Theory of structure
Trusses
L6

Assistant Lecturer
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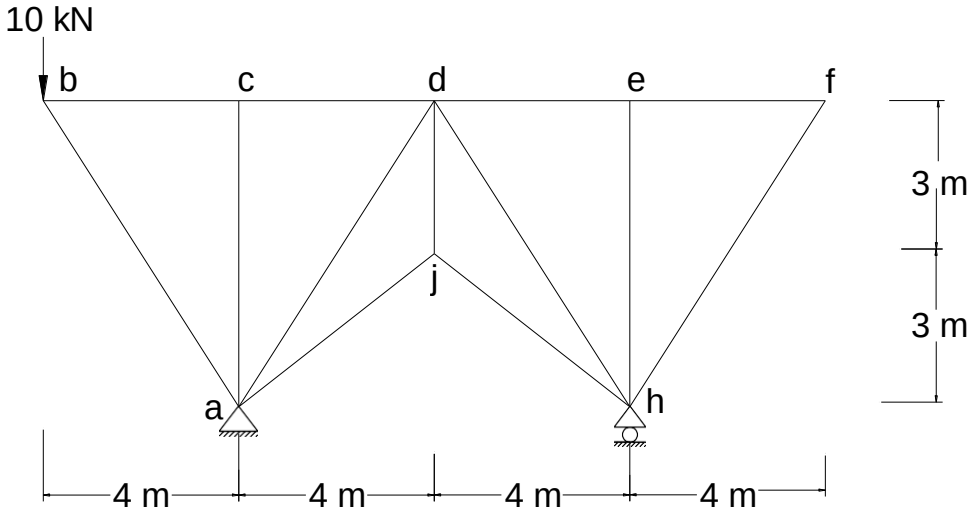
Ex3: For the simple truss shown in fig. find the axial force in bars HD & HJ.



Solution

$\sum M_a = 0$

(hy *8) – (10*4) = 0 => hy = 5 kN

$\uparrow \sum f_y = 0$

ay – 10 – 5 = 0 => ay= 15 kN

ca, eh, fh, fe & ed = 0

For hd & hj use joint h

$\uparrow \sum f_y = 0$

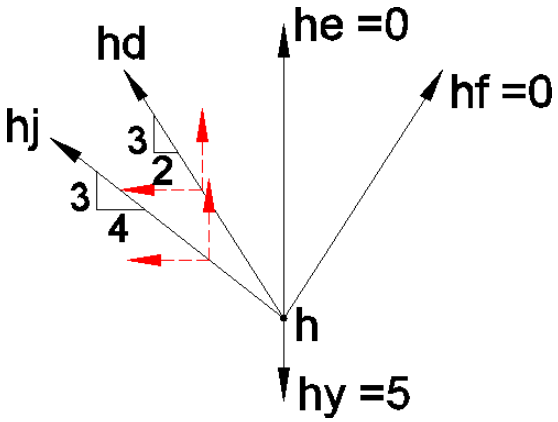
$hd * \frac{3}{\sqrt{13}} + hj * \frac{3}{5} = 5 \quad \ldots\ldots\ldots\ldots 1$

$\rightarrow \sum f_X = 0$

$-hd * \frac{2}{\sqrt{13}} - hj * \frac{4}{5} = 0$

$hd = -\frac{\sqrt{13}}{2} * \frac{4}{5} * hj \ldots\ldots\ldots\ldots\ldots 2$

Sub equation 2 in equation 1



$$(-\frac{\sqrt{13}}{2} * \frac{4}{5} * \text{hj}) * \frac{3}{\sqrt{13}} + (\text{hj} * \frac{3}{5}) = 5$$

hj = -8.34 kN = 8.34 kN (Comp.)

