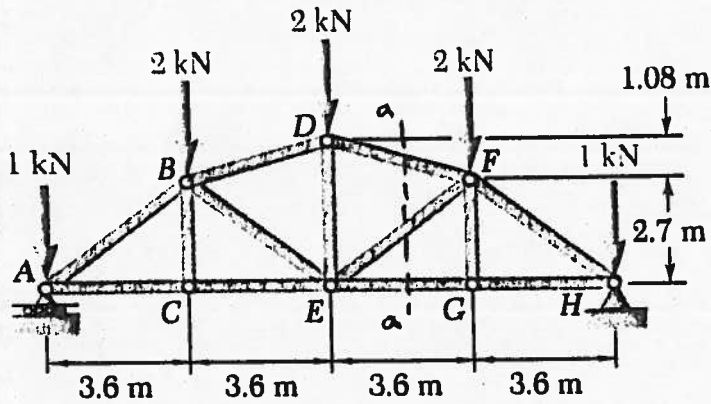


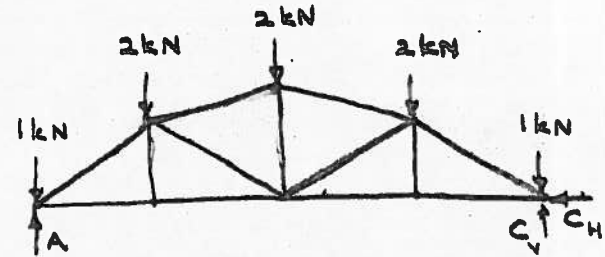
**Question 1:**

The loads supported by the truss are shown in Figure.

- (a) Determine the reaction of the support A.
- (b) Identify the zero-force members of this truss
- (c) Using the section *aa* shown, determine the axial load in member DF. State whether this axial load is a tension or a compression.



(a)



$$\sum C \quad A(14.4) - 1(14.4) - 2(9.8) - 2(7.2) - 2(3.6) = 0$$

$$A = 4 \text{ kN}$$

$$\uparrow \quad A - 1 - 2 - 2 - 2 - 1 + C = 0$$

$$A + C = 8$$

$$\therefore C = 4 \text{ kN}$$

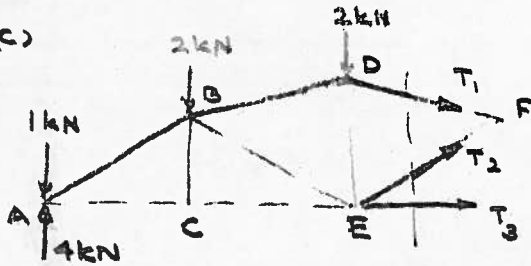
(b) Two-Force Members:

Node C: BC

Node G: FG

BC and FG are two-force members.

(c)



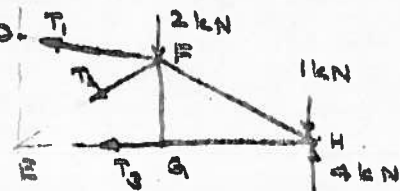
$$\sum E \quad -4(7.2) + 1(7.2) + 2(3.6) - T_1 \frac{3.6}{\sqrt{1.08^2 + 3.6^2}} \times (3.78) = 0$$

$$T_1 = - \frac{14.4 \times 3.7585}{3.6 \times 3.78} = -3.977 \text{ kN}$$

(Compression)

$\therefore$  Axial load on DF = 3.977 kN (C)

(c)



Method (2)

$$\sum E \quad \frac{T_1 \times 3.6}{\sqrt{3.6^2 + 1.08^2}} \times 2.7 + \frac{T_1 \times 1.08}{\sqrt{3.6^2 + 1.08^2}} \times 3.6 - 2 \times 3.6 - 1 \times 7.2 + 4 \times 7.2 = 0$$

$$\therefore T_1 = -3.977 \text{ kN}$$

Method (3)

or  $\sum E$  Treat  $T_1$  as acting at D. (Transmissibility)

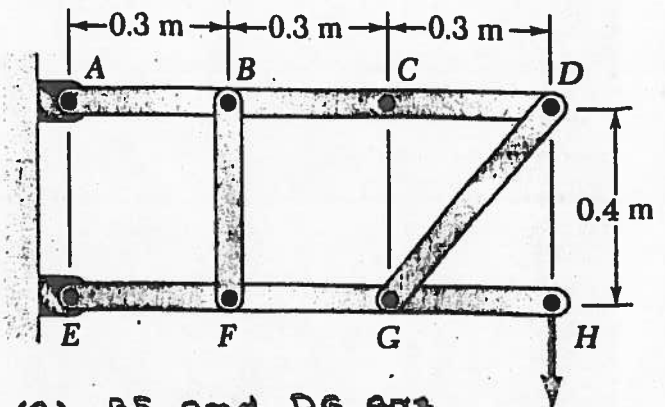
$$\frac{T_1 \times 3.6}{\sqrt{3.6^2 + 1.08^2}} \times 3.78 - 2 \times 3.6 - 1 \times 7.2 + 4 \times 7.2 = 0$$

