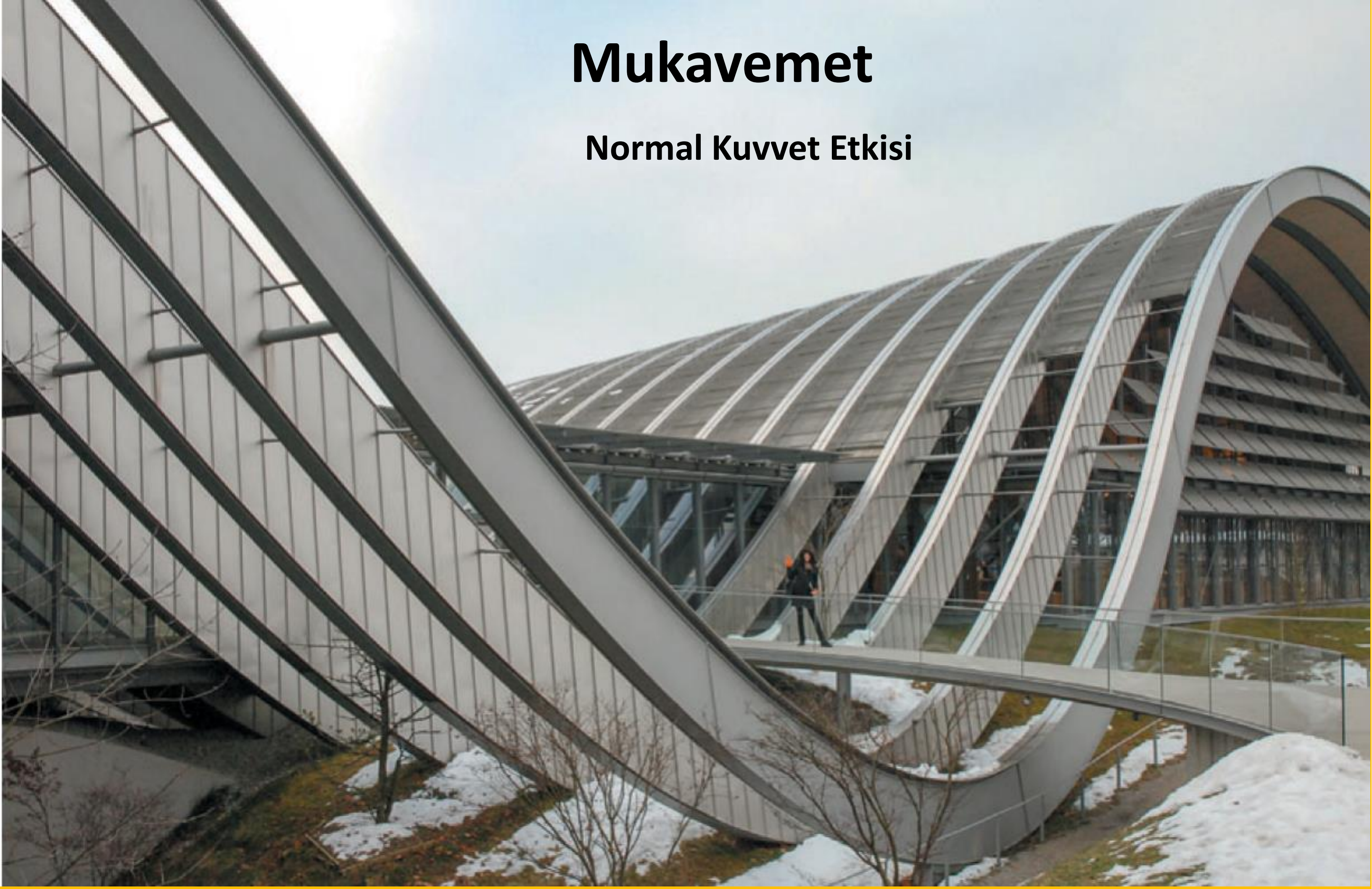
Mukavemet

Normal Kuvvet Etkisi

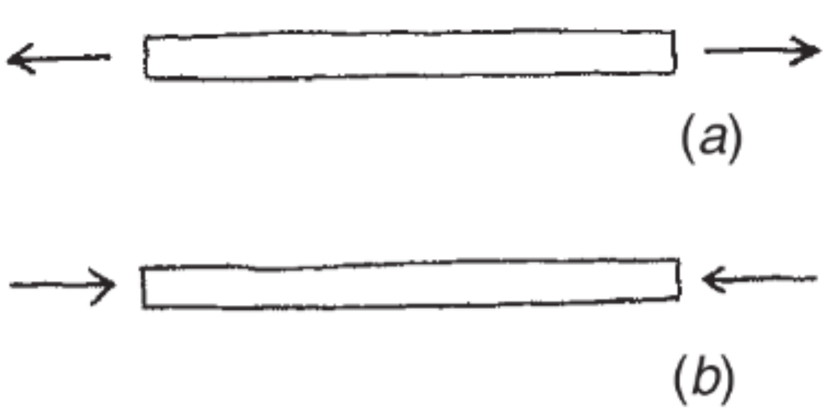


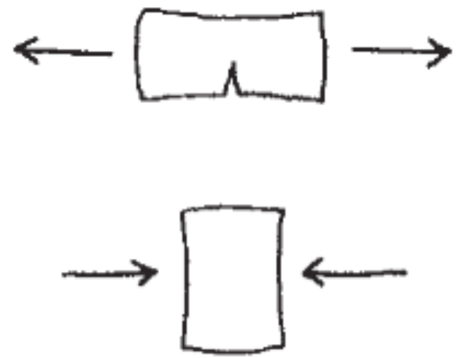
Dr. Haluk Sesigür
I.T.U. Faculty of Architecture
Structural and Earthquake Engineering WG