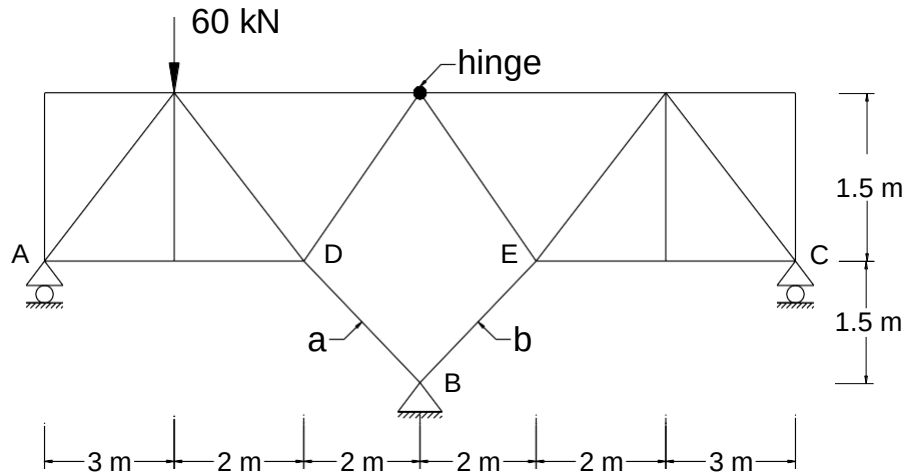
$$\text{hd} = -\frac{\sqrt{13}}{2} * \frac{4}{5} * (-8.34) = 12 \text{ kN (Ten.)}$$

H.W: For the same example find axial force in bars aj & ad

Ex4: For the compound truss shown in fig. Find

i- Reaction at supports.