$$\therefore T_1 = -3.977 \text{ kN}$$

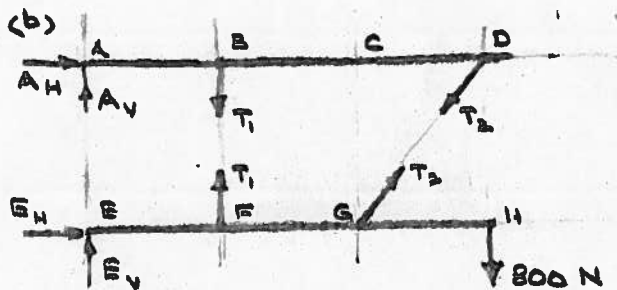
**Question 2:**

The frame shown in Figure consists of four members ABCD, EFGH, CF and DG. It supports the load 800 N at H.

- Identify the two-force members of this frame.
- Draw the free-body-diagrams of the members ABCD and EFGH
- Determine the reactions of the supports A and E.



(a) BF and DG are two-force members.  $800\text{ N}$   
 $\therefore$  They can be replaced by pairs of equal and opposite forces.



(c) Method (1).

For ABCD:  $\sum \curvearrowright A$   $T_1(0.3) + T_2 \frac{0.4}{\sqrt{0.3^2 + 0.4^2}} \times 0.9 = 0$   
 $\therefore T_1 + 2.4 T_2 = 0 \quad (1)$

For EFGH:  $\sum \curvearrowright E$   $-T_1(0.3) - T_2 \frac{0.4}{\sqrt{0.3^2 + 0.4^2}} (0.6) + 800 \times 0.9 = 0$   
 $\therefore T_1 + 1.6 T_2 = 2400 \quad (2)$

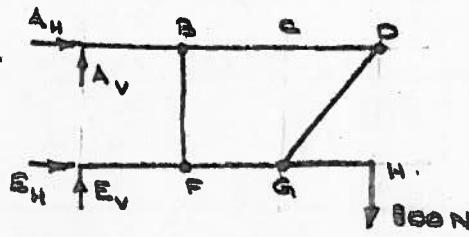
Using (1)  $-2.4 T_2 + 1.6 T_2 = 2400$   
 $T_2 = -3000\text{ N}$   
 $T_1 = +7200\text{ N}$

For ABCD:  $\rightarrow A_H - \frac{0.3 T_2}{\sqrt{0.3^2 + 0.4^2}} = 0$   
 $\therefore A_H = 1800\text{ N}$   
 $\uparrow A_V - T_1 - \frac{0.4 T_2}{\sqrt{0.3^2 + 0.4^2}} = 0$   
 $\therefore A_V = 4800\text{ N}$

For EFGH:  $\rightarrow E_H + \frac{0.3 T_2}{\sqrt{0.3^2 + 0.4^2}} = 0$   
 $\therefore E_H = +1800\text{ N}$   
 $\uparrow E_V + T_1 + \frac{0.4 T_2}{\sqrt{0.3^2 + 0.4^2}} - 800 = 0$   
 $\therefore E_V = -4000\text{ N}$

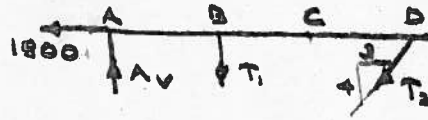
Method (2):

For whole frame



$$\begin{aligned} \sum \circlearrowleft (A) \quad & (E_H)(0.4) - (800)(0.9) = 0 \\ & \therefore E_H = 1800 \text{ N} \\ \rightarrow & A_H + E_H = 0 \\ & \therefore A_H = -1800 \text{ N} \end{aligned}$$

For ABCD:



$$\begin{aligned} \rightarrow & -1800 - \frac{3}{5}T_2 = 0 \\ & \therefore T_2 = -3000 \text{ N} \end{aligned}$$

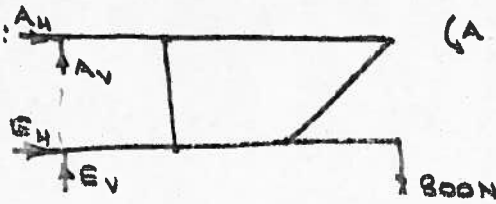
$$\begin{aligned} \sum \circlearrowleft (B) \quad & (A_V)(0.3) + \frac{4}{5}T_2 \times 0.6 = 0 \\ & \therefore A_V = 4800 \text{ N} \end{aligned}$$

For whole frame

$$\begin{aligned} \uparrow & A_V + E_V - 800 = 0 \\ & \therefore E_V = -4000 \text{ N} \end{aligned}$$