Normal Kuvvet

Çekme Kuvveti

Çekme Kuvveti Etkisi

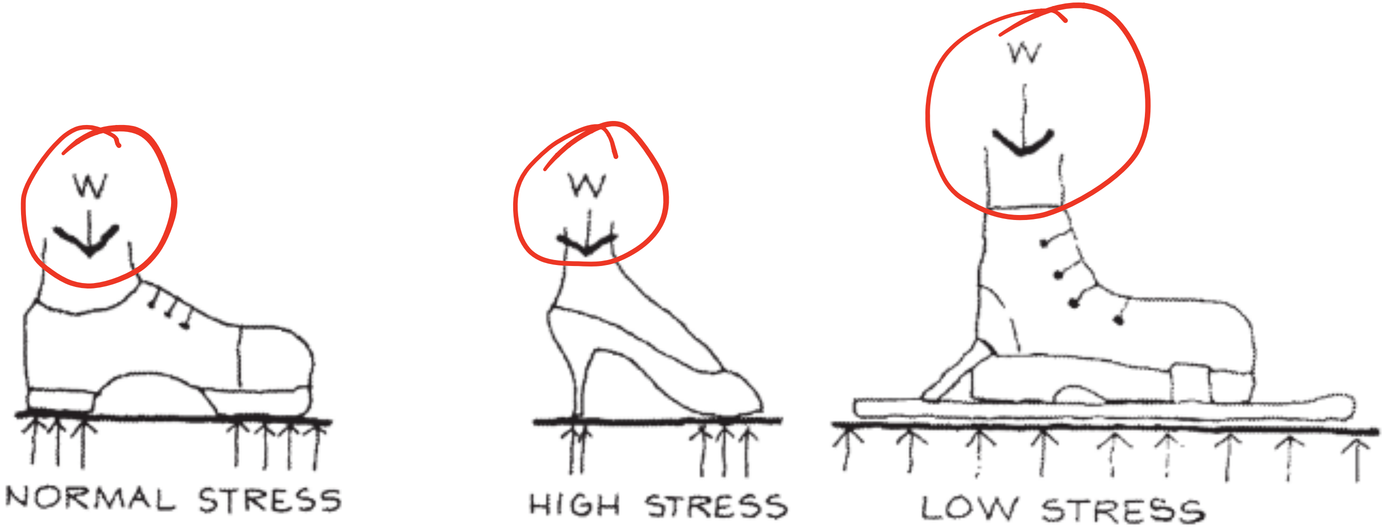




Basınç Kuvveti

Basınç Kuvveti Etkisi

NORMAL GERİLME DEĞİŞİMİ



normal büyüklük gerilme

çok büyük gerilme

düşük gerilme

sigma (normal gerilme)

$$\sigma = \frac{P}{A} = \frac{\text{kuvvet}}{\text{kuvvete dik alan}}$$

Gerilme: birim alana etkiyen kuvvet

$$\epsilon = \frac{\delta}{L}$$

δ → uzama miktarı (m)

L → ilk boy (m)

şekil-değiştirme (epsilon)

ε (boyutsuz bir değer)

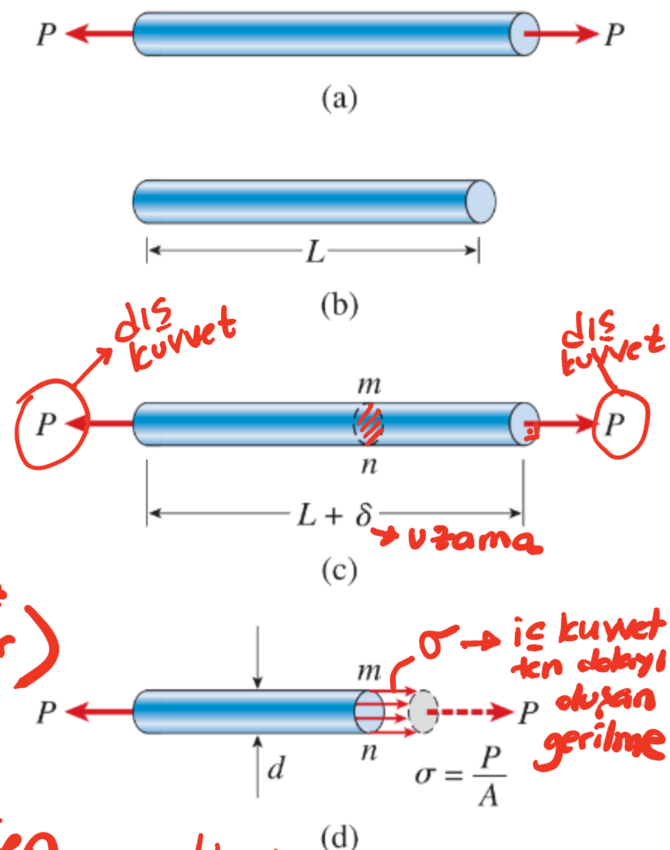


FIG. 1-2 Prismatic bar in tension: (a) free-body diagram of a segment of the bar, (b) segment of the bar before loading, (c) segment of the bar after loading, and (d) normal stresses in the bar

δ = yüklemeden sonraki boy − ilk boy

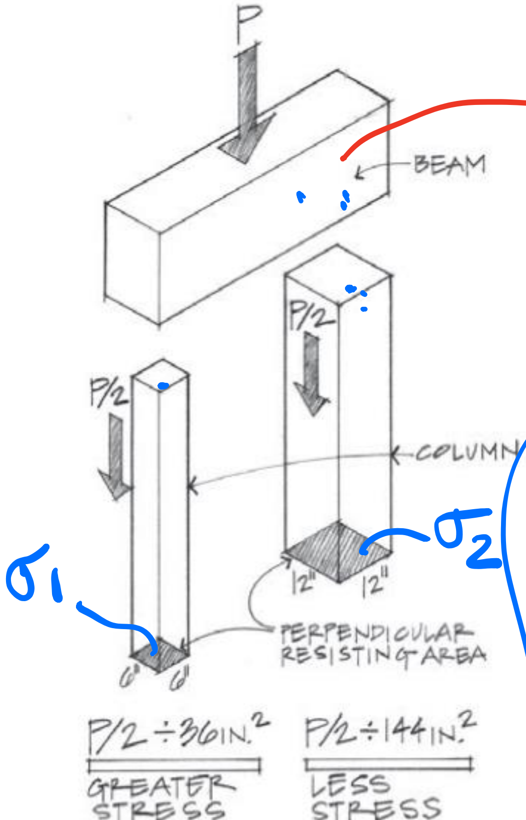
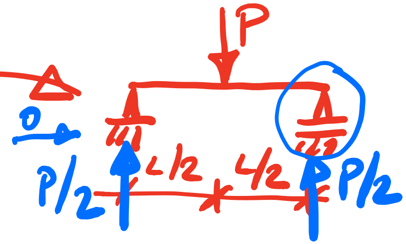
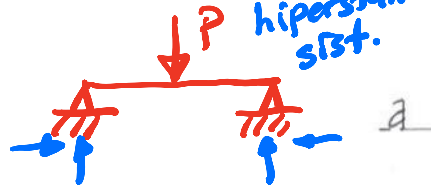


