①



Anonymous answered this
118 answers

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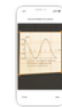
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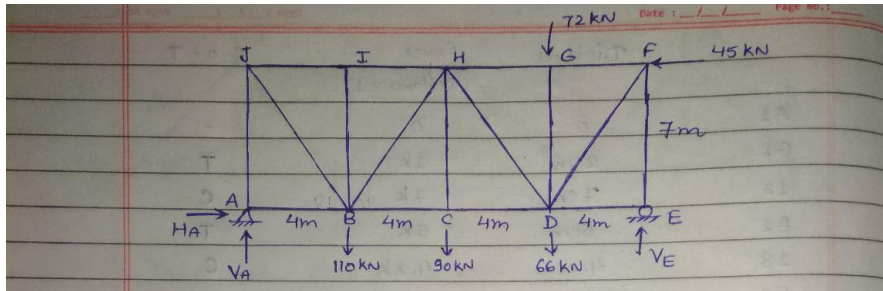


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Member forces due to given loading \rightarrow

$$\sum F_x = 0$$

$$H_A - 45 = 0$$

$$H_A = 45 \text{ kN } (\rightarrow)$$

$$\sum F_y = 0$$

$$V_A + V_E - 110 - 90 - 66 - 72 = 0$$

$$V_A + V_E = 338 \text{ kN}$$

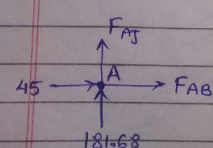
Taking moment about E \rightarrow

$$V_A \times 16 - 110 \times 12 - 90 \times 8 - 66 \times 4 - 72 \times 4 - 45 \times 7 = 0$$

$$V_A = 181.68 \text{ kN } (\uparrow)$$

$$V_E = 338 - 181.68 = 156.32 \text{ kN } (\uparrow)$$

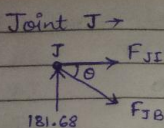
Joint A \rightarrow



$$F_{AJ} = -181.68 \text{ kN}$$

$$F_{AB} = -45 \text{ kN}$$

Joint J \rightarrow



$$\theta = \tan^{-1}\left(\frac{7}{4}\right) = 60.25^\circ$$

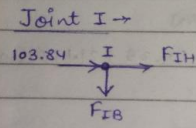
$$181.68 - F_{JB} \sin(60.25) = 0$$

$$F_{JB} = 209.26 \text{ kN}$$

$$F_{JI} + 209.26 \cos(60.25) = 0$$

$$F_{JI} = -103.84 \text{ kN}$$

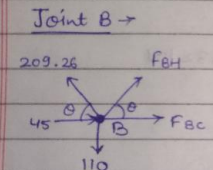
Joint I \rightarrow



$$F_{IH} = -103.84 \text{ kN}$$

$$F_{IB} = 0$$

Joint B \rightarrow



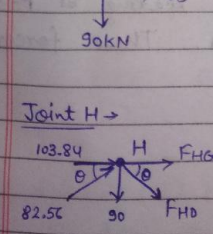
$$F_{BH} \sin(60.25) + 209.26 \sin(60.25) - 110 = 0$$

$$F_{BH} = -82.56 \text{ kN}$$

$$F_{BC} - 82.56 \cos(60.25) + 45 - 209.26 \cos(60.25) = 0$$

$$F_{BC} = 101.29 \text{ kN}$$

Joint C \rightarrow



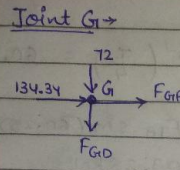
Joint H \rightarrow

$$82.56 \sin(60.25) - 90 - F_{HD} \sin(60.25) = 0$$

$$F_{HD} = -21.1 \text{ kN}$$

$$F_{HG} + 103.84 + 82.56 \cos(60.25) - 21.1 \cos(60.25) = 0$$

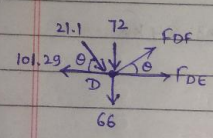
$$F_{HG} = -134.34 \text{ kN}$$



Joint G \rightarrow

$$F_{GF} = -134.34 \text{ kN}$$

$$F_{GD} = -72 \text{ kN}$$




Joint D \rightarrow

$$F_{DF} \sin(60.25) - 72 - 66 - 21.1 \sin(60.25) = 0$$

$$F_{DF} = 180.05 \text{ kN}$$

$$F_{DE} + 180.05 \cos(60.25) - 101.29 + 21.1 \cos(60.25) = 0$$

$$F_{DE} = 0$$



Joint E \rightarrow

$$F_{EF} = -156.32 \text{ kN}$$

for part (a) and (b) \rightarrow Virtual work method \rightarrow

(i) A unit load (1 kN) is applied at joint F in horizontal direction (\rightarrow) and all member forces are calculated only due to unit load.