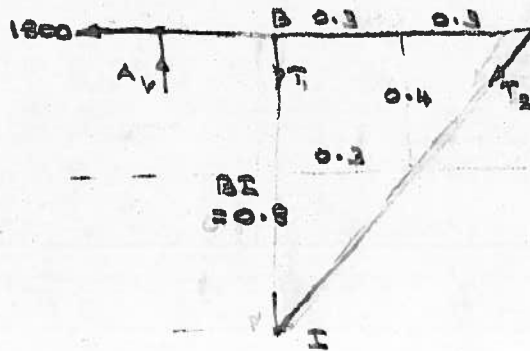
Method (3):

For whole frame:



$$\begin{aligned} \sum \circlearrowleft (A) \quad & (E_H)(0.4) - (800)(0.9) = 0 \\ & E_H = 1800 \text{ N} \\ \rightarrow & A_H + E_H = 0 \\ & \therefore A_H = -1800 \text{ N} \end{aligned}$$

For ABCD:



$$\begin{aligned} \sum \circlearrowleft (I) \quad & (1800)(0.8) - A_V(0.3) = 0 \\ & \therefore A_V = 4800 \text{ N} \end{aligned}$$

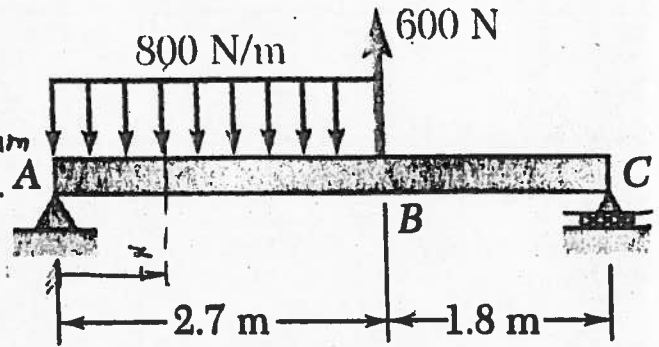
For whole frame

$$\begin{aligned} \uparrow & A_V + E_V - 800 = 0 \\ & \therefore E_V = -4000 \text{ N} \end{aligned}$$

**Question 3:**

Loads supported by the simply-supported 4.5 m long beam ABC are shown in Figure. The distance  $x$  from the left end A represents the cross-section of the beam

- Determine the reactions of the supports A and C.
- Express the expressions for shear and bending moment for the span AB ( $0 < x < 2.7$ ).
- Express the expressions for shear and bending moment for the span BC ( $2.7 < x < 4.5$ ).



(a) Equivalent load:



(A)

$$-2160 \times 1.35 + 600 \times 2.7 + C(4.5) = 0$$

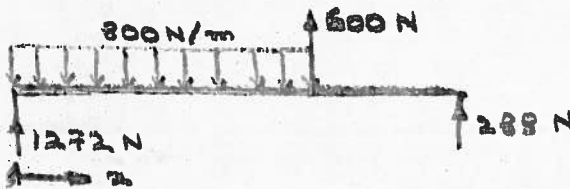
$$\therefore C = 288 \text{ N}$$

$$\uparrow A_v - 2160 + 600 + C = 0$$

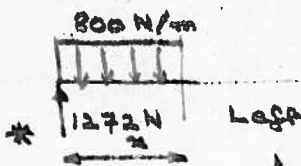
$$\therefore A_v = 1272 \text{ N}$$

$$\rightarrow A_h = 0$$

Actual Load:



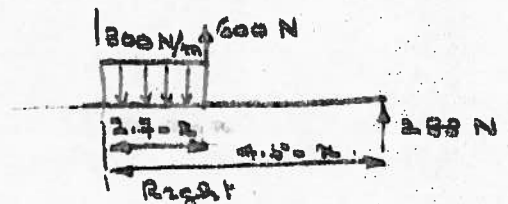
(b) Span AB ( $0 < x < 2.7$ )



$$\uparrow V = 1272 - 800x \text{ N}$$

$$\curvearrowright M = 1272x - 800x \cdot \frac{x}{2}$$

$$= 1272x - 400x^2 \text{ Nm}$$



$$\downarrow V = 800(2.7 - x) - 600 - 288$$

$$= 1272 - 800x \text{ N}$$

$$\curvearrowleft M = -800(2.7 - x) \left( \frac{2.7 - x}{2} \right) + 600(2.7 - x) + 288(4.5 - x)$$

$$= 1272x - 400x^2 \text{ Nm}$$

(c) Span BC ( $2.7 < x < 4.5$ )

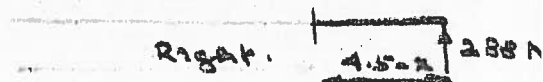


$$\uparrow V = 1272 - 2160 + 600$$

$$= -288 \text{ N}$$

$$\curvearrowleft M = (1272)(x) - 2160(x - 1.35) + 600(x - 2.7)$$

$$= 1296 - 288x$$



$$\downarrow V = -288 \text{ N}$$

$$\curvearrowright M = 288(4.5 - x)$$

$$= 1296 - 288x \text{ Nm}$$