Figure 5.7 Two columns with the same load, different stress.



$$\sigma_1 = \frac{(P/2)}{6 \times 6}$$

$$\sigma_2 = \frac{(P/2)}{12 \times 12}$$



$$\sigma_1 > \sigma_2$$

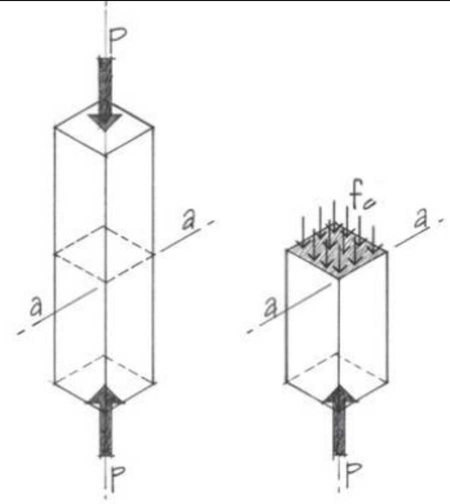


Figure 5.8 Normal compressive stress across section a-a.

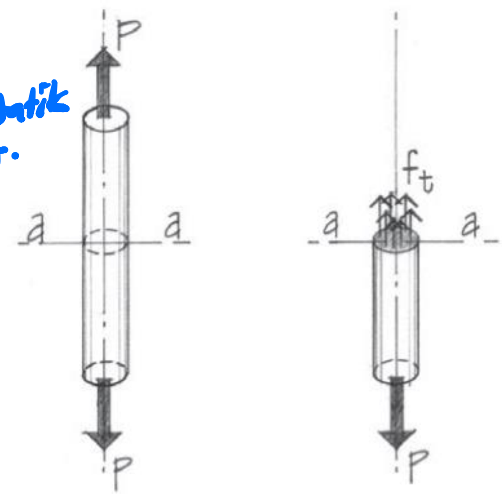
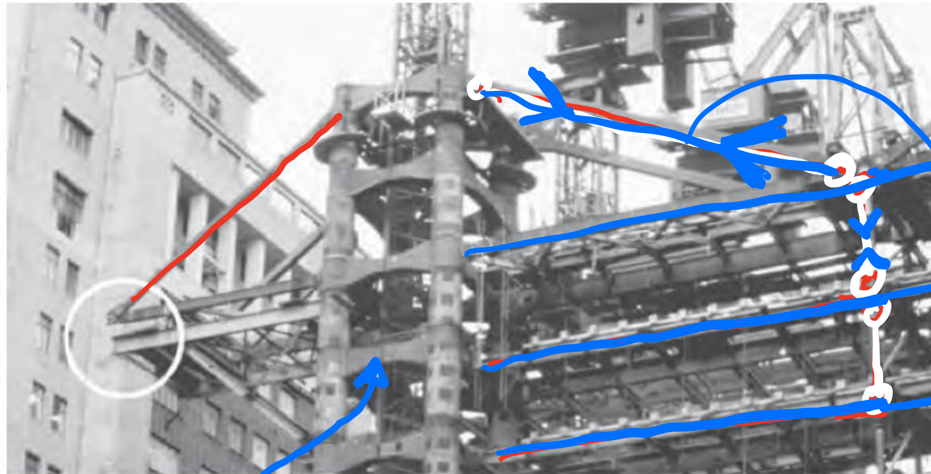
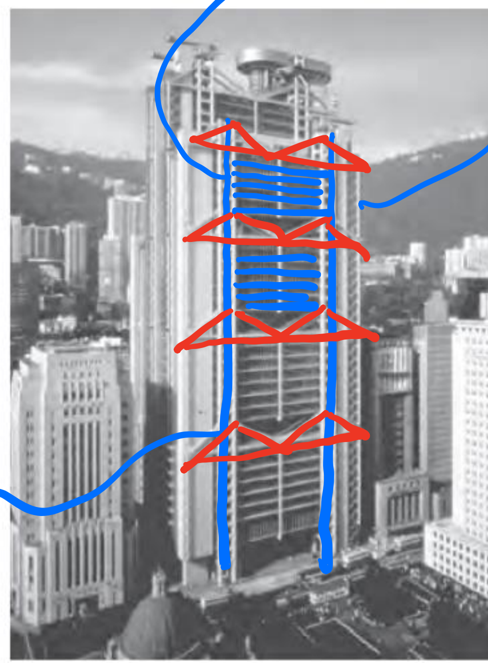


Figure 5.9 Normal tensile stress through section a-a.

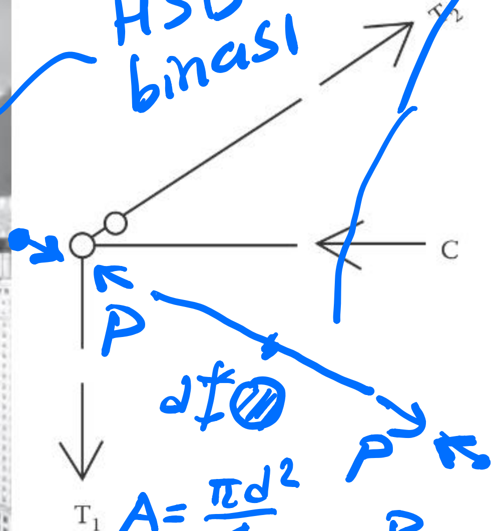
Mukavemet
Normal Kuvvet Etkisi





HSBC binası

mega taşıyıcı



$A = \frac{\pi d^2}{4}$

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


Renault Distribution Centre, Swindon, UK, 1980-1982, Foster+Partners
askı elemanları
(kablo)
kolon
L/2
L
M
N
Asma Sistemler

