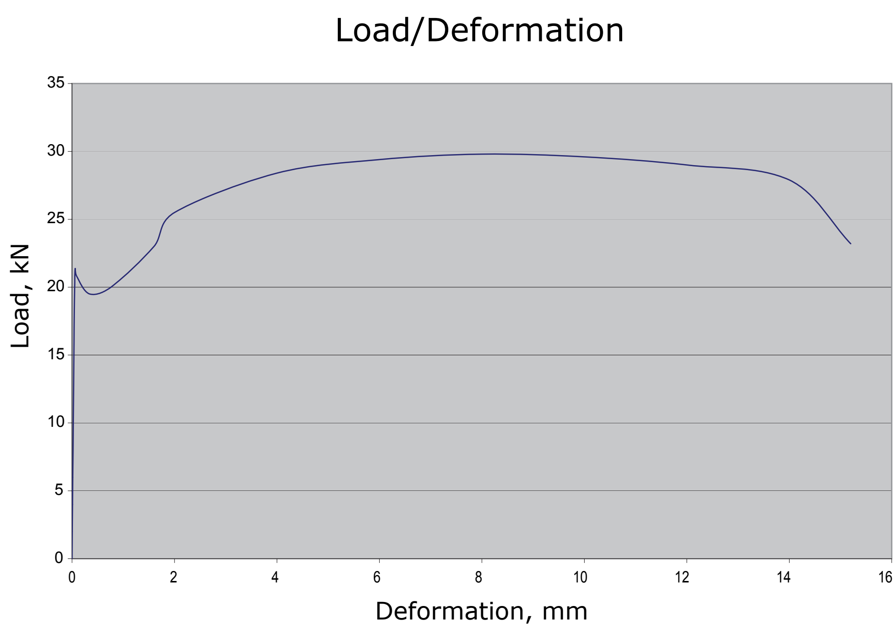
TENSION AND COMPRESSION LAB REPORTS

We have a graph of load/deformation from the tension and compression labs. We need to convert them to stress/strain values to calculate E and to find the yield point with the offset method.

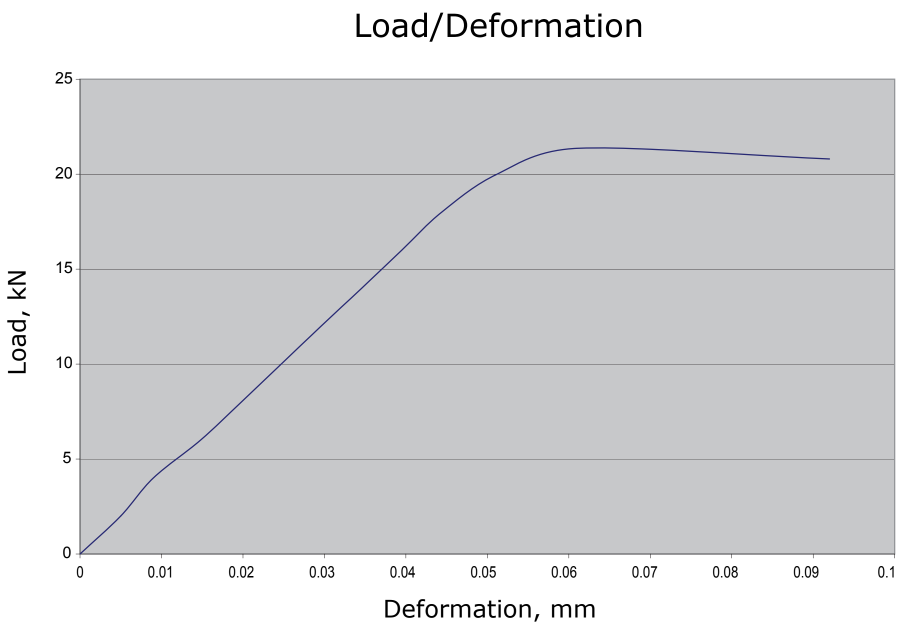
Consider the following data (based on a gauge length of 40 mm and a diameter of 10 mm):

Load, kN	Deformation, mm	Load, kN	Deformation, mm
0	0.0000	20.8	0.0920
2	0.0050	19.5	0.3400
4	0.0090	20	0.7600
6	0.0148	23	1.600
8	0.0197	25.5	2.0000
10	0.0247	28.4	4.0000
12	0.0296	29.4	6.0000
14	0.0346	29.8	8.0000
16	0.0395	29.6	10.0000
18	0.0444	29.0	12.0000
20	0.0512	27.9	14.0000
21.36	0.0610	23.2	15.2000

The graph of this data has the classic curve for a ductile material:



