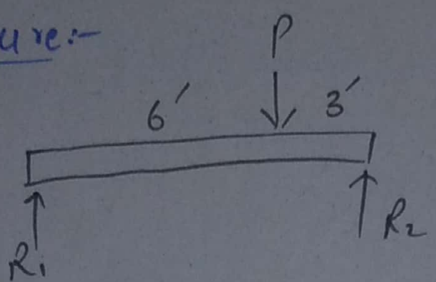
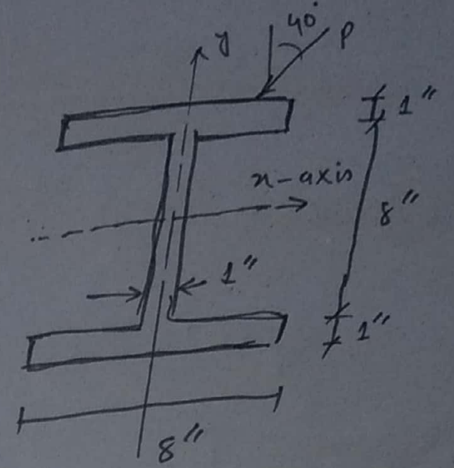
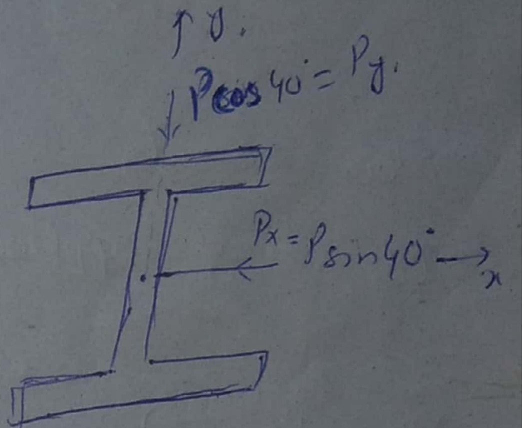
Pb # 1334:-

A beam simply supported at the ends has the cross section and is loaded with the concentrated load P as shown in fig. If the maximum stress is not exceed 20 ksi, determine safest value of P?

Figure:-

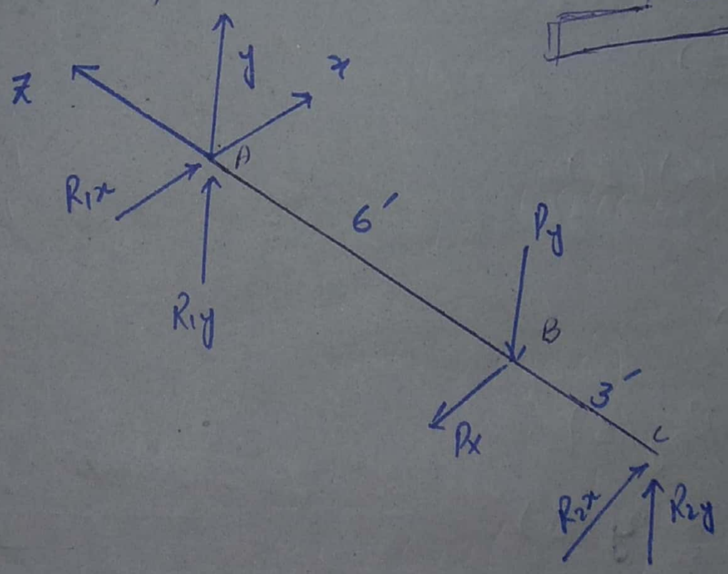




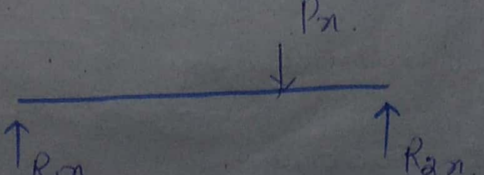


Solution:-

The 3-D view of beam is;



