Name → Shubham Raj

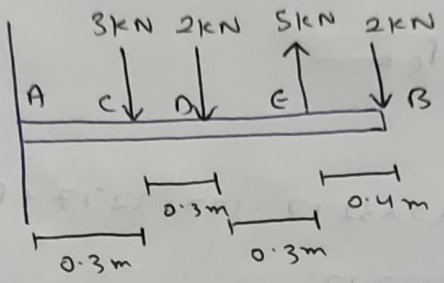
CE19B030

Strength of materials

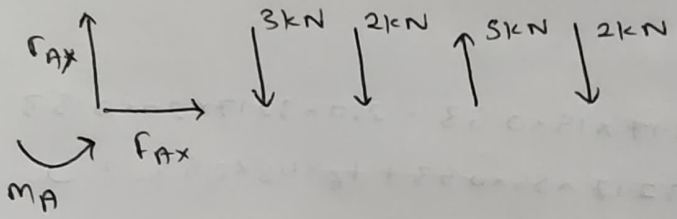
Assignment-1

1)

i)



Here A is a fixed joint member,



$\Sigma V = 0 \Rightarrow f_{AY} - 3 - 2 + 5 - 2 = 0$

$\Rightarrow f_{AY} = 2\,kN$

$\Sigma H = 0 \Rightarrow f_{AX} = 0$

$\Sigma m_A = 0 \Rightarrow m_A - 3\times0.3 - 2\times0.6 + 5\times0.9 - 2\times1.3 = 0$

$\Rightarrow m_A - 4.7 + 4.5 = 0$

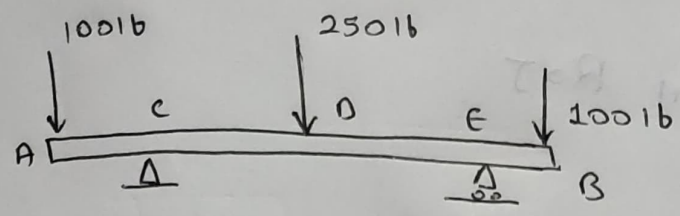
$\Rightarrow m_A = 0.2$

$f_{AY} = 2\,kN\ (\uparrow)$

$f_{AX} = 0$

$m_A = 0.2\,kN\cdot m\ (\circlearrowleft)$

11)

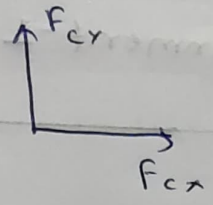


$g = 32.17$ feet/s²

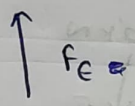
1 inch = 0.83 feet

1" = 0.83'

At point C,



At point E,



$\Sigma V = 0 \Rightarrow -100\times32.17 - 250\times32.17 - 100\times32.17 + F_{cy} + F_E = 0$

$\Rightarrow F_{cy} + F_E = 450\times32.17$

$\Sigma H = 0 \Rightarrow F_{cx} = 0$

$\Sigma M_C = 0 \Rightarrow +100\times32.17\times15\times0.83 - 250\times32.17\times20\times0.83$

$- 100\times32.17\times55\times0.83 + F_E\times45\times0.83 = 0$

$\Rightarrow F_E\times45\times0.83 = (250\times20 + 100\times55 - 100\times15)\times32.17\times0.83$

$\Rightarrow F_E = \dfrac{9000\times32.17}{45}$

$= 6.434$k ~~6.434k~~ 6,434 lbf

$= 6.434$ klbf

$F_{cy} = 8042.5$ lbf

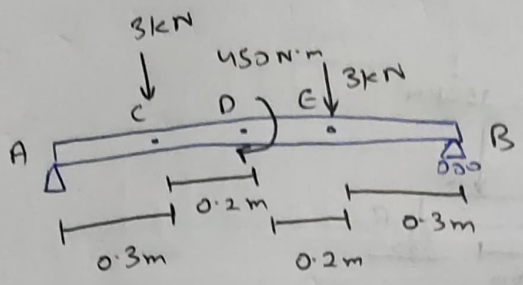
$= 8.043$ klbf

$F_{cy} = 8.043$ klbf (↑)

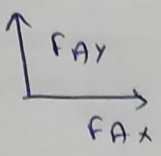
$F_{cx} = 0$

$F_E = 6.434$ klbf (↑)

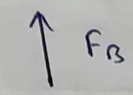
iii)



