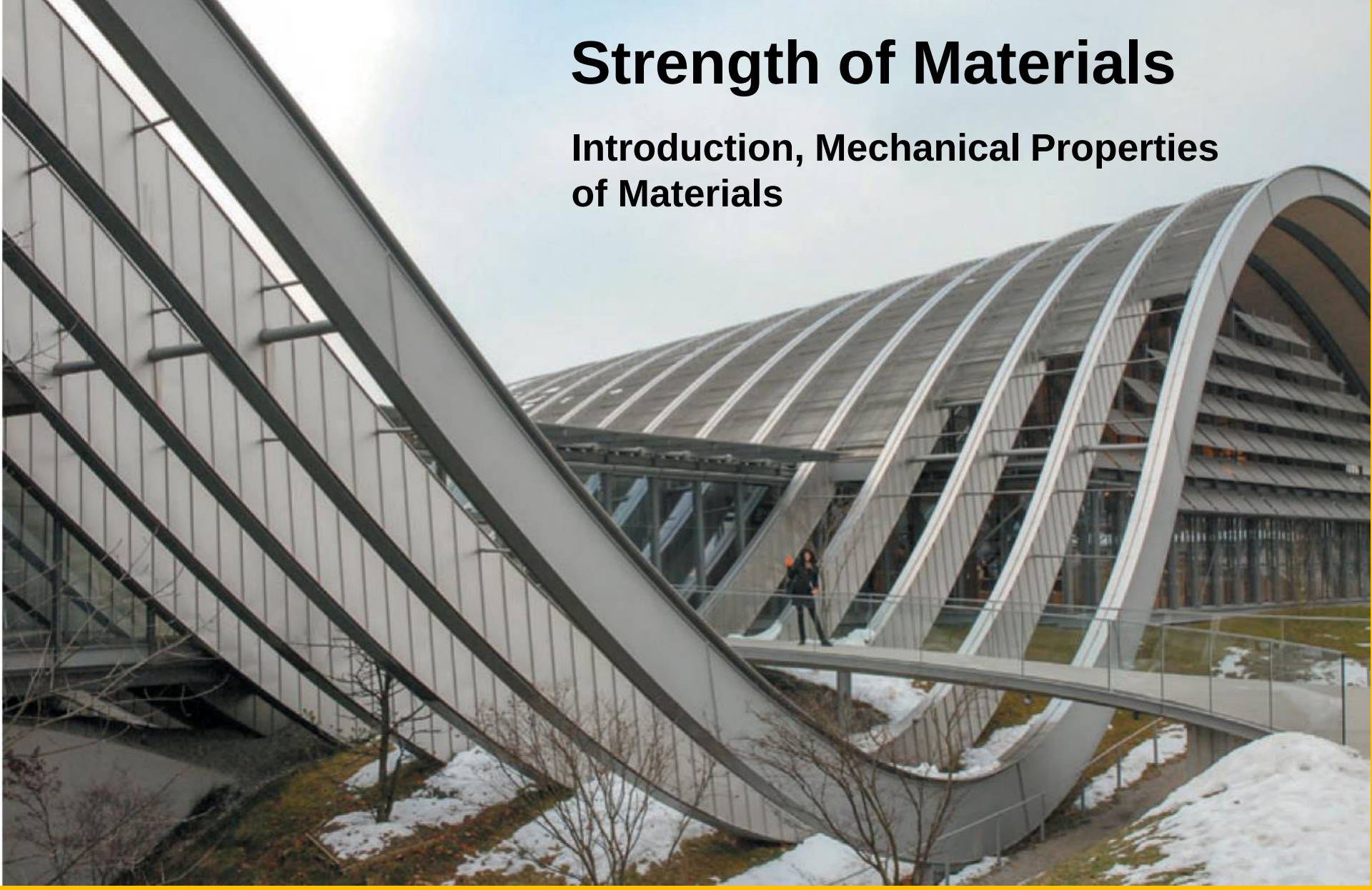
# Strength of Materials

## Introduction, Mechanical Properties of Materials



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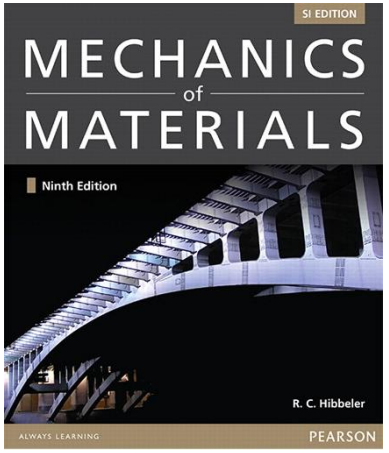
# INTRODUCTION

## Reference Books

**Mechanics of Materials, SI Edition, 9/E**
Russell C. Hibbeler
©2014 • Prentice Hall • Paper, 866 pp



# INTRODUCTION

## Other References:

| | | | | |
|---|---|---|---|---|
| Beer, F.P., Johnston, R., Dewolf J.T., Mazurek D. | Statics and Mechanics of Materials | 2010 | McGraw-Hill |  |
| Karataş, H | Mukavemet | 1986 | Çağlayan |   |