Renault Distribution Centre, Swindon, UK, 1980-1982, Foster+Partners

NORMAL GERİLME – ŞEKİL DEĞİŞTİRME İLİŞKİSİ

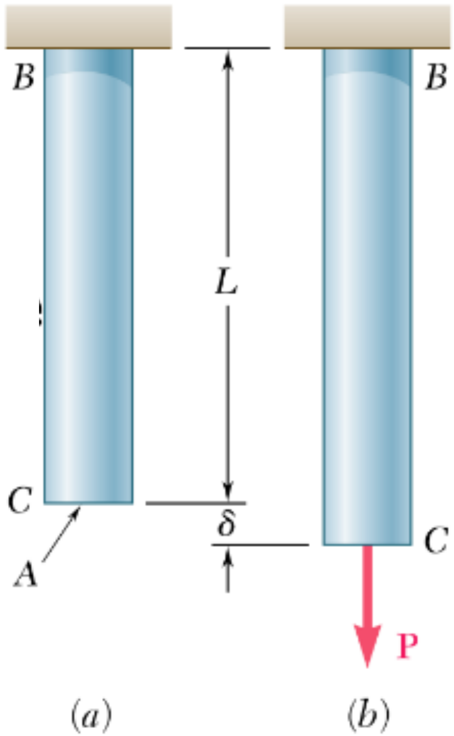


Fig. 2.1 Deformation of axially-loaded rod.

$$\epsilon = \frac{\delta}{L}$$

L: ilk boy
δ: uzama
ε: şekil-değiştirme

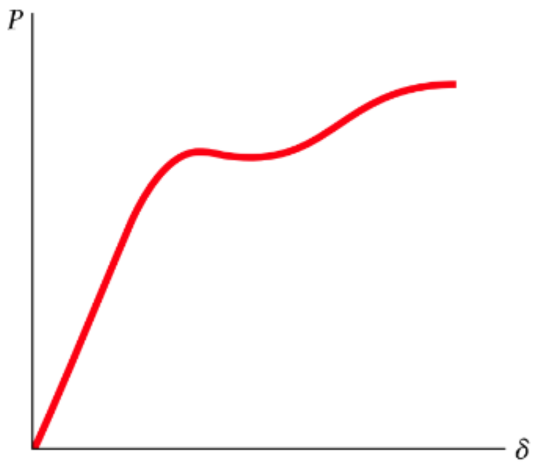
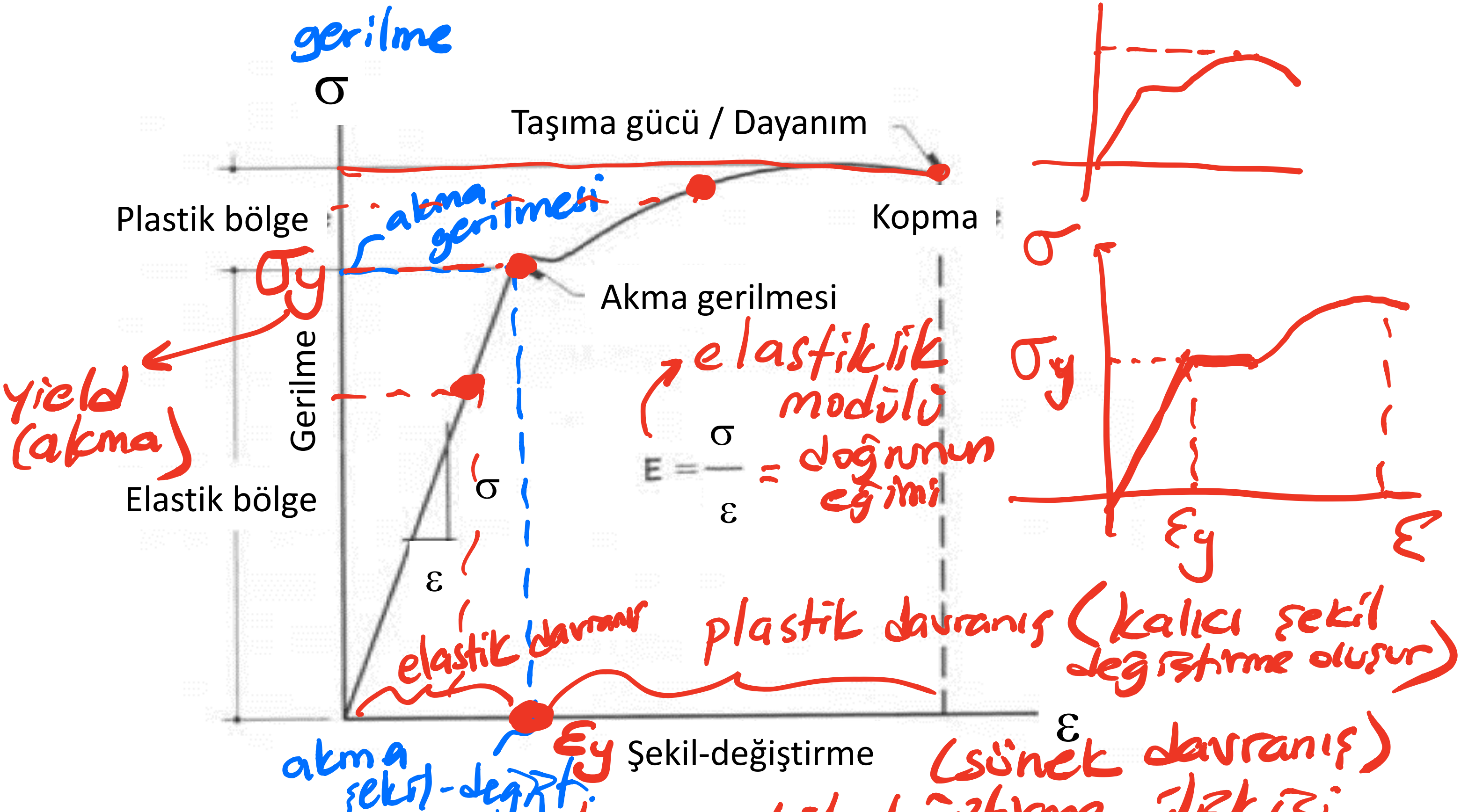


Fig. 2.2 Load-deformation diagram.

