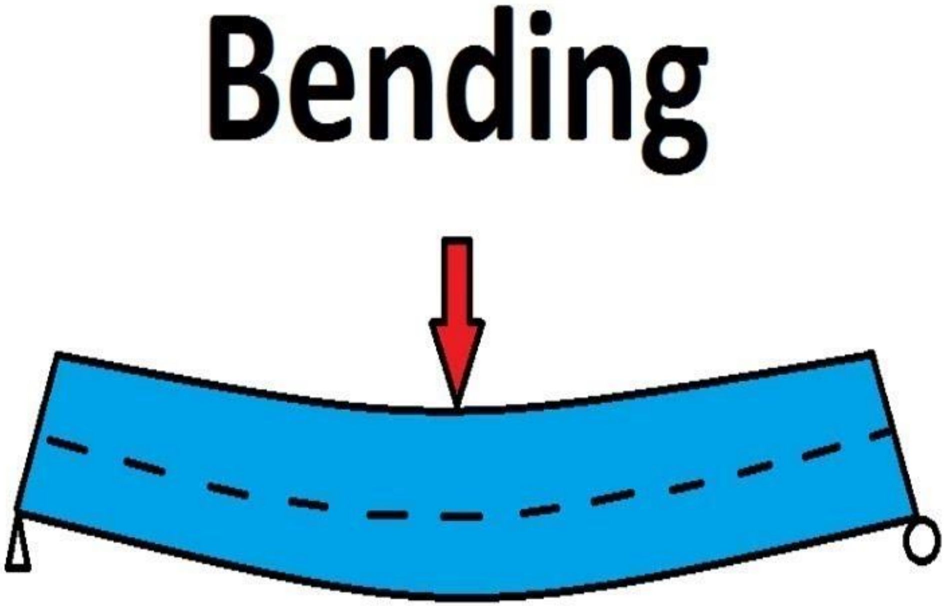
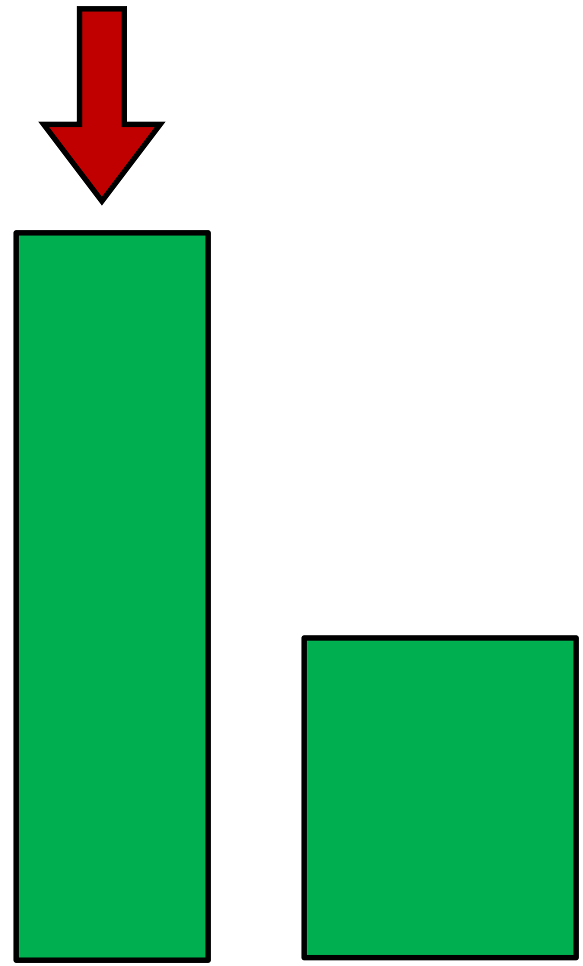