| Aköz, Y., Eratlı, N. | Çözümlü Statik-Mukavemet Problemleri | 2005 | Birsen |  |

# INTRODUCTION

Course plan:

Strength of Materials

1 Midterm + Final Exam

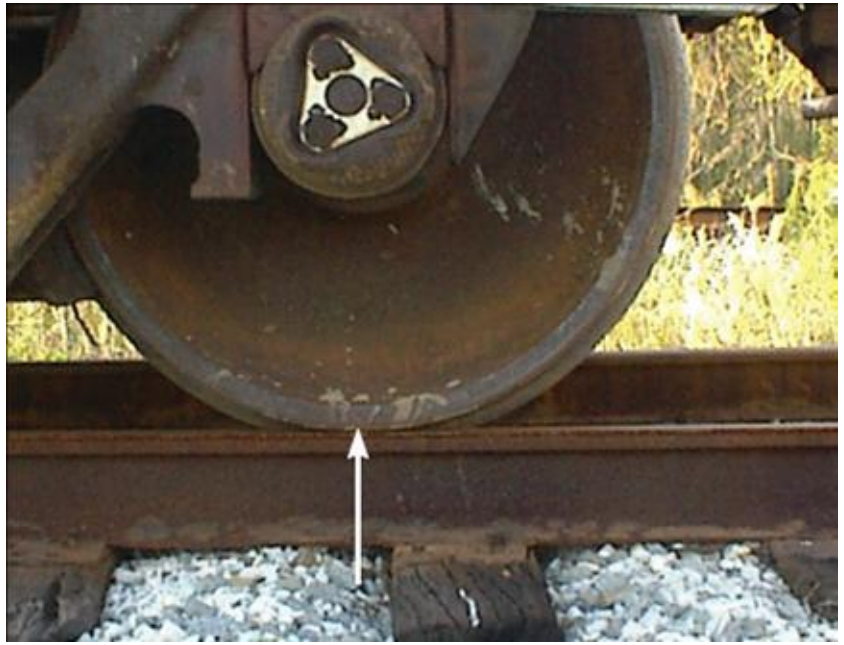
Theory and Application

Course Syllabus
Internal forces.
Stress.
Strain.
Tension and compression.
Shear.
Torsion.
Bending moment.
Combined bending and shear.
Combined bending and axial force.
Buckling.

# WHAT IS MECHANICS?

Study of what happens to a “thing” (the technical name is “BODY”) when FORCES are applied to it.

Either the body or the forces can be large or small.