ii- Axial force in bars a & b



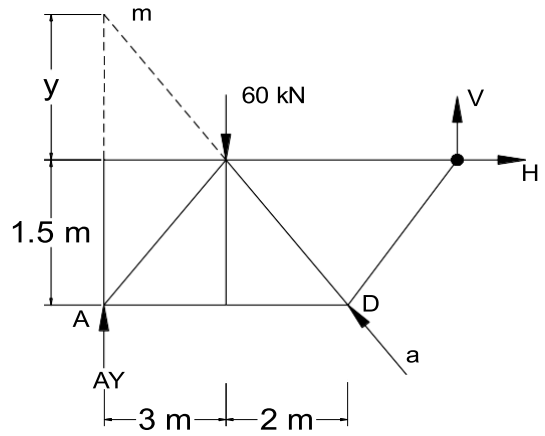


fig. 1

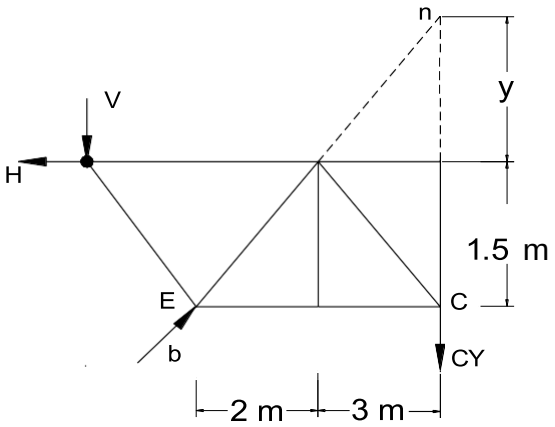


fig. 2

i) Reaction at supports

$$\frac{y}{3} = \frac{1.5}{2} \Rightarrow y = 2.25$$

From fig 1

$$\sum M_m = 0$$

(H*2.25) + (V*7) – (60*3) = 0

2.25H + 7V -180 = 0 1

From fig 2

$\sum M_n = 0$

H *2.25 – V*7 = 0

$H = \frac{7V}{2.25}$ ……..2

Sub equation 2 in equation 1

$2.25 * \frac{7V}{2.25} + 7 * V - 180 = 0$

V = 12.86 kN

$H = \frac{7 * 12.86}{2.25} = 40\ kN$

From fig 1

$\sum M_D = 0$

(Ay*5) + (40*1.5) – (12.86*2) – (60*2) = 0

Ay = 17.14 kN ↑

From fig 2

$\sum M_E = 0$

(Cy*5) – (12.86*2) – (40*1.5) = 0

Cy = 17.14 kN ↓

From the whole truss

$\sum F_X = 0$, => Bx = 0

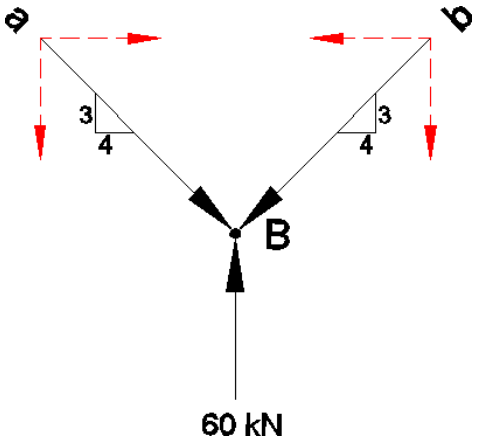
↑ $\sum F_y = 0$

17.14 – 17.14 – 60 + By = 0

By = 60 kN ↓

ii) Axial force in bars a&b

For a& b use joint B



$\uparrow \sum F_y = 0$

$$60 - a * \frac{3}{5} - b * \frac{3}{5} = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots 1$$

$\rightarrow \sum F_x = 0$

$$a * \frac{4}{5} - b * \frac{4}{5} = 0$$

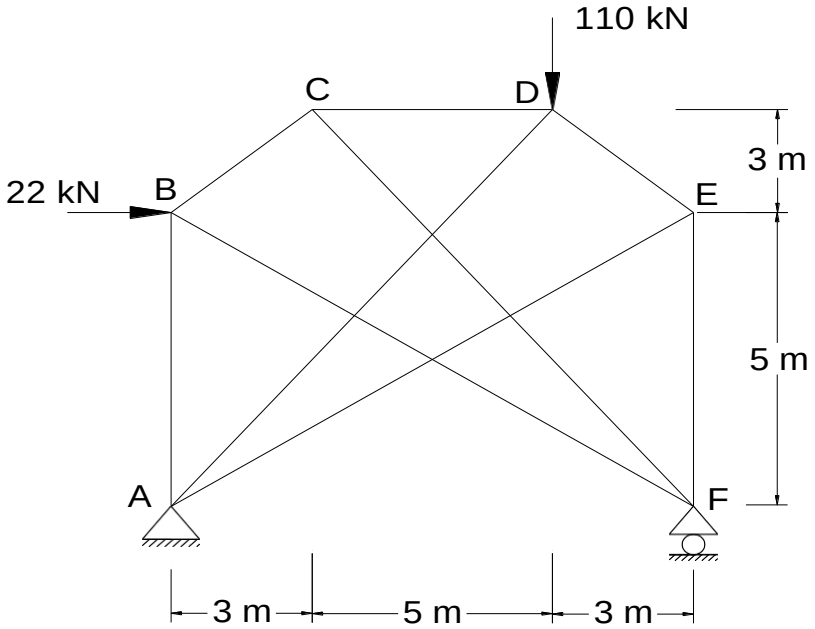
a = b.....2, sub in equation 1

$$60 - a * \frac{3}{5} - a * \frac{3}{5} = 0$$

a= 50 kN (comp.)

b = 50 kN (comp.)

Ex5: For the compound truss shown in fig. find the axial force in bars a, b &c



$\sum M_A = 0$

(22*5) + (110*8) – (By*11) = 0

By = 90 kN ↑

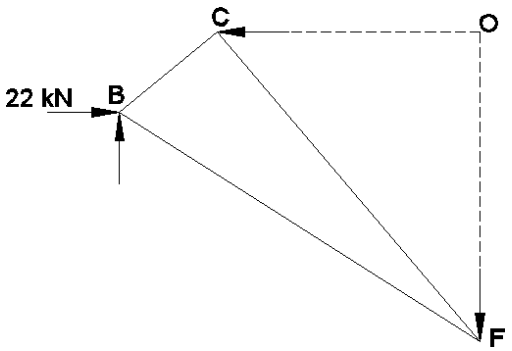
↑ $\sum F_y = 0$, => Ay + 90 – 110 = 0 => Ay = 20 kN ↑

→ $\sum F_X = 0$, => 22 - Ax = 0 => Ax = 22 kN ←

$\sum M_0 = 0$

C*11 – 22*3 = 0 => C =6 kN (comp.)

