

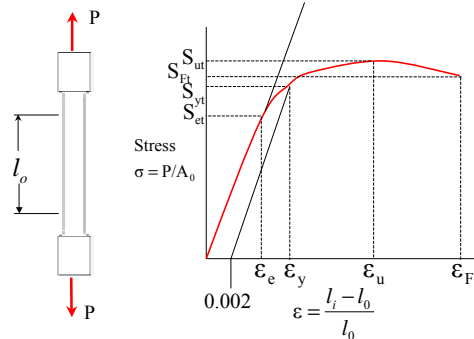
Mechanical Properties of Ductile Metallic Materials

Lecture 1

Engineering 473
 Machine Design



Mechanical Properties (Static Strength – Monotonic Elongation)

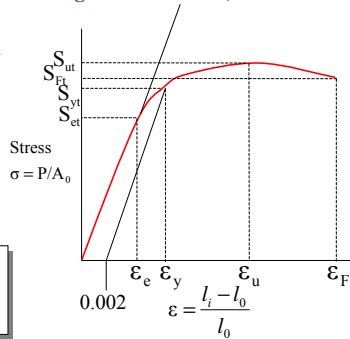


Mechanical Properties (Static Strength Nomenclature)

Subscripts

- y ≡ 0.2% offset yield
- u ≡ ultimate
- e ≡ elastic
- F ≡ fracture
- t ≡ tension
- c ≡ compression

S_{yt} & S_{ut} are generally given in handbooks.



Mechanical Properties (True Stress & True Strain)

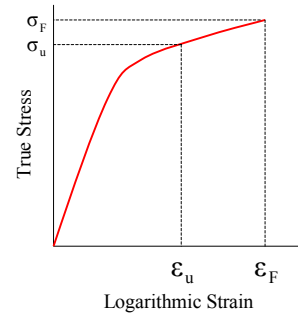
Logarithmic Strain

$$d\varepsilon = \frac{dl}{l}$$

$$\varepsilon = \int_{l_0}^{l_i} \frac{dl}{l} = \ln \frac{l_i}{l_0}$$

True Stress

$$\sigma = \frac{P}{A_i}$$



Mechanical Properties (Example Data)

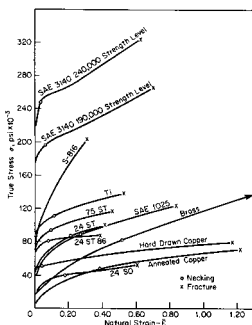
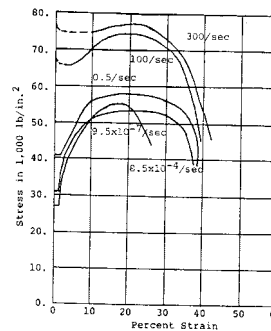


FIGURE 2.2.2 True stress-strain curves for several materials.