# Mechanics

- Mechanics can be divided into 3 branches:
  - Rigid-body Mechanics
  - Deformable-body Mechanics
  - Fluid Mechanics

- Rigid-body Mechanics deals with
  - Statics
  - Dynamics

# TENSION AND COMPRESSION TEST

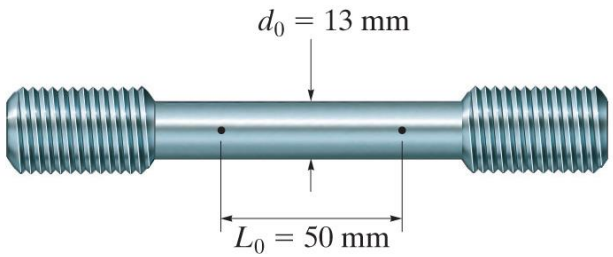
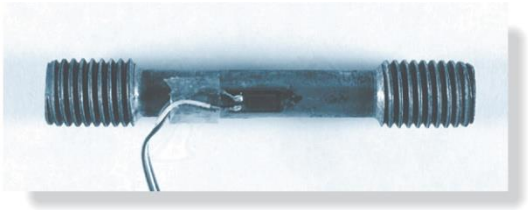



Figure: 03_01a



Typical steel specimen with attached strain gauge.

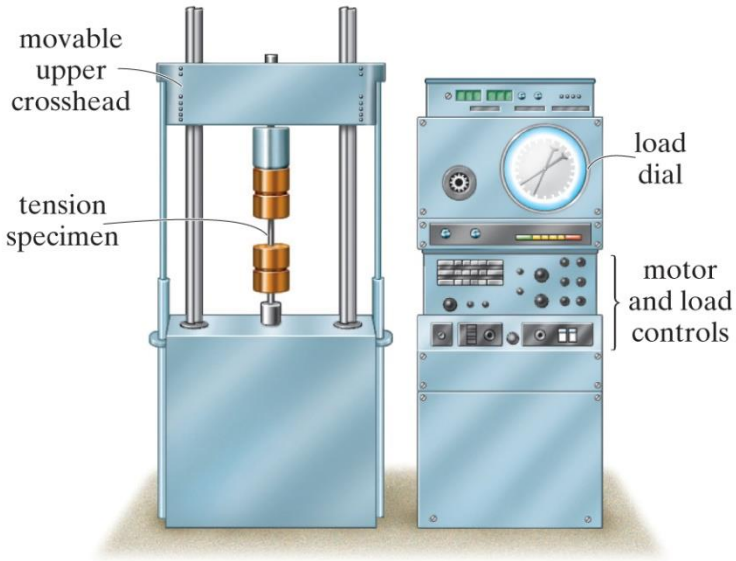
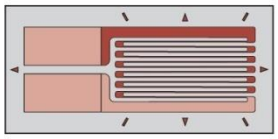



Figure: 03_02



Electrical–resistance
strain gauge

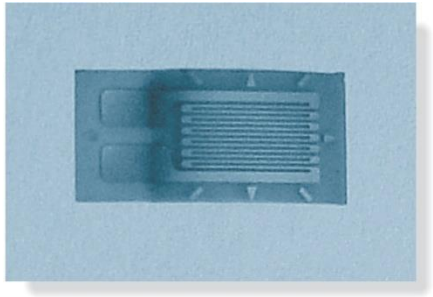
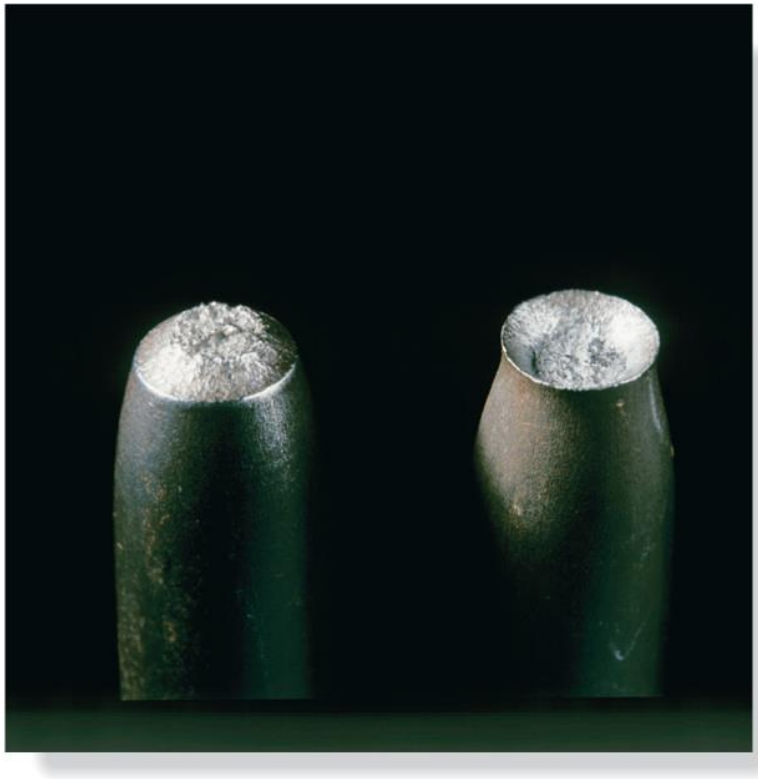