By = 90 kN



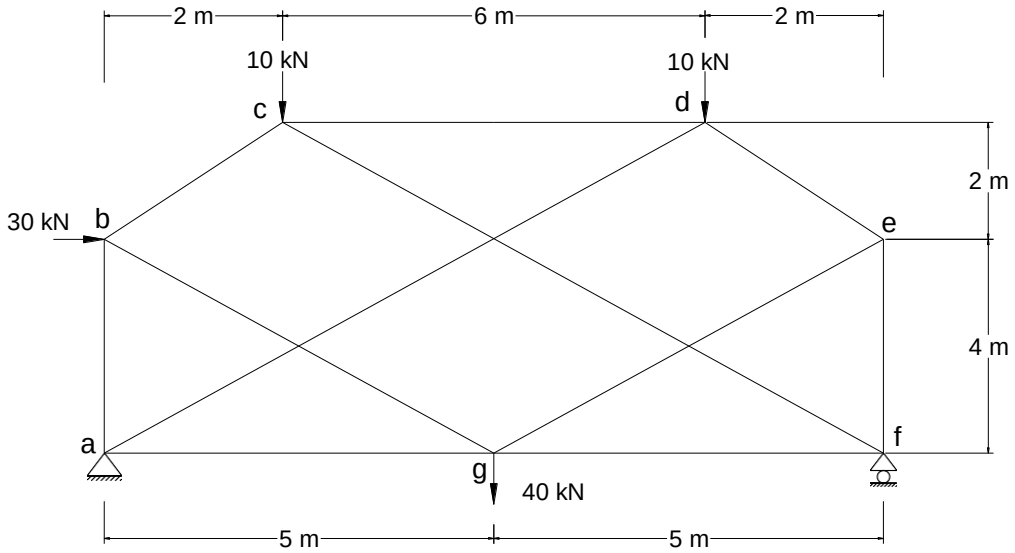
↑ $\sum F_y = 0$

90 + 6 – b = 0 => b = 96 kN (comp.)

→ $\sum F_x = 0$

22 – a = 0 => a = 22kN (comp.)

Ex 6 Analysis the truss shown in fig. finds all bars forces.



Solution procedure

1- Assume the force in any bar for example (ad) and equal (R) in tension
2- Calculate the force in another bar for example (ab) in term of (R) by following two paths.
   a) First path: (joint d), (joint c) & (joint b). By applying equilibrium equations we find the force in bar (ad) in term of (R).
   b) Second path: (joint a), from it we find the value of force in the bar (ab) in term of (R).
3- We equal the forces outputs in bar (ab) which Obtained from the two paths, we solve the equation to find the value of (R).
4- All the forces of the bars can now be calculated after identifying the value of (R).

Solution:

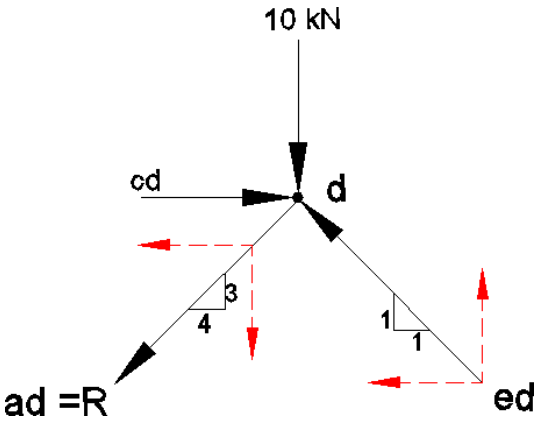
$\sum M_A = 0$ => fy = 42 kN ↑

$\sum F_y = 0$ => ay = 18 kN ↑

$\sum F_x = 0$ => ax = 30 kN ←

Let force in bar ad = R (tension)

