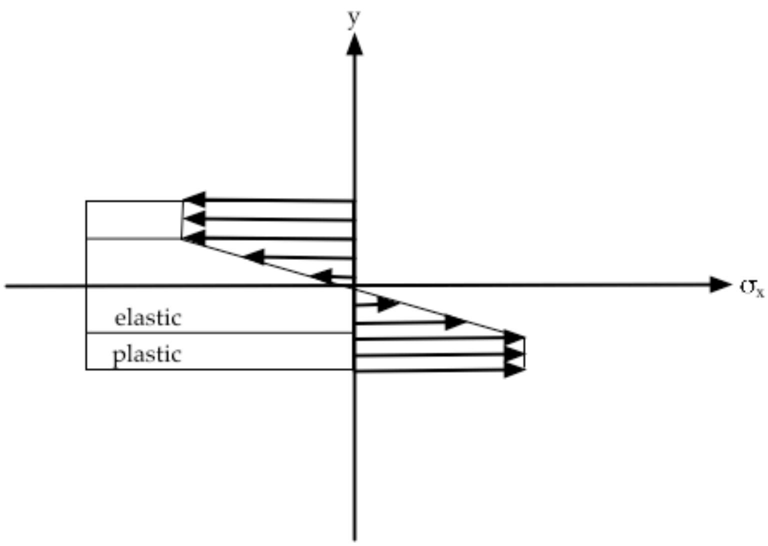
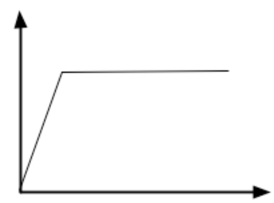
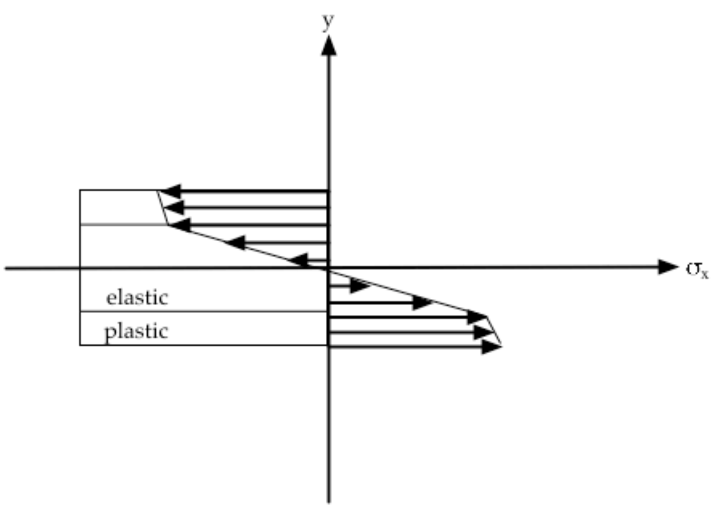
1. a) Strain distribution for elastic-perfectly plastic rectangular beam with a high enough bending moment that some yielding has occurred in the beam.

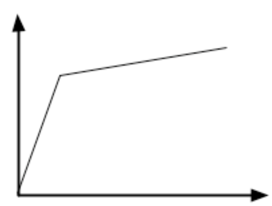




elastic-perfectly plastic stress-strain curve

1. b) Repeat a) with an elastic-plastic stress-strain relation with linear hardening





elastic-perfectly plastic stress-strain curve
with linear hardening

2.

4.5 Initial portion of a tension test on 7075−T651 Al. $d_i = 9.07$, $L_i = 50.8\,mm$

(a) $\sigma = \frac{P}{A_i} = \frac{4P}{\pi d_i^2} = \frac{4\,(7.22 \times 10^3\,N)}{\pi\,(9.07\,mm)^2} = 112\ MPa$

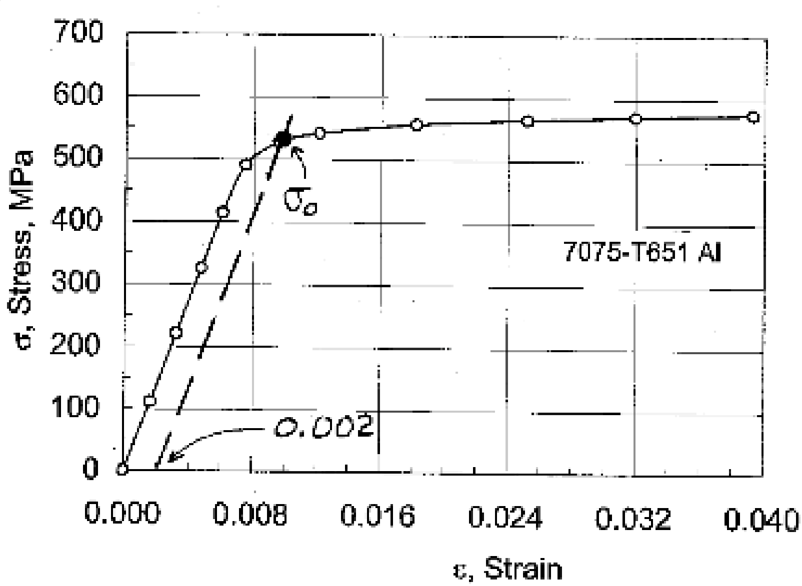
$\varepsilon = \frac{\Delta L}{L_i} = \frac{0.0839\,mm}{50.8\,mm} = 0.00165$

P, kN	ΔL, mm	σ, MPa	ε
0	0	0	0
7.22	0.0839	112	0.00165
14.34	0.1636	222	0.00322
21.06	0.241	326	0.00474
26.8	0.308	415	0.00606
31.7	0.380	491	0.00748
34.1	0.484	528	0.00953
35.0	0.614	542	0.01209
36.0	0.924	557	0.01819
36.5	1.279	565	0.02518
36.9	1.622	571	0.03193
37.2	1.994	576	0.03925

Other values similarly ◀

(b) On graph at $\varepsilon_{po} = 0.002$:

$\sigma_o = 530\ MPa$ ◀



(4.5, p.2)

(c) $P_{o2} = ?$ for $d_2 = 20\ mm$

$$\sigma_o = \frac{P_{o2}}{A_2}, \quad 530\ \frac{N}{mm^2} = \frac{4P_{o2}}{\pi d_2^2} = \frac{4P_{o2}}{\pi (20\,mm)^2}$$

$P_{o2} = 166.5\ kN$ ◀

For $d_1 = 9.07\ mm$

$$530\ \frac{N}{mm^2} = \frac{4P_{o1}}{\pi d_1^2} = \frac{4P_{o1}}{\pi (9.07\,mm)^2}$$

$P_{o1} = 34.2\ kN$

The load at yielding for a 20 mm dia. bar is much higher than for the 9.07 mm dia. bar, specifically about 5 times larger. The values differ due to the differing areas having the same P/A at yield. ◀

3. Dowling 4.16

Engineering stress and strain are based on initial values (A_i and L_i) whereas true stress and strain are based on the current values (A and L). Current values of A and L change throughout the test. For example, in tensile testing A decreases and L increases, which means that true stress rises above engineering stress and true strain drops below engineering strain.