Top View:-



$\Sigma M_{A_y} = 0$ ↺+ ↻- or $\{ \uparrow + \ \downarrow - \}$ → use this one

$-P_x(6) + R_{2x}(9) = 0$

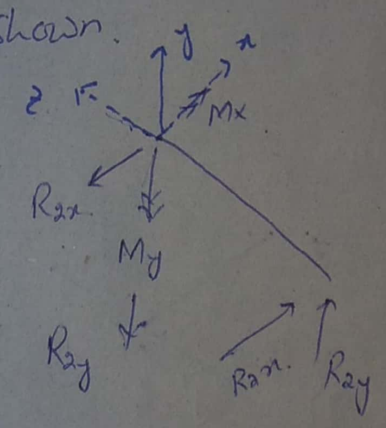
$$\boxed{R_{2x} = \frac{2}{3} P_x}$$

$\Sigma M_{Ax} = 0$ $+\uparrow$ $\downarrow -$

$P_y(6) - R_{2y}(9) = 0$

$$\boxed{R_{2y} = \frac{2}{3} P_y}$$

Now consider a section at right of load applied as shown.



$M_y = R_{2x}(3)$

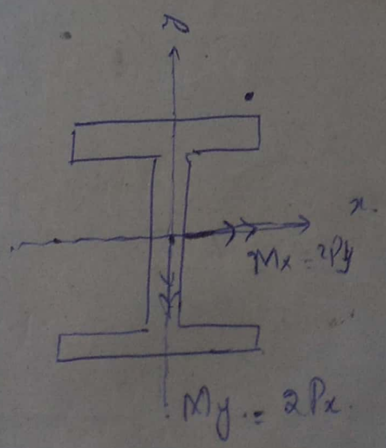
$= \frac{2}{3}(P_x)(3)$

$M_y = 2P_x \rightarrow (1)$

$M_x = R_{2y}(3)$

$= \frac{2}{3} P_y (3)$

$M_x = 2P_y \rightarrow (2)$



Now consider an imaginary load in +ve first quadrant.

Write equation of stresses. ...plane with sa...

$$\sigma_T = -\frac{M_x y}{I_x} - \frac{M_y x}{I_y} \rightarrow (A)$$

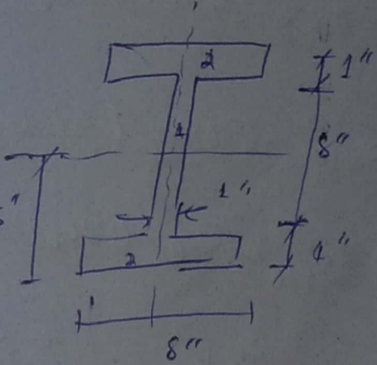
∵ From moments w... write eqn of stresses.

$\sigma_T = 20\,ksi$

$M_x = 2P_y \Rightarrow 2P\cos 40° \Rightarrow 1.5321P$

$M_y = 2P_x \Rightarrow 2P\sin 40° \Rightarrow 1.2855P$

To find $I_x = ?$



$$I_x = \frac{8(10)^3}{12} - \frac{(8-1)(8)^3}{12}$$

$$I_x = 666.67 - 298.67$$

$$I_x = 368\ in^4$$

To find I_y.

$$I_y = I_1 + 2I_2$$

$$I_y = \left(\frac{bd^3}{12}\right)_1 + \left(2\left(\frac{bd^3}{12}\right)\right)_2$$

$$I_y = \frac{1^3(8)}{12} + 2\left(\frac{1(8)^3}{12}\right)$$

$$I_y = 0.67 + 85.33$$

$$\boxed{I_y = 86\ in^4}$$

Scanned by CamScanner

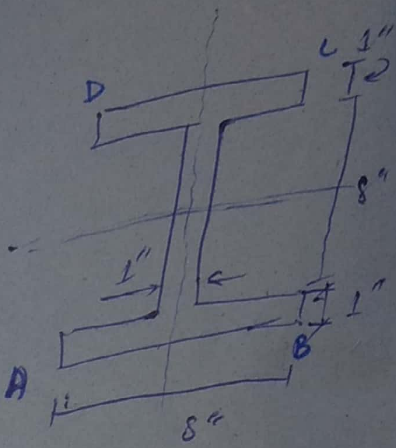
By putting Values in eq (A).