Use joint d



$\uparrow \sum F_y = 0$

$$ed * \frac{1}{\sqrt{2}} - 10 - 0.6R = 0$$

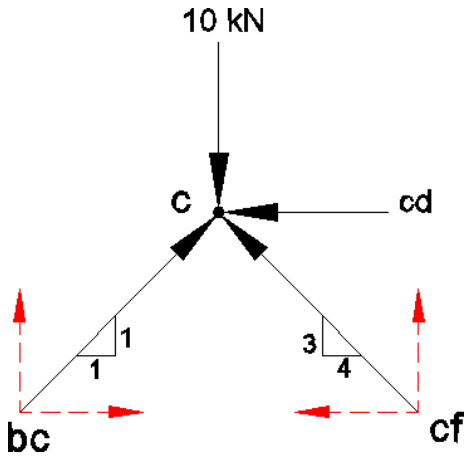
$$ed = \sqrt{2}\,(10 + 0.6R)$$

$\rightarrow \sum F_x = 0$

$$d - 0.8R - \sqrt{2}\,(10 + 0.6R) * \frac{1}{\sqrt{2}} = 0$$

$$cd = 10 + 1.4R$$

Use joint c



$\uparrow \sum F_y = 0$

$$bc * \frac{1}{\sqrt{2}} + cf * \frac{3}{5} - 10 = 0$$

$$bc = \sqrt{2}\,(10 - 0.6\,cf) \ldots\ldots\ldots 1$$

$\rightarrow \sum F_x = 0$

$$bc * \frac{1}{\sqrt{2}} - cf * \frac{4}{5} - 10 - 1.4R = 0 \ \ldots\ldots\ldots 2$$

Sub equation 1 in equation 2

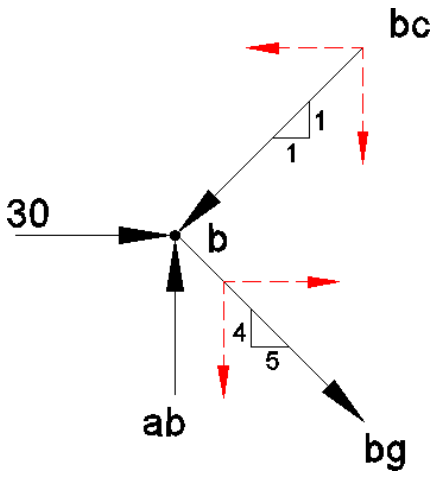
$$(\sqrt{2}\,(10 - 0.6\,cf) * \frac{1}{\sqrt{2}}) - (cf * \frac{4}{5}) - 10 - 1.4R = 0$$

$$cf = -R$$

$$bc = \sqrt{2}\,(10 - 0.6 * (-R))$$

$$bc = \sqrt{2}\,(10 + 0.6R)$$

Use joint b



$\rightarrow \sum F_x = 0, \Rightarrow 30 - 10 - 0.6R + bg * \frac{5}{\sqrt{41}} = 0$

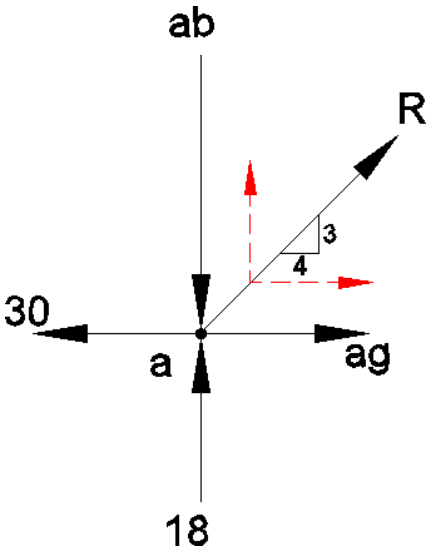
$bg = \frac{\sqrt{41}}{5}(0.6R - 20)$

$\uparrow \sum F_y = 0$

$ab - 10 - 0.6R - (0.6R - 20) * \frac{\sqrt{41}}{5} * \frac{4}{\sqrt{41}} = 0$

$ab = -6 + 1.08R$

Use joint a



$\rightarrow \sum F_x = 0$

ag + 0.8R - 30 = 0

ag= 30 – 0.8R

$\sum F_y = 0$

18 + 0.6R = -6 + 1.08R

R = 50 kN (ten.)

ad= 50 kN (ten.)

ab = -6 + (1.08*50) = -48 = 48 kN (comp.)

cd= 10+1.4 *50 =80 kN (ten.)

$bg = \frac{\sqrt{41}}{5}(0.6 * 50 - 20) \Rightarrow bg = 2\sqrt{41}$ kN (ten.)

