ID:- 15799

Semester:- 2nd year batch civil

Subject:- Mechanics of Materials

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Insituite:- Iqra University "pesbawar"

Steel railroad rails 10m long are laid with a clearance of 3mm at a temperature of 25°. At what temperature will the rails just touch? What stress would be induced in the rails at that temperature if there were no initial clearance? Assume $\alpha = 11.7\ \mu m/(m\cdot°C)$ and $E = 250\ GPa$.

Given data:-

$$\alpha = 11.7\ \mu m/(m\cdot°)$$

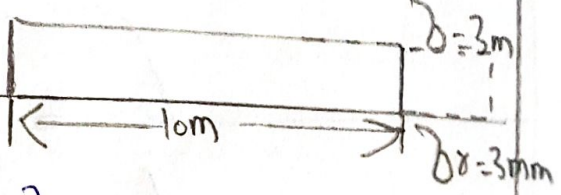
$$E = 250\ GPa$$

$$\delta = 3\ mm$$

$$\delta_x = 3\ mm$$

$$L = 10m$$

Solution:-



Temperature at which $\delta_x = 3mm$

$$\delta_x = \alpha L(\Delta T)$$

$$\delta x = \alpha L (T_f - T_i)$$

$$3 = (11.7 \times 10^{-6})(6000)(T_f - 25)$$

$$3 = (0.117)(T_f - 25)$$

$$3 = (0.117 T_f - 2.925)$$

$$3 + 2.925 = 0.117 T_f$$

$$5.925 = 0.117 T_f$$

$$\frac{5.925}{0.117} = T_f \Rightarrow T_f = 50.64°$$

$$\frac{\delta L}{E} = \alpha L (\Delta T)$$

$$\sigma = \sigma = \alpha E (T_f - T_i)$$

$$\sigma = (11.7 \times 10^{-6})(200000)(50.64 - 25)$$

$$\sigma = (0.0000117)(25000)(25.64)$$

$$\sigma = (2.925)(25.64)$$

$$\sigma = 75 \text{ MPa}$$

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1. A steel road is stretched between two rigid walls and carries a tensile of 5000 N at 20°C if the allowable stress is not to exceed 200 MPa at -40°C, what is the minimum diameter of the road? Assume $\alpha = 11.7\ \mu m/(m \cdot °C)$ and $E = 200$ GPa.

Solution:- Tensile load = 5000 N

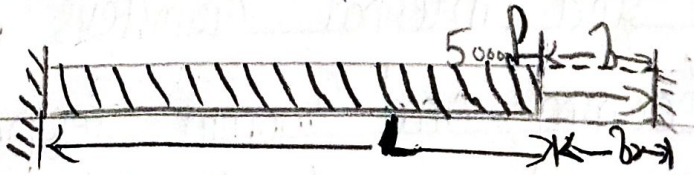
Temperature = 20°C

Allowable Stress not exceed = 200 Mpa at -40°

Minium diameter = ?

$\alpha = 11.7\ \mu m/(m \cdot °C)$

$E = 200$ Gpa



$$\delta = \delta_T + \delta_n$$

$$\frac{PL}{E} = \alpha L(\Delta T) + \frac{PL}{AE}$$

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Solution:- Tensile load = 5000 N

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$\alpha = 11.7\ \mu m/(m \cdot °C)$

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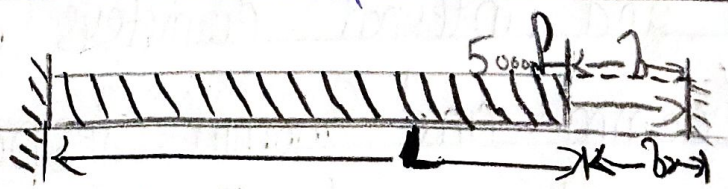


$$\delta = \delta_T + \delta_P$$

$$\frac{\alpha L}{E} = \alpha L(\Delta T) + \frac{PL}{AE}$$

$$\sigma = \alpha E (\Delta T) + \frac{P}{A}$$

$$200 = (11.7 \times 10^{-6})(200000)(60) + \frac{5000}{A}$$

$$200 = (0.000117)(200000)(60) + 5000/A$$

$$200 = (140.4) + 5000/A$$

$$59.6 + 5000/A$$

$$A = \frac{5000}{59.6} = 83.90\ mm^2$$

$$1/4\pi d^2 = 83.90$$

$$1/4(3.1415)(d^2) = 83.90$$

$$0.7851d^2 = 83.90$$

$$0.785 = 83.1d^2$$

$$d = 9.11mm$$

External and internal diameters of a propeller shaft are 600mm and 300mm respectively. Find the maximum shear stress developed in the cross section when a twisting moment of 60 kN-m is applied if span of shaft is 5m, find twisting angle of shaft. Take modulus of rigidity, $G = 0.8 \times 10^5\ N/mm^2$

Given data:-

D = 600mm

d = 300mm

T = 60kN-m

L = 5m

Solution:-

$T = \pi/16 * T * D(pwr\ 4) - d(pwr\ 4)/D$

$60 * 1000000 = 3.149/16 * t * 600(4) - 300(4)$

600

$t = 0.666\ N/mm^2$

$\frac{t}{R} = \frac{G\theta}{L}$ ------ $R = D/2 = 600/2 = 300mm$

$\Rightarrow 0.0176$ radians

A column is used to support an axial compressive load. The length is 30 feet. The column is shown in figure. The ends of column are fixed. Find the critical buckling load. Take E = 31000 ksi and I = 1540 in4 Also find the slenderness ration if the area of column is equal to 160 in2.

