SOLUTION AND SCHEME OF VALUATION

Analysis of determinate structures 15CV42

IAT-I March-2018

1 (a) Explain determinate and indeterminate structures with the help of examples.

Ans: Determinate structure :- A structure which can be analysed by using equations of eqm only are known as determinate structures.

examples: cantilever beam

2.5

three hinged arch

simply supported beam

Indeterminate structures :- structure which cannot be analysed by using eqns of equilibrium only are termd as indeterminate structures.

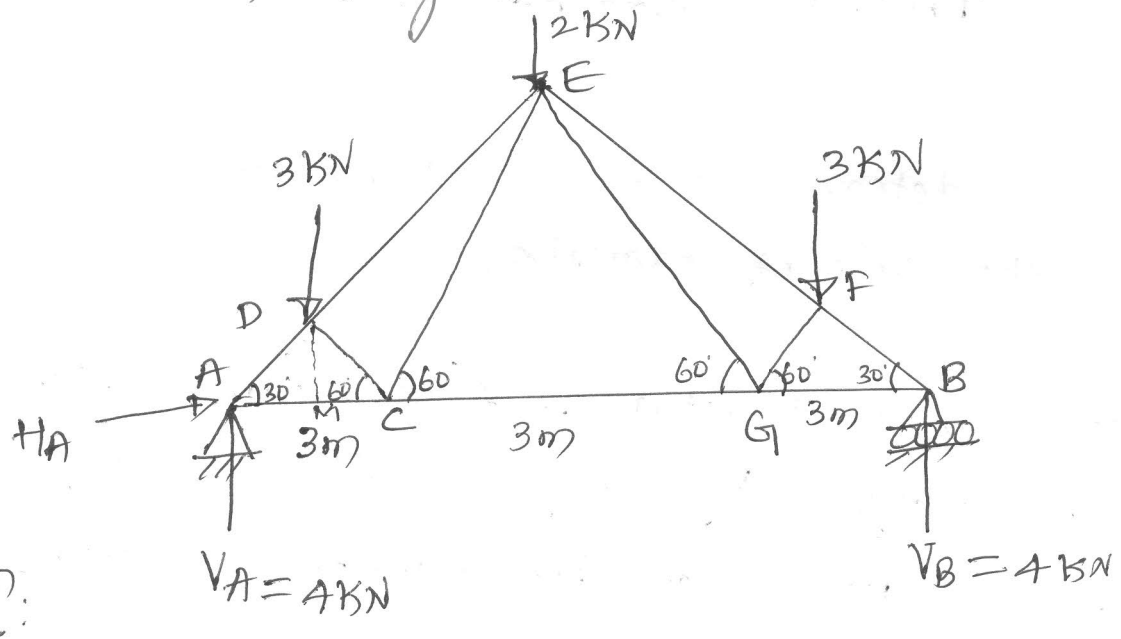
e.g Fixed beam

2.5

Propped cantilever beam

continuous beams

1 (b) Analyse the plane truss shown in fig by method of joints and verify forces in any three members by method of sections.



Soln:

(1) Support reactions:

$$\Sigma F_y = 0$$

$$V_A + V_B = 3+2+3$$

$$V_A + V_B = 8\ KN$$

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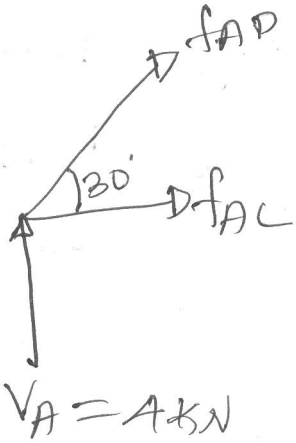
Due to symmetry $V_A = V_B = \frac{8}{2} = 4\ KN$

(2) Member forces:

Joint 'A':



$$\Sigma F_y = 0$$

$$V_A + f_{AD} \sin 30^\circ = 0$$

$$f_{AD} = -8\ KN\ (C)$$

$\Sigma F_x = 0$

$f_{AD}\cos 30^\circ + f_{AC} = 0$

$-8\cos 30^\circ + f_{AC} = 0$

$f_{AC} = 6.928\ KN$

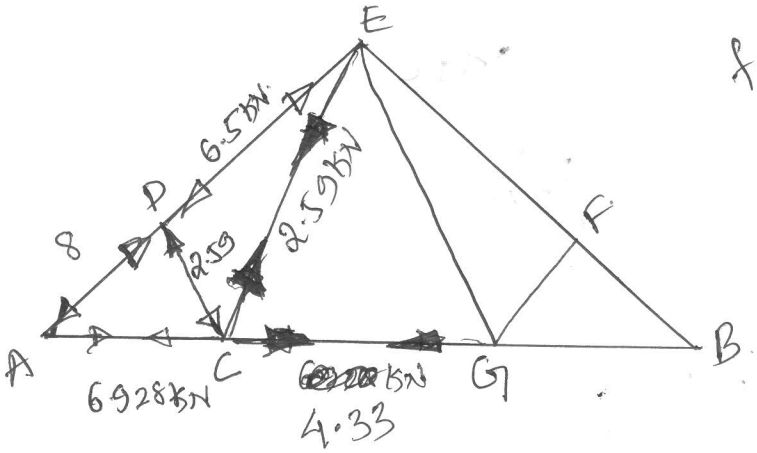
Due to symmetry

$f_{CE} = f_{EG}$

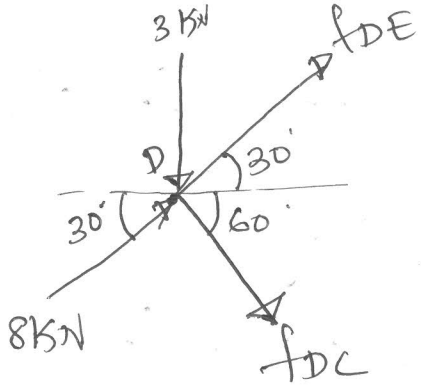
$f_{EF} = f_{ED}$

$f_{FB} = f_{AD}$

$f_{BG} = f_{AC}$



Joint 'D'



$\Sigma F_x = 0$

$f_{DE}\cos 30^\circ + f_{DC}\cos 60^\circ + 8\cos 30^\circ = 0$

$\Sigma F_y = 0$

$f_{DE}\sin 30^\circ - f_{DC}\sin 60^\circ + 8\sin 30^\circ = 0$

$f_{DE} = -6.5\ KN\ (C)$ $f_{DC} = -2.59\ KN\ (C)$

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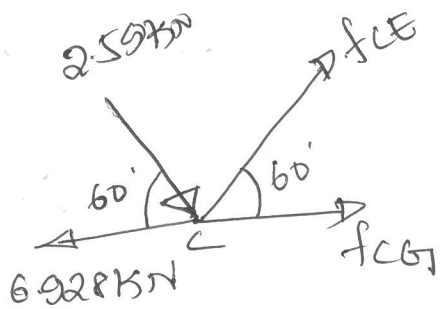
Joint 'C':