At point A,



At point B,



$\Sigma V = 0 \Rightarrow f_{AY} + f_B = 6kN$

$\Sigma H = 0 \Rightarrow f_{AX} = 0$

$\Sigma M_D = 0 \Rightarrow -450 + 3\times10^3 \times 0.2 - 3\times10^3 \times 0.2 - f_{AY} \times 0.5 + f_B \times 0.5 = 0$

$\Rightarrow f_B - f_{AY} = 900N$

$f_B = 3.45kN$

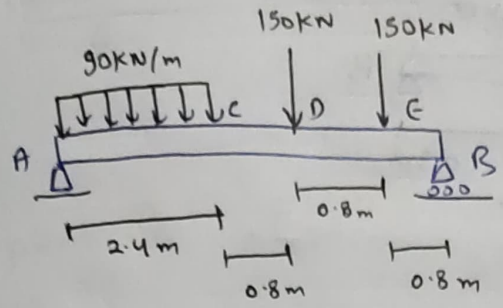
$f_{AY} = 2.55kN$

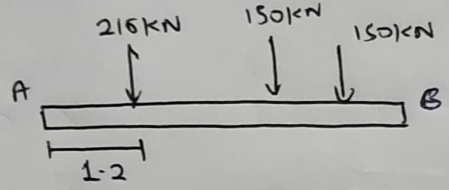
$f_{AY} = 2.55\,KN(\uparrow)$

$f_B = 3.45kN(\uparrow)$

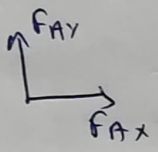
$f_{AX} = 0$

IV)





At point A,



At point B,

$\Sigma V = 0 \Rightarrow F_{AY} + F_B = 516\,kN$

$\Sigma H = 0 \Rightarrow F_{AX} = 0$

$\Sigma M_A = 0 \Rightarrow -216 \times 1.2 - 150 \times 3.2 - 150 \times 4 + F_B \times 4.8 = 0$

$\Rightarrow F_B \times 4.8 = 1339.2$

$\Rightarrow F_B = 279\,kN$

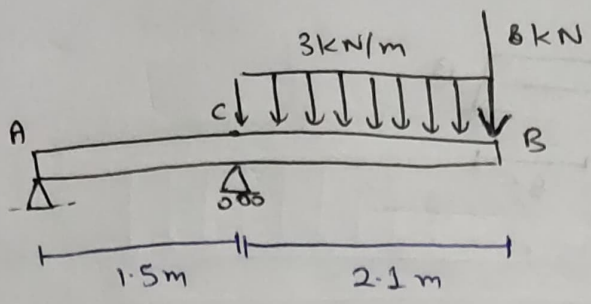
$F_{AY} = 237\,kN$

$F_{AY} = 237\,kN(\uparrow)$

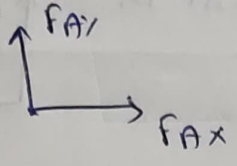
$F_{AX} = 0$

$F_B = 279\,kN(\uparrow)$

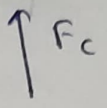
v>

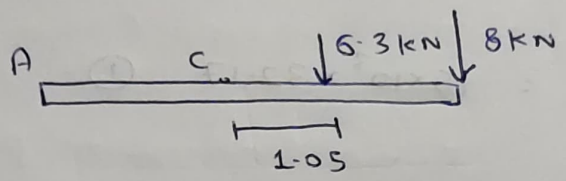


At point A,



At point C,





$\Sigma V = 0 \Rightarrow f_{AY} + F_C = 14.3\,kN$

$\Sigma H = 0 \Rightarrow f_{AX} = 0$

$\Sigma m_C = 0 \Rightarrow -f_{AY} \times 1.5 - 6.3 \times 1.05 - 8 \times 2.1 = 0$

$\therefore f_{AY} = -15.61\,kN$

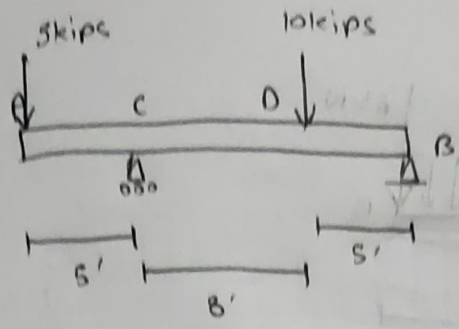
$F_C = 29.91\,kN$

$f_{AY} = +15.61\,kN\ (\downarrow)$

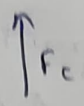
$f_C = 29.91\,kN\ (\uparrow)$

$f_{AX} = 0$

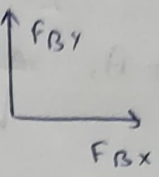
vi>



At point C,



At point B,



$\Sigma V = 0 \Rightarrow \quad F_{BY} + F_c = 15\times10^3 \times 32.17$ (I)