Given data:-

L = 30'

Ends of column are fixed

E = 31000 ksi

$I = 1540\ in^4$

Solution:- As we know that

$$F = \frac{n\pi^2 EI}{L^2}$$

Here both ends are fixed so

$n = 4$

So $F = \frac{(4)(3.14)^2(31000)(1540)}{(30 \times 12)^2}$

$= \frac{188095\,6000}{129600}$

$F = 1451354.1 lb$

$F = 1.45 \times 10^4 klb$

Also find cylinderical ratio

As cylinderical ratio $= \frac{L}{r}$

Here,

$A = 160 m^2$

So, $A = \pi r^2$

$160 = 3.14(r)^2$

$160/3.14 = r^2$

$\sqrt{r^2} = \sqrt{50.96} \Rightarrow r = 7.138$ inch

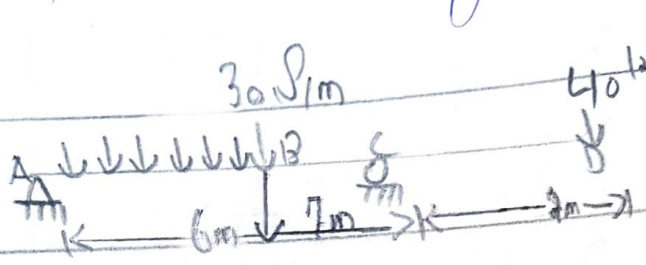
Now, cyclindrical ratio $= L/r$

$= 30 \times 12 / 7.138$

cylindrical ratio $= 50.434$

Find shear force and bending moment diagram of given beam?

Draw shear force and bending moment diagram



Find reactions at A and B

Taking moment at (A)

$$3 \times 180 = R_C \times 13$$

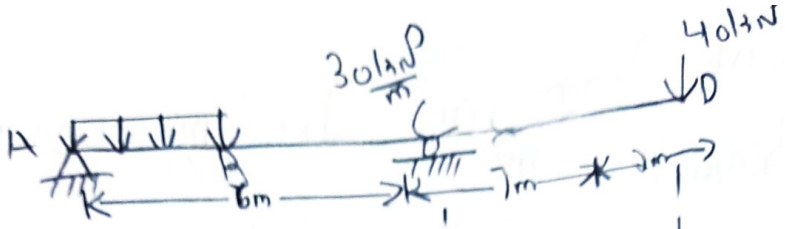
$$R_C = \frac{180 \times 3}{13} \Rightarrow R_C = 41.4 \text{ kN}$$

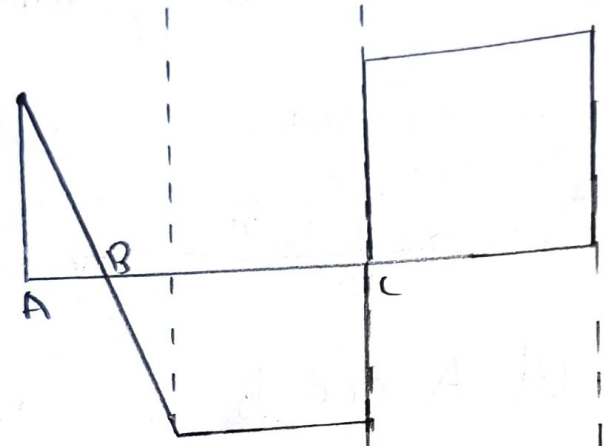
Now, $R_A + R_C = 180$

$$R_A = 180 - 41$$

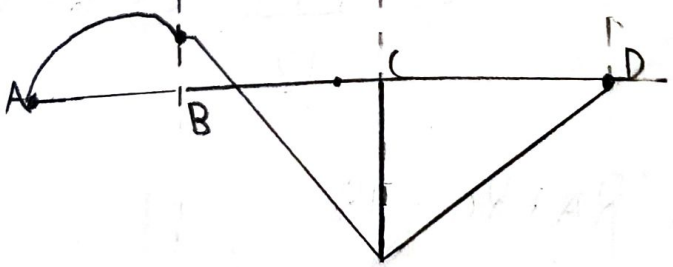
$$R_A = 138.6 \text{ kN}$$

Now Shear force and Bending moment diagram





S.F Diagram



B.M Diagram