$$\sigma_T = -\frac{1.5321 P_y (y)}{368} - \frac{1.2855 P_x (x)}{86}.$$

$$20\times10^3 = -4.16\times10^{-3} P(y) - 0.01494 P(x).$$

$$2\times10^3 = -4.16\times10^{-3} P(y) - 0.01494 P(x). \quad \rightarrow (1)$$

For corner A $(-4, -5)$



eq (1) =)

$$2\times10^3 = -4.16\times10^{-3} P(y) - 0.01494 P(x)$$

$$2\times10^3 = -4.16\times10^{-3} P(-5) - 0.01494(-4) P.$$

$$2\times10^3 = 0.0208P + 0.05976P$$

$$2\times10^3 = 0.08056P.$$

$$P = 24826.216\,N.$$

or $\boxed{P = 24.82\,KN.}$

For corner B:- $(4, -5)$.

eq (1) =) $2\times10^3 = -4.16\times10^{-3} P(-5) - 0.01494(4)P.$

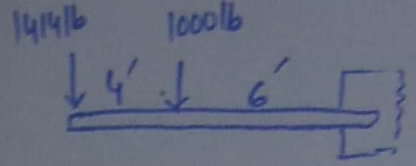
$$2\times10^3 = 0.0208P - 0.05976P.$$

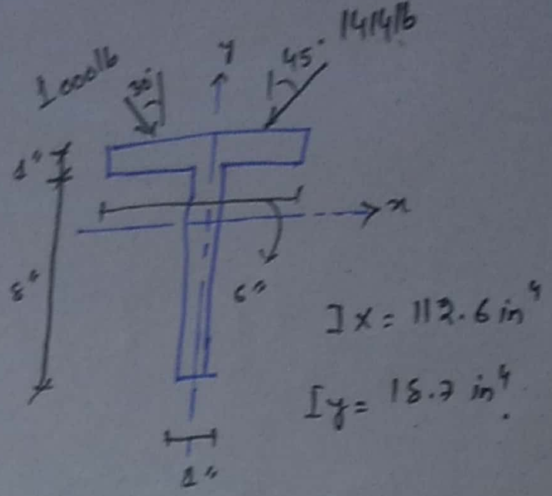
$$2\times10^3 = -0.03896P.$$

$$P = -51334.7\,N \Rightarrow \boxed{P = -51.33\,KN}$$

Pb#1336:- A Cantilever beam 10' long with same section as Pb#1335 that carries two concentrated load applied as shown. Compute the Inclination of N.A at wall and max. compressive and tensile stress?