Figure: 03_03a

# APPLICATIONS

Typical necking pattern which has occurred on this steel specimen just before fracture.

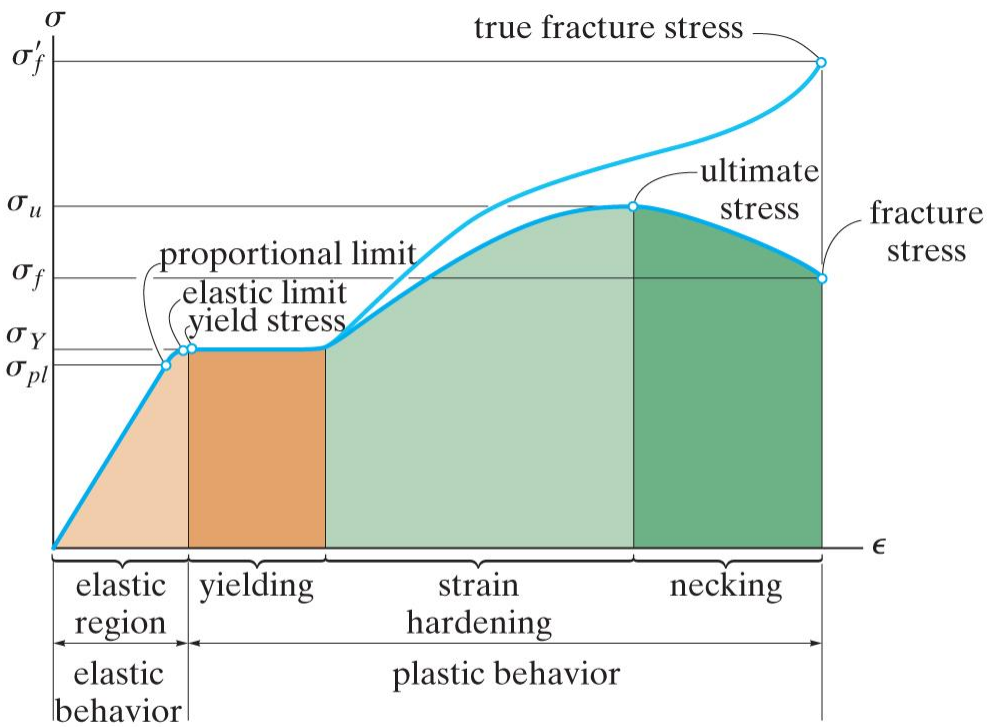
# APPLICATIONS (cont)



This steel specimen clearly shows the necking that occurred just before the specimen failed. This resulted in the formation of a "cup-cone" shape at the fracture location, which is characteristic of ductile materials.