$\Sigma H = 0 \Rightarrow \quad F_{BX} = 0$

$\Sigma m_A = 0 \Rightarrow \quad F_c \times 5 - 10\times10^3 + 32.17 \times 13 + F_{B_y} \times 18 = 0$

$\Rightarrow \quad 5 \cdot F_c + 18 \cdot F_{B_y} = 13\times10^4 \times 32.17$ (II)

$13 F_{BY} = 130\times10^3 \times 32.17 - 75\times10^3 \times 32.17$

$F_{BY} = \dfrac{55\times10^3 \times 32.17}{13}$

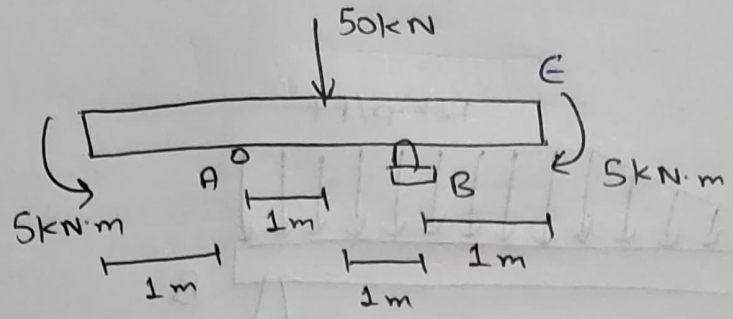
$= 136.10\times10^3$ lbf

& I

$F_c = 346.45\times10^3$ lbf

$F_{BY} = 136.10\times10^3$ lbf (↑)
$F_{BX} = 0$
$F_c = 346.45\times10^3$ lbf (↑)

VII>



At point A, F_A ↑

At point B, F_{BY} ↑, F_{BX} →

$\Sigma V = 0 \Rightarrow F_{BY} + F_A = 50kN$

$\Sigma H = 0 \Rightarrow F_{BX} = 0$

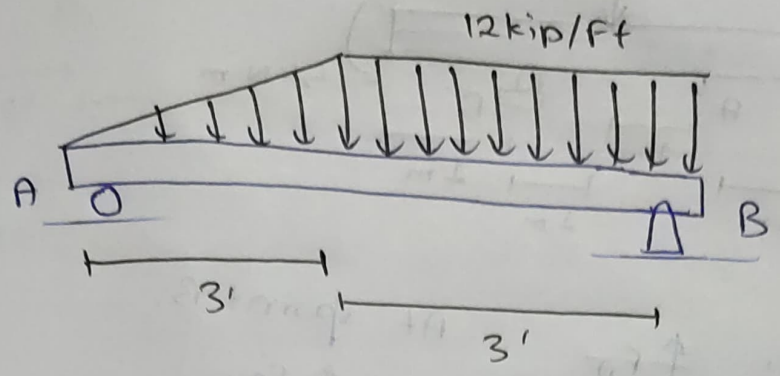
$\Sigma m_B = 0 \Rightarrow -5 + 50 \times 1 - F_A \times 2 + 5 = 0$

$\Rightarrow F_A = 25kN$

$F_{BY} = 25kN$

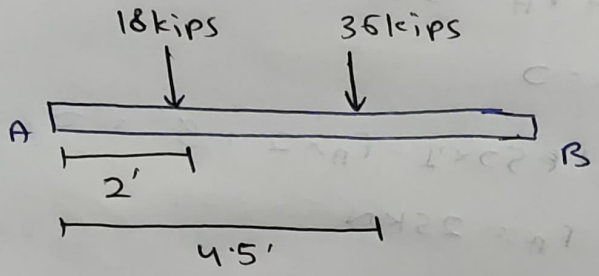
$F_{BY} = 25\,kN\ (\uparrow)$
$F_{BX} = 0$
$F_A = 25kN\ (\uparrow)$

viii)



Total load: $\frac{1}{2} \times 12 \times 3 = 18$ kips (Triangular part)

Total load: $12 \times 3 = 36$ kips (rectangular part)



At point A, $\uparrow F_A$

At point B, F_{BY} (↑), F_{BX} (→)