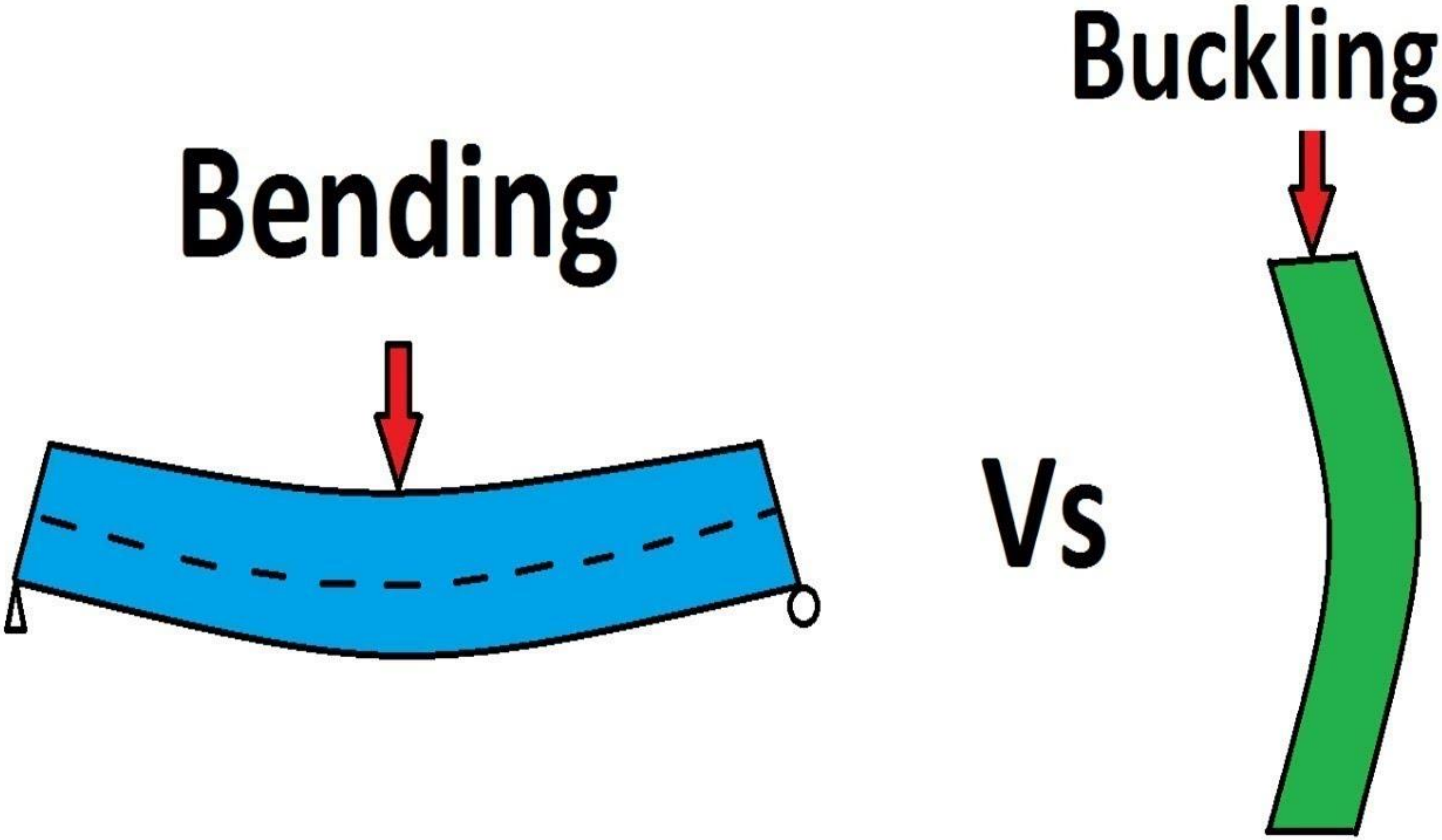
4-12/4-13 Long and Intermediate Columns with Central Loading