# STRESS STRAIN DIAGRAM

- Note the critical status for strength specification
  - proportional limit
  - elastic limit
  - yield stress
  - ultimate stress
  - fracture stress




Conventional and true stress-strain diagrams for ductile material (steel) (not to scale)

Figure: 03_04

# STRENGTH PARAMETERS

- Modulus of elasticity (Hooke's Law)

$$\sigma = E\varepsilon$$ (initial slope)

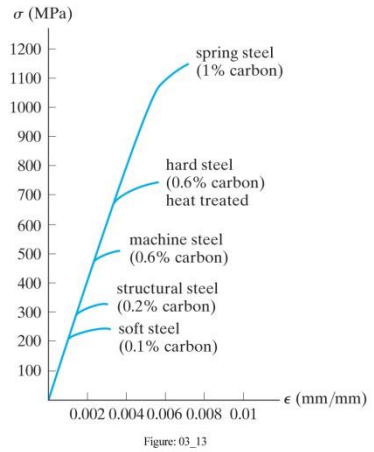
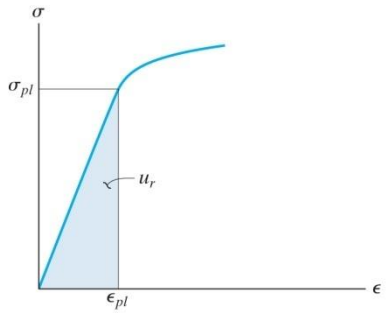


Figure: 03_13

- Modulus of Resistance

$$u_r = \frac{1}{2}\sigma_{pl}\varepsilon_{pl} = \frac{1}{2}\frac{\sigma_{pl}^2}{E}$$

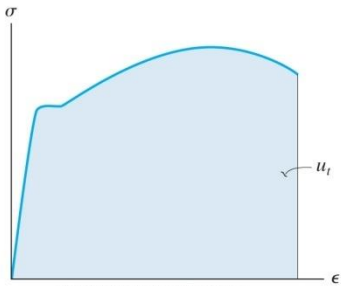


Modulus of resilience $u_r$

(a)

Figure: 03_16a

- Modulus of Toughness
  - It measures the enter area under the stress-strain diagram

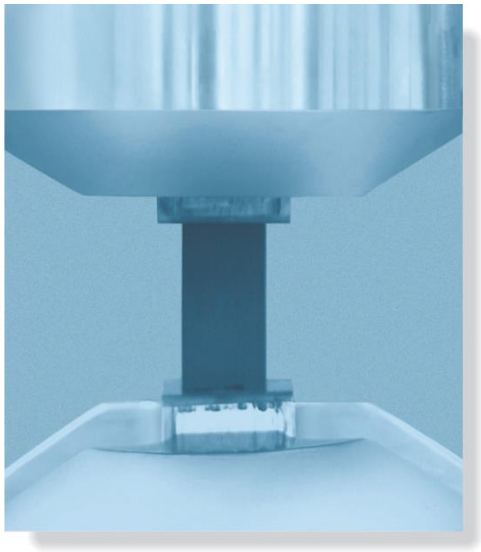


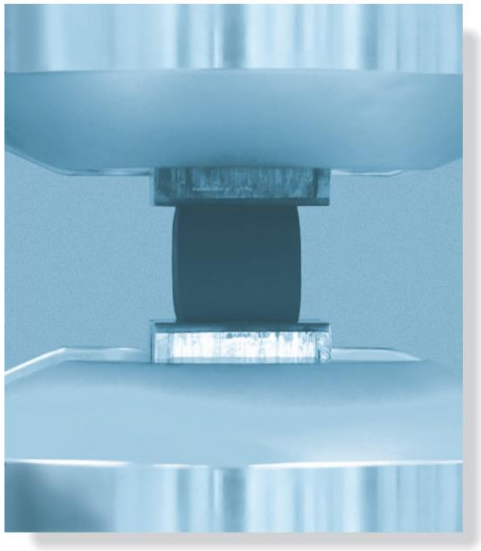
Modulus of toughness $u_t$

(b)

