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BMM3643 Manufacturing Processes
Bulk Metal Deformation

Individual Assignment 4

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Individual Assignment 4 - Bulk Metal Deformation

- Aims
  - Able to apply formulae depends on various types of forging force
  - Able to analyze and apply true stress versus true strain graph in forging force calculation

- Expected Outcomes
  - Understand and able to apply the suitable formulae depends on types of forging processes

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Example 1: Open die forging force

1. A solid cylindrical slug made of 304 stainless steel is 150 mm in diameter and 100 mm high. It is reduced in height by 50% at room temperature by open-die forging with flat dies. Assuming that the coefficient of friction is 0.2, calculate the forging force at the end of the stroke.

<u>Solution:</u>

The forging force at the end of the stroke: $F = Y_f \pi r^2 \left(1 + (2\mu r/3h)\right)$

Final dimensions: Final height, h = 100/2 = 50 mm,

To get the final radius, r

volume constancy: volumes before deformation = volumes after deformation

$$(\pi)(75)\char`^2(100) = (\pi)(r)\char`^2(50) \Rightarrow r = 106mm$$

$$\varepsilon = \ln\left(\frac{100}{50}\right) = 0.69$$

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Example 1: Open die forging force (continue)

<u>Solution:</u>

From the graph, the flow stress for 304 stainless steel at a true strain of 0.69 is about 1000 MPa. (forging force must be in units N and m)

$$F = Y_f \pi r^2 (1 + (2\mu r/3h))$$

$$F = (1000)(10^6)(\pi)(0.106)^2(1) + \frac{(2)(0.2)(0.106)}{(3)(0.050)}$$

$$= 4.5 \times 10^7 \text{ N} = \underline{\underline{45\,\text{MN}}}$$

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Example 2: Drawing force

1. A round wire made of a perfectly plastic material with a yield stress of 200 MPa is being drawn from a diameter of 2.5 to 1.5 mm in a draw die of 15°. Let the coefficient of friction be 0.1. Estimate the drawing force required for both friction and frictionless conditions.

<u>Solution:</u>

d_0 = 2.5mm, so the initial cross-sectional area is $A_0 = \frac{\pi}{4} {d^2}_0$ = 4.909 mm^2

d_f = 1.5mm, A_f = 1.767mm^2, F = $Y_{avg} A_f$ In A_o/A_f = 361 N

Therefore, μ = 0.1, α = 15° = 0.262 radians,

F = $Y_{avg} A_f$ [(1+ μ/α) In (A_o/A_f) + (2/3)α]

= <u>560N</u>

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1. A round billet made of 70-30 brass is extruded at a temperature of 675°C. The billet diameter is 125 mm and the diameter of the extrusion is 50 mm. Calculate the extrusion force required if extrusion constant, k, is 250 MPa.
2. Assume that a round slug of 10 mm in diameter and made of a metal with Y_{avg} = 350 MPa is reduced to a final diameter of 7 mm by cold extrusion. Find the force F.

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Individual Assignment 4 Format

Please remember to **include the questions** given in the assignments. **Cover page** of the assignment should include:

1. Your Name & No. Matric
2. Section
3. Lecturer’s Name
4. Submission date

Late submission also will be penalized.

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