GERİLME - ŞEKİL DEĞİŞTİRME İLİŞKİSİ



çeliğin gerilme şekil-değiştirme ilişkisi

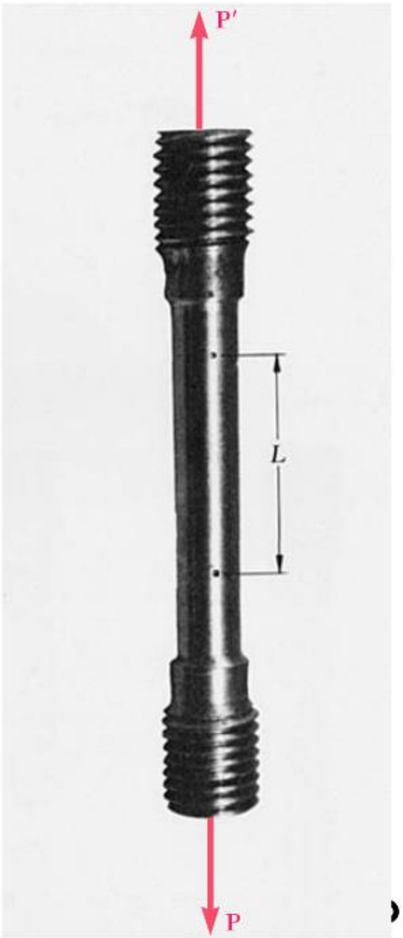


Photo 2.3 Test specimen with tensile load.

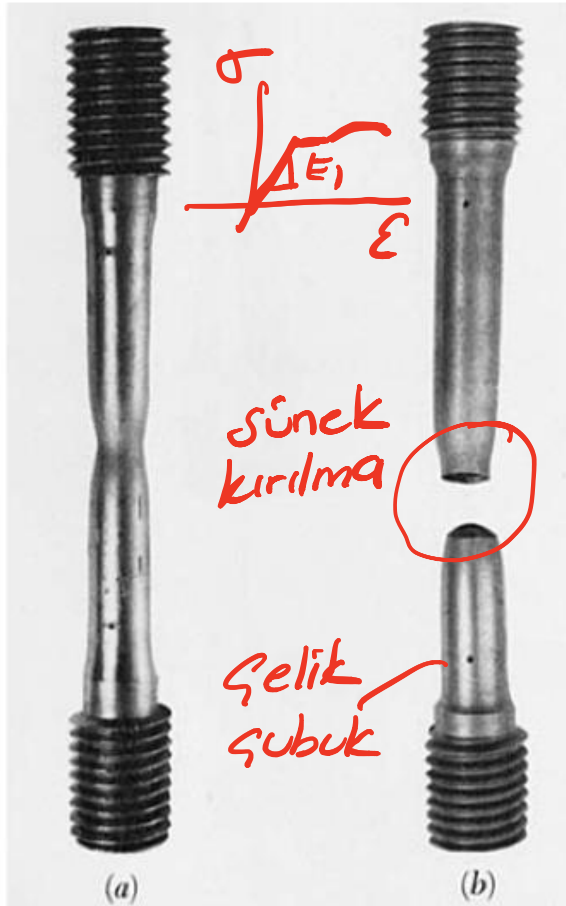


Photo 2.4 Tested specimen of a ductile material.

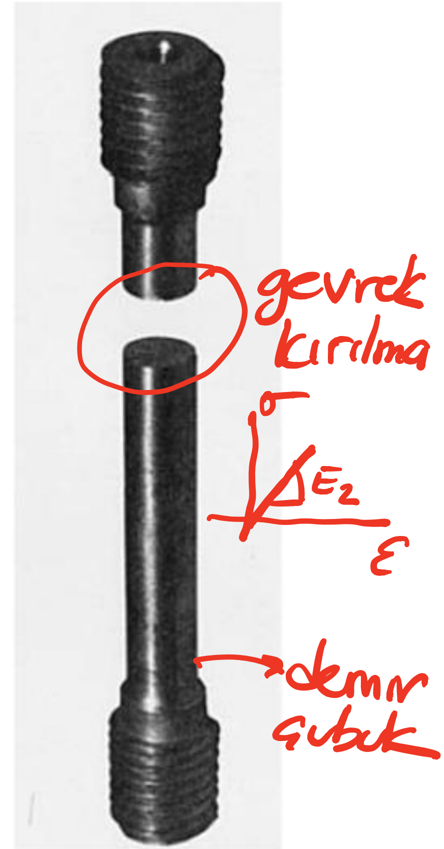
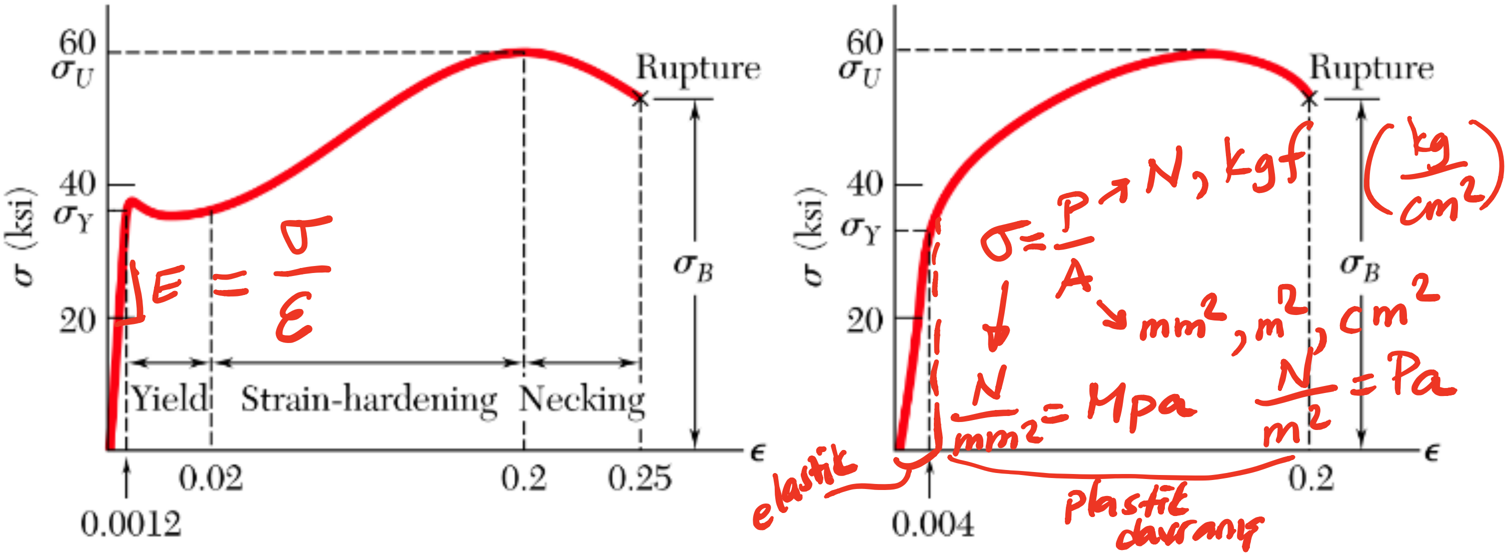


Photo 2.5 Tested specimen of a brittle material.