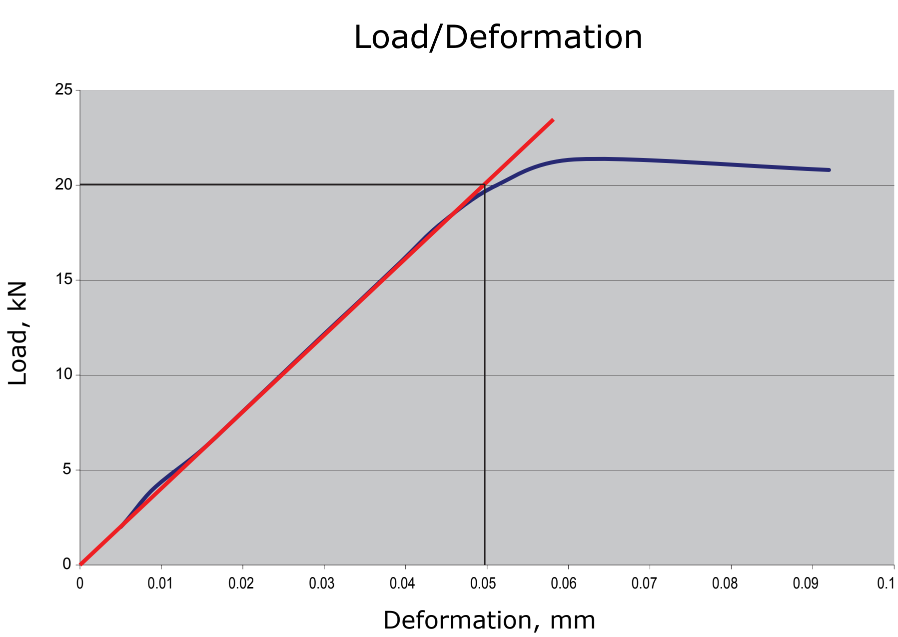
As can be seen, the elastic part of the plot is a very small part on the left. Let's just look at that part (which more closely corresponds to the plots that we have from our lab):



We want to find Young's Modulus, $E = \sigma/\epsilon$. For σ, we use $\sigma = P/A_0$ where A_0 is the original cross-sectional area of the sample. For ϵ, we use $\epsilon = d/L_0$ where L_0 is the original gauge length. For the data above,

$$\begin{aligned} E &= \frac{\sigma}{\epsilon} \\ &= \frac{P/A_0}{\delta/L_0} \\ &= \frac{P}{\delta} \cdot \frac{L_0}{A_0} \end{aligned}$$

We have $L_0 = 40$ mm and $A_0 = \frac{\pi(10)^2}{4}$ mm^2 from above so $\frac{L_0}{A_0} = 0.5093$. We can get $\frac{P}{\delta}$ from the graph:

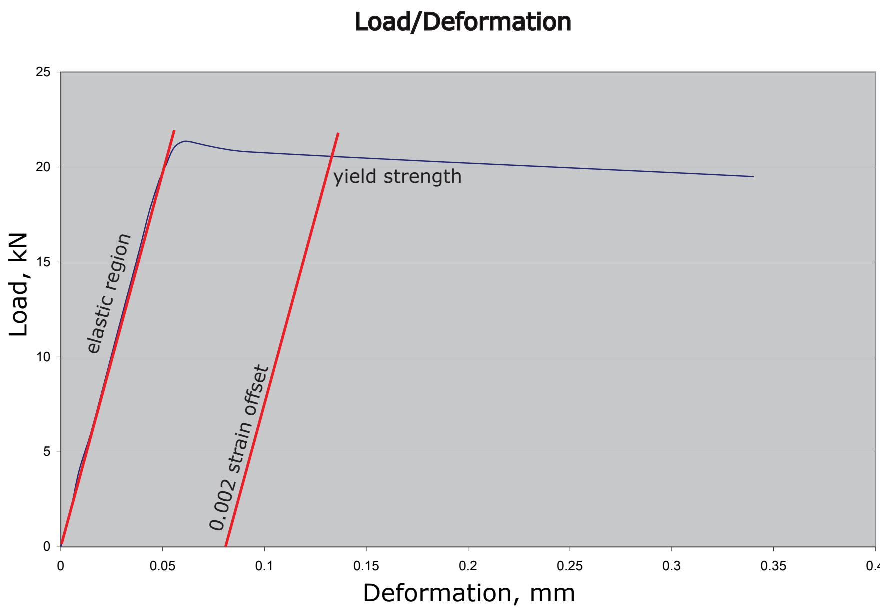


Draw a line along the proportional part of the curve. The slope of the curve is read from a point on the straight line:

$$\begin{aligned}
\frac{P}{\delta} &= \frac{20\text{ kN}}{0.0495\text{ mm}} \\
E &= \frac{20\text{ kN}}{0.0495\text{ mm}} \cdot 0.5093\frac{1}{\text{mm}} \\
&= 205.78\text{ GPa}
\end{aligned}$$

Next, to calculate the yield strength, we use the offset method. We find the location on the x-axis corresponding to 0.2% strain (or whatever the offset is for the material in question).

$$\begin{aligned}
\epsilon &= \frac{\delta}{L_0} \\
\delta &= \epsilon L_0 \\
&= 0.002 \times 40 \\
&= 0.08\text{ mm}
\end{aligned}$$



The yield strength is given by the point where the line parallel to the linear elastic region line crosses the load-deformation plot.