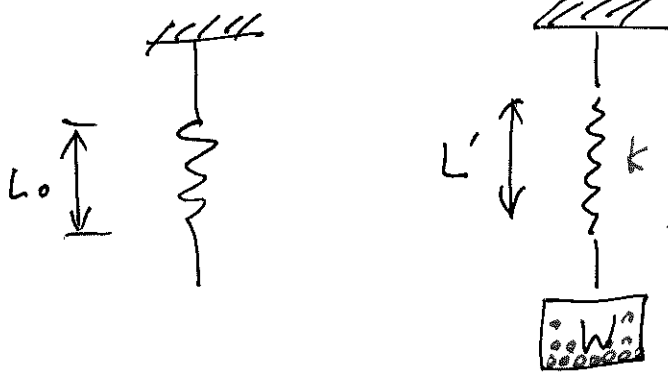


Chapter 3 Mechanical properties of Materials

- Constitutive law (solid mechanics)
 \Rightarrow relationship b/w stress & strain

• physics

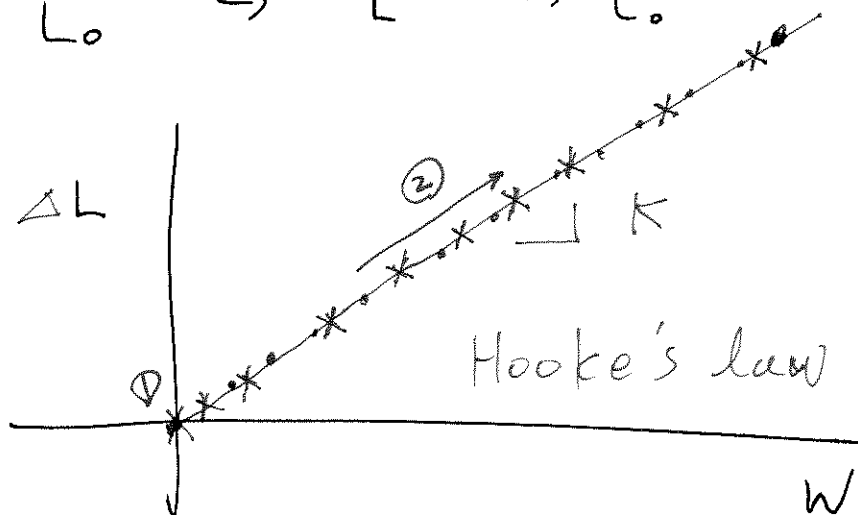
Force vs. Deformation



Hooke's law
 $W = k(L' - L_0)$
 k : spring constant

- ① initial L_0 ② load L' ③ unload L_0

Linear Elastic (assumption)



$$(\Delta L = L' - L_0)$$

- : loading
- x : unloading

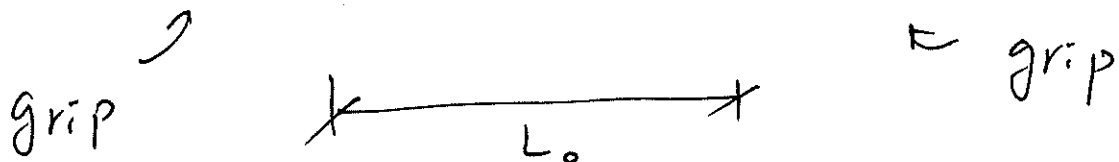
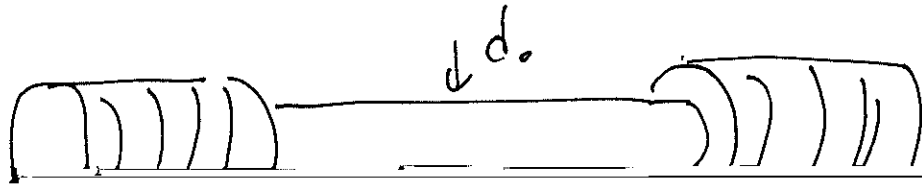
Hooke's law

3.1 Tension & Compression Test

(Uniaxial)

Refer to ASTM E8 ✓

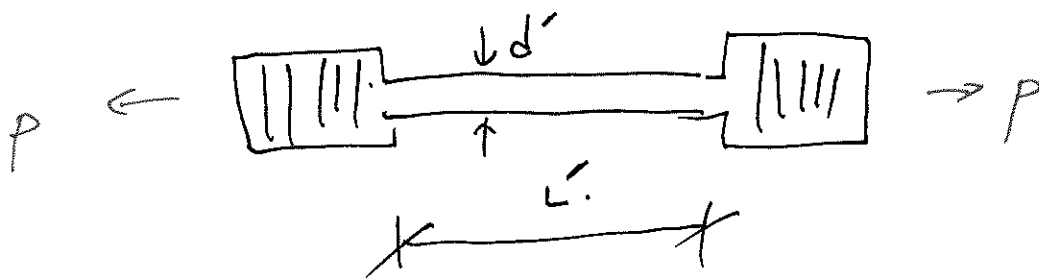
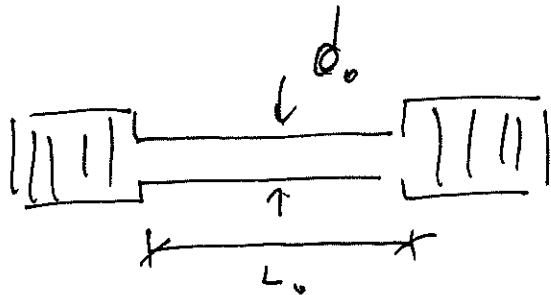
Uniaxial Tension Test (e.g. steel)