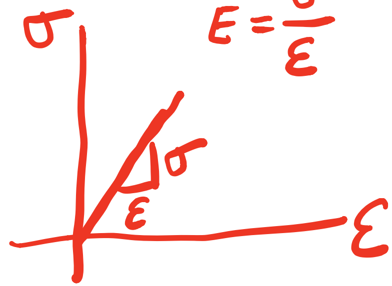


(*a*) Low-carbon steel (*b*) Aluminum alloy

Fig. 2.6 Stress-strain diagrams of two typical ductile materials.

çelik → $E = \boxed{210000}$ Mpa
beton → $E \cong 21000$ Mpa
yığma → $E \cong 2100$ Mpa
ahşap → $E \cong 10500$ Mpa

$E = \frac{\sigma}{\varepsilon}$



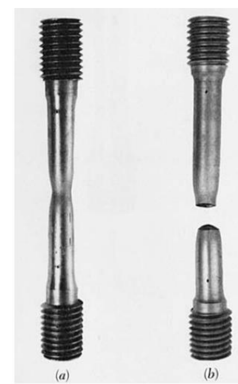


Photo 2.4 Tested specimen of a ductile material.

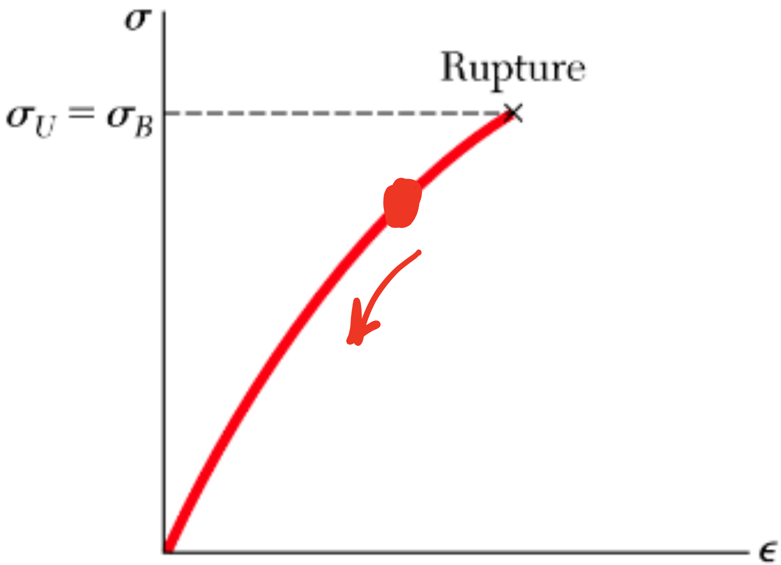


Fig. 2.7 Stress-strain diagram for a typical brittle material.

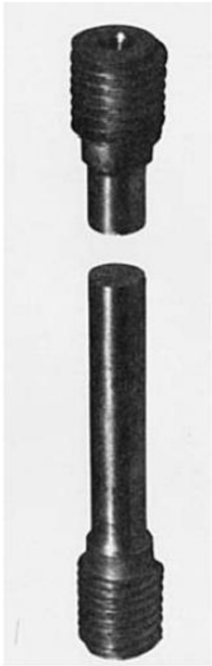
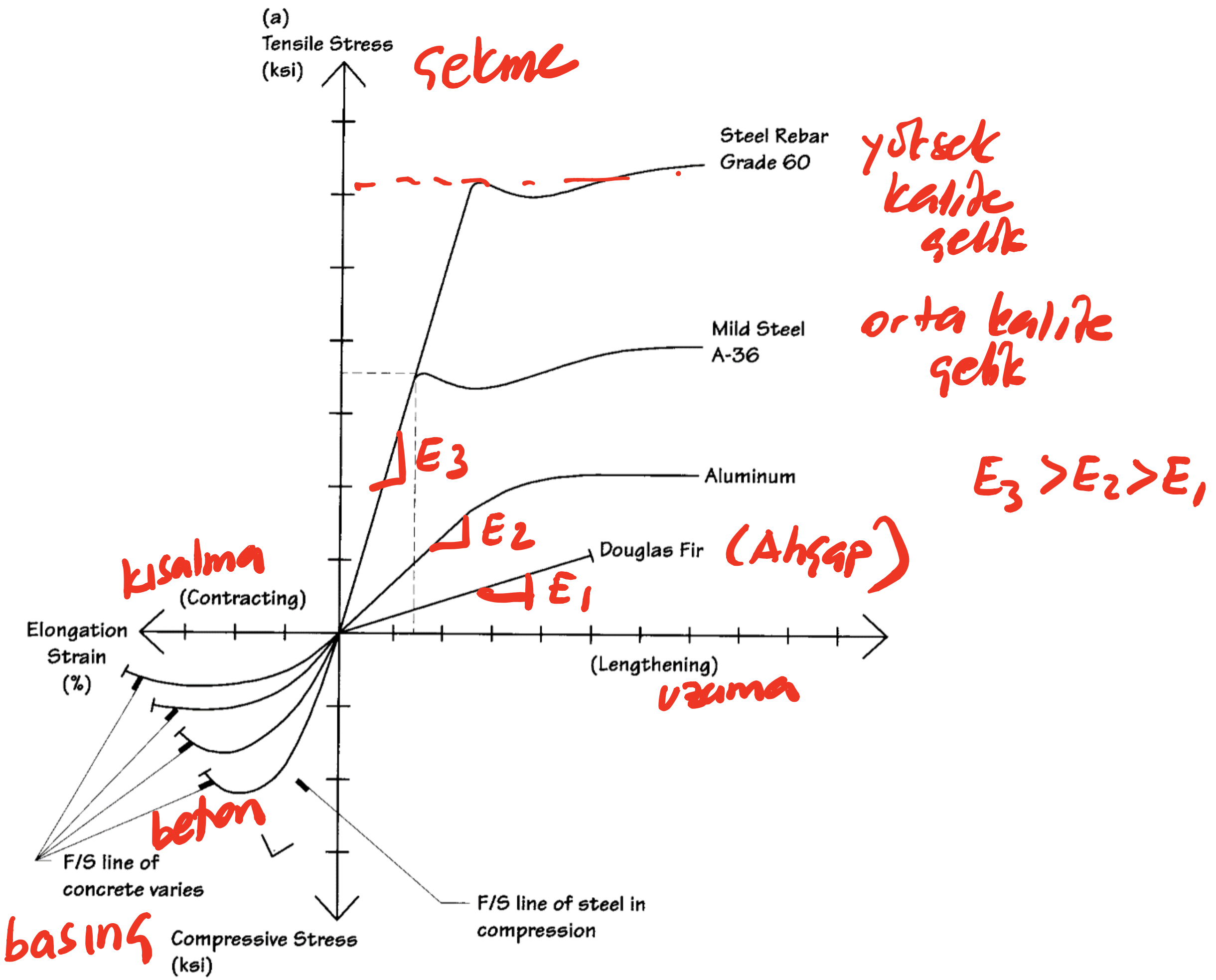


