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7925

section : A

Q #1)

Given Data :-

factor of safety = 2

$E = 10.3 \times 10$ psi

length = 6 ft

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

condition one end Hinged and one end fixed

So $l_e = 0.7L$

Required.

Safe center load =>

Solution

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

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

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

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

$$= \frac{3/4}{2\sqrt{3}} = \frac{0.75}{3.40}$$

$$r = 0.2101 \text{ in}$$

Now we will find crippling load

$$P_{cr} = \frac{\pi^2 EA}{(l_e/k)^2}$$

$$= \frac{(3.14)(10.3 \times 10^6)(1.5 \text{ in}^2)}{(0.72/r)^2}$$

$$= \frac{(9.8590) \times 15.45 \times 10^6}{(0.72 \times \frac{r}{0.46})^2}$$

$$P_{cr} = \frac{152.33}{54444}$$

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

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

for P_{safe}

$$P_{safe} = \frac{P_{cr}}{\text{Factor of safety}}$$

$$P_{safe} = \frac{2.7979}{2}$$

$$P_{saf} = 1.3989$$

Q#2

Given Data

Load = 20 kips $= 2.4 \times 10^5$ psi

Length = L = 10 ft

$E = 29 \times 10^6$ psi

Required Data

Length of each side = ?

Solution: As we know that

$$\frac{Le}{r} = \sqrt{\frac{\pi^2 E}{6P}}$$

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

$$\frac{Le}{r} = 1.19 \times 10^3$$

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

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

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

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

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

1st Method

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

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

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

$$b^2 = 138.72$$

$$\sqrt{b} = \sqrt{138.72}$$

$$b = 11.77$$

2nd Method

$$I = Ar^2$$

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

$$\frac{b^2}{12} = \frac{4^4}{12} \Big/ r^2$$

$$\frac{I}{1} = \frac{5^2}{12 \cdot 1^2}$$

$$b^2 = 128^2$$

$$b = 11.77$$

Q#3) Given Data

Load = 20 kips = 2.4×10^5 psi

Length = L = 10 ft

$E = 1.6 \times 10^6$ psi

Required Data

Length of each side = ?

Sol:- As we know that

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

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

$$\frac{L_e}{r} = \sqrt{\frac{9.8596 \times 1.6 \times 10^6 \times 10^{-5}}{2.4}}$$

$$= \sqrt{65.730}$$

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

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

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

$r = 14.802$ inch

$r = 14.820$ inch

15] Method of

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

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

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

$b^2 = 2629.190$

$\sqrt{b} = \sqrt{2629.190}$

$b = 51.275$

2nd Method

$$I = Ar^2$$

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

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

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

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

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

$$h^2 = 2629.190$$

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

$$h = 51.275$$

Q#4) Given Data

column = 310mm x 415mm

E = 200 x 10^9 Pa

L = 240 x 10^9 Pa

L = 12m

factor of safety = 2.5

Required

(a) = Lmin = ?

P safe = ?

Solution As we know that

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

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

$$\frac{Le}{r} = \sqrt{\frac{(3.14)^2 \times (200 \times 10^9)}{240 \times 10^6}}$$

$Le = 90.64$

Now

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

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

$r = 12.99 mm$

Now

$Le = 90.64 \times 12.99$

$Le = 1177.4 mm$

Now for pin Hinge

$L = Le$

$Lmm = 1177.4 mm$

Part B

$$P_{cr} = \frac{\pi^2 EAr^2}{Le^2}$$

$$P_{cr} = \frac{(3.14)^2 (200 \times 10^9)(1395)(12.99)^2}{(12 \times 1000)^2}$$

$$P_{cr} = 32.2343 \text{ GN}$$

Now

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

$$P_{safe} = \frac{32.2343 \text{ GN}}{2.5}$$

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