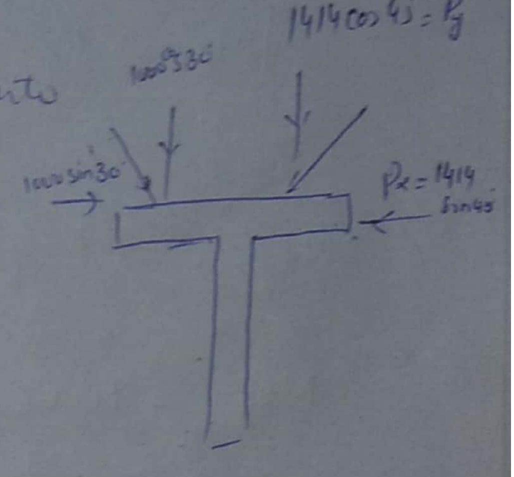
Figures:-

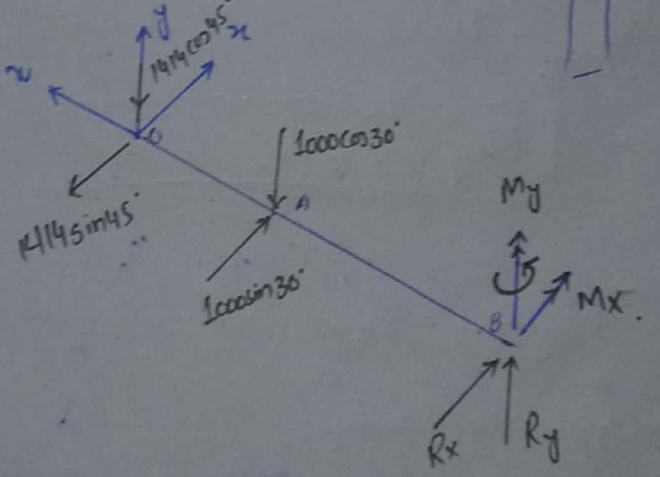




Solution:-

First resolve the force into rectangular components





Apply conditions of equilli_

$\Sigma F_x = 0$ $(\uparrow + \ \downarrow -)$

$-1414\sin 45 + 1000\sin 30 + R_x = 0$

$$\boxed{R_x = 500\,lb}$$

$\Sigma F_y = 0$ (↑+ ↓-)

$$-1414\cos 45^\circ - 1000\cos 30^\circ + R_y = 0.$$

$$\boxed{R_y = 1865.9\,lb}$$

$\Sigma M_{B_x} = 0$ (↑+ ↓-)

$$M_{Rx} - 1000\cos 30^\circ \times 6 - 1414\cos 45^\circ (10) = 0.$$

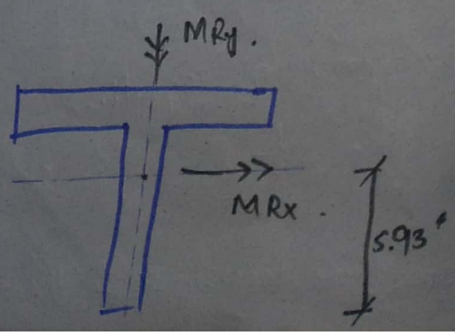
$$\boxed{M_{Rx} = 15194.6\,lb.ft.}$$

$\Sigma M_{B_y} = 0$ (↑+ ↓-)

$$M_{Ry} - 1000\sin 30 (6) + 1414\sin 45^\circ (10) = 0.$$

$$\boxed{M_{Ry} = -6998.4\,lb\,ft}$$

Note:- Negative sign show that our assume direction is wrong.



Now write eqn of stresses in first quadrant.

$$\sigma_T = -\sigma_{fx} - \sigma_{fy}.$$

$$\sigma_T = -\frac{M_{Rx}(y)}{I_x} - \frac{M_{Ry}(x)}{I_y}.$$

By putting values.

$$\sigma_T = -\frac{15194.6 \times 12}{112.6}(y) - \frac{6998.4 \times 12(x)}{18.7}.$$

$$\sigma_T = -1619.3y - 4491.2x \longrightarrow (2).$$

Now used this eqn to find stresses at different corners.

$$\sigma_T = -1619.3(y) - 4491.2x$$

	x (in)	y (in)	σ_T (ksi)
A	-0.5	-5.93	11.85
B	0.5	-5.93	7.36
C	3	3.07	-18.44
D	-3	3.07	8.5

$$\boxed{\sigma_{max}^{C} = 11.85 ksi}$$

$$\boxed{\sigma_{max}^{T} = 18.44 ksi}$$

Location of Neutral Axis:-

As $\sigma_T = -1619.3y - 4491.2x$.

At N.A. $\sigma_T = 0$. So,

$0 = -1619.3y - 4491.2x$.

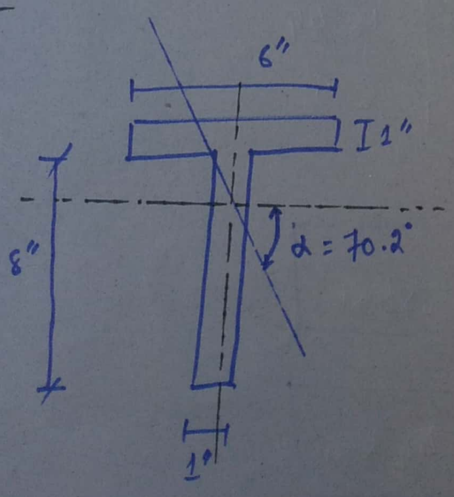
$$\frac{y}{x} = -\frac{4491.2}{1619.3}$$

$$\tan\theta = \frac{y}{x} = \frac{-4491.2}{1619.3}$$

$$\theta = \tan^{-1}(-2.77)$$

$$\boxed{\theta = -70.2^\circ}$$

Figure:-



Corner C (4, 5).

