Exercise walk-through

8.2
Casting and forming

University Mechanical Engineering

Casting: the riser freezes last

the riser freezes after the casting, so it can feed the shrinkage

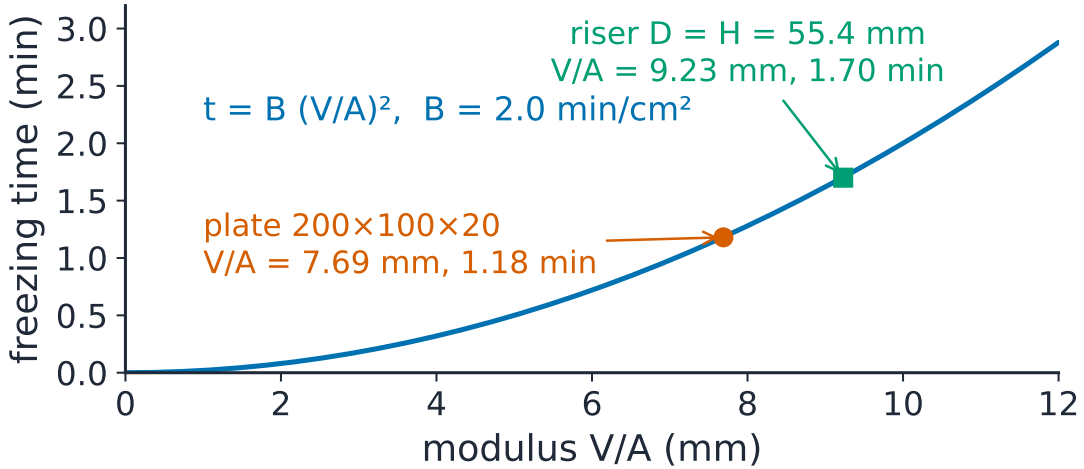


Plate 200×100×20: $V/A = \mathbf{7.69}$ mm, $t = B(V/A)^2 = \mathbf{1.18}$ min. A $D = H$ **riser** needs $D/6 = 1.2 \times 7.69$: $D = \mathbf{55.4}$ mm, freezing in $\mathbf{1.70}$ min.

Forming: drawing the shaft wire

1. **Strain** 6 $\to$ 5 mm: $\varepsilon = \ln(36/25) = \mathbf{0.365}$.
2. **Flow stress** $K = 500$ MPa, $n = 0.2$: $\overline{Y} = K\varepsilon^n/(1+n) = \mathbf{341}$ MPa.
3. **Stress, force** $\sigma_d = \overline{Y}\varepsilon = \mathbf{124}$ MPa; $F = \mathbf{2.44}$ kN on the 5 mm exit.
4. **Check** Exit **flow stress** 409 MPa, so σ_d is 30% of it; the ideal limit is $\varepsilon = 1 + n$, about 70% reduction.

Exercises 2.1·2.2

2.1 A steel cube casting has 60 mm sides. Find its casting modulus (cm) and its solidification time (one decimal, min). [3]

2.2 Size a cylindrical riser ($D = H$) whose modulus is 20% above the cube's. Find D (nearest mm) and its freezing time (two decimals, min). [3]

Exercises 2.1·2.2

2.1 A steel cube casting has 60 mm sides. Find its casting modulus (cm) and its solidification time (one decimal, min). [3]

2.1

- $V/A = a^3/(6a^2) = a/6 = 60/6 = 10$ mm $=$ **1.0** cm.
- $t = B(V/A)^2 = 2.0 \times 1.0^2 =$ **2.0** min.

2.2 Size a cylindrical riser ($D = H$) whose modulus is 20% above the cube's. Find D (nearest mm) and its freezing time (two decimals, min). [3]

2.2

- $D/6 = 1.2 \times 10$, so $D =$ **72** mm.
- $t = B(V/A)^2 = 2.0 \times 1.2^2 =$ **2.88** min.

Exercises 2.3·3.1

2.3 Wire of 8 mm is drawn to 7 mm ($K = 500$ MPa, $n = 0.2$). Find the true strain (three decimals), the mean flow stress (nearest MPa), the drawing stress (one decimal, MPa) and the drawing force (two decimals, kN). [5]

3.1 In ideal drawing the wire breaks when σ_d reaches the drawn wire's flow stress $K\varepsilon^n$. Show that this happens at $\varepsilon = n + 1$, and find the largest area reduction in one pass for $n = 0.2$ (one decimal, %). Why is real practice well below it? [5]

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2.3

- $\varepsilon = \ln(A_0/A_f) = \ln(64/49) = \mathbf{0.267}$.
- $\bar{Y} = K\varepsilon^n/(n+1) = 500 \times 0.267^{0.2}/1.2 = \mathbf{320}$ MPa.
- $\sigma_d = \bar{Y}\varepsilon = 320 \times 0.267 = \mathbf{85.5}$ MPa.
- $F = \sigma_d A_f = 85.5 \times \pi \times 3.5^2 = \mathbf{3.29}$ kN.

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3.1

- Set $\sigma_d = K\varepsilon^{n+1}/(n+1)$ equal to $K\varepsilon^n$: $\varepsilon/(n+1) = 1$, so $\varepsilon = n + 1$.
- $\varepsilon = 1.2$: reduction $= 1 - A_f/A_0 = 1 - e^{-1.2} = \mathbf{69.9}\%$.
- Friction and redundant work raise the real drawing stress, so passes are kept to about 20 to 45% reduction.