Experiment No:

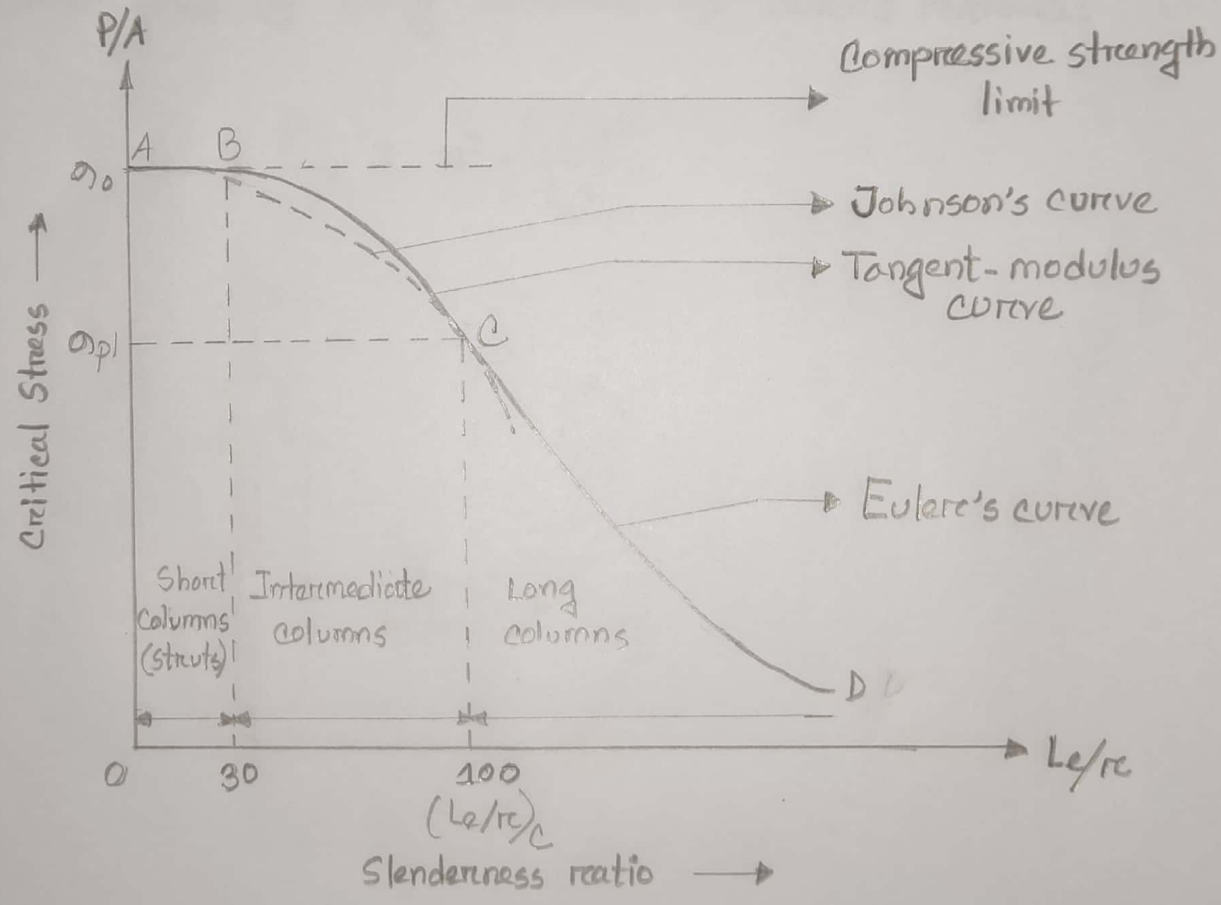
Experiment Name: Determination of Buckling Test of Slender Column.

Introduction:

Column: A column is a compression member that is so slender compared to its length that under gradually increasing loads it fails by buckling at loads considerably less than those required to cause failure by crushing.

- Long Columns – Fail by buckling / Excessive lateral bending. $\left(\frac{L}{r} > 100\right)$
- Intermediate Columns – Fail by combination of buckling and crushing. $\left(\frac{L}{r} = 100\right)$
- Short Columns – Fail by crushing $\left(\frac{L}{r} < 30\right)$

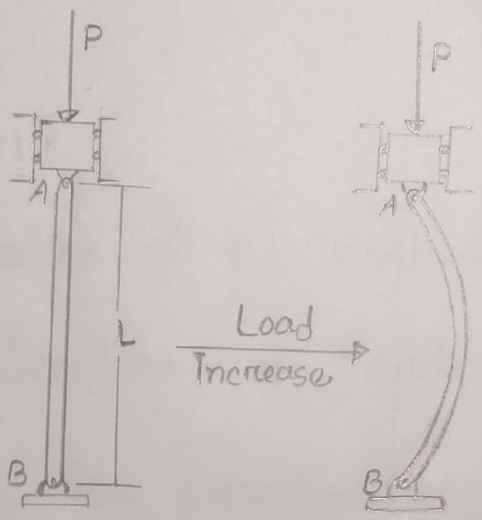
**Slenderness ratio:** The ratio L/r is called the slenderness ratio of the column. Since an axially loaded column tends to buckle about the axis of least moment of inertia, the least radius of gyration should be used to determine the slenderness ratio.