4-12/4-13 Long and Intermediate Columns with Central Loading



If you apply gradually increasing compressive forces at each end, very small axial deflections would happen at first, but then the stick would bend (buckle), and very quickly bend so much as to possibly fracture.

4-12/4-13 Long and Intermediate Columns with Central Loading

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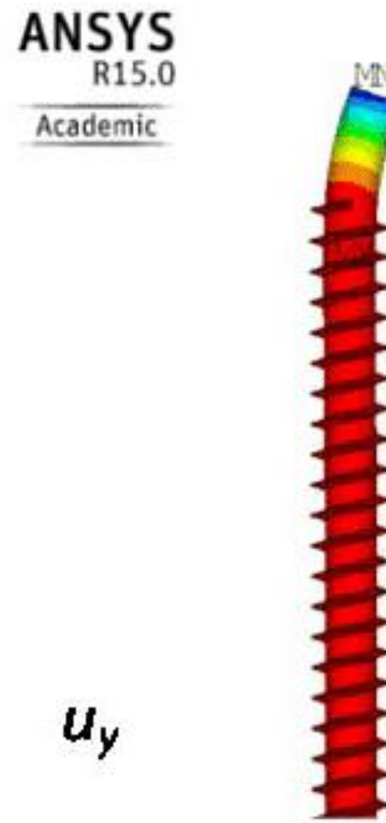
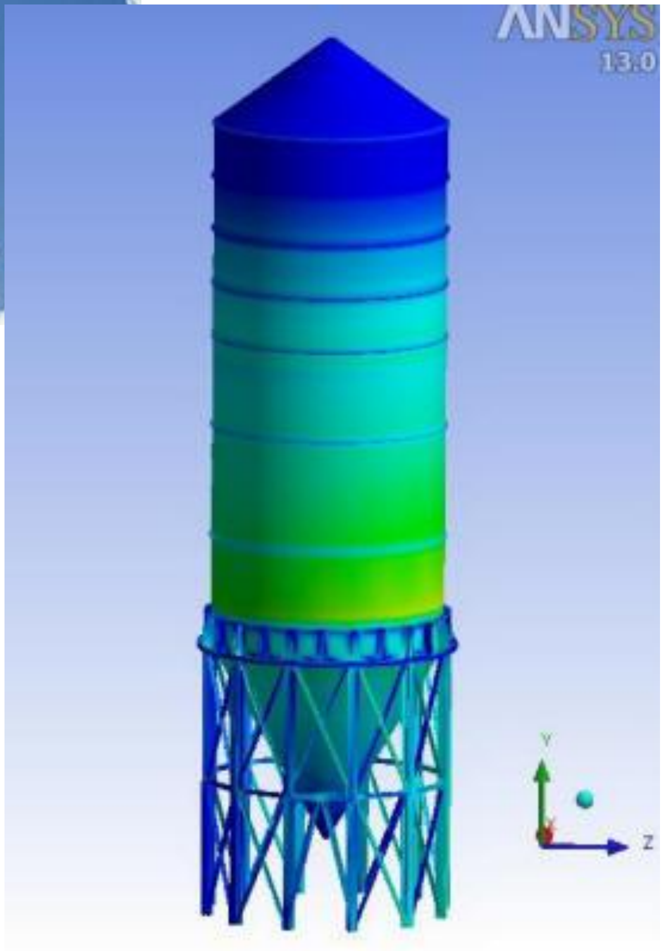
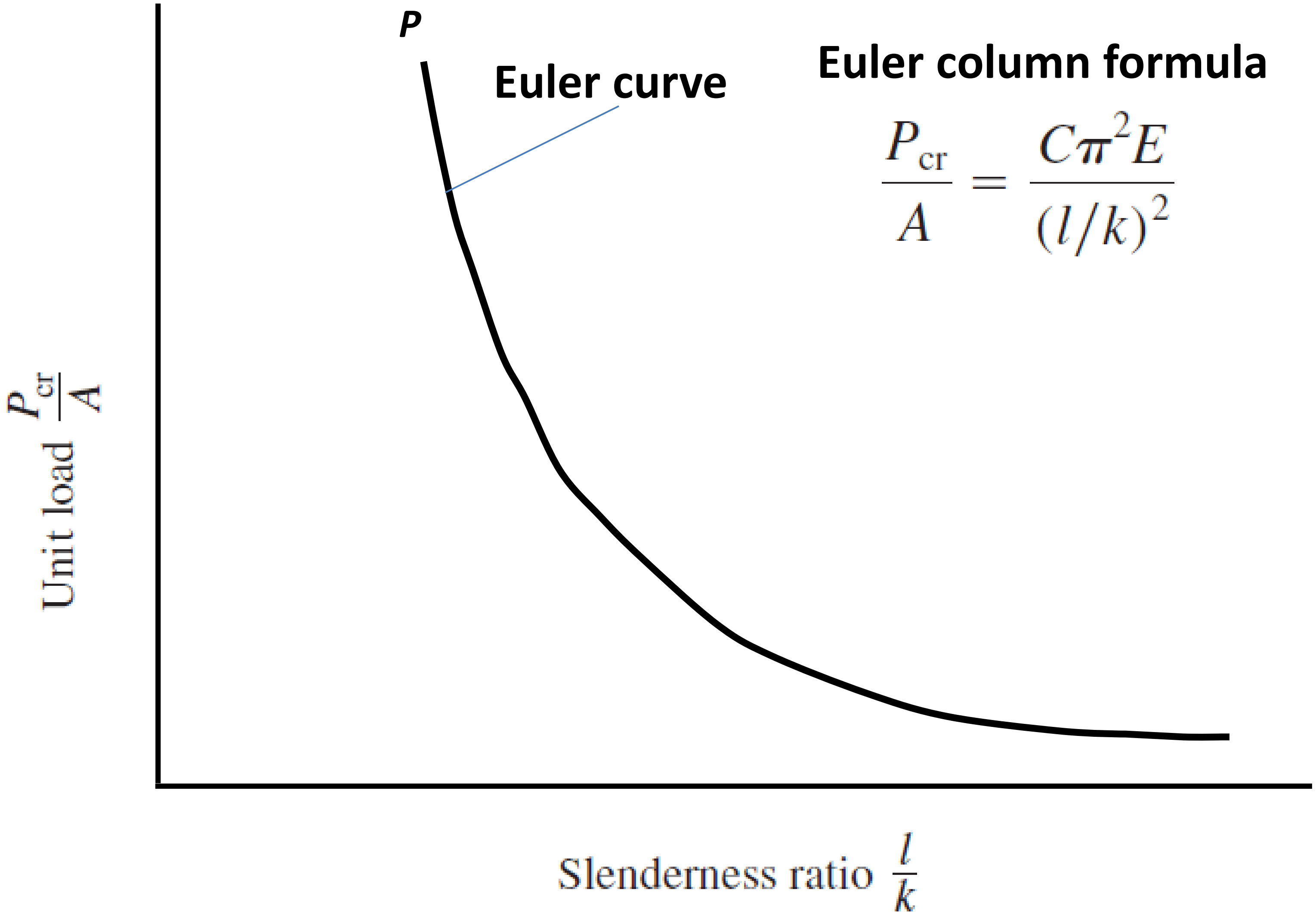