Typical size

$d_0 \sim \frac{1}{2}$ in

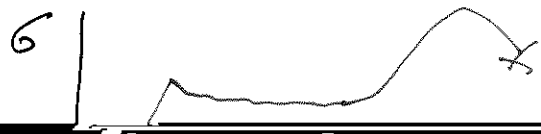
$L_0 \sim 2$ in



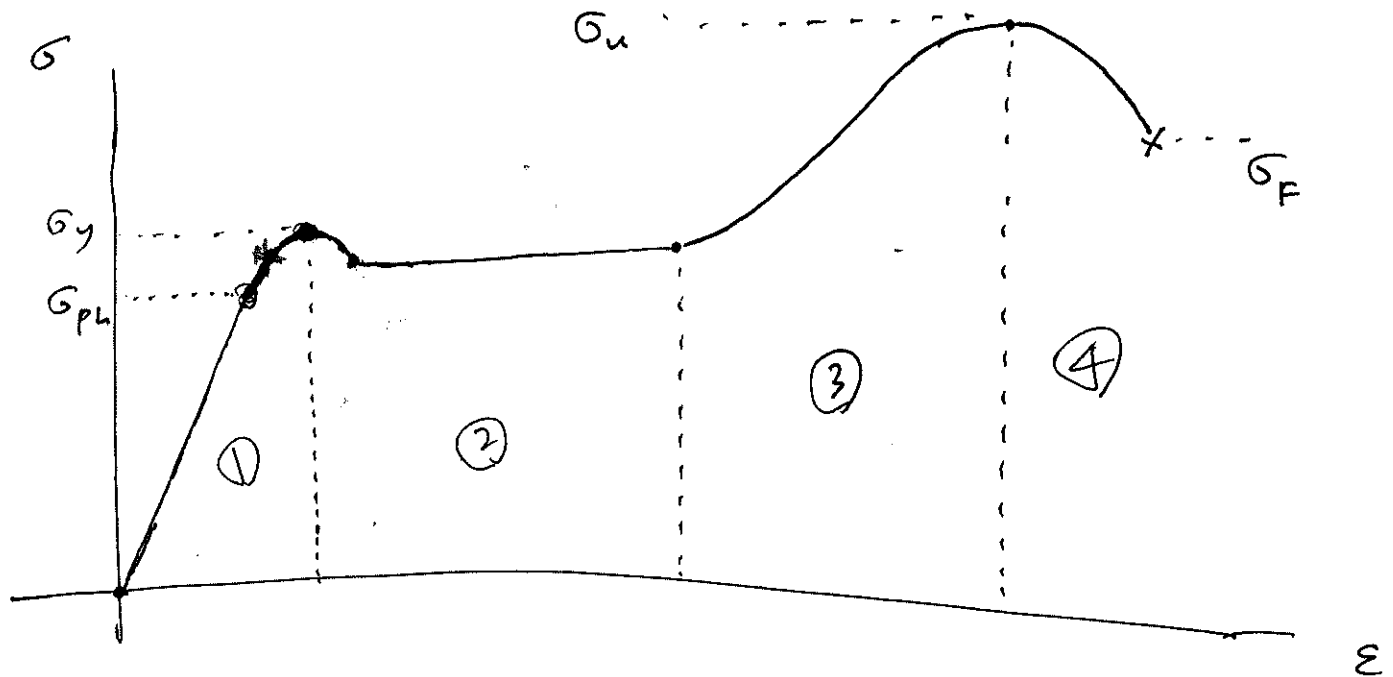
3.2

Stress-Strain Diagram

Uniaxial
(Tension Test)



σ - ϵ diagram for a uniaxial tension test (steel)



① Elastic Behavior

σ_{pl} : proportional limit. \uparrow material is linear elastic.

σ_y : yield point

up to σ_y : material is elastic

b/w σ_{pl} and σ_y : material is non-linear elastic

② yielding (plastic deformation)

ϵ_e
 ~~ϵ_e~~ ϵ_p

T : total

02/21/2022

③ Strain hardening

• After yield (②), material can support additional load (stress increases)

↑ Increases to σ_u , ultimate stress
stress

• σ_u : max. stress that the material can
sustain.

④ Necking (Strain softening)

• ~~Beyond~~ ^{Before} σ_u , specimen is deforming uniformly

• Beyond (or Past) σ_u , cross-section ~~is~~ decreases in a specific region (\Rightarrow necking)

Constitutive Law

~~σ~~ vs. ~~ϵ~~ relationship
Stress Strain

ex) Hooke's law ($F = k \Delta l$)