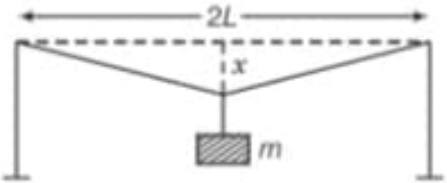
Q. 6 A mild steel wire of length $2L$ and cross-sectional area A is stretched, well within elastic limit, horizontally between two pillars (figure). A mass m is suspended from the mid-point of the wire. Strain in the wire is

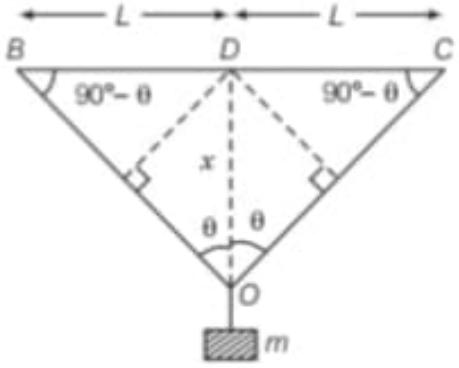


(a) $\frac{x^2}{2L^2}$ (b) $\frac{x}{L}$ (c) x^2/L (d) $x^2/2L$

Thinking Process

We will assume the vertical displacement x to be very small compared to L. Change in the length will be calculated by difference of final total length and initial length $2L$.

Ans. *(a)* Consider the diagram below



Hence, change in length

$$\Delta L = BO + OC - (BD + DC)$$

$$= 2BO - 2BD \qquad (\because\ BO = OC,\ BD = DC)$$

$$= 2\,[BO - BD]$$

$$= 2[(x^2 + L^2)^{1/2} - L]$$

$$= 2L\left[\left(1 + \frac{x^2}{L^2}\right)^{1/2} - 1\right]$$

$$\approx 2L\left[1 + \frac{1}{2}\frac{x^2}{L^2} - 1\right] = \frac{x^2}{L} \qquad [\because\ x << L]$$

$\therefore$ $$\text{Strain} = \frac{\Delta L}{2L} = \frac{x^2/L}{2L} = \frac{x^2}{2L^2}$$