True Stress-Logarithmic Strain Curves for Several Metallic Materials

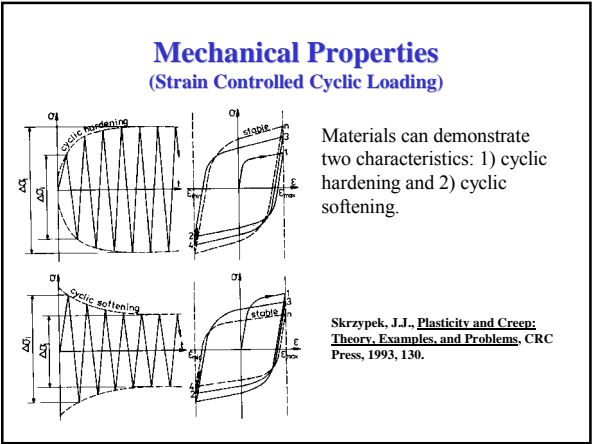
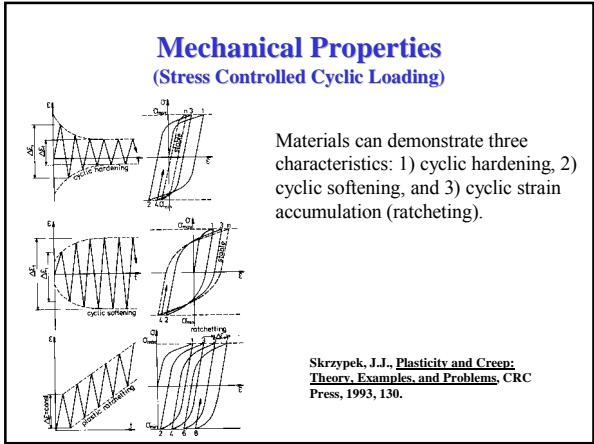
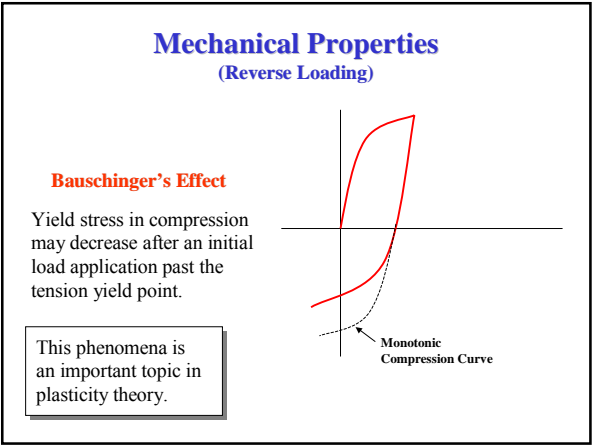
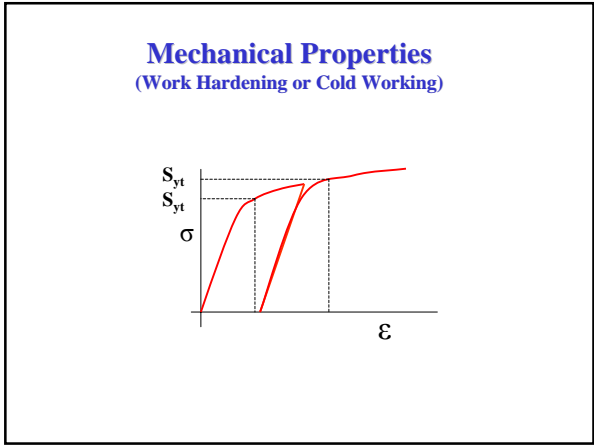
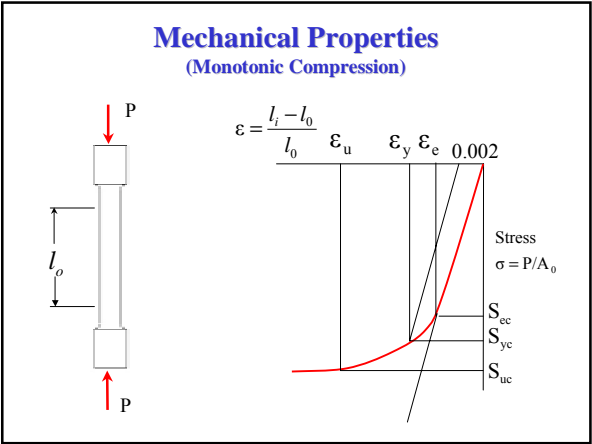
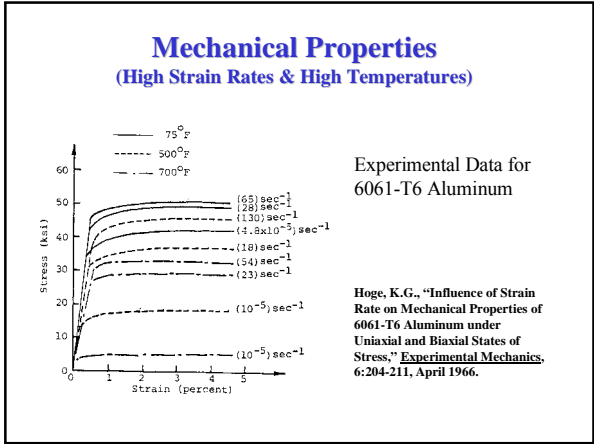
H. Schwartzbart, W.F. Brown, Jr., "Notch-Bar Tensile Properties of Various Materials and their Relation to the Unnotch Flow Curve and Notch Sharpness," Trans. ASM, 46, 998, 1954.

Mechanical Properties (High Strain Rates)



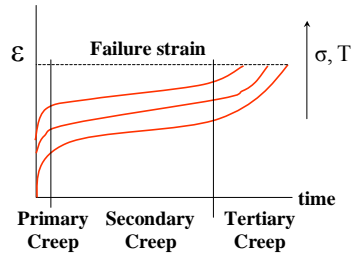
Stress-Strain Curves for Mild Steel at Room Temperatures at Various Rates of Strain

Manjoine, M.L., "Influence of Rate of Strain and Temperature on Yield Stresses of Mild Steel," Journal of Applied Mechanics, 11(A):211-218, December 1944.



Mechanical Properties (Creep)

Creep is most pronounced at high temperatures. It may also occur at room temperatures when the stress level is close to the yield strength.



Typical curves obtained from constant stress/temperature tests.

Summary

The strength of ductile metallic materials is dependent on several parameters.

1. Load Direction (Tensile or Compressive)
2. Strain Rate (Slow or Fast)
3. Temperature (Hot or Cold)
4. Load History (Monotonic or Cyclic)
5. Fabrication Process (Next Class)

- Metals are complex materials when used throughout their total response envelope.
- Fortunately their elastic properties are most commonly used.

Assignment

Read pages 25-34 in Mott.