What are Columns and Structural Members?

Worksheet

A column is a vertical compression member; its buckling capacity is given by Euler's formula Pcr = EI / L, where a longer or more slender column buckles at a much lower load than a short, stocky one.

Questions

1. A column has E = 200 GPa, I = 410 m, L = 3 m. What is its Euler buckling load?

A) 877 kN
B) 8770 kN
C) 87.7 kN
D) 219 kN

2. If a column's length doubles, its critical buckling load...

A) Doubles
B) Stays the same
C) Drops to 1/4
D) Drops to 1/2

3. Which is more prone to buckling?

A) A short, stocky column
B) A long, slender column
C) A column with larger I
D) A fixed-fixed column

4. In Euler's formula, what does I represent?

A) Column length
B) Applied load
C) Moment of inertia of the cross-section
D) Material density

5. A steel column has E = 200 GPa, I = 410 m, and an effective length L = 3 m (pinned-pinned). Find its Euler critical buckling load.

6. A timber column has E = 12 GPa, I = 810 m, and L = 4 m. Find its critical buckling load.

7. Take the steel column from Example 1 but double its unbraced length to L = 6 m. How does the buckling capacity change?

8. Define: What is a structural column?

9. Define: What is Euler's buckling formula?

10. Define: What is slenderness ratio?

Answer Key

1. A) 877 kN - Pcr = EI/L = (200e9)(4e-6)/9 877 kN.

2. C) Drops to 1/4 - Pcr is inversely proportional to L, so doubling L divides Pcr by 4.

3. B) A long, slender column - Long, slender columns buckle at much lower loads than short, stocky ones.

4. C) Moment of inertia of the cross-section - I is the second moment of area of the cross-section, describing resistance to bending.

5. Pcr = EI / L Pcr = (20010) (410) / 3 Pcr = 9.8696 800,000 / 9 877,300 N 877.3 kN

6. Pcr = EI / L Pcr = 9.8696 (1210 810) / 4 Pcr = 9.8696 96,000 / 16 59,220 N 59.2 kN

7. Pcr = EI / L = 9.8696 800,000 / 36 219,300 N 219.3 kN 877.3 / 219.3 4 doubling the length cuts the buckling capacity to 1/4 (Pcr 1/L)

8. A vertical member that carries axial compressive loads from beams/slabs down to the foundation.

9. Pcr = EI/L - the axial load at which a slender column buckles.

10. Effective length divided by radius of gyration (L/r); higher values mean greater buckling risk.