Photo 2.5 Tested specimen of a brittle material.

îdeal-elastik

elastik



13.29 Stress/strain curves for several materials. By convention, tensile stress lies in the first quadrant, and compressive stress in the third.

NORMAL KUVVET ETKİSİNDE DEFORMASYON HESABI

Consider a homogeneous rod BC of length L and uniform cross section of area A subjected to a centric axial load **P** (Fig. 2.17). If the resulting axial stress $\sigma = P/A$ does not exceed the proportional limit of the material, we may apply Hooke's law and write

$$\sigma = E\epsilon \qquad (2.4)$$

$E = \dfrac{\sigma}{\varepsilon}$ (1)

(Hooke kanunu)

from which it follows that

$\sigma = \dfrac{P}{A}$ (2)

?

$$\epsilon = \frac{\sigma}{E} = \frac{P}{AE} \qquad (2.5)$$

Recalling that the strain ϵ was defined in Sec. 2.2 as $\epsilon = \delta/L$, we have

$$\delta = \epsilon L \qquad (2.6)$$

(3) $\boxed{\varepsilon = \dfrac{\delta}{L}} = \dfrac{P}{AE}$

$\boxed{\delta = \dfrac{P.L}{A.E}}$

and, substituting for ϵ from (2.5) into (2.6):

$$\boxed{\delta = \frac{PL}{AE}} \qquad (2.7)$$

1.) Gerilme hesabı

$\sigma = \dfrac{P}{A}$

2.) Uzama/kısalma hesabı

$\delta = \dfrac{P.L}{E.A}$

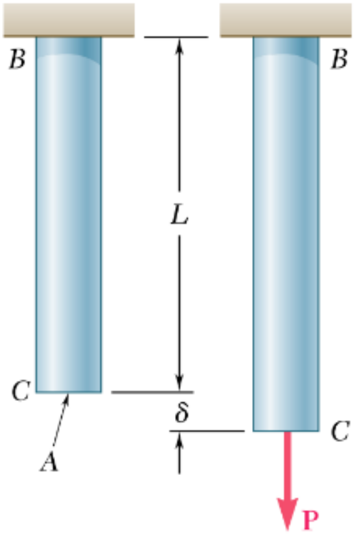


Fig. 2.17 Deformation of axially loaded rod.

HİPERSTATİK SİSTEM

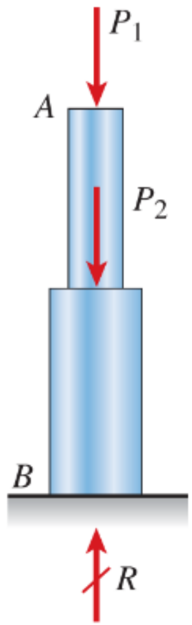


FIG. 2-14 Statically determinate bar

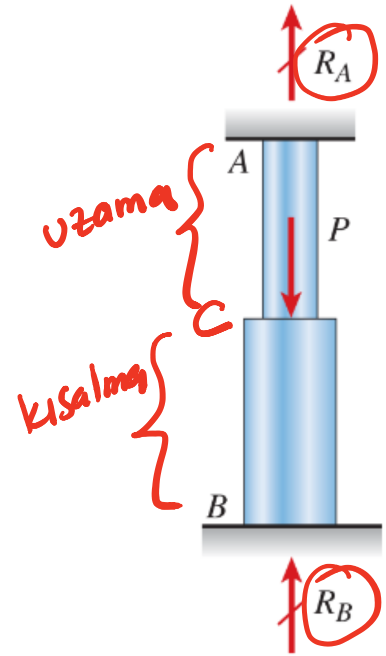


FIG. 2-15 Statically indeterminate bar

Bilinmeyen: 2 adet

Denge denk. sayısı $\Sigma Y=0$ 1 adet

Uygunluk denk.

$$\delta_{AB}=0$$

$$\delta_{AC}+\delta_{BC}=0$$

point C. As already discussed, the reactions R_A and R_B cannot be found by statics alone, because only one **equation of equilibrium** is available:

$$\sum F_{vert}=0 \qquad R_A - P + R_B = 0 \qquad \text{(a)}$$

STATICALLY INDETERMINATE MEMBERS

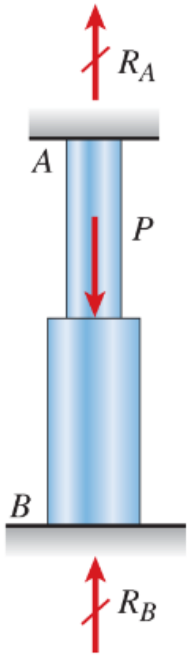


FIG. 2-15 Statically indeterminate bar

As already discussed, the reactions R_A and R_B cannot be found by statics alone, because only one **equation of equilibrium** is available:

$$\sum F_{vert} = 0 \qquad R_A - P + R_B = 0 \tag{a}$$

$$\delta_{AB} = 0 \tag{b}$$

This equation, called an **equation of compatibility**, expresses the fact that the change in length of the bar must be compatible with the conditions at the supports.