Figure:03_16b

# POISSON's RATIO





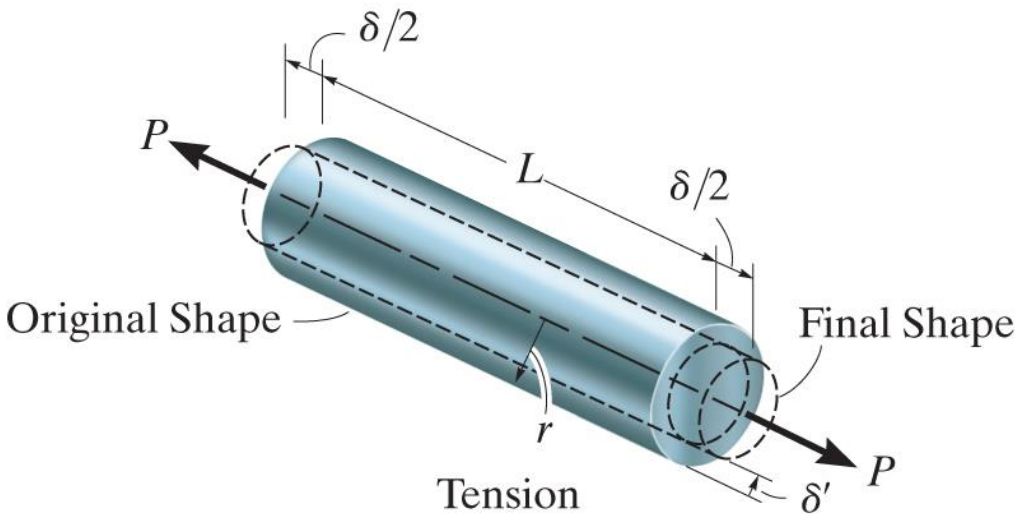



Figure: 03_21

$$\nu = -\frac{\varepsilon_{lat}}{\varepsilon_{long}}$$

# SHEAR STRESS-STRAIN DIAGRAM

- Strength parameter G – Shear modulus of elasticity or the modules of rigidity
- G is related to the modulus of elasticity E and Poisson's ratio *v*.

$$\tau = G\gamma$$

$$G = \frac{E}{2(1+v)}$$

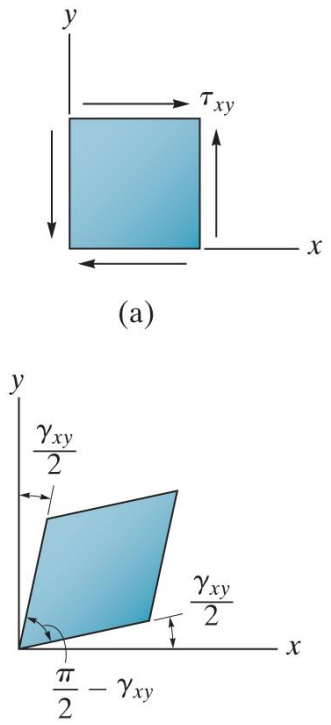



Figure: 03_23

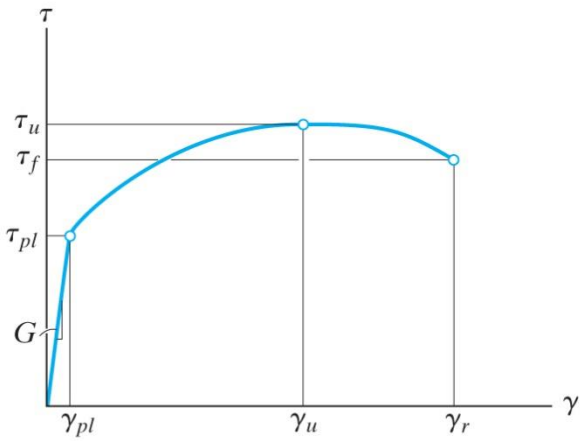



Figure: 03_24