Metal Forming Processes —— ME5807

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Outlines

Introduction to Metal Forming

Classification of Metal Forming Processes

Introduction to Metal Forming

Metal Forming is the largest group of manufacturing processes in which plastic deformation is used to changed the shape of metal workpiece. In metal forming:–

- The tool, usually called as a die, applies stresses that exceed the yield strength of the metal.
- The metal takes a shape determined by the geometry of the die.

Classification of Metal Forming Processes

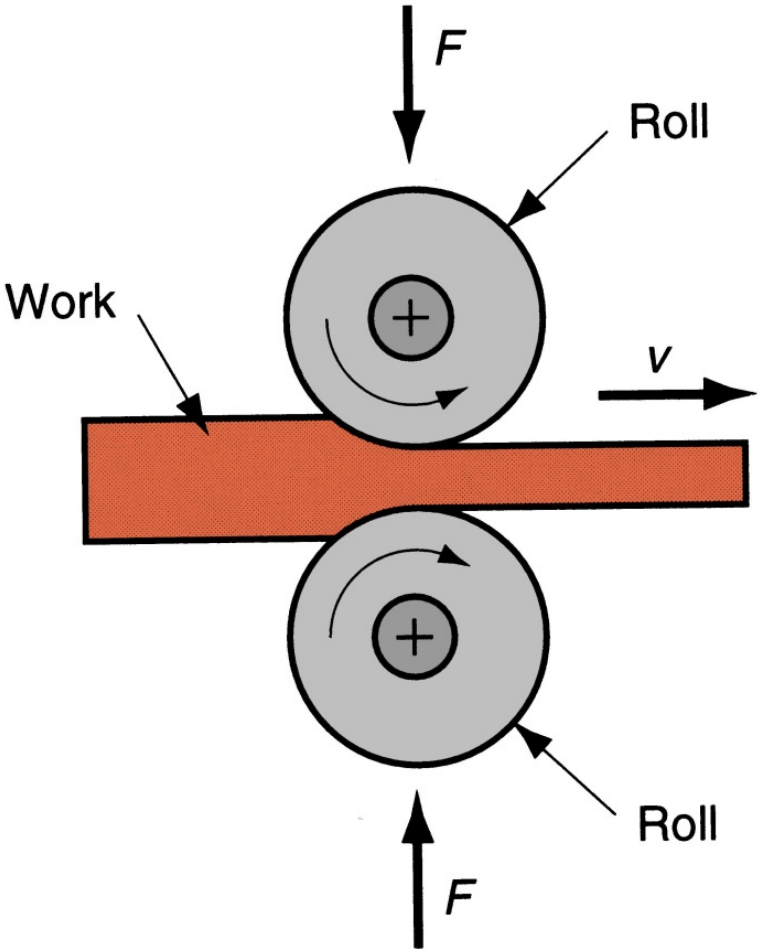
1. Bulk Forming (stock has high V/A)
   - Rolling
   - Forging
   - Extrusion
   - Wire and bar drawing