Example 18.1: Stress and strain in compression

A square concrete column in an office building is shown in Fig. 18.3. The column has cross-sectional dimensions 400 mm × 400 mm and supports a total vertical load of 2000 kN. Calculate the direct compressive ***stress*** at any point in the column.

If the column reduces in length by 3.5 mm as a result of the loading and the column's original length was 4 metres, calculate the ***strain*** in the column.

Solution

The column is clearly in compression.

The column's cross-sectional area, $A = 400 \times 400 = 160{,}000 \text{ mm}^2$

Axial load $P = 2000 \text{ kN} = 2000 \times 10^3 \text{ N}$

$$\text{Stress } (\sigma) = \frac{\text{Force } (P)}{\text{Area } (A)} = \frac{2000 \times 10^3}{160{,}000} = 12.5 \text{ N/mm}^2$$

$$\text{Strain } (\varepsilon) = \frac{\text{Change in length } (\delta L)}{\text{Original length } (L)} = \frac{3.5 \text{ mm}}{4000 \text{ mm}} = 8.75 \times 10^{-4} = 0.000875$$

(Remember: strain has no units.)

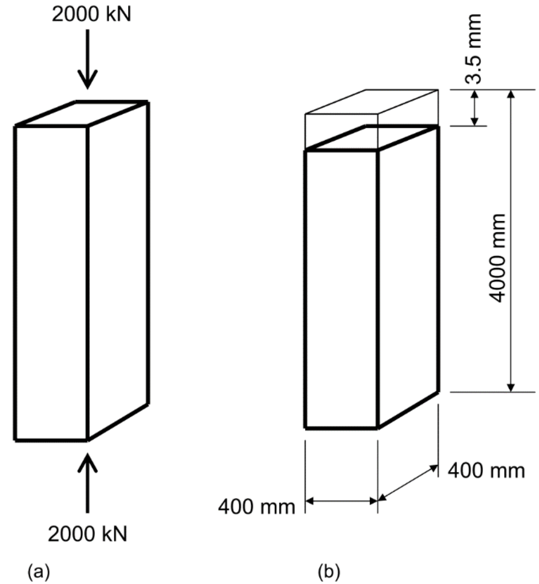
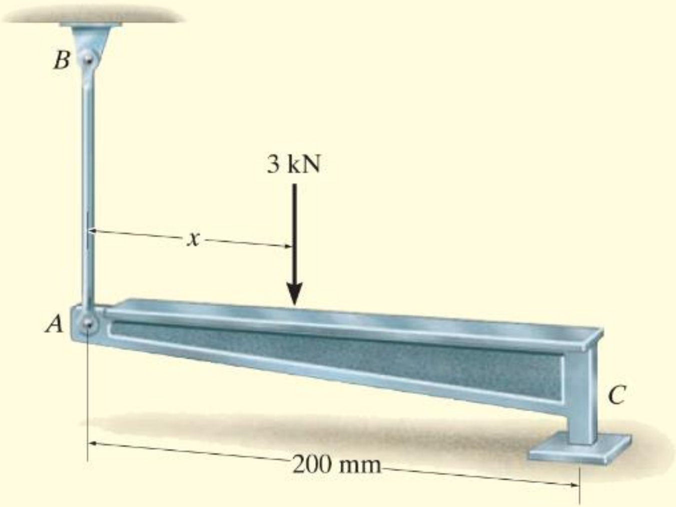


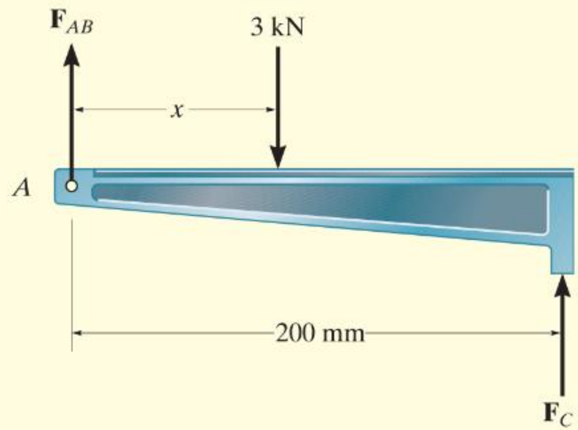
Fig. 18.3 Compressive stress and strain (Example 18.1).

EXAMPLE 1.9

Member *AC* shown in Fig. 1–19*a* is subjected to a vertical force of 3 kN. Determine the position *x* of this force so that the average compressive stress at the smooth support *C* is equal to the average tensile stress in the tie rod *AB*. The rod has a cross-sectional area of 400 mm^2 and the contact area at *C* is 650 mm^2.



(a)



(b)

Fig. 1–19

SOLUTION

Internal Loading. The forces at A and C can be related by considering the free-body diagram for member AC, Fig. 1–19*b*. There are three unknowns, namely, F_{AB}, F_C, and x. To solve this problem we will work in units of newtons and millimeters.

$$+\uparrow \Sigma F_y = 0; \qquad F_{AB} + F_C - 3000\text{ N} = 0 \qquad (1)$$

$$\circlearrowright + \Sigma M_A = 0; \qquad -3000\text{ N}(x) + F_C(200\text{ mm}) = 0 \qquad (2)$$

Average Normal Stress. A necessary third equation can be written that requires the tensile stress in the bar AB and the compressive stress at C to be equivalent, i.e.,

$$\sigma = \frac{F_{AB}}{400\text{ mm}^2} = \frac{F_C}{650\text{ mm}^2}$$

$$F_C = 1.625 F_{AB}$$

Substituting this into Eq. 1, solving for F_{AB}, then solving for F_C, we obtain

$$F_{AB} = 1143\text{ N}$$

$$F_C = 1857\text{ N}$$

The position of the applied load is determined from Eq. 2,

$$x = 124\text{ mm} \qquad \textit{Ans.}$$

NOTE: $0 < x < 200$ mm, as required.