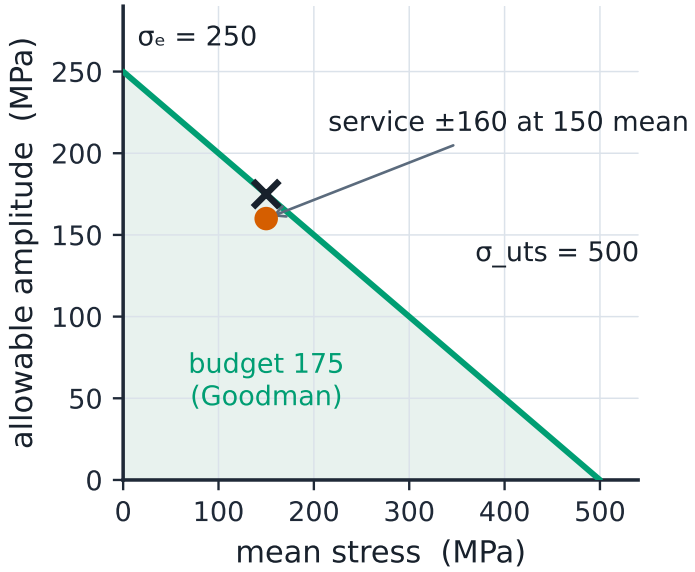
Exercise walk-through

4.5
Processing and property links

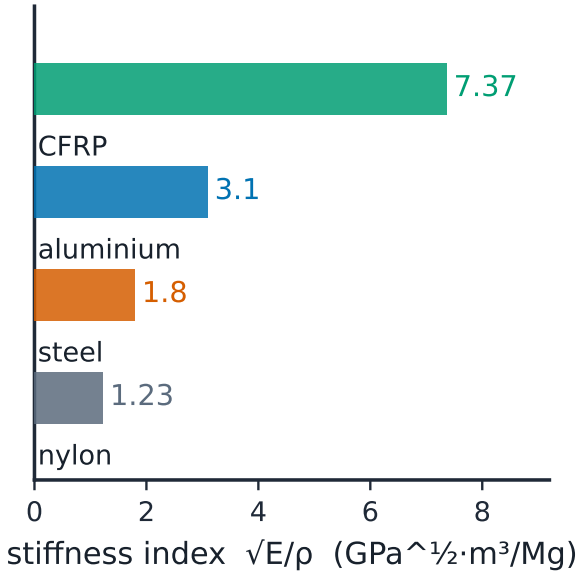
University Mechanical Engineering

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.

The project sheet, reproducible

1. **Structure** BCC 0.6802, FCC 0.7405; Hall-Petch 183.6 $\rightarrow$ 262.3 MPa for 50 $\rightarrow$ 10 µm.
2. **Certificate** Rod 191.0 MPa: 0.477 vs 1.364 mm; true ln 1.2 $=$ 0.1823; **toughness** 176 MJ/m^3.
3. **Choice** Routes 280/24, 260/26, 620/16, 950/8; Chvorinov 22.2 vs 50.0 s; Basquin 226.1 $\rightarrow$ 142.6; Goodman 175.0; index 7.37 / 3.10 / 1.80 / 1.23 - steel mount, CFRP handle.

Exercises 2.1·2.2

2.1 A cylinder 30 mm diameter × 60 mm long: V/A (mm, one decimal) and freezing time (one decimal, s). [4]

2.2 A bar 40×40×160 mm: V/A (three decimals, mm) and freezing time (one decimal, s). [4]

Exercises 2.1–2.2

2.1 A cylinder 30 mm diameter × 60 mm long: V/A (mm, one decimal) and freezing time (one decimal, s). [4]

2.1

- $V = \pi(0.015)^2(0.06) = 4.24\times10^{-5}$ m^3; $A = 2\pi(0.015)^2+2\pi(0.015)(0.06) = 7.07\times10^{-3}$ m^2.
- $V/A = 6.0$ mm, $t = 1.8 \times 10^6 \times (6.0 \times 10^{-3})^2 = 64.8$ s.

2.2 A bar 40×40×160 mm: V/A (three decimals, mm) and freezing time (one decimal, s). [4]

2.2

- $V = 2.56 \times 10^{-4}$ m^3; $A = 2(0.04)^2 + 4(0.04)(0.16) = 0.0288$ m^2.
- $V/A = 8.889$ mm, $t = 1.8 \times 10^6 \times (8.889 \times 10^{-3})^2 = 142.2$ s.

Exercises 2.3·2.4

2.3 Which solidifies last, and what does that imply for placing the riser? [2]

2.4 For the impact-loaded mount bracket, choose as-rolled (280 MPa / 24%) or quenched + tempered 600°C (620 / 16%) with one sentence of reasoning. [4]

Exercises 2.3·2.4

2.3 Which solidifies last, and what does that imply for placing the riser? [2]

2.3

- The bar (larger V/A, 142.2 s): the riser must attach there, with an even larger V/A.

2.4 For the impact-loaded mount bracket, choose as-rolled (280 MPa / 24%) or quenched + tempered 600°C (620 / 16%) with one sentence of reasoning. [4]

2.4

- Quenched + tempered 600°C.
- Impact energy is absorbed by plastic area: 16% elongation buys toughness the 950/8 route cannot, and 620 MPa clears the specification with margin.