**Critical Load:** A critical load can be interpreted as the maximum axial load to which a column can be subjected and still remain straight, although in such an unstable condition that a slight sideways thrust will cause it to bow out.

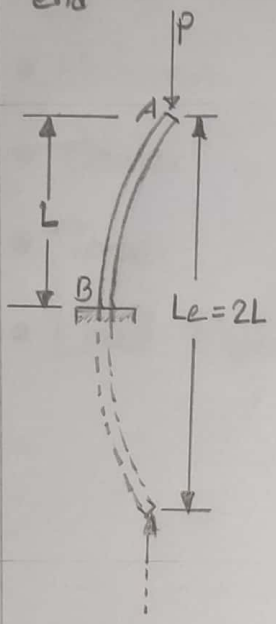
Critical Load of Long Columns by Euler's Formula:

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

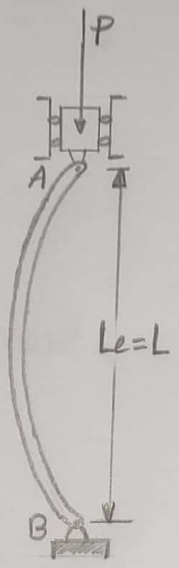


## Support Condition:

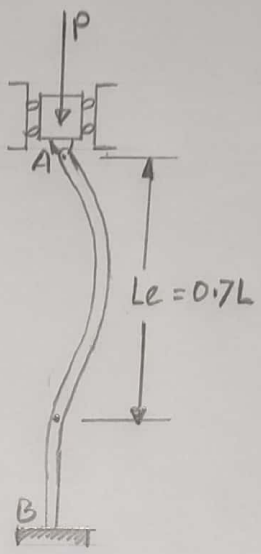
(a) One fixed end, one free end



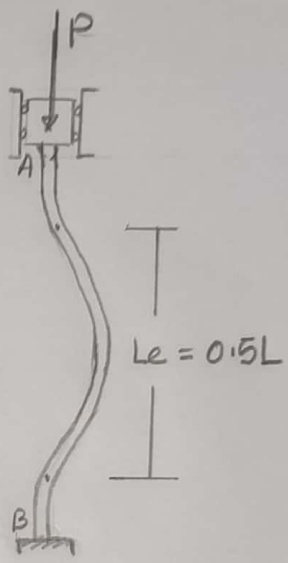

(b) Both ends pinned




(c) One fixed end, one end pinned




(d) Both ends fixed




## Objectives:

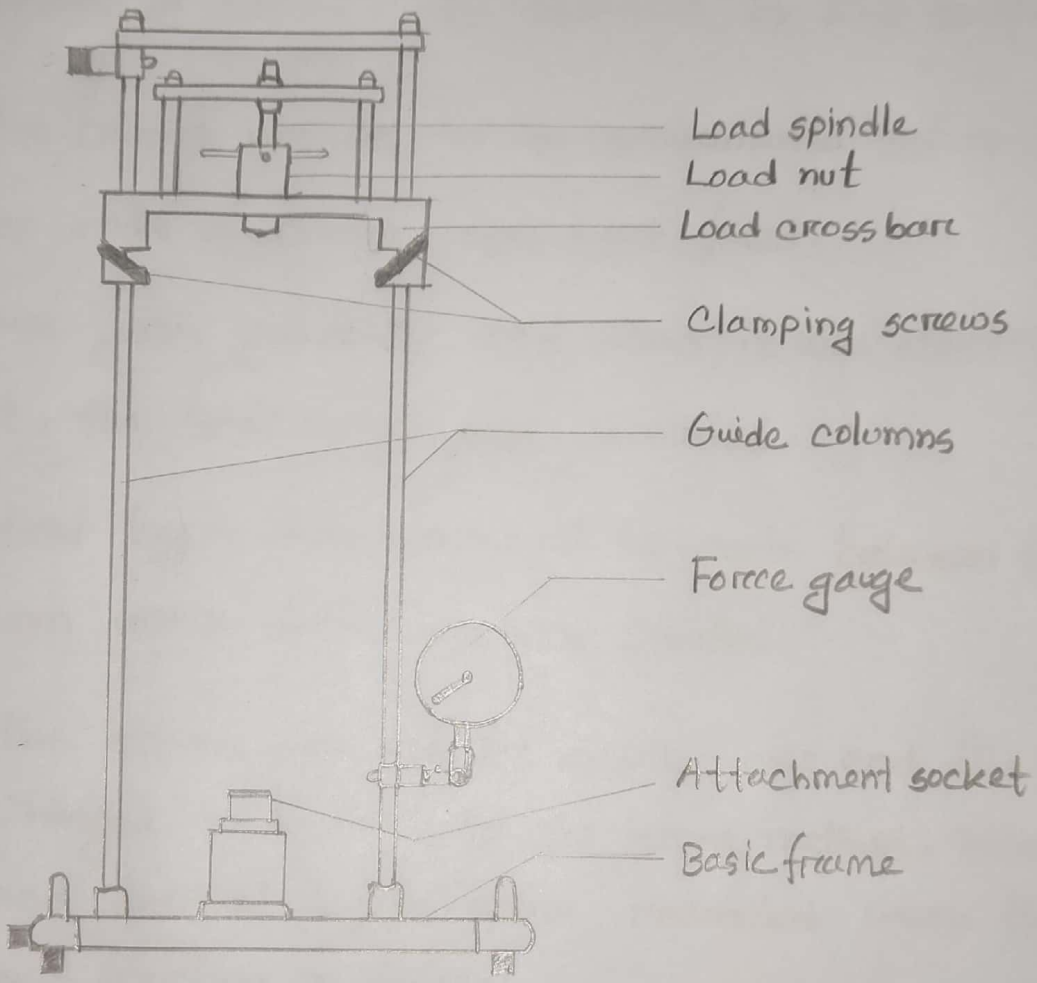
(i) Determination of the Critical Load for different Support Condition of Slender Column.

