



SNS COLLEGE OF TECHNOLOGY

DEPARTMENT OF AGRICULTURAL ENGINEERING

23AGT205-STRENGTH OF MATERIALS FOR AGRICULTURAL ENGINEERING

NOTES UNIT IV

Stresses :

Crushing Load $= P_c$

→ Crushing Stress $\sigma_c = \frac{P_c}{A}$

→ Crimping Stress $= \frac{\text{Crimping load}}{\text{Area}} = \frac{P}{A} = \frac{\pi^2 E A}{A (l_e/k)^2}$

$= \frac{\pi^2 E}{(l_e/k)^2}$

→ Slenderness Ratio $= \frac{\text{Actual length}}{\text{Least radius of gyration}}$

$= \frac{L}{k}$

LIMITATION OF EULER'S FORMULA

Since, Crimping Stress $= \frac{\pi^2 E}{(l_e/k)^2}$

WKT, $l_e = L$ for both ends hinged,

Crimping Stress $= \frac{\pi^2 E}{(L/k)^2}$

WKT, $L/k = \text{Slenderness Ratio}$

∴ If $L/k = \text{Small Value}$, Crimping Stress is high



PROBLEMS

1. A Solid round bar 3m long & 5cm in diameter used as a strut with both ends hinged. Determine the crippling or collapsing load. Take $E = 2.0 \times 10^5 \text{ N/mm}^2$.

Given:

Length of bar, $l = 3\text{m} = 3000\text{mm}$

Diameter of bar, $d = 5\text{cm} = 50\text{mm}$

Young's modulus, $E = 2.0 \times 10^5 \text{ N/mm}^2$

Moment of Inertia

$$I = \frac{\pi d^4}{64}$$

$$= \frac{\pi \times 5^4}{64}$$

$$= 30.68 \text{ cm}^4$$

$$= 30.68 \times 10^4 \text{ mm}^4$$

Let $P = \text{Crippling Load}$

As both the ends of the bar are hinged, hence the crippling load given by,

$$P = \frac{\pi^2 EI}{L^2}$$

$$= \frac{\pi^2 \times 2 \times 10^5 \times 30.68}{(3000)^2}$$

$$= 67288 \text{ N} = 67.288 \text{ kN}$$



2. For above Problem determine the crippling load, when the given strut is used with following condition

- (i) One end of the strut is fixed & the other end is free
- (ii) Both the ends of strut are fixed.
- (iii) One end is fixed & other is hinged.

Data from Previous Problem

Given

$$L = 3000 \text{ mm}$$

$$d = 50 \text{ mm}$$

$$E = 2.0 \times 10^5 \text{ N/mm}^2$$

$$I = 30.68 \times 10^4 \text{ mm}^4$$

Let $P =$ crippling load

- (i) One end is Fixed & other is Free

$$P = \frac{\pi^2 EI}{4L^2}$$

$$= \frac{\pi^2 \times 2 \times 10^5 \times 30.68 \times 10^4}{4 \times 3000^2}$$

$$= 16822 \text{ N}$$

- (ii) when both ends are fixed

$$P = \frac{4\pi^2 EI}{L^2} = \frac{4\pi^2 \times 2 \times 10^5 \times 30.68 \times 10^4}{3000^2}$$

$$= 269152 \text{ N} = 269.152 \text{ kN}$$



(iii) One end is fixed & other end is hinged

$$P = \frac{2\pi^2 EI}{l^2}$$

$$= \frac{2\pi^2 \times 2 \times 10^5 \times 30.68 \times 10^4}{3000^2}$$

$$= 1345.16 \text{ N}$$