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Assignment = 3

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Date: 15 Jun 2020

Numerical #01

Given DATA :-

$L_e = 6ft$ $\quad L_e = 0.7L$

$E = 10.3 \times 10^6 psi$

Factor of safty = 2.

$b = 3/4$ inch, $h = 2$ inch

Condition one end Hinged one end Fixed

So, $L_e = 0.7L$

Required

safe Central load = ?

Solution

$$P_{cr} = \frac{\pi^2 EI}{L_e^2}$$

$$P_{cr} = \frac{\pi^2 E A r^2}{L_e^2} \quad -(1) \quad \because I = Ar^2$$

Now $r = \sqrt{\frac{I}{A}}$

$$r = \sqrt{\frac{\frac{bb^3}{12}}{bh}} = \sqrt{\frac{b^2}{12}}$$

$$r = \frac{b}{2\sqrt{3}}$$

$$r = \frac{3/4}{2\sqrt{3}} = \frac{0.75}{3.46}$$

$$r = 0.216 \text{ in}$$

Now we find crippling load.

So, $P_{cr} = \frac{\pi^2 E A}{(L_e/r)^2}$

$$= \frac{(3.14)^2 (10.3 \times 10^6)(0.5 \text{ in}^2)}{(0.7 \text{ L}/r)^2}$$

$$P_{cr} = \frac{(9.8596) \times 15.45 \times 10^6}{\left(\frac{0.7 \times 72}{0.216}\right)^2}$$

$$P_{eq} = \frac{152.33}{54444.4}$$

$$P_{eq} = 2.7979 \times 10^3 \text{ psi}$$

$$P_{eq} = 2.7979 \text{ ksi}$$

For safe load :-

$$P_{safe} = \frac{P_{cr}}{\text{factor of safty}}$$

$$P_{safe} = 1.3989 \text{ ksi}$$

Question #02.

Given data

Column = 310 mm x 45 mm

$E = 200 \times 10^9 Pa$.

$\sigma_p = 240 \times 10^6 Pa$.

$L = 12 m$

Factor of safty = 2.5

Required :-

a) $L_{mm} = ?$

b) $P_{safe} = ?$

Solution

As we know that

$$\sigma_p = \frac{E\pi^2}{(Le/r)^2}$$

$$\Rightarrow \frac{le}{r} = \sqrt{\frac{\Sigma\pi^2}{E}}$$

$$\frac{le}{r} = \sqrt{\frac{(3.14)^2 \times (200\times10^3)}{240\times10^6}}$$

$$\boxed{\frac{le}{r} = 90.64}$$

Now

$$r = \sqrt{\frac{b^2}{12}}$$

$$r = \sqrt{\frac{(45)^2}{12}}$$

$$\boxed{r = 12.99\ mm}$$

Now

$$le = 90.64 \times 12.99$$

$$le = 1177.44\ m.$$

Now for pin hinge

$L = Le$

$L_{min} = 1177.44 mm$

Part b

$$P_{cr} = \frac{\pi^2 E A r^2}{Le^2}$$

$$P_{cr} = \frac{(3.14)^2 (200 \times 10^3)(15950)(12.99)}{(12 \times 1000)^2}$$

$P_{cr} = 82.2345 kN$

Note:

For safe.

$$P_{safe} = \frac{P_{cr}}{\text{factor of safty}}$$

(7)

$$P_{safe} = \frac{82.2345 \text{ GN}}{2.3}$$

$$\boxed{P_{safe} = 12.8937 \text{ GN}}$$

Question #03

Given data:-

Load = 90 kips $= 2.4 \times 10^5$ psi

Length = L = 10 ft

$E = 29 \times 10^6$ psi

Required data:-

Length of each side = ?

Solution

$$\frac{L_e}{r} = \sqrt{\frac{\pi^2 E}{\sigma_p}}$$

$$\frac{L_e}{r} = \sqrt{\frac{(3.14)^2 \times (29 \times 10^6)}{2.4 \times 10^5}}$$

$$\frac{L_e}{r} = \sqrt{1.19 \times 10^5}$$

$$\frac{Le}{r} = 34.5$$

$$r = \frac{Le}{34.5}$$

$$r = \frac{10 \times 12}{34.5}$$

$$r = \frac{120}{34.5}$$

$$r = 3.4 \text{ inch}$$

Now

$$r = \sqrt{\frac{b^2}{12}}$$

$$r^2 \times 12 = b^2$$

$$b^2 = (3.4)^2 \times 12$$

$b^2 = 138.72$

$b = 11.77$

So,

$I = Ar^2$

$A = \frac{I}{r^2}$

$b^2 = \frac{b^3}{I} / r^2$

$\frac{1}{1} = \frac{h^2}{12r^2}$

$h^2 = 12r^2$

$h = 11.77$ Ans

Question # 04

Given data:

Load = 90 kips = 2.4×10^5 psi

Length = L = 10 ft

$E = 1.6 \times 10^6$ psi

Required:

Given data.

Length of each side = ?

Solution:

$$\frac{l_e}{r} = \sqrt{\frac{\pi^2 E}{6p}}$$

$$\frac{l_e}{r} = \sqrt{\frac{(3.14)^2 \times (1.6 \times 10^6)}{2.4 \times 10^5}}$$

$$\frac{l_e}{r} = \sqrt{65.730}$$

$$\frac{le}{r} = 8.107$$

$$r = \frac{le}{8.107}$$

$$r = \frac{10 \times 12}{8.107}$$

$$r = \frac{120}{8.107}$$

$$r = 14.802 \text{ inch}$$

1st method

$$r = \sqrt{\frac{b^2}{12}}$$

$$r^2 \times 12 = b^2$$

$$b^2 = (14.802)^2 \times 12$$

$b^2 = 2629.190$

$b = \sqrt{51.275}$

2nd method

$$I = Ar^2$$

$$A = \frac{I}{r^2}$$

$$I = \frac{h^2}{12r^2}$$

$$h^2 = 12r^2$$

$$\sqrt{h^2} = \sqrt{2629.190}$$

$$\boxed{h = 51.275}$$

ans