let forces in members due to given loading be P-forces and due to unit load is K-forces. These forces are tabulated below \rightarrow

Member	Length (m)	P-forces (kN)	K-forces (kN)	$\frac{PKL}{AE}$ (mm)
AB	4	-45	1	-0.057
AJ	7	-181.68	0.437	-0.176
JB	8.06	209.26	-0.5	-0.267
JI	4	-103.84	0.248	-0.033
IH	4	-103.84	0.248	-0.033
IB	7	0	0	0
BH	8.06	-82.56	0.5	-0.105
BC	4	101.29	0.5	0.064
CH	7	90	0	0
CD	4	101.29	0.5	0.064
HD	8.06	-21.1	-0.5	0.027
HG	4	-134.34	0.744	-0.127
GF	4	-134.34	0.744	-0.127
GD	7	-72	0	0
DF	8.06	180.05	0.5	0.230
DE	4	0	0	0
EF	7	-156.32	-0.437	0.152
				<u>-0.388</u>

$\Delta F_x = -0.388 \text{ mm}$
 Negative sign shows that Joint displaced in opposite direction to the applied unit load

$\Delta F_x = 0.388 \text{ mm}$ (\leftarrow)

(ii) Now a unit load of 1kN is applied in vertical direction (\downarrow) at joint F. and similar calculations are done and tabulated below \rightarrow

Member	Length (m)	P-forces (kN)	K-forces (kN)	$\frac{PKL}{AE}$ (mm)
AB	4	-45	0	0
AJ	7	-181.68	0	0
JB	8.06	209.26	0	0
JI	4	-103.84	0	0
IH	4	-103.84	0	0
IB	7	0	0	0
BH	8.06	-82.56	0	0
BC	4	101.29	0	0
CH	7	90	0	0
CD	4	101.29	0	0
HD	8.06	-21.1	0	0
HG	4	-134.34	0	0
GF	4	-134.34	0	0
GD	7	-72	0	0
DF	8.06	180.05	0	0
DE	4	0	0	0
EF	7	-156.32	-1	0.347

$\Delta F_y \cdot \Delta F_y = 0.347 \text{ mm } (\downarrow)$

$\Delta_f = \sqrt{(\Delta F_x)^2 + (\Delta F_y)^2}$

$\Delta_f = \sqrt{(0.388)^2 + (0.347)^2}$

$\Delta_f = 0.52 \text{ mm}$ **Ans.**

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Up next for you in Civil Engineering

Vehicles A and B are traveling toward each other in the opposing lanes on a straight segment of a two-lane highway at 35 and 40 mph

[See answer](#)

Need help with all

1.1. A large truck becomes stuck on a bridge at a distance of 17.5 ft from the left end of a 300 ft long bridge. A car is traveling at 42 mph, a coefficient of friction equal to 0.5, and a level roadway. Determine if the vehicle will cross or not.

1.2. What is the minimum radius of curvature allowable for a roadway with a 60 mph design speed assuming that the minimum allowable superelevation rate is 0.12?

[See answer](#)

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Q: Answer the following. B and C use VIRTUAL WORK METHOD (VWM) D and E use CASTIGLIANO'S PRINCIPLE (CP)
 Note that Point H is 1m from joint C and the subscript of x in delta H sub x as an example represents horizontal direction while y in delta H sub y as an example represents vertical direction.

Q: 1. A truss shown below is subjected to a horizontal force at joint C. Its axial rigidity, $AE=10,000N$. - $10N AE = \text{constant}$
USING METHOD OF CONSISTENT DEFORMATIONS FOR INDETERMINATE TRUSSES - ONE REDUNDANT b.
Calculate $A=[SuL/AE]$, the relative displacement of joint B and D, due to actual load if member BD (as redundant) is removed?

A: [See answer](#)


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