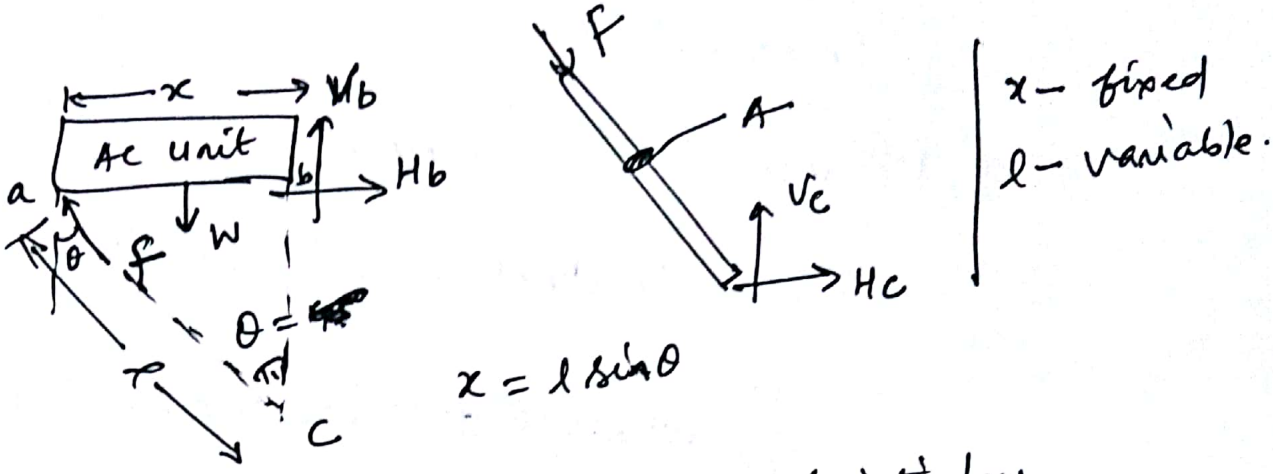
Quiz - 2 Solution

Que-1 FBD:



$x = l \sin\theta$

Assumptions – pinned joints & frictionless.
– massless members.

(II) W – weight of the AC unit $= mg = \rho V g$

$\Sigma F_x = 0$; $f \sin\theta = H_b + H_c$ — (I)

$\Sigma F_y = 0$; $f \cos\theta + V_b + V_c = W$ — (II)

Taking moment about point b,

$f \cos\theta \times l \sin\theta = W \times \frac{l \sin\theta}{2}$

$$\boxed{F = \frac{W}{2\cos\theta}} \quad \text{— (3)}$$

(I) Stress in the rod.

$$\sigma_{max} = \frac{F}{A} = \frac{W}{2\cos\theta \cdot A}$$

:- Volume of rod V = Area x length
$= A \times L$

$$\sigma_{max} = \frac{W}{2\cos\theta \cdot \left(\frac{V}{L}\right)} = \frac{W}{2\cos\theta \cdot V}\left(\frac{x}{\sin\theta}\right)$$

$$V = \frac{Wx}{\sigma_{max} \cdot \sin 2\theta}$$

Rod volume to be minimum;

$$\frac{dV}{d\theta} = 0; \quad V \sin 2\theta = \frac{Wx}{\sigma_{max}} = A.$$

$$\frac{dV}{d\theta} \sin 2\theta + V \cos 2\theta \cdot x\, 2 = 0.$$

$$\frac{dV}{d\theta} \sin 2\theta + 2V\cos 2\theta = 0.$$

$$\frac{dV}{d\theta} = -\frac{2V\cos 2\theta}{\sin 2\theta} = 0;$$

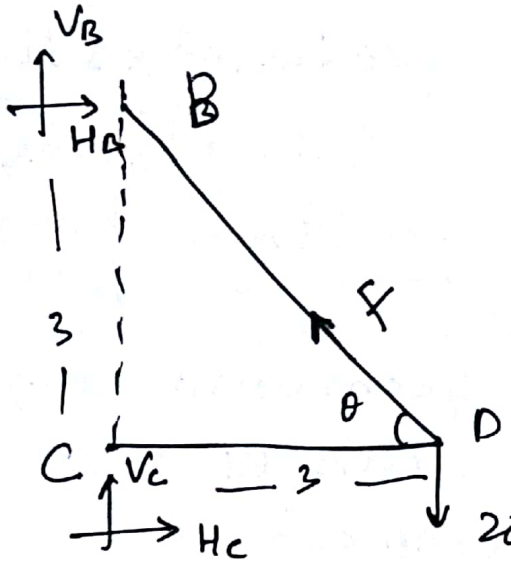
$$\cos 2\theta = 0$$

$$2\theta = \pi/2; \quad \theta = \pi/4.$$

= Rod volume to be minimum θ, will be equal to $\pi/4$ (45°).

