1) consider a column R.S of length → l and uniform cross sectional area → A carrying load → P at R & S.

2) The column is hinged at both its end R & S.

3) The moment due to the distance x from the end S. Let y be the deflection at the section

4) Moment due to applied load the section is given by.

Moment = load x distance

$M = -(Pxy)$

General Bending Moment equation

$$EI \frac{d^2y}{dx^2} = M$$

Sub M in general equation

$$EI \frac{d^2y}{dx^2} = -Py$$

$$EI \frac{d^2y}{dx^2} + Py = 0$$

$\div EI$

$$\frac{d^2y}{dx^2} + \frac{P}{EI} y = 0$$

The above differential eqn is

$y = A \cos\left(x\sqrt{\frac{P}{EI}}\right) + B \sin\left(x\sqrt{\frac{P}{EI}}\right)$

At point S.

$x=0 \; ; \; y=0$

$0 = A \cos(0\sqrt{P/EI}) + B \sin(0\sqrt{P/EI})$

$0 = A \cos(0) + B \sin(0)$

$0 = A + 0 \qquad A = 0$

At point 'R'

$x = l \; ; \; y = 0$

$0 = A \cos(l\sqrt{P/EI}) + B \sin(l\sqrt{P/EI})$

$= 0 \times \cos(l\sqrt{P/EI}) + B \sin(l\sqrt{P/EI})$

$0 = 0 + B \sin(l\sqrt{P/EI})$

$0 = B \sin(l\sqrt{P/EI})$

$\sin(l\sqrt{P/EI}) = 0$

$l\sqrt{P/EI} = \sin^{-1}(0)$

$l\sqrt{P/EI} = \pi$

$l^2(P/EI) = \pi^2$

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