$\Sigma V = 0 \Rightarrow F_A + F_{BY} = 54 \times 10^3 \times 32.17$

$\Sigma H = 0 \Rightarrow F_{BX} = 0$

$\Sigma M_A = 0 \Rightarrow -18 \times 10^3 \times 32.17 \times 2 - 36 \times 10^3 \times 4.5 \times 32.17 + F_{BY} \times 6 = 0$

$\Rightarrow F_{BY} \times 6 = 198 \times 10^3 \times 32.17$

$F_{BY} = 1061.61 \times 10^3$ lbf

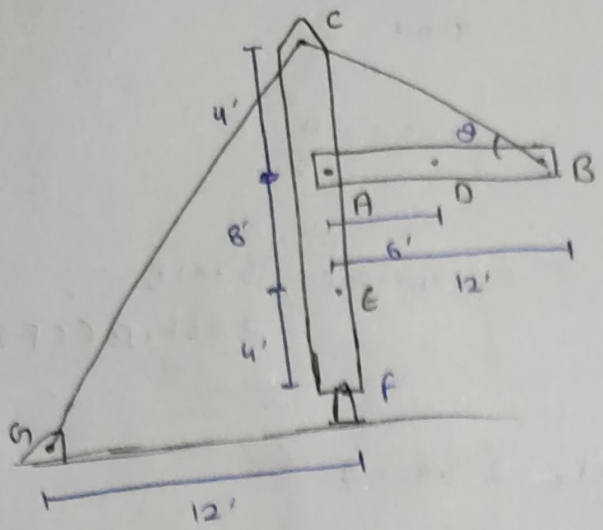
$F_A = 675.57 \times 10^3$ lbf

$F_{BY} = 1061.61 \times 10^3$ lbf (↑)

$F_{BX} = 0$

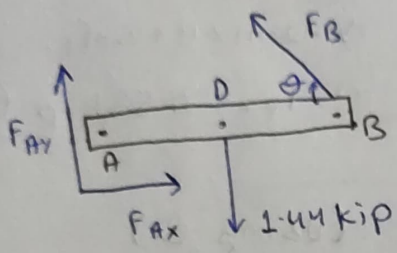
$F_A = 675.57 \times 10^3$ lbf (↑)

2)



$\sin\theta = \frac{4}{12.65} = 0.32$

$\cos\theta = \frac{12}{12.65} = 0.95$



weight = 120×12
= 1.44 kip (AB)

$\Sigma V = 0 \Rightarrow F_{AY} + F_B \cdot 0.32 = 1.44$ (i)

$\Sigma H = 0 \Rightarrow F_{AX} = 0.95 F_B$ (ii)

$\Sigma M_A = 0 \Rightarrow -1.44 \times 6 + F_B \times 0.32 \times 12 = 0$

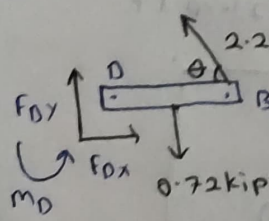
$\Rightarrow F_B = 2.25 \text{ kip}$

From (ii)

$F_{AX} = 2.14 \text{ kip}$

From (i)

$F_{AY} = 0.72 \text{ kip}$



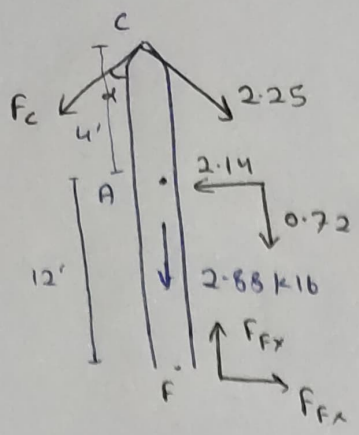
$\Sigma V = 0 \Rightarrow F_{DY} - 0.72 + 0.72 = 0$

$\Rightarrow F_{DY} = 0$

$\Sigma H = 0 \Rightarrow F_{DX} = 2.14 \text{ kip}$

$\Sigma M_D = 0 \Rightarrow M_D - 0.72 \times 6 + 0.72 \times 12 \times 0.5 = 0$

$\Rightarrow M_D = -2.16 \text{ kip·ft}$



$\sin\alpha = \frac{3}{5}$

$\cos\alpha = \frac{4}{5}$

weigth = 180 × 16

= 2.88 kip (↓F)

$\Sigma V = 0 \Rightarrow F_{FY} - 0.72 - 0.72 - \frac{4}{5}F_C - 2.88 = 0$

$\Rightarrow F_{FY} - \frac{4}{5}F_C = 4.32$ ①

$\Sigma M_C = 0$

$\Rightarrow -2.14 \times 4 + 15 \times F_{FX} = 0$

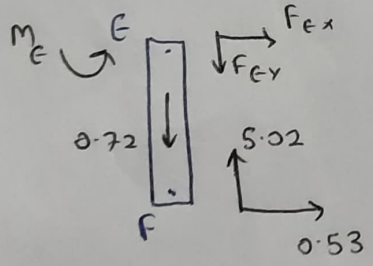
$\Rightarrow F_{FX} = 0.53$ kip ⑪

$\Sigma H = 0 \Rightarrow F_{FX} - 2.14 + 2.14 - F_C \cdot \frac{3}{5} = 0$

$\Rightarrow F_{FX} = \frac{3}{5}F_C \Rightarrow F_C = 0.88$ kip (Using ⑪)

$F_{FY} = 4.32 + \frac{4}{5} \times 0.88$

$= 5.02$ kip



$\Sigma V = 0 \Rightarrow 5.02 - 0.72 - F_{EY} = 0$

$\Rightarrow F_{EY} = 4.3$ kip

$\Sigma H = 0 \Rightarrow F_{EX} = -0.53$ kip

$\Sigma M_E = 0 \Rightarrow M_E + 0.53 \times 4 = 0$

$\Rightarrow M_E = -2.12$ kip·ft

On point D,

$F_{DY} = 0$

$F_{DX} = 2.14$ kip (→)

$M_D = 2.16$ kip ft (↻)

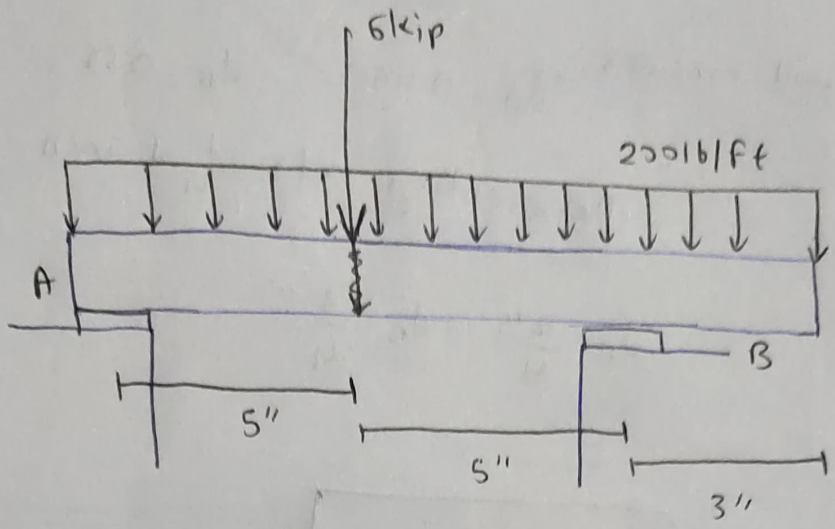
On point E,

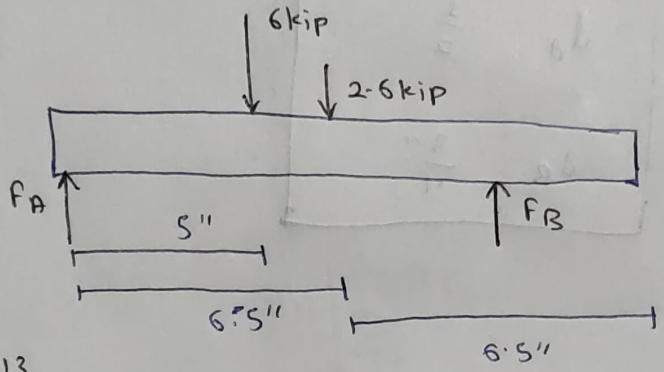
$F_{EY} = 4.3$ kip (↓)

$F_{EX} = 0.53$ kip (←)

$M_E = 2.12$ kip·ft (↺)

3)





Load = 200 × 13

= 2.6 kip × 32.17 ↳ g in ft/s²

$\Sigma V \to 0 \Rightarrow f_A + f_B = 8.6\text{kip}$

$\Sigma m_A = 0 \Rightarrow -6\times5 - 25\times6.5 + f_B\times10 = 0$

$\Rightarrow 45.9 = f_B \times 10$

$\Rightarrow f_B = 4.59\text{ kip} \times 32.17 \curvearrowright g$

$f_A = 3.91\text{ kip} \times 32.17 \curvearrowright g$

$(\sigma)_{pine} = 2.81\text{ksi}$ $(\sigma)_{brick} = 6.70\text{ksi}$

Now,

$2.81 = \frac{3.91}{3\times d_A} \Rightarrow d_A = 0.46''$

$2.81 = \frac{4.69}{3\times d_B} \Rightarrow d_B = 0.56''$

For brick,

$6.70 = \frac{3.91}{3\times d_A} \Rightarrow d_A = 0.19''$

$6.70 = \frac{4.69}{3\times d_B} \Rightarrow d_B = 0.23''$

value of d_A and d_B is more in case of pin,

Hence,

we will consider

$d_A = 0.46''$ $d_B = 0.56''$

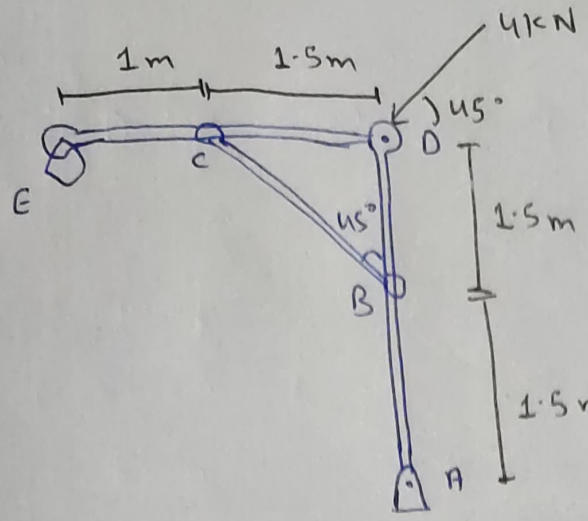
Representing into $\frac{1}{4}$ of inch.

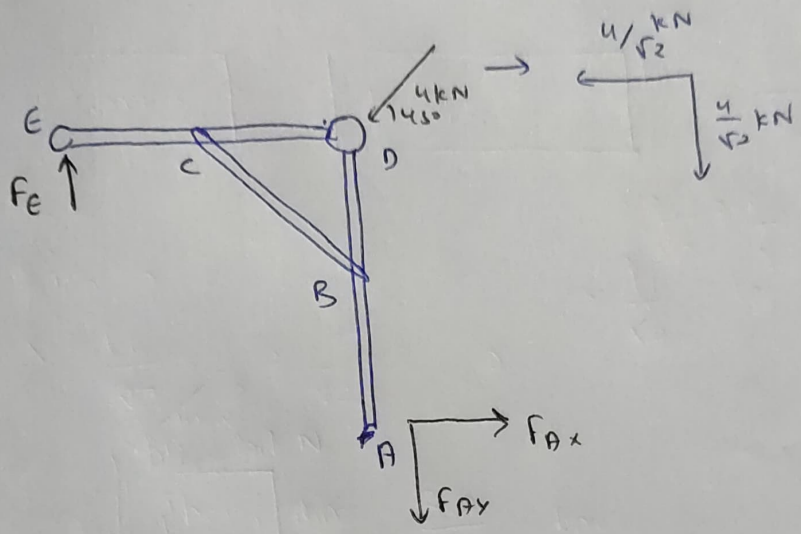
$d_A = \frac{2''}{4}$ $d_B = \frac{3}{4}''$

$d_A = \frac{1}{2}''$

$d_B = \frac{3''}{4}$

4)





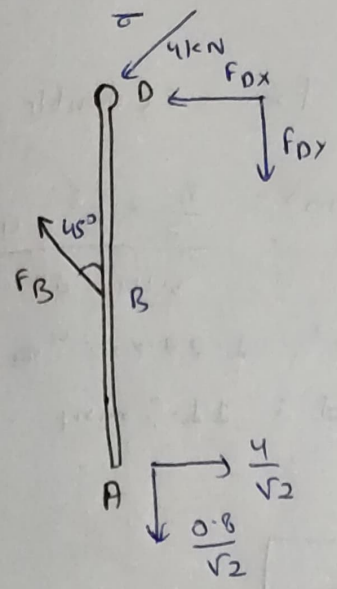
$\Sigma H = 0 \Rightarrow \quad F_{Ax} = \frac{4}{\sqrt{2}}$

$\Sigma M_A = 0 \Rightarrow \quad \frac{4}{\sqrt{2}} \cdot 3 - \frac{5}{2} \times F_E = 0$

$\Rightarrow \quad F_E = \frac{4 \cdot 8}{\sqrt{2}}$

$\Sigma V = 0 \Rightarrow \quad -F_{AY} + F_E = \frac{4}{\sqrt{2}}$

$\Rightarrow \quad F_{AY} = \frac{2 \cdot 8}{\sqrt{2}}$



$\Sigma H = 0$

$\Rightarrow \frac{4}{\sqrt{2}} - \frac{F_B}{\sqrt{2}} - F_{DX} - \frac{4}{\sqrt{2}} = 0$

$\Rightarrow F_{DX} = -\frac{F_B}{\sqrt{2}}$

$\Sigma V = 0$

$\Rightarrow -\frac{0.8}{\sqrt{2}} + \frac{F_B}{\sqrt{2}} - F_{DY} - \frac{4}{\sqrt{2}} = 0$

$\Rightarrow \frac{F_B}{\sqrt{2}} = F_{DY} + \frac{4.8}{\sqrt{2}}$

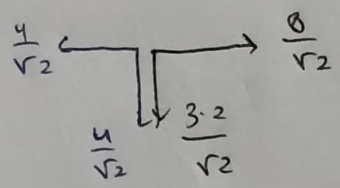
$\Sigma M_D = 0$

$\Rightarrow -\frac{F_B}{\sqrt{2}} \times \frac{3}{2} + \frac{4}{\sqrt{2}} \times 3 = 0$

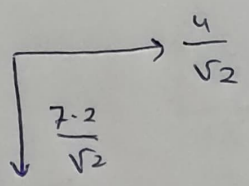
$\Rightarrow F_B = 8\,kN$

Then, $F_{DY} = \frac{3.2}{\sqrt{2}}$ $\quad F_{DX} = -\frac{8}{\sqrt{2}}$

At point D,



$\Rightarrow$



$F_r = \sqrt{\frac{16}{2} + \frac{51.84}{2}} = \sqrt{33.92}$

$= 5.82\,kN$

$\sigma = 40 MPa$

Then, for D (Single shear)

$$40 \times 10^6 = \frac{5.82 \times 10^3}{3.14 \times d^2} \times 4$$

$$\Rightarrow d^2 = 1.85 \times 10^{-4} m^2$$

$$\Rightarrow d = 13.6 mm$$

$d_D = 13.6 mm$

and for C (double shear)

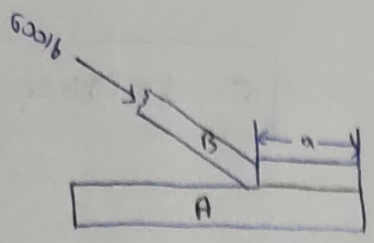
$$40 \times 10^6 = \frac{\frac{6}{2} \times 10^3}{3.14 \times d^2} \times 4$$

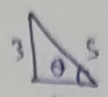
$$\Rightarrow d^2 = 1.27 \times 10^{-4} m^2$$

$$d = 11.3 mm$$

$d_c = 11.3 mm$

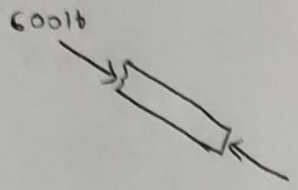
5)

