Mechanics of Materials I:

Fundamentals of Stress & Strain and Axial Loading

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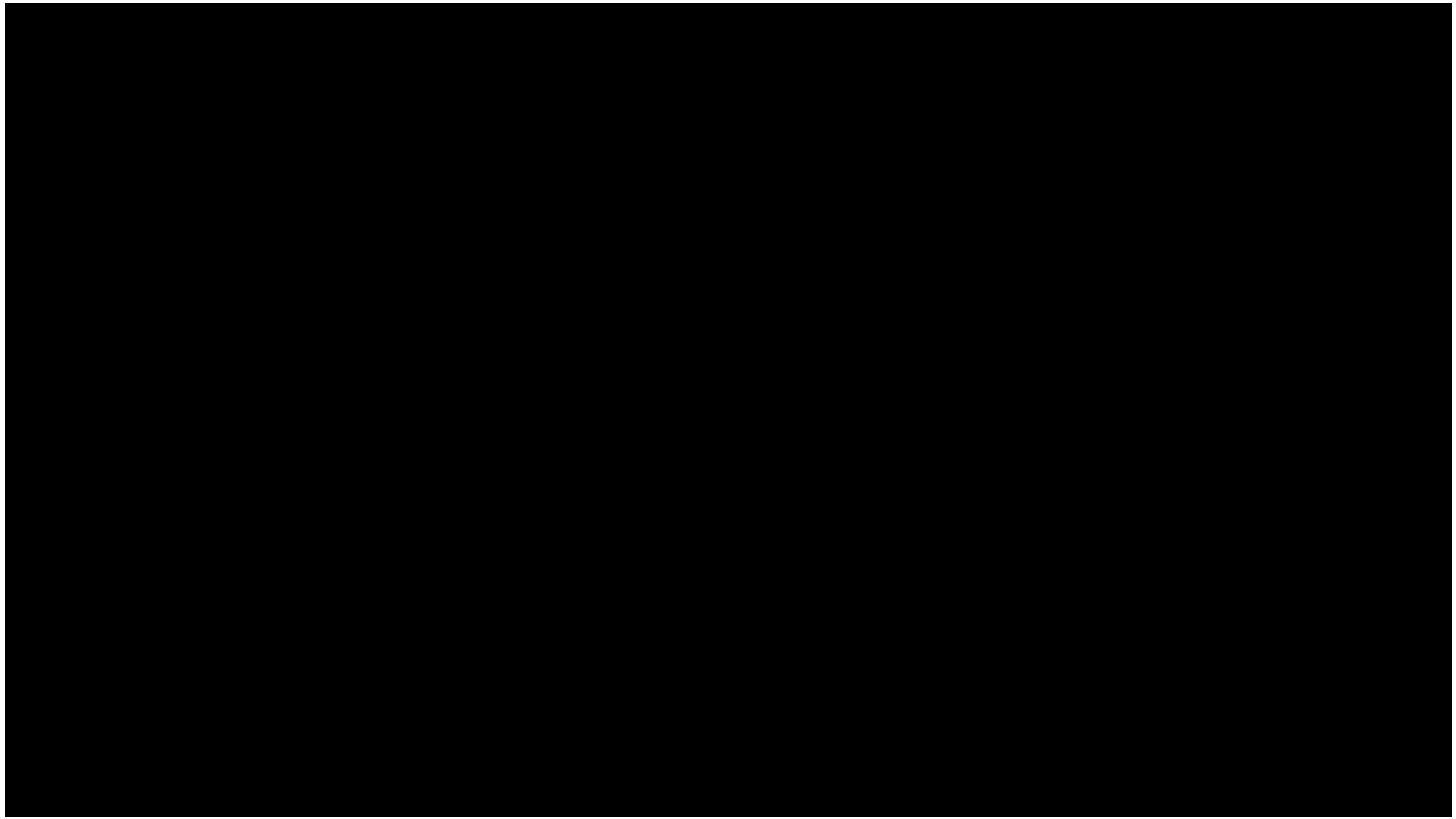
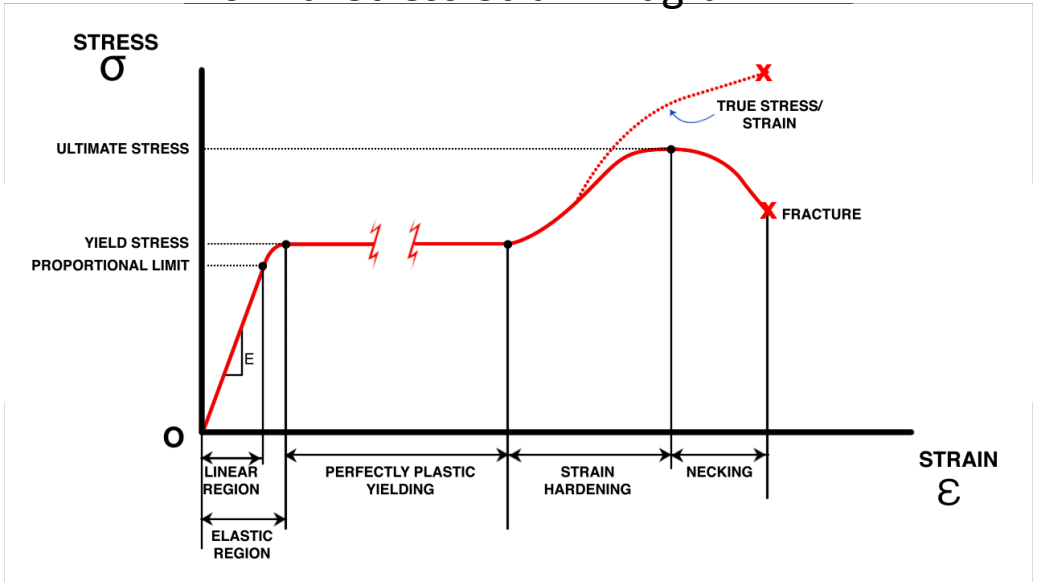
Module 10 Learning Outcomes