Que-2 FBD:

Assumptions - Considering joints are pin joints & frictionless



$\Sigma F_x = 0$;

$-f\cos\theta + H_B + H_C = 0$

$\Sigma F_y = 0$;

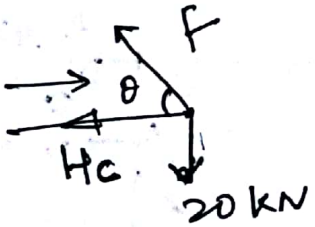
$V_C + V_B + f\sin\theta = 20\ kN$

Taking moment about point C

$H_B \times 3 + 20 \times 3 = f\sin 45 \times 3$

$H_B - f\sin 45 = -20$

Consider point B.



$\Sigma F_x = 0$; $f\cos 45 + H_C = 0$

$H_C = -f\cos 45$

$\Sigma F_y = 0$; $f\sin 45 = 20\ kN$.

$f = 20\sqrt{2}\ kN$

$H_C = -20\ kN$ Compression.

* Extension of bar Cd due to H_C; $\delta_{cd} = \frac{H_C l}{AE}$

$= \frac{20 \times 10^3 \times 3}{3200 \times 10^{-6} \times 200 \times 10^9}$

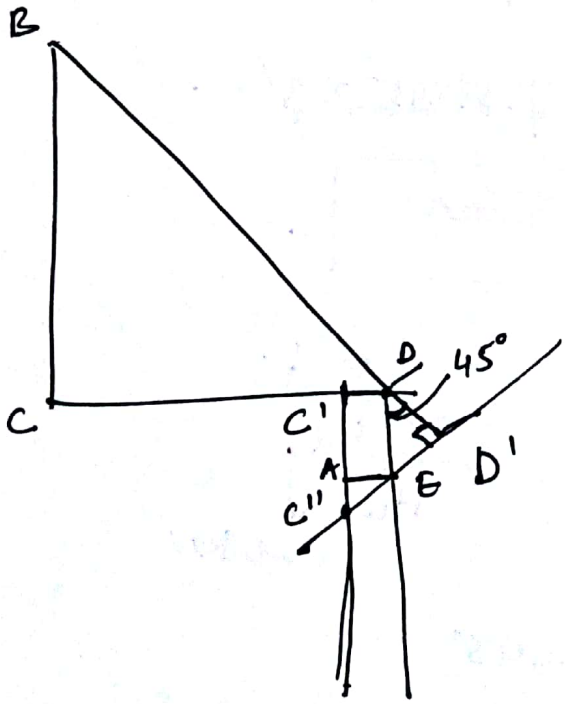
$\delta_{cd} = 0.09375$ mm

* ~~Vertical def~~ Extension of rod BD due to tension f

$$\delta_{BD} = \frac{20\sqrt{2}\times10^{3}\times3\sqrt{2}}{491\times10^{-6}\times200\times10^{9}}$$

$\delta_{BD} = 1.2219$ mm .

In order to satisfy geometric compatibility of the deformations, bars BD & CD at point D should always connected.



$DE = C'C'' - AC''$; $DE = AC'$,

from geometry

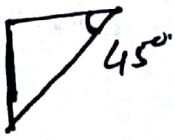
$DE = \sqrt{2}\,DD'$

where $DD' = \delta_{BD}$

$DE = \sqrt{2}\times 1.2219$

~~$DE = AC''$~~ = ~~$C'C''$~~

$AE = C'D = AC''$



$C'C'' = DE + C'D$.

$= \sqrt{2}\times1.2219 + 0.09375$

$C'C'' = 1.8217$ mm .