4-12/4-13 Long and Intermediate Columns with Central Loading



4-12/4-13 Long and Intermediate Columns with Central Loading



Euler column formula

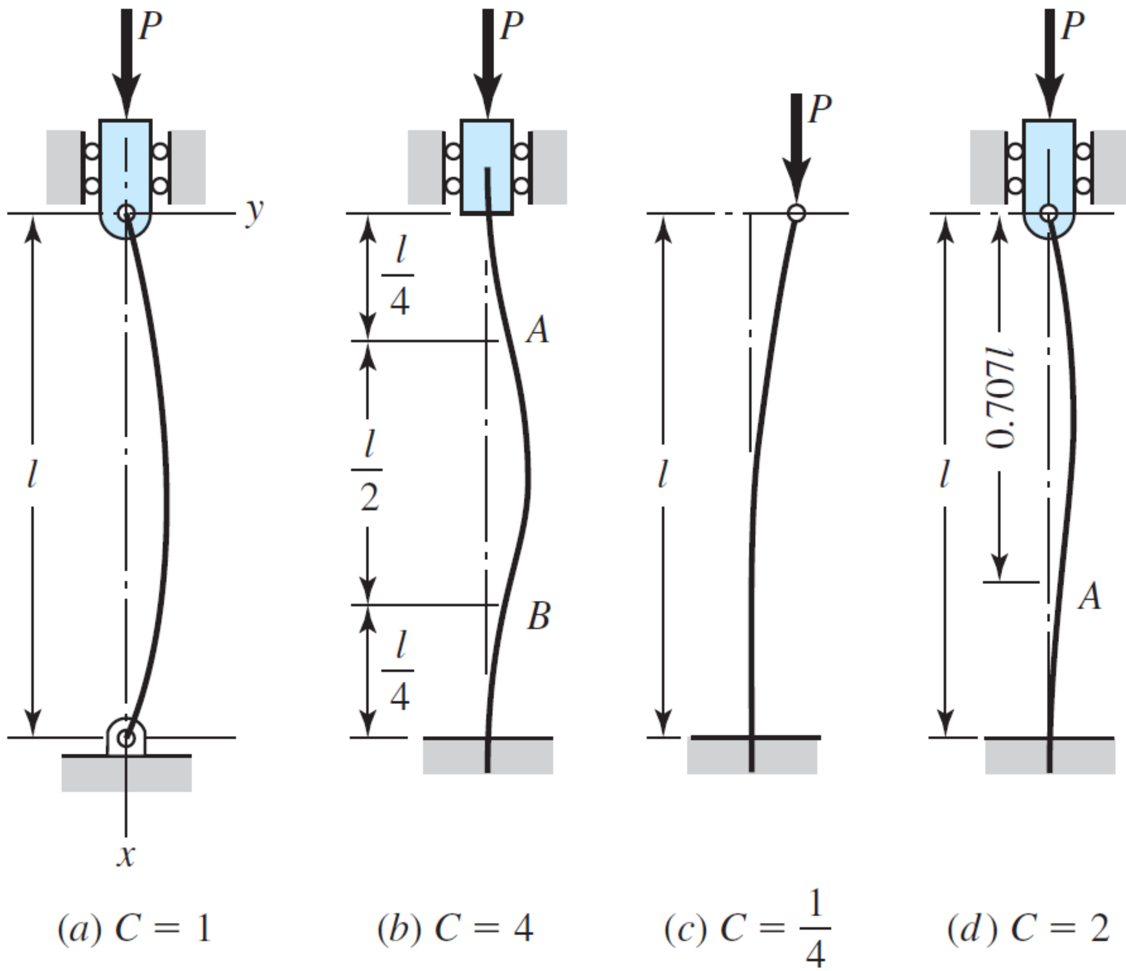
$$\frac{P_{cr}}{A} = \frac{C\pi^2 E}{(l/k)^2}$$

