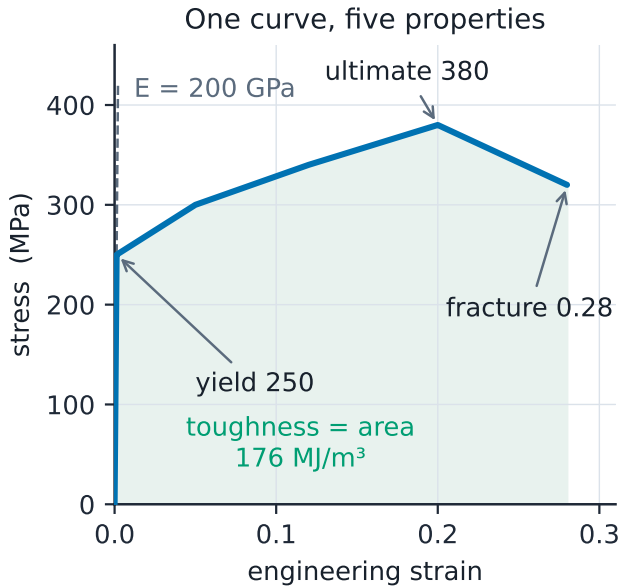
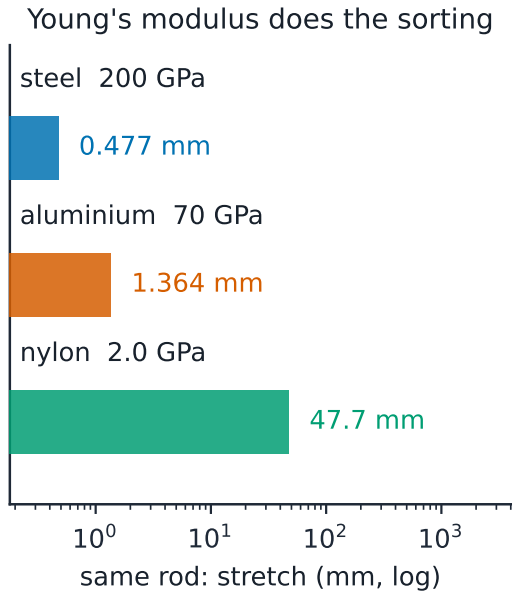
Exercise walk-through

4.2
Stress-strain and elastic behaviour

University Mechanical Engineering

Stress-strain: the certificate convention

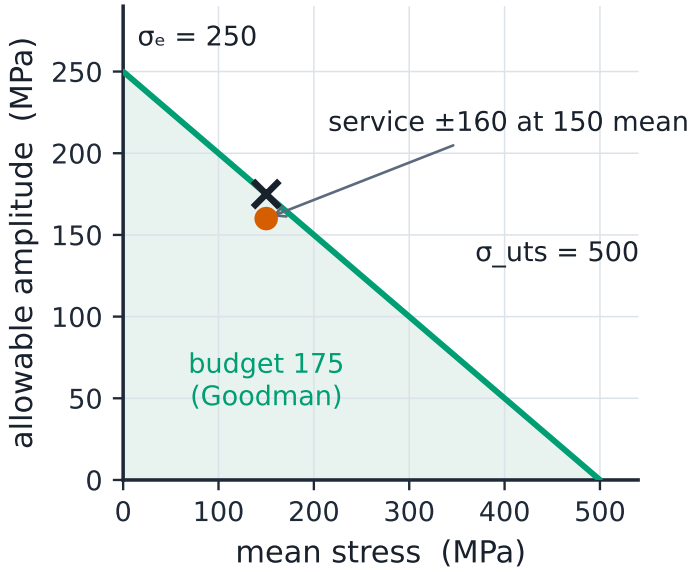




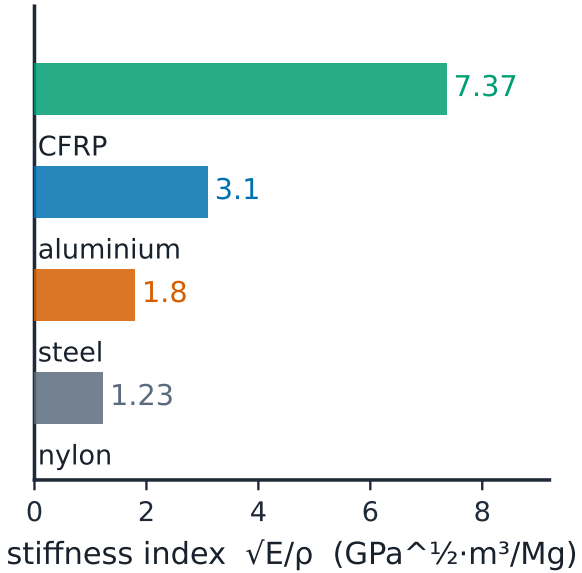
191.0 MPa is elastic in steel: the rod stretches 0.477 mm, aluminium 1.364 mm.

Failure and selection: show the arithmetic

Goodman: the mean eats the budget



The index ranks; constraints eliminate



Goodman cuts 250 to **175** MPa at 150 mean; CFRP leads the stiffness index.

Selection in action: one method, two answers

1. **Rank** $\sqrt{E}/\rho$: CFRP 7.37 wins stiffness-per-mass at 2.4× aluminium.
2. **Eliminate** Plain nylon fails the T_g constraint; ceramics fail the survival probability at these loads.
3. **Split** The mount ships quenched-and-tempered steel (620 MPa, 16%); the carry-handle ships CFRP.

Exercises 2.1·2.2

2.1 The cross-sectional area (four significant figures, mm^2) and the engineering stress (one decimal, MPa). [4]

2.2 The elastic extension in steel and in aluminium (three decimals, mm), with the modulus ratio stated. [4]

Exercises 2.1·2.2

2.1 The cross-sectional area (four significant figures, mm^2) and the engineering stress (one decimal, MPa). [4]

2.1

- $A_0 = \pi(6.0)^2 = 113.1\ \mathrm{mm}^2$.
- $\sigma = 20{,}000/113.1 \times 10^{-6} \cdot 10^{6} = 176.8$ MPa.

2.2 The elastic extension in steel and in aluminium (three decimals, mm), with the modulus ratio stated. [4]

2.2

- Steel: $\varepsilon = 176.8/200{,}000 = 8.84 \times 10^{-4}$, $\delta = 1.061$ mm.
- Aluminium: $\delta = 1.061 \times 200/70 = 3.032$ mm.

Exercises 2.3·2.4

2.3 At an engineering strain of 0.15: the true strain (four decimals) and true stress as a multiple of engineering stress. [3]

2.4 One sentence each: what does the 0.2% offset convention fix, and why must ductility percentages quote a gauge length? [3]

Exercises 2.3·2.4

2.3 At an engineering strain of 0.15: the true strain (four decimals) and true stress as a multiple of engineering stress. [3]

2.3

- $\varepsilon_t = \ln 1.15 = 0.1398$.
- $\sigma_t = 1.15\sigma$.

2.4 One sentence each: what does the 0.2% offset convention fix, and why must ductility percentages quote a gauge length? [3]

2.4

- The offset line defines where plastic flow counts as begun, removing judgement from the yield read.
- Necking localises strain, so the percentage depends on the length over which it is averaged.

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