- Define/Discuss Material Properties associated with Stress-Strain Diagrams
- Define Hooke's Law

Normal Stress-Strain Diagram



Normal Stress-Strain Diagram



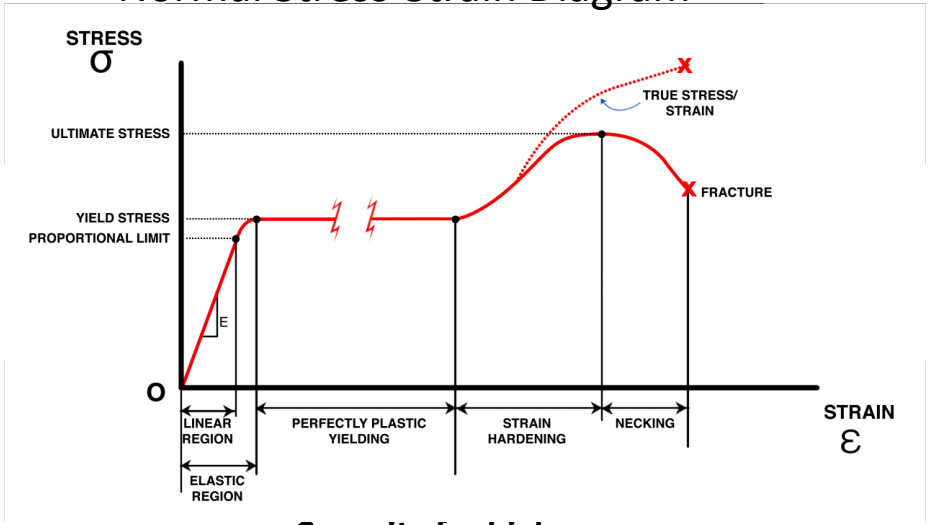
Material Properties

Stiffness: E = Modulus of Elasticity
= Young's Modulus

Hooke's Law (valid for linear elastic region):

$$\sigma = E\,\varepsilon$$

Normal Stress-Strain Diagram



Strength: Capacity for high stress/ultimate stress

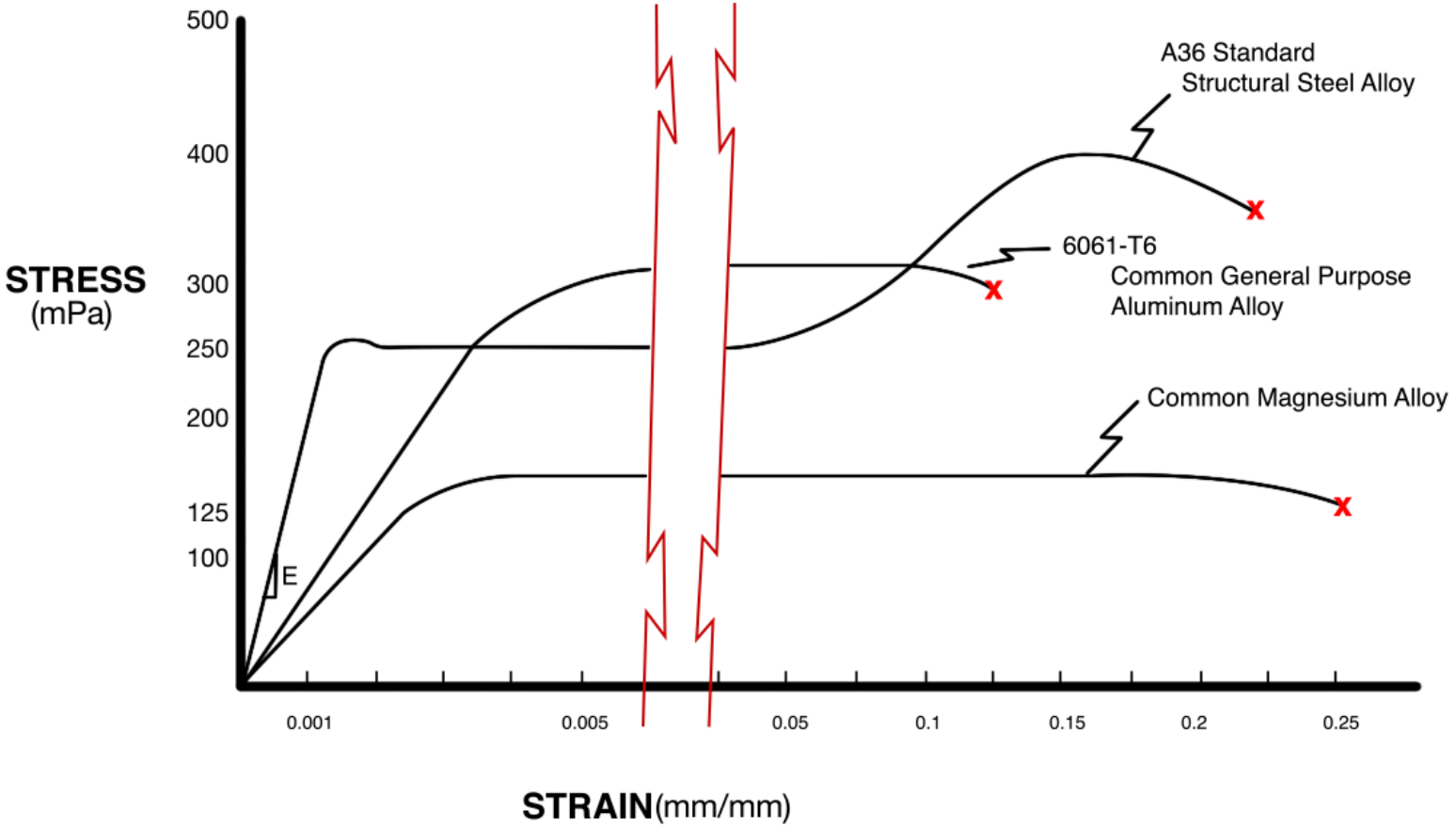
Toughness: Capacity for energy absorption (area under stress-strain curve)

Resilience: Capacity for deforming elastically (area under elastic region)