eq ① =)

$$2\times10^{3} = -4.16\times10^{-3}(+5)P - 0.01494(4)P.$$

$$2\times10^{3} = -0.0208P - 0.05976P.$$

$$P = -24826.21\,N.$$

or $\boxed{P = -24.82\ KN}$

For Corner D:- (-4, 5)

eq ① =)

$$2\times10^{3} = -4.16\times10^{3}(5)P - 0.01494(-4)P.$$

$$= -0.0208P + 0.05976P.$$

$$P = \frac{2\times10^{3}}{0.03896}$$

$$P = 51334.7.$$

or $\boxed{P = 51.3\,KN}$

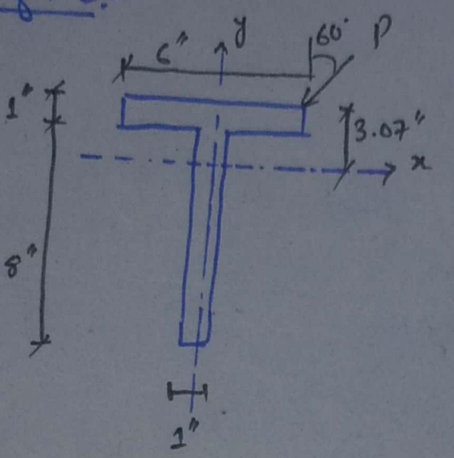
Use the smallest value of P

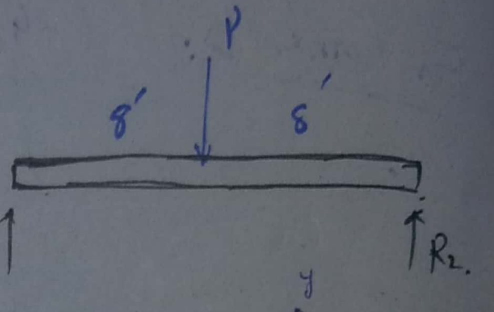
so, $\boxed{P = 24.82\,KN}$ Ans

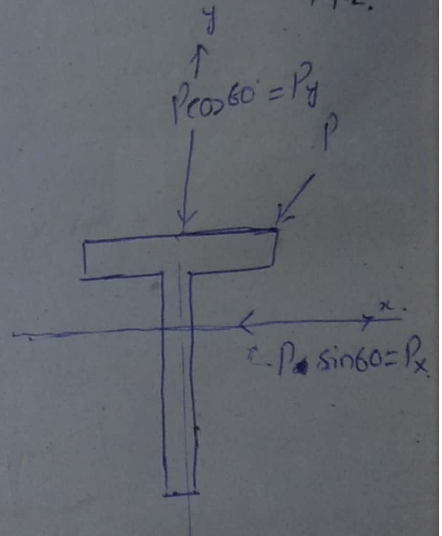
Pb# 1335:- The T section shown in fig is -the cross section of simply supported beam 16 ft long that carries a central concentrated load inclined at 60° to y-axis. The centroid x-axis is 3.07" below top of the section

$I_x = 112.6\ in^4$, $I_y = 18.7\ in^4$; If $\sigma_c \le 12000$ psi and $\sigma_T \le 5000$ psi, What is the max. load that will not overstress the beam?