$I = Ak^2$, where A is the area and k the *radius of gyration*,

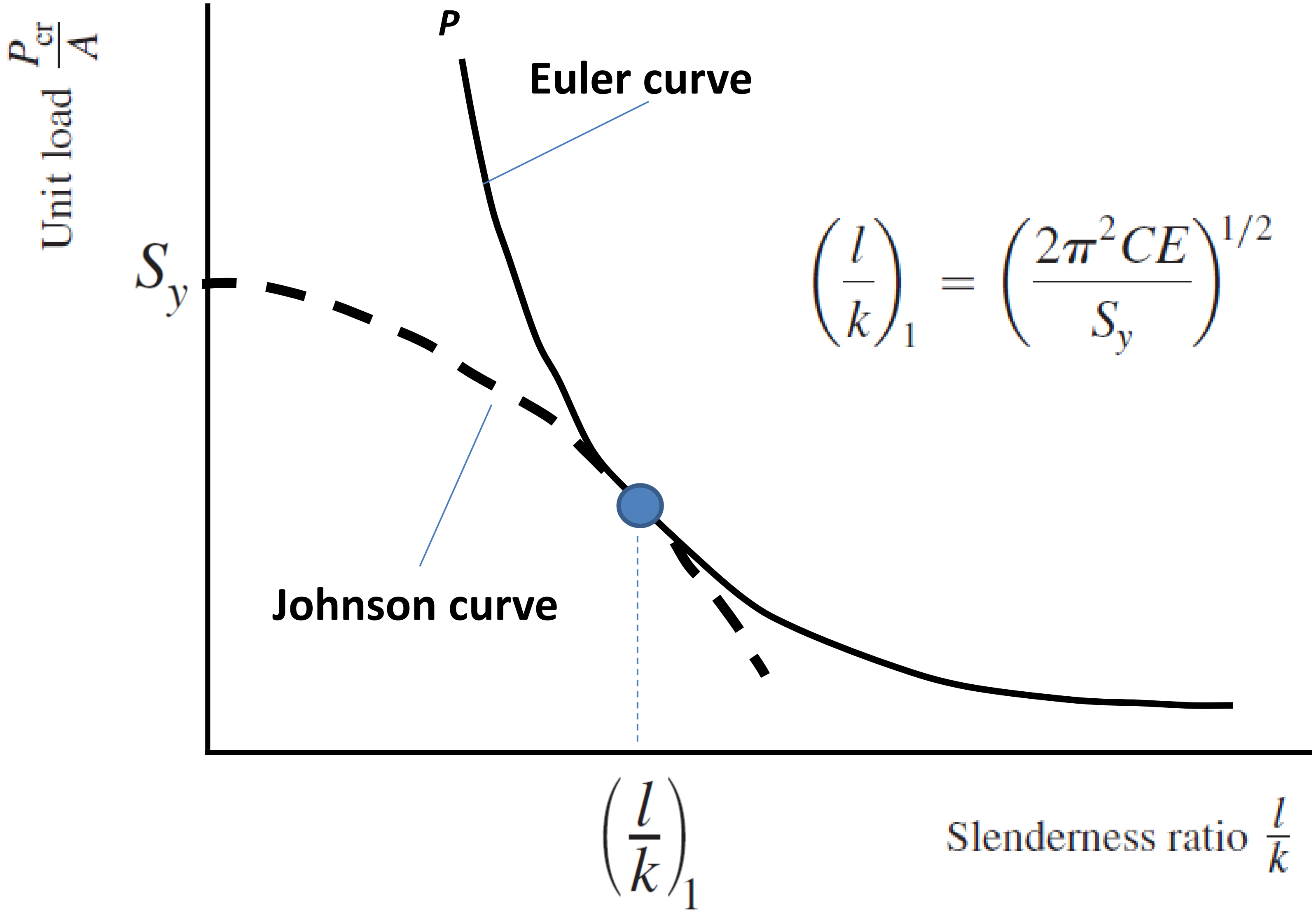
4-12/4-13 Long and Intermediate Columns with Central Loading