$\Sigma F_x = 0$

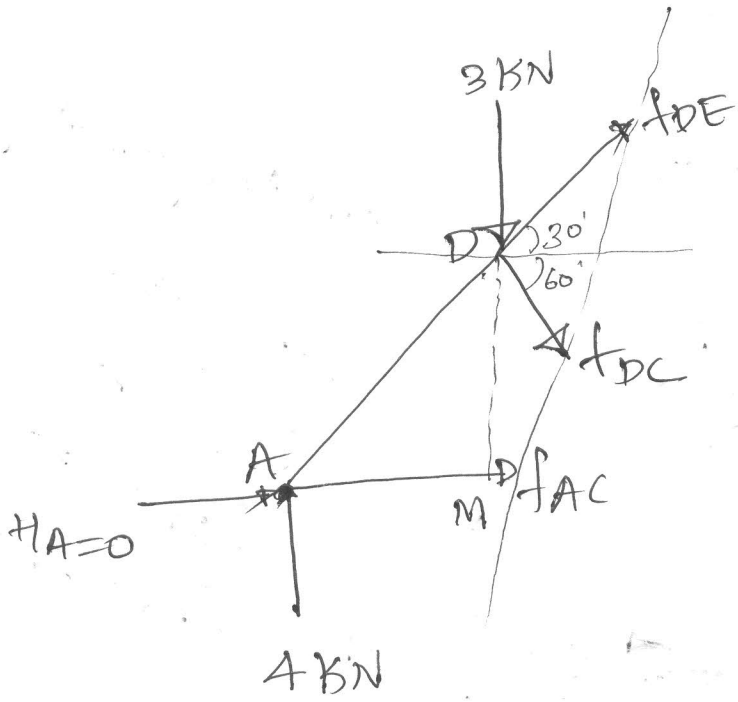
$-6.928 + 2.59\cos 60^\circ + f_{CG} + f_{CE}\cos 60^\circ = 0$

$\Sigma F_y = 0$

$-2.59\sin 60^\circ + f_{CE}\sin 60^\circ = 0$

$f_{CE} = +2.59\ KN\ (T)$ $f_{CG} = 4.33\ KN\ (T)$

(3) Method of sections



$\Sigma F_x = 0$

$f_{AC} + f_{DC}\cos 60^\circ + f_{DE}\cos 30 = 0$ → (1)

$\Sigma f_y = 0$

$-3 + 4 - f_{DC}\sin 60^\circ + f_{DE}\sin 30 = 0$ → (2)

$\Sigma M_A = 0$

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$3 \times 2.24\text{m} + f_{DC} \times 2.59 = 0$

$\cos 30 = \frac{AD}{3} \Rightarrow AD = 2.59\text{m}$ ∴ AD = 2.59 cos 30

= 2.24 m

$f_{DC} = -2.59$ KN

$f_{DE} = 0.486$ KN

2(a) State the assumptions made in the analysis of truss.

01X05 = 05

Ans:

(1) The truss is perfect

(2) Young's modulus is same throughout

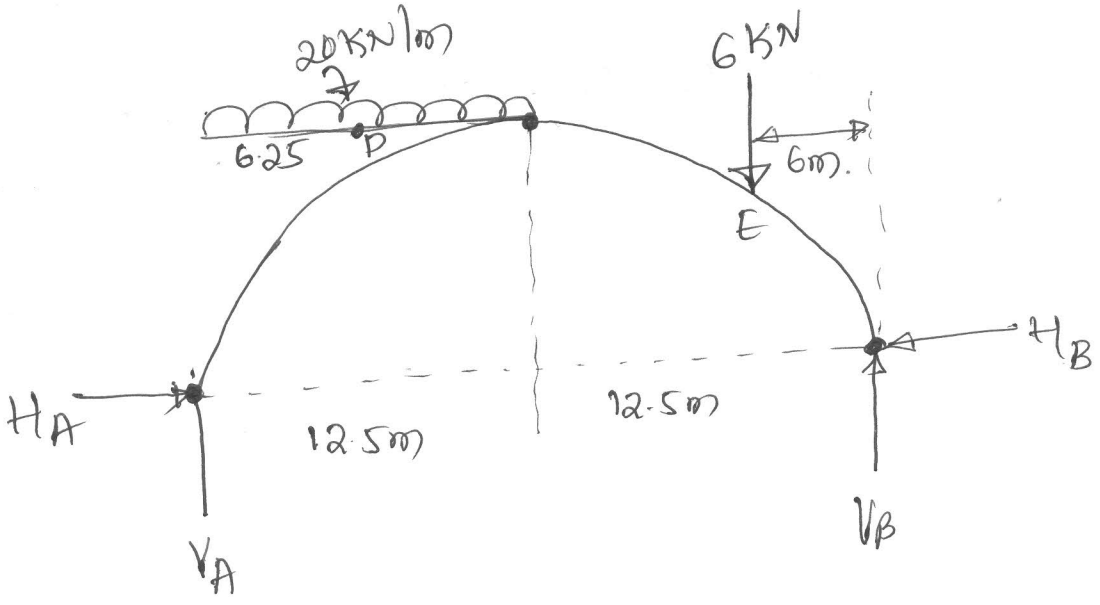
(3) All the joints are pinned or hinged

(4) self wt of the truss is neglected

(5) The loads will act at joints only.

2(b) A three hinged parabolic arch has a span of 25m and a central rise of 5m. It carries a udl of 20 KN/m over the left half portion and a point load of 6KN at a distance of 6m from the right hinge. Draw BMD. Calculate normal thrust and radial shear at a distance of 6m from the right hinge.

Soln:



① Support reactions:

$$\Sigma F_x = 0$$

$$H_A - H_B = 0$$

$$H_A = H_B = H$$

$$\Sigma F_y = 0$$

$$V_A + V_B - 20 \times 12.5 - 6 = 0 \longrightarrow (i)$$

$$\Sigma M_A = 0$$

$$20 \times 12.5 \times \frac{12.5}{2} + 6(25-6) - V_B \times 25 = 0$$

$$V_B = 67.06\,KN \qquad V_A = 188.94\,KN$$

$\Sigma M_A = 0$ (LHS)

$$-20 \times 12.5 \times \frac{12.5}{2} + V_A \times 12.5 - H_A \times 5 = 0$$

$$H_A = 159.85 \text{ KN}$$

$$H_A = H_B = H = 159.85 \text{ KN}$$

$$R_A = \sqrt{V_A^2 + H_A^2}$$

$$= 247.488 \text{ KN}$$

$$R_B = \sqrt{V_B^2 + H_B^2}$$

$$= 173.346 \text{ KN}$$

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$$\theta_A = \sqrt{\frac{V_A}{H_A}}$$

$$\theta_A = 49.765$$

$$\theta_B = \sqrt{\frac{V_B}{H_B}}$$

$$\theta_B = 22.75$$

(2) Rise and slope equation:

$$y = \frac{4h}{l^2} x(l-x)$$

$$= \frac{4 \times 5}{(25)^2} x(25-x)$$

$$y = 0.8x - 0.032x^2 \longrightarrow (1)$$

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$$\tan\theta = \frac{dy}{dx} = 0.8 - 0.064x$$

$$\frac{dy}{dx} = 0.8 - 0.064x \longrightarrow (2)$$

(3) BMD

$M_A = M_B = M_C = 0$

$$M_D = -20 \times 6.25 \times \frac{6.25}{2} + V_A \times 12.5 - H_A \times y_D$$

$$= -390.625 + 2361.75 - 159.85\left[0.8x - 0.032x^2\right]$$

$x = 6.25$

$$= -390.625 + 2361.75 - 799.25 + 199.81$$

$$= 1371.6875 \text{ KNM}$$

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$$M_E = V_B \times 6 - H_B \cdot y_E$$

$$= 67.06 \times 6 - 159.85\left[0.8 \times 6 - 0.032 \times 6^2\right]$$

$$= 402.36 - 767.28 + 184.1472$$

$M_E = -180.77$ KNM.

(4) Normal thrust and radial shear

$NT = H\cos\theta + V\sin\theta$

$H = 159.85$ KN, $V = -67.06$ KN

$\tan\theta = 0.8 - 0.064x$

$\theta = \tan^{-1}[0.8 - 0.064 \times 6]$

$\theta = 22.58^\circ$

$NT = 121.84$ KN

$RS = H\sin\theta - V\cos\theta$

$RS = 123.29$ KN

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BMD