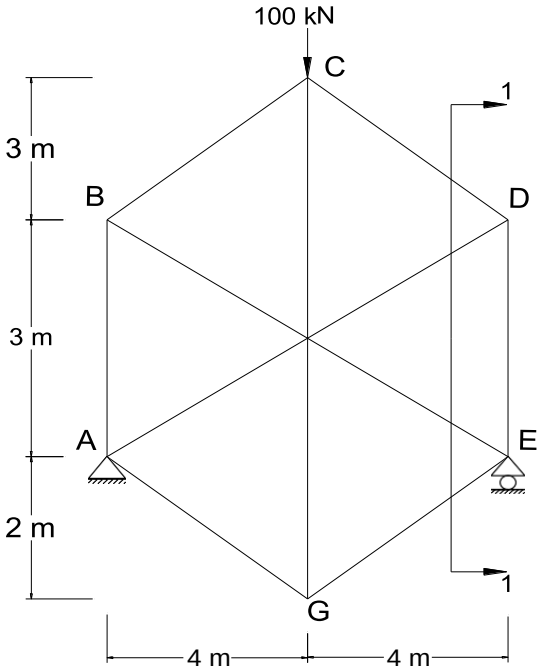
ag = 30 – 0.8*50 = 10 kN (ten.)

cf= -R = -50 = 50 kN (comp.)

$bc = \sqrt{2}(10 + 0.6 * 50) \Rightarrow bc = 40\sqrt{2}$ kN (comp.)

Ex 7: Analysis the truss shown in fig.

1- classify the truss
2- find the force in bar AD.



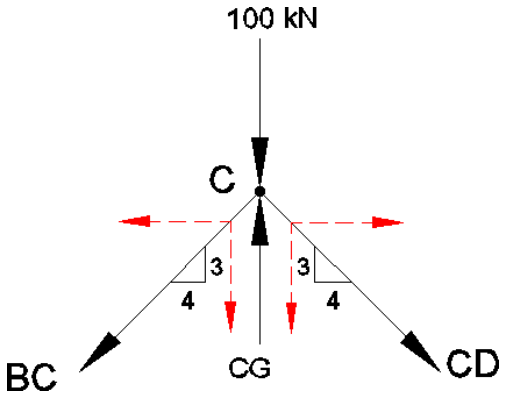
Sol:

Section 1 ------ 1

$\sum M_o = 0$

$$(50 * 4) + (\text{CD} * \frac{4}{5} * 4.5) - (GE * \frac{2}{\sqrt{5}} * 3.5) = 0 \dots\dots\dots 1$$

Joint C as F.B.D



$\rightarrow \sum F_x = 0$

$$\text{CD} * \frac{4}{5} - BC * \frac{4}{5} = 0$$

CD = BC

$\uparrow \sum F_y = 0$

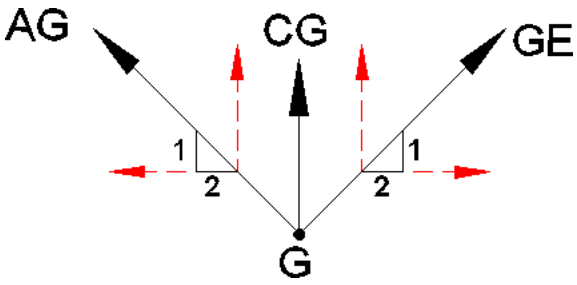
$$100 + 2 * \text{CD} * \frac{3}{5} = CG \dots\dots\dots 2$$

(Joint G) as F.B.D

$\rightarrow \sum F_x = 0$

$\text{GE} * \frac{2}{\sqrt{5}} - AG * \frac{2}{\sqrt{5}} = 0$

GE = AG



$\uparrow \sum F_y = 0$

$\text{CG} = 2\text{GE} * \frac{1}{\sqrt{5}} \ldots\ldots\ldots\ldots 3$

From equation 2&3

$100 + 2 * \text{CD} * \frac{3}{5} = 2\text{GE} * \frac{1}{\sqrt{5}} \ldots\ldots\ldots 4$

Solve equation 1 & equation 4similary to find

Cd = -249.6 kN (Comp.)

GE = -223.2 kN (Comp.)

Use joint D

$\rightarrow \sum F_x = 0$

$\text{AD} * \frac{8}{\sqrt{73}} + 249.6 * \frac{4}{5} = 0$

AD = -213.76 kN = 213.76 kN (Ten.)