Figure 4–18

(*a*) Both ends rounded or pivoted; (*b*) both ends fixed; (*c*) one end free and one end fixed; (*d*) one end rounded and pivoted, and one end fixed.



4-12/4-13 Long and Intermediate Columns with Central Loading

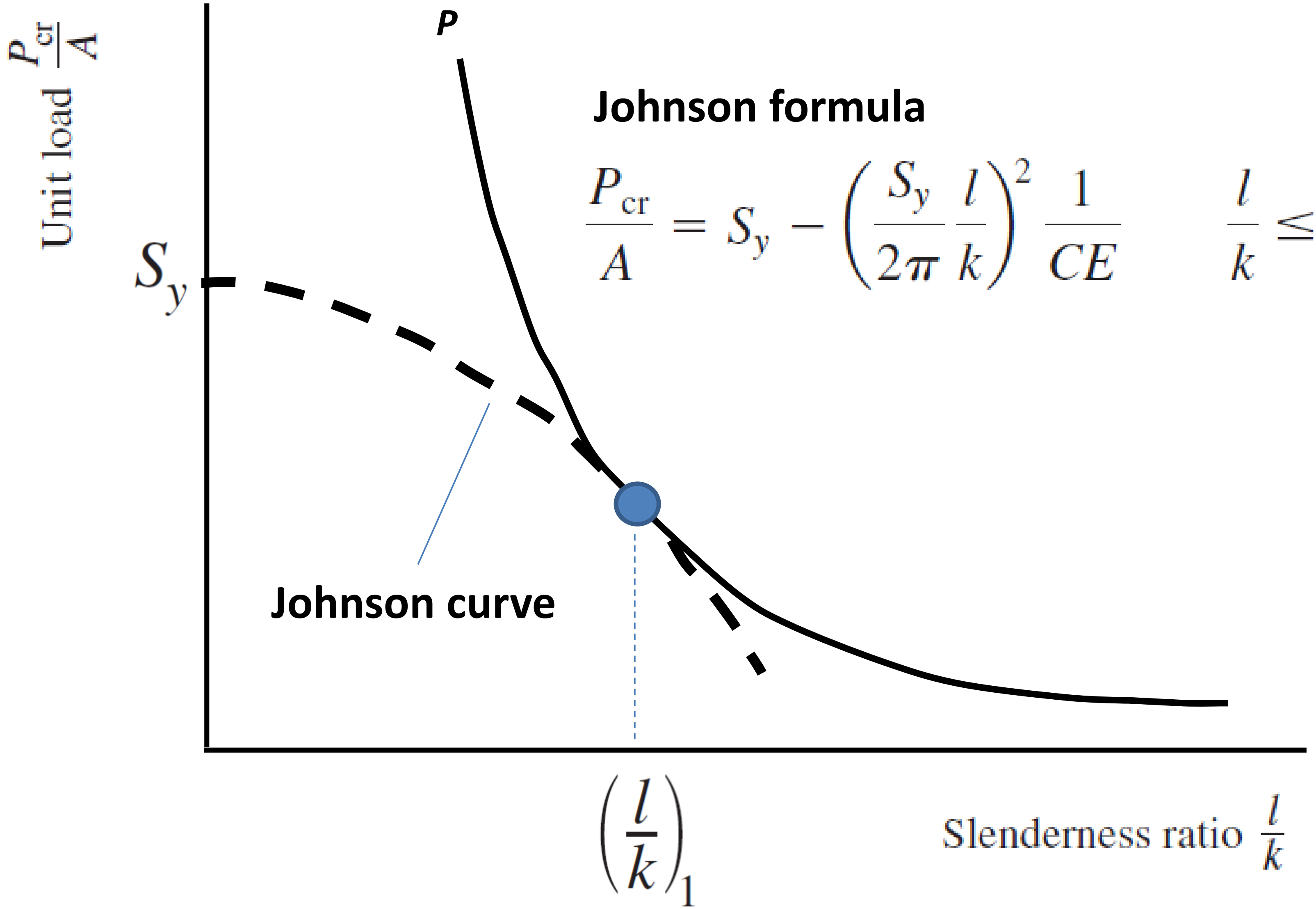


$$\left(\frac{l}{k}\right)_1 = \left(\frac{2\pi^2 CE}{S_y}\right)^{1/2}$$

4-12/4-13 Long and Intermediate Columns with Central Loading

Johnson formula

$$\frac{P_{cr}}{A} = S_y - \left(\frac{S_y}{2\pi}\frac{l}{k}\right)^2 \frac{1}{CE} \qquad \frac{l}{k} \le \left(\frac{l}{k}\right)_1$$



4-12/4-13 Long and Intermediate Columns with Central Loading

BIRZEIT UNIVERSITY

EXAMPLE 4–17 Specify the diameter of a round column 1.5 m long that is to carry a maximum load estimated to be 22 kN. Use a design factor $n_d = 4$ and consider the ends as pinned (rounded). The column material selected has a minimum yield strength of 500 MPa and a modulus of elasticity of 207 GPa.

We shall design the column for a critical load of

$$P_{cr} = n_d P = 4(22) = 88 \text{ kN}$$

Then, using Eq. (4–51) with $C = 1$ (see Table 4–2) gives

$$d = \left(\frac{64P_{cr}l^2}{\pi^3 CE}\right)^{1/4} = \left[\frac{64(88)(1.5)^2}{\pi^3(1)(207)}\right]^{1/4}\left(\frac{10^3}{10^9}\right)^{1/4}(10^3) = 37.48 \text{ mm}$$

Millimeters

0.05, 0.06, 0.08, 0.10, 0.12, 0.16, 0.20, 0.25, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90, 1.0, 1.1, 1.2, 1.4, 1.5, 1.6, 1.8, 2.0, 2.2, 2.5, 2.8, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 8.0, 9.0, 10, 11, 12, 14, 16, 18, 20, 22, 25, 28, 30, 32, 35, 40, 45, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300

4-12/4-13 Long and Intermediate Columns with Central Loading

EXAMPLE 4–17 Specify the diameter of a round column 1.5 m long that is to carry a maximum load estimated to be 22 kN. Use a design factor $n_d = 4$ and consider the ends as pinned (rounded). The column material selected has a minimum yield strength of 500 MPa and a modulus of elasticity of 207 GPa.

Table A–17 shows that the preferred size is 40 mm. The slenderness ratio for this size is

$$\frac{l}{k} = \frac{l}{d/4} = \frac{1.5(10^3)}{40/4} = 150$$

To be sure that this is an Euler column, we use Eq. (5–51) and obtain

$$\left(\frac{l}{k}\right)_1 = \left(\frac{2\pi^2 CE}{S_y}\right)^{1/2} = \left[\frac{2\pi^2(1)(207)}{500}\right]^{1/2}\left(\frac{10^9}{10^6}\right)^{1/2} = 90.4$$

where $l/k > (l/k)_1$ indicates that it is indeed an Euler column. So select

$$d = 40 \text{ mm}$$