2. Sheet metal working (stock has low V/A)
   - Bending
   - Deep drawing
   - Cutting

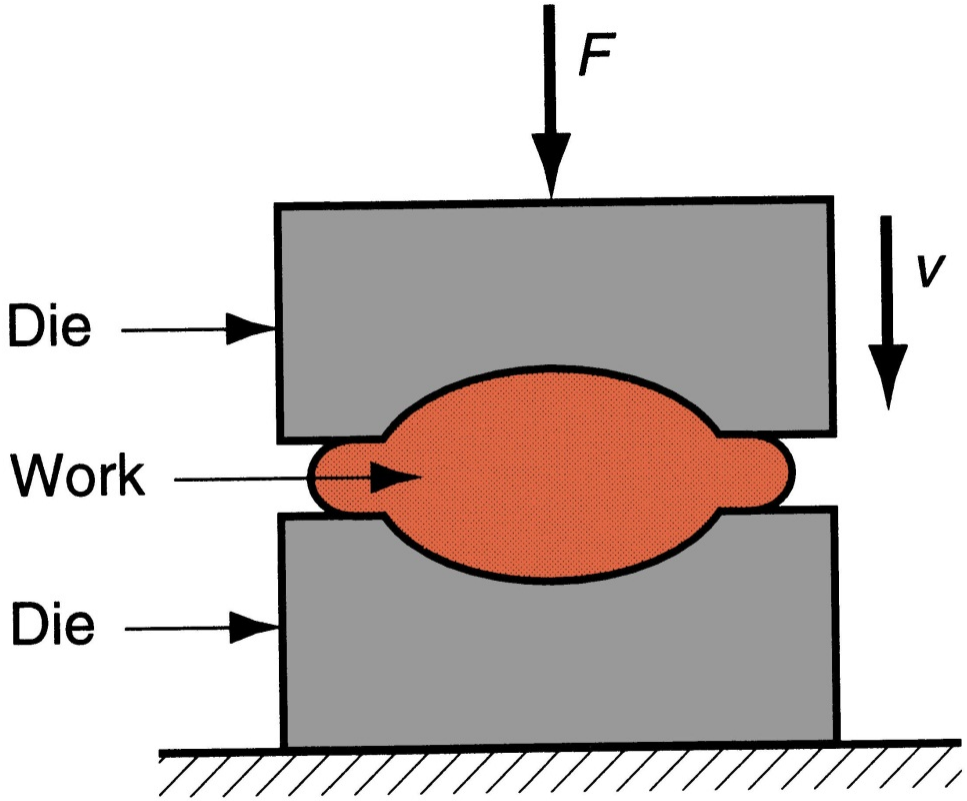
Bulk Forming Processes

- Characterised by significant deformations and massive shape changes
- ”Bulk” refers to workparts with relatively low surface area-to-volume ratios.
- Starting work shapes include cylindrical billets and rectangular bars.

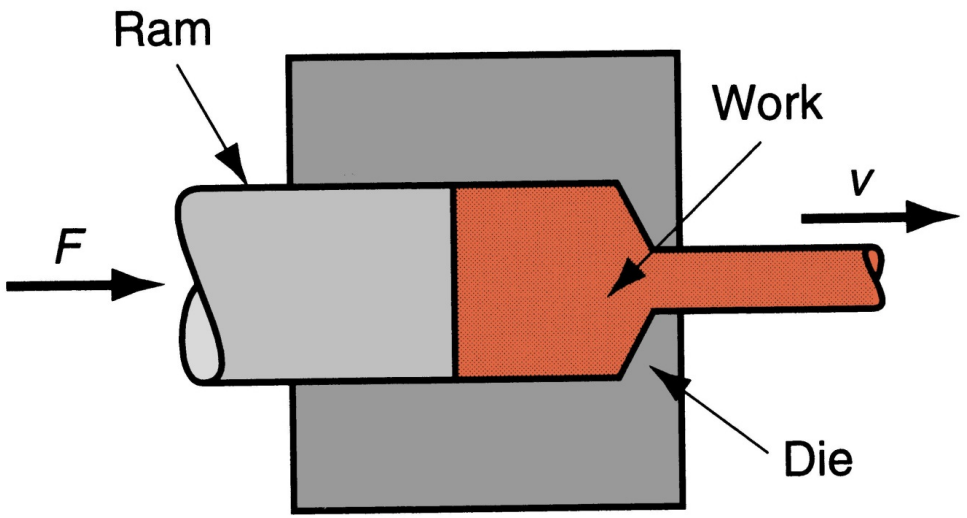
Rolling



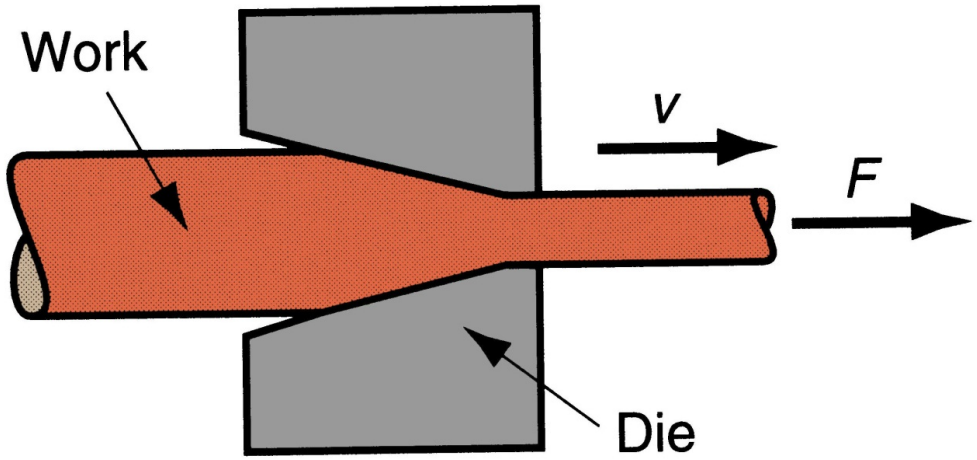
Forging



Extrusion



Wire and Bar Drawing



Sheet Metal Working

- Forming and related operations performed on metal sheets, strips, and coils
- High surface area-to-volume ratio of starting metal, which distinguishes these from bulk deformation
- Often called pressworking because presses perform these operations.
  - Parts are called stampings
  - Usual tooling: punch and die

Material Behaviour in Metal Forming

Compressive stresses

- Examples: rolling, forging, extrusion.

Tensile and Compressive

- Examples: Bending.

Tensile stresses

- Examples: Stretching.

Shear stresses

- Examples: Punching.

