

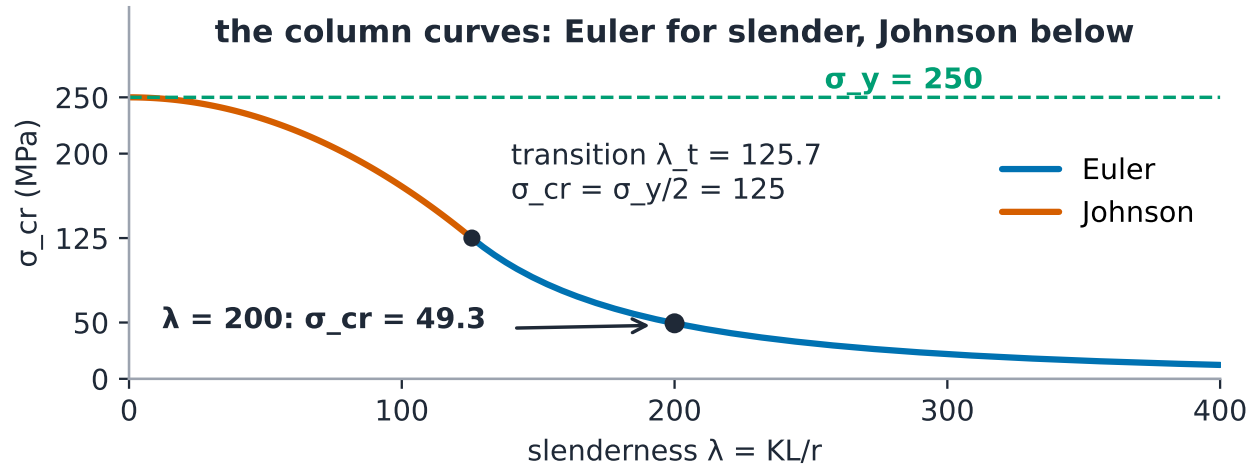
Exercise walk-through

6.6

Buckling and failure criteria

University Mechanical Engineering

Buckling and failure criteria



Rod $d = 20$ mm, 1 m pinned: $P_{cr} = 15.5$ kN at $\sigma_{cr} = 49.3$ MPa, $\lambda = 200$;
 Johnson takes over below $\lambda_t = 125.7$. At $n = 2.5$: $P_{allow} = 6.2$ kN.

The bracket file, one method

- 1 **Along the axis** $\sigma = 221.0$ MPa, $\delta = 1.658$ mm, held-cold 96.0 MPa; shaft:
 $\tau = 56.6$ MPa, $\phi = 3.24^\circ$, 5.65 kW.
- 2 **Across the section** $M_{max} = 4.5$ kN · m, $\sigma = 105.5$ MPa; $\tau_{max} = 1.41$ MPa;
Mohr: $R = 39.1$, $\sigma_1 = 109.1$ MPa, $\sigma' = 97.4$ MPa.
- 3 **Move and stay** $\delta = 9.89$ mm mid-span, 1.35 mm at a tip; strut $P_{cr} = 15.5$ kN at
 $\lambda = 200$, $P_{allow} = 6.2$ kN at $n = 2.5$.

Check yourself

- The rod and the shaft? (221.0 MPa, 1.658 mm; 56.6 MPa, 3.24°, 5.65 kW.)
- The diagrams and the stresses? ($PL/4 = 4.5$ and $wL^2/8 = 2.25 \text{ kN} \cdot \text{m}$; $\sigma = 105.5$, $\tau = 1.41 \text{ MPa}$.)
- The sag, the circle, the verdict? (9.89 mm; $R = 39.1$, $\sigma_1 = 109.1$, $\sigma' = 97.4 \text{ MPa}$.)
- The strut and its factor? ($P_{cr} = 15.5 \text{ kN}$ at $\lambda = 200$; $P_{allow} = 6.2 \text{ kN}$ at $n = 2.5$.)

Exercises 2.1-2.3

2.1 The slenderness ratio (integer) and which curve - Euler or Johnson - governs, with the reason. [3]

2.2 The Euler buckling load (one decimal, kN). [4]

2.3 The allowable load at a design factor $n = 2.0$ (one decimal, kN). [3]

Exercises 2.1-2.3

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2.1

- $\lambda = KL/r = 1500/6.25 = \mathbf{240}$.
- $240 > \lambda_t = 125.7$, so Euler governs.

2.2 The Euler buckling load (one decimal, kN). [4]

2.2

- $P_{cr} = \pi^2 EI/L^2 = 9.870 \times 200 \times 10^9 \times 1.917 \times 10^{-8}/2.25 = \mathbf{16.8}$ kN.

2.3 The allowable load at a design factor $n = 2.0$ (one decimal, kN). [3]

2.3

- $P_{allow} = P_{cr}/n = 16.8/2.0 = \mathbf{8.4}$ kN.

Exercise 2.4

2.4 A separate point carries principals $\sigma_1 = 60$ and $\sigma_2 = 20$ MPa: the von Mises stress (one decimal, MPa) and, in one sentence, what it is compared against to decide on yielding. [4]

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2.4

- $\sigma' = \sqrt{60^2 - 60 \times 20 + 20^2} = \sqrt{2800} = \mathbf{52.9}$ MPa.
- It is compared with the yield stress in uniaxial tension ($\sigma_y = 250$ MPa): below, no yielding by the distortion-energy criterion.