Ductility: Capacity for high deformation/strain

Brittleness: Low capacity for deformation/strain

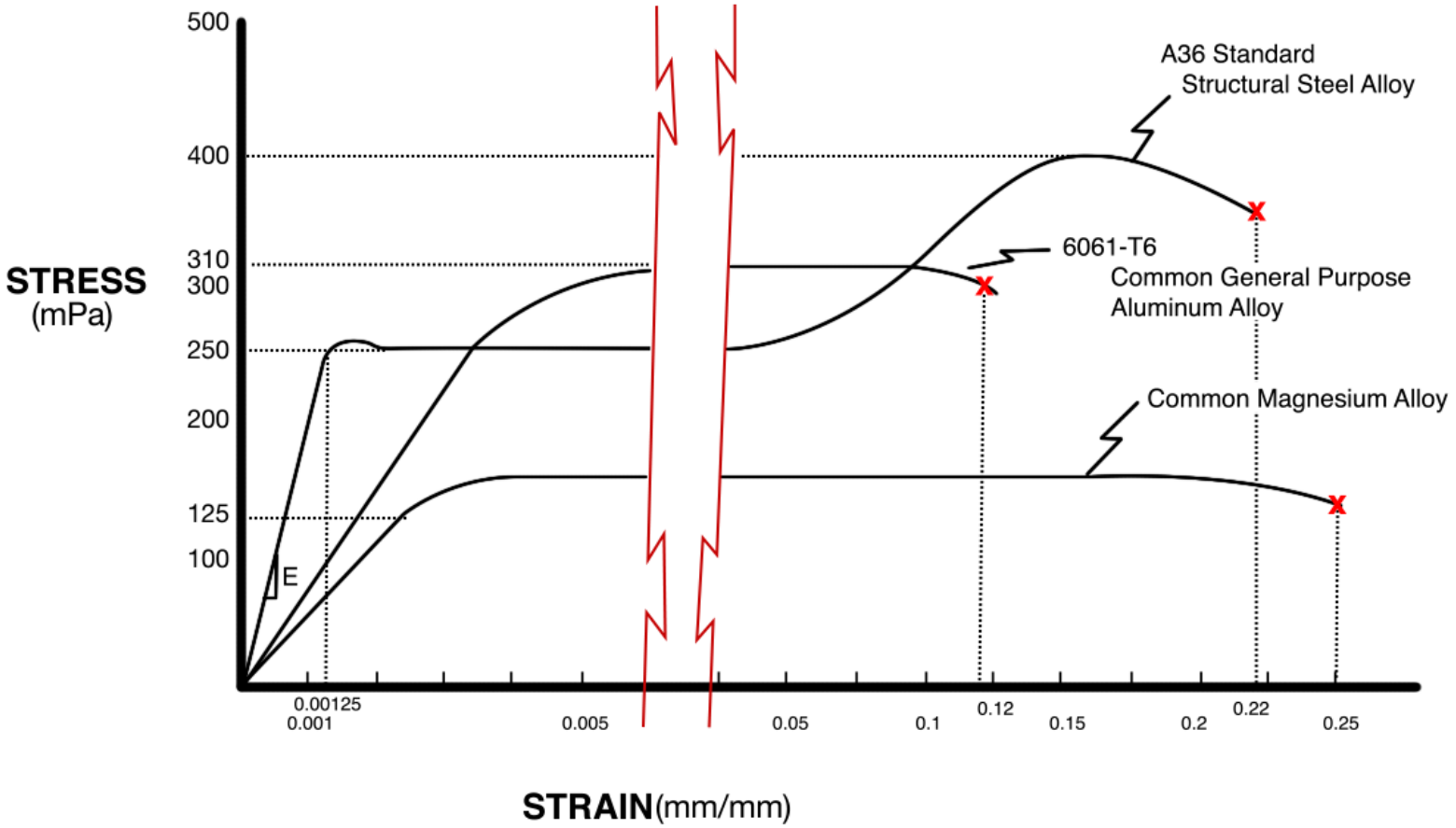
Worksheet


500
400
300
250
200
125
100
STRESS
(mPa)
E
A36 Standard
Structural Steel Alloy
6061-T6
Common General Purpose
Aluminum Alloy
Common Magnesium Alloy
0.001
0.005
0.05
0.1
0.15
0.2
0.25
STRAIN(mm/mm)

Worksheet (cont.)

1) What is the approximate Modulus of Elasticity for A36 Steel?
2) What is the approximate Ultimate Strength of A36 Steel?
3) What is the approximate Ultimate Strength of 6061-T6 Aluminum?
4) What is the approximate Proportional Limit of the common Magnesium Alloy?
5) What is the approximate Yield Stress of the A36 Steel?
6) Which of these material is the strongest? Why?
   Aluminum or Magnesium
7) Which is the most ductile material? Why?
   Steel or Aluminum or Magnesium
8) Which is the most brittle material? Why?
   Steel or Aluminum or Magnesium
9) Which material is the stiffest? Why?
   Steel or Aluminum or Magnesium

Worksheet solution



Worksheet solution:

1) What is the approximate Modulus of Elasticity for A36 Steel? $E = \frac{\sigma}{\epsilon} = \frac{250}{0.00125} = 200{,}000\ MPa = 200\ GPa$ ANS

2) What is the approximate Ultimate Strength of A36 Steel? 400 MPa ANS.

3) What is the approximate Ultimate Strength of 6061-T6 Aluminum? 310 MPa ANS.

4) What is the approximate Proportional Limit of the common Magnesium Alloy? 125 MPa ANS

5) What is the approximate Yield Stress of the A36 Steel? 250 MPa ANS

6) Which of these material is the strongest? Why?
   (Aluminum) or Magnesium HIGHEST ULTIMATE STRESS ANS

7) Which is the most ductile material? Why?
   Steel or Aluminum or (Magnesium) HIGHEST ϵ ANS

8) Which is the most brittle material? Why?
   Steel or (Aluminum) or Magnesium LOWEST ϵ ANS.

9) Which material is the stiffest? Why?
   (Steel) or Aluminum or Magnesium HIGHEST E ANS.