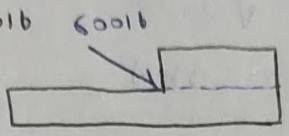


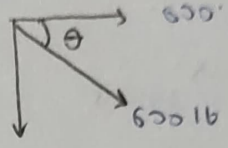


$\sin\theta = \frac{3}{5}$

$\cos\theta = \frac{4}{5}$







$600 \cdot \frac{4}{5} = 480lb$

$600 \cdot \frac{3}{5} = 360lb$

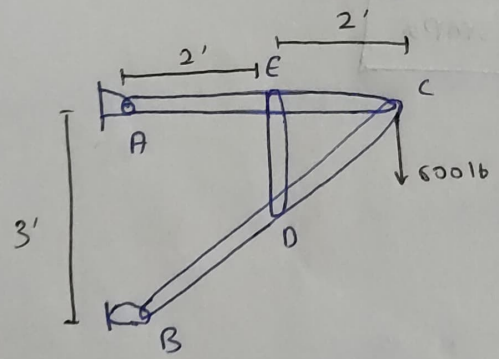
Now,

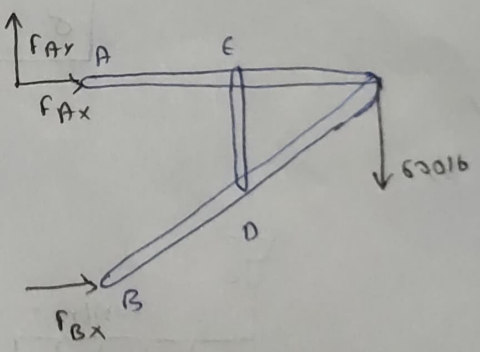
$$\sigma = \frac{F}{A} \Rightarrow 50 = \frac{480}{1.5 \times a} \Rightarrow a = 6.4$$

So, smallest dimension of a is 6.5 inch

$\boxed{a = 6.5''}$

6)





$\Sigma M_B = 0 \Rightarrow -f_{Ax} \cdot 3 - 600 \times 4 = 0$

$\Rightarrow f_{Ax} = -800lb$

$\Sigma H = 0 \Rightarrow f_{Bx} + f_{Ax} = 0$

$\Rightarrow f_{Bx} = -f_{Ax}$

$= 800lb$

$\Sigma V = 0 \Rightarrow f_{Ay} = 600lb$

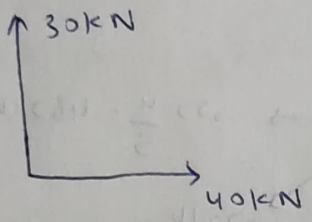
$$A = \frac{3.14}{4} \times (0.25)^2$$

$$= 490.63 \times 10^{-4} \text{ in}^2$$

$$\sigma = \frac{\frac{1 \text{ kip}}{2}}{490.63 \times 10^{-4}} = 10.19 \text{ ksi}$$

$$\boxed{\sigma = 10.19 \text{ ksi}}$$

7)



$$F_R = \sqrt{2500}$$

$$= 50 \text{ kN}$$

It is a dour-shear member,

So,

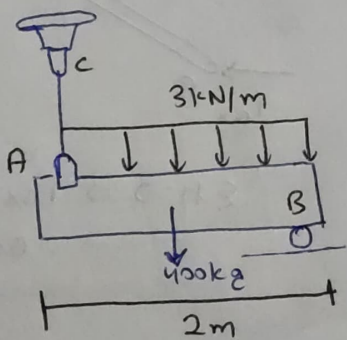
$$\sigma = \frac{\frac{50}{2} \times 10^3}{\frac{3.14}{4} \times (30)^2 \times 10^{-6}} = \frac{25 \times 10^3}{7.07 \times 10^{-4}}$$

$$= 3.53 \times 10^7 \text{ N/m}^2$$

$$= 35.3 \text{ MPa}$$

$$\boxed{\sigma = 35.3 \text{ MPa}}$$

8)



$400 \times 10 = 4000\,N$

↓

g

This 4000N is a dead load

So, 4000×1.2

$= 4.8\,kN$

Now, for live load,

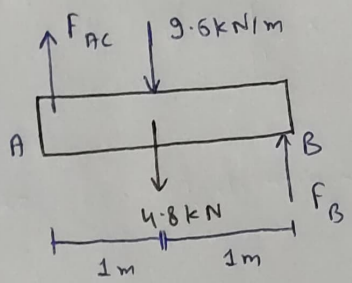
Total load : $\frac{1}{b} \times 3 \times 2$

$= 6$

Considering live load factor

effective load : 6×1.6

$= 9.6\,kN$



$\Sigma V = 0 \Rightarrow f_{AC} + f_B = 14.4\,kN$

$\Sigma M_B = 0 \Rightarrow -14.4 \times 1 + f_B \times 2 = 0$

$\Rightarrow f_B = 7.2\,kN$

$f_{AC} = 7.2\,kN$

Now we have to consider resistance factor,

$$0.9\sigma = \frac{f}{A} \Rightarrow 0.9 \times 345 \times 10^6 = \frac{7.2 \times 10^3}{\frac{3.14}{4} \cdot d^2}$$

$$\Rightarrow d^2 = \frac{7.2 \times 4 \times 10^3}{3.14 \times 0.9 \times 345 \times 10^6}$$

$$= \frac{28.8}{974.97 \times 10^3}$$

$$= 0.029 \times 10^{-3}$$

$$= 29 \times 10^{-6}$$

$d = 5.38 \times 10^{-3}\,m$

d = 5.38 mm