Figure:-

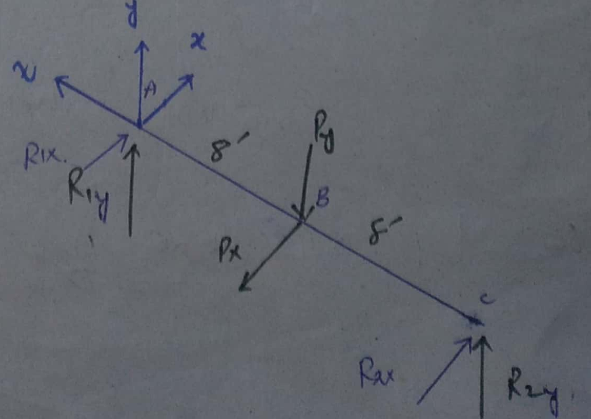






Solution:-

The 3-D view of the beam is;



$\Sigma M_{A_x} = 0$ (↑+ ↓−)

$P_y(8) - R_{2y}(16) = 0$

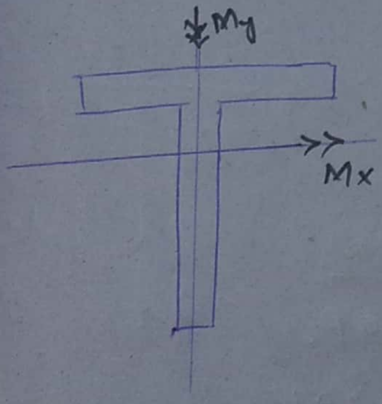
$$\boxed{R_{2y} = \frac{1}{2} P_y}$$

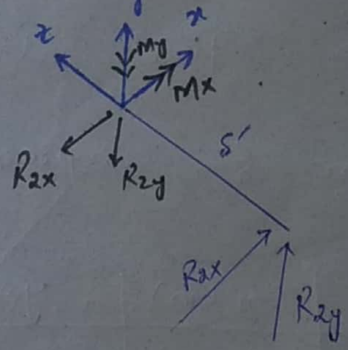
$\Sigma M_{A_y} = 0$ (↑+ ↓−)

$-P_x(8) + R_{2x}(16) = 0$

$$\boxed{R_{2x} = \frac{1}{2} P_x}$$

Now consider a section ①-① and take right of beam.





$M_y = R_{2x}(8) = 8R_{2x} = 8\left(\frac{1}{2}P_x\right) = 4P_x$

$M_x = R_{2y}(8) = 8R_{2y} = 8\left(\frac{1}{2}P_y\right) = 4P_y$

Now consider an imaginary load in first quadrant and write eqns of stresses for that ①

$$\sigma_T = -\frac{M_x\, y}{I_x} - \frac{M_y (x)}{I_y} \longrightarrow (1)$$

Since;

$$M_x = 4P_y = 4P\cos 60^\circ = 2P$$

$$M_y = 4P_x = 4P\sin 60^\circ = 2\sqrt{3}P$$

$$I_y = 18.7\ in^4, \quad I_x = 112.6\ in^4$$

By putting values in eq (1)

$$\sigma_T = -\frac{2P.y(12)^3}{112.6} - \frac{2\sqrt{3}P.(x)(12)^3}{18.7}$$

$$\delta_T = \frac{-24P(y)}{112.6} - \frac{24\sqrt{3}P(x)}{18.7}$$

$$\delta_T = -0.2131P(y) - 2.223P(x) \rightarrow (A)$$

Now consider all corner to check where tension & where compression.

	x (in)	y (in)	δ_T
A	-0.5	-5.93	2.375 P
B	0.5	-5.93	0.15P
C	3	3.07	-7.323 P
D	-3	3.07	6.01P

At corner C we have tensile stress;

so; $\delta_t = +7.323P$

$$P = \frac{\delta_t}{7.323} \Rightarrow P = \frac{5000}{7.323} \Rightarrow \boxed{P = 682.8\,lb}$$

For Compressive Stress:-

$\delta_c = 2.375P \Rightarrow \delta_c = 12000, \Rightarrow P = \frac{12000}{2.375}$

$\boxed{P = 5052.63\,lb}$

$\delta_c = 0.15P \Rightarrow P = \frac{12000}{0.15} \Rightarrow \boxed{P = 80{,}000\,lb}$

$\delta_c = 6.01P \Rightarrow P = \frac{12000}{6.01} \Rightarrow \boxed{P = 1996.7\,lb}$

Use smallest value of P; $\boxed{P = 682.81\,lb}$ Ans