(ii) Compare the experimental critical load with that given by the Euler's equation.

## Apparatus:

- Buckling Test Machine.
- Slide Calipers.
- Column.
- Scale.
- Tape.
- Load Equipment.

# Buckling Test Machine:



## Procedure:

1. The diameter of column was recorded by slide calipers.

2. Then the column was set in an experimental set up and first two ends of column was kept fixed.

3. Load was given gradually and when it was starting to deflect, the total weight was recorded.

4. The critical length was measured by scale between two points from which deflection was started.

5. Then the column was set by keeping one end fixed and one end hinged and then by the same method, total weight and critical length were recorded when the column was starting to deflect.

6. After that the column was set by keeping both end hinged and by the similar way, total weight for deflection and critical length were recorded.

## Calculation:

Length of the column, $L = 85.5\ cm = 0.855\ m$

Diameter of the column, $d = 1.05\ cm = 0.0105\ m$

Modulus of Elasticity of steel, $E_s = 200\ GPa$
$= 200 \times 10^9\ Pa$

Moment of Inertia, $I = \frac{\pi d^4}{2^4 \times 4}$

$= \frac{\pi d^4}{64} = \frac{\pi \times (0.0105)^4}{64}$

$= 5.967 \times 10^{-10}\ m^4$

Case-1 : One end fixed and other end hinged.

$$P = \frac{n^2 E I \pi^2}{Le^2} = \frac{1^2 \times 200 \times 10^9 \times 5.967 \times 10^{-10} \times \pi^2}{(0.855 \times 0.7)^2}$$

Here, $Le = 0.7L$

$= 3288.1943\ N$

$= 335.19\ kg$

Case-2: Both end hinged

$$P = \frac{n^2 E I \pi^2}{Le^2} = \frac{1^2 \times 200 \times 10^9 \times 5.967 \times 10^{-10} \times \pi^2}{(0.855)^2}$$

Here, $Le = L$

$= 1611.2152\ N$

$= 164.24\ kg$

Case-3: Both end fixed

$$P = \frac{n^2 EI\pi^2}{(Le)^2} = \frac{1^2 \times 200 \times 10^9 \times 5.967 \times 10^{-10} \times \pi^2}{(0.5 \times 0.855)^2}$$

Here, $Le = 0.5L$

$$= 6444.8608\,N$$

$$= 656.97\,kg$$

## Data Table:

| Case No | Theoretical Load (kg) | Actual Load (kg) |
|---|---|---|
| (I) One end fixed and other hinged | 335.19 | 15.82 kg |
| (II) Both end hinged | 164.24 | 11.3 kg |
| (III) Both end fixed | 656.97 | 27.12 kg |

## Result:

Critical Load for Slender Column —

Experimentally :

1. One end fixed and other hinged : 15.82 kg
2. Both end hinged : 11.3 kg
3. Both end fixed : 27.12 kg

Theoritically :

1. One end fixed and other hinged : 335.19 kg
2. Both end hinged : 164.24 kg
3. Both end fixed : 656.97 kg

## Discussion: