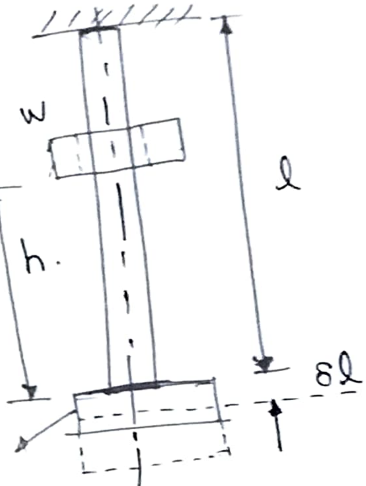
Impact stress

stress produced in member due to falling load.

consider a bar carrying a load W at height h. falling on the collar provided at the collar



A - cross sectional area of bar.

E - youngs modulus of the material.

l - length of the bar.

δl - deformation of the bar.

P - force at which deflection. δl is produced.

σ_i - stress induced in bar due to application of impact load.

h - height through which the load falls.

Energy gained by system in the form of strain energy.

$$= \frac{1}{2} \times P \times \delta l.$$

potential energy lost by the weight.

$$= W(h + \delta l).$$

$$\frac{1}{2} \times P \times \delta l = W(h + \delta l).$$

$P = \sigma_i \times A$ $\quad \sigma_i$ - stress induced by Impact load

$\delta l = \frac{\sigma_i}{E} \times l.$ $\quad \because$ stress/strain $= E$.

$$\frac{1}{2} \times \sigma_i A \times \frac{\sigma_i \times l}{E} = W\left(h + \frac{\sigma_i \times l}{E}\right)$$

$$\frac{Al}{2E}(\sigma_i)^2 - \frac{Wl}{E}(\sigma_i) - Wh = 0$$

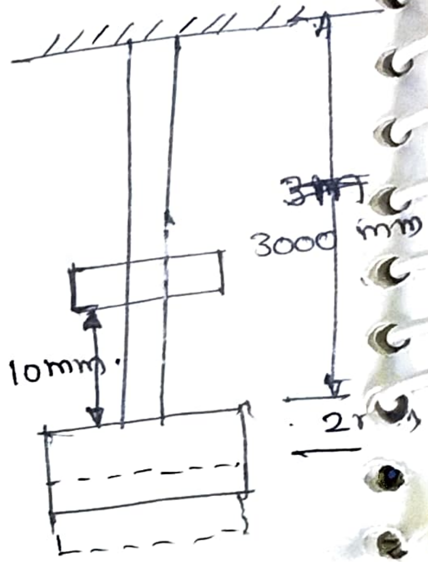
From this quadratic equation we find that (29)

$$\boxed{\sigma_i = \frac{W}{A}\left(1 + \sqrt{1 + \frac{2hAE}{Wl}}\right)}$$

problem

An unknown weight falls through 10 mm on a coll[ar] rigidly attached to the lower end of a vertical bar 3 m long 600 mm² in section. If maximum instantaneous extension is known to be 2 mm, what is corresponding stress and the value of unknown weight.

Take $E = 200\ kN/mm^2$.



given data.

$h = 10\,mm$

$l = 3\,m = 3000\,mm.$

$A = 600\,mm^2.$

$\delta l = 2\,mm.$

$E = 200\ kN/mm^2$

$= 200 \times 10^3\ N/mm^2.$

$$\sigma_1 = \frac{W}{A}\left[1+\sqrt{1+\frac{2hAE}{Wl}}\right] \quad -①$$

we know.

$$\frac{\sigma}{\epsilon} = E$$

$$\sigma = E \times \epsilon = E \times \frac{\delta l}{\cancel{\delta} l}$$

$$= 200 \times 10^3 \times \frac{2}{3000}$$

$$= \cancel{13}\ \frac{400}{3} = 133.3\ N/mm^2.$$

value of unknow weygh W

sub = $\sigma = 133.3\ N/mm^2$ value in formula. ①

$$\frac{400}{3}\ \cancel{133.33} = \frac{W}{600}\left[1+\sqrt{1+\frac{2 \times 1\cancel{0} \times \cancel{6}\cancel{00}^2 \times 200 \times 10^3}{W \times \cancel{3000}}}\right]$$

$$\frac{400 \times 600}{3W} = 1+\sqrt{1+\frac{800000}{W}}$$

$$\frac{80000}{W}\ \cancel{x} - 1 = \sqrt{1+\frac{800000}{W}}$$

squary on both sides,

$$\frac{6400 \times 10^{\cancel{8}2}}{W^2}\ \cancel{+1} - \frac{16\cancel{0000}}{W} = \cancel{1}+\frac{80\cancel{0000}}{W}$$

$$\frac{6400 \times 10^2}{W^2} - \frac{16}{W} = \frac{80}{W} \qquad \frac{6400 \times 10^2}{W} = 96.$$

$$\boxed{W = \underline{6666.7\,N}}$$ Ans