Material Properties in Metal Forming

The following material properties which decides that how the behave under loading..

- Strength
- Hardness
- Toughness
- Elasticity
- Plasticity
- Malleability

Tensile Test / Properties - Nominal Stress-Strain

The tensile test is used to determine:

- Modulus of Elasticity
- Elastic Limit
- Elongation
- Proportional limit
- Reduction in Area
- Tensile Strength
- Yield point
- Yield strength

Tensile Test / Properties - Nominal Stress-Strain

The Stress (σ) ans strain (ϵ) can be plotted as:

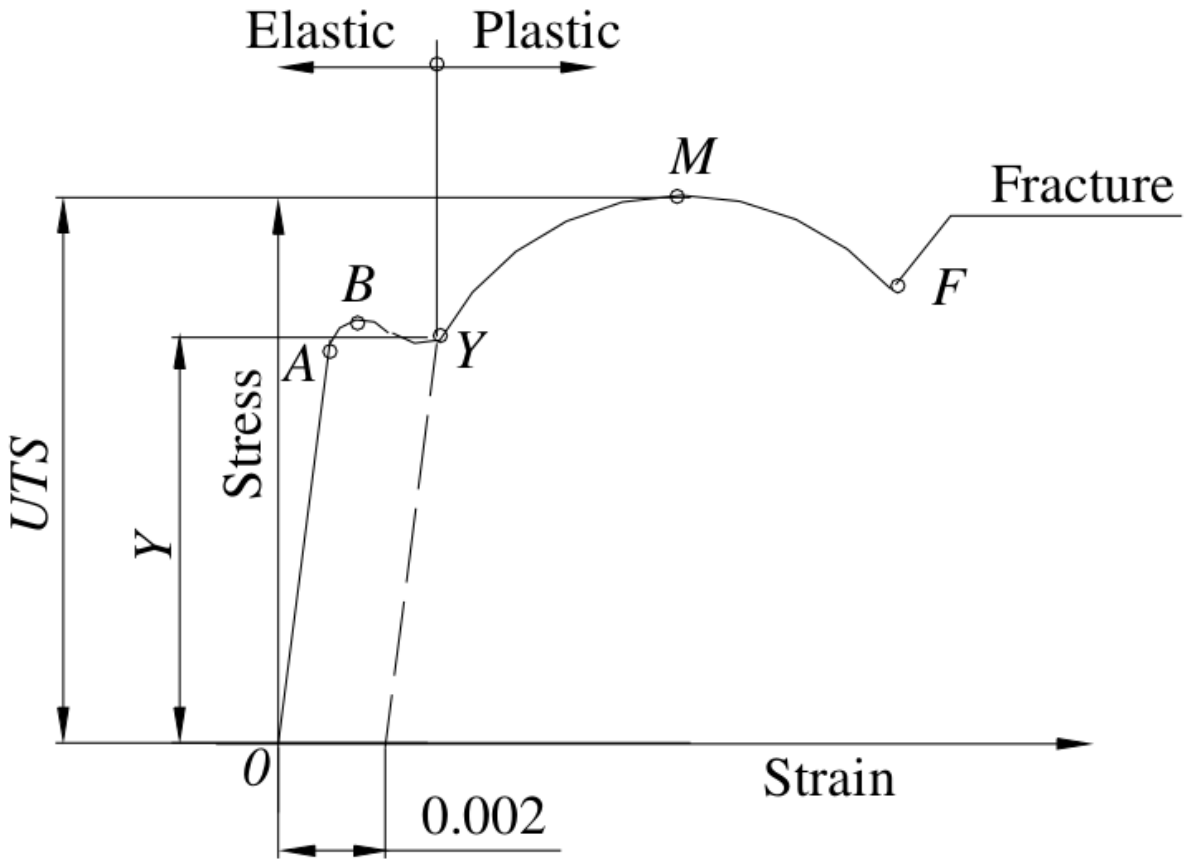
- Nominal / Engineering Stress-Strain, or
- True Stress-Strain

Tensile Test / Properties - Nominal Stress-Strain

Nominal (Engineering) Stress, $\sigma_n = \frac{F}{A_o}$

Nominal(Engineering) Strain $\epsilon_n = \frac{l - l_o}{l_o} = \frac{\Delta l}{l_o}$

Tensile Test / Properties - Nominal Stress-Strain



Tensile Test / Properties - Ductility

in terms of elongation, $\delta = (\frac{l_f - l_o}{l_o})x100$

in term of reduction in cross-sectional area, $\psi = (\frac{A_o - A_f}{A_o})x100$

Material Properties in Metal Forming

- Desirable material properties:
  - Low yield strength
  - High ductility
- Properties affected by temperature:
  - Ductility increases and yield strength decreases when work temperature is raised.
- Other factors:
  - Strain rate and friction.