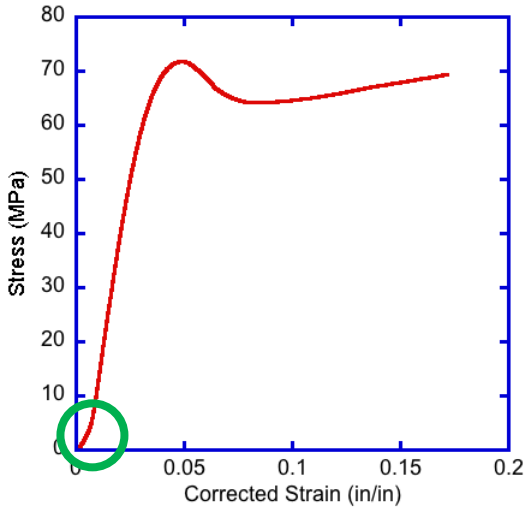
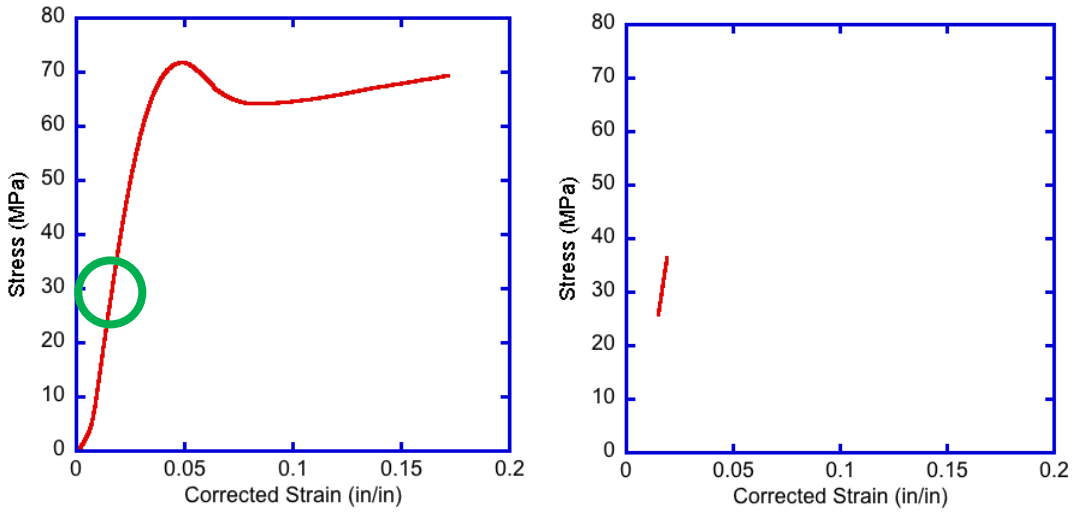
Correction procedure for start-up toe in compression tests

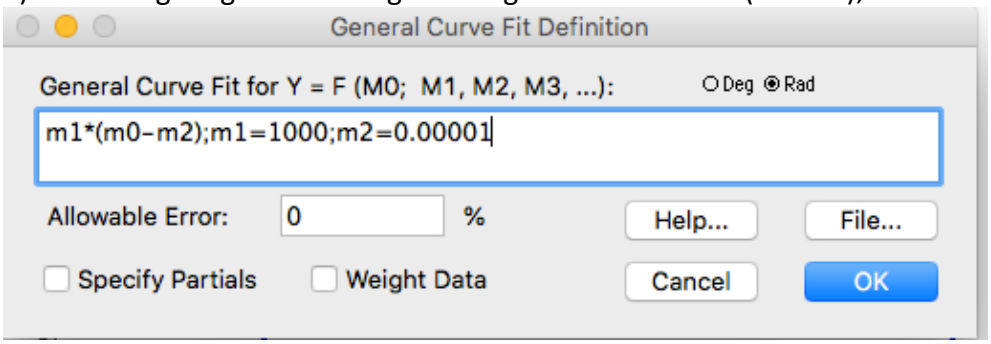
After results have been corrected for the initial length:
[strain=(strain reported by Instron)*(1in/L0)]
One has something like:

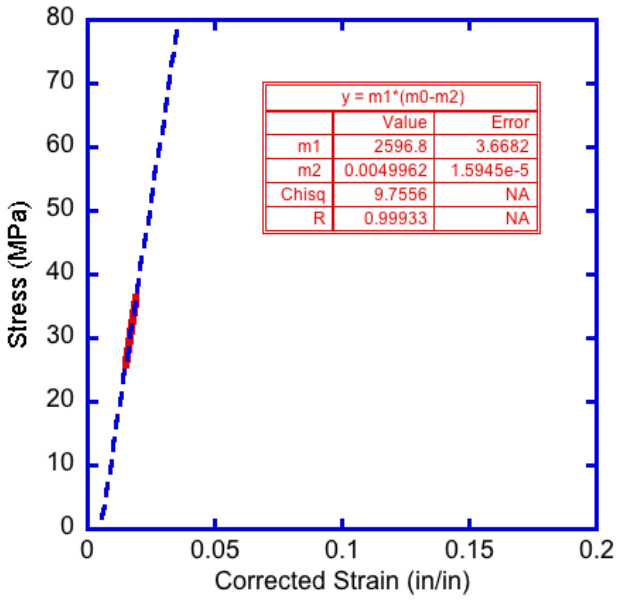


The circled part is the “start-up toe” which results from the sample not being exactly a right cylinder. It usually extends to a strain of about 0.005. For a 1 in sample, this is 0.005 in ~0.1 mm which is a reasonably small sample prep tolerance. It is assumed that the initial part is linear and that it follows the linear behavior that extends out to 0.03 or so.
The correction procedure is as follows:
1) identify and mask off a linear section.



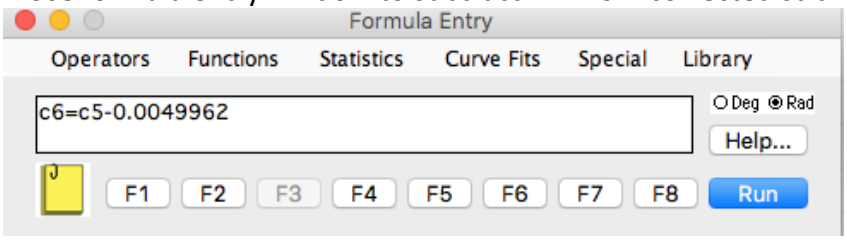
2) Fit a straight light to this region using the formula m1*(m0-m2); m1=1000; m2=0.000001





3) Clearly the line does not go through (0,0). To correct, the x-intercept (m2=0.0049962) must be subtracted from the strain.

- unmask data (a step it is easy to forget)
- extract data (click on grid)
- label new column “Toe Corr Strain”
- Use formula entry window to subtract m2 from corrected strain

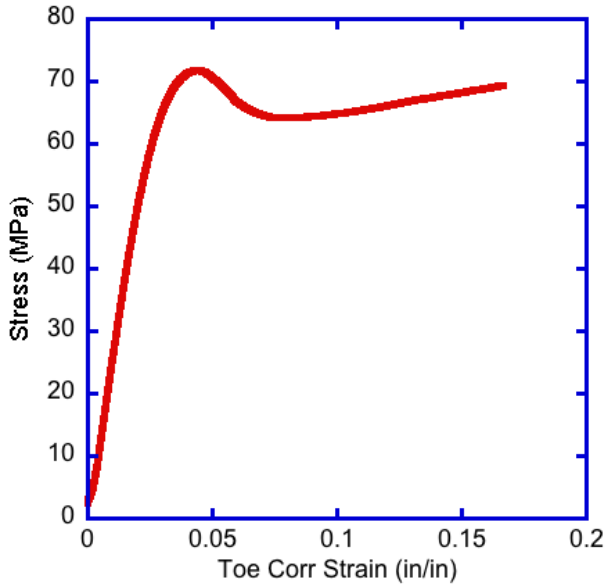


•giving:

Data 2 10:45:37 4/18/2018

	Load (kN) C2	Strain .../mm) C3	Stress (MPa) C4	Corre...(in/in) C5	Toe C...Strain C6
0	-0.00050000	0.0000	-0.0031600	0.0000	-0.0049962
1	-0.0014400	0.0000	-0.0090500	0.0000	-0.0049962
2	-0.00068000	0.0000	-0.0042900	0.0000	-0.0049962
3	-0.0014500	0.0000	-0.0091100	0.0000	-0.0049962
4	-0.0013500	0.0000	-0.0085000	0.0000	-0.0049962
5	0.0010500	-2.0000e-05	0.0066000	2.1119e-05	-0.0049751
6	0.0016100	-5.0000e-05	0.010150	5.2798e-05	-0.0049434
7	0.0033200	-7.0000e-05	0.020890	7.3918e-05	-0.0049223
8	0.0049700	-9.0000e-05	0.031250	9.5037e-05	-0.0049012

4) Now plot Toe-Corr Strain vs. stress for the Engineering Stress-Strain



5) Since the cross-sectional area increases as the sample is compressed approximately so that the volume is constant, the true stress = Force/A=StressEng*A0/A where A is the true area and A0 is the initial area. Volume=A0*L0=A*L -> A0/A=L/L0=(L0-ΔL)/L0=1-StrainEng

Or: **True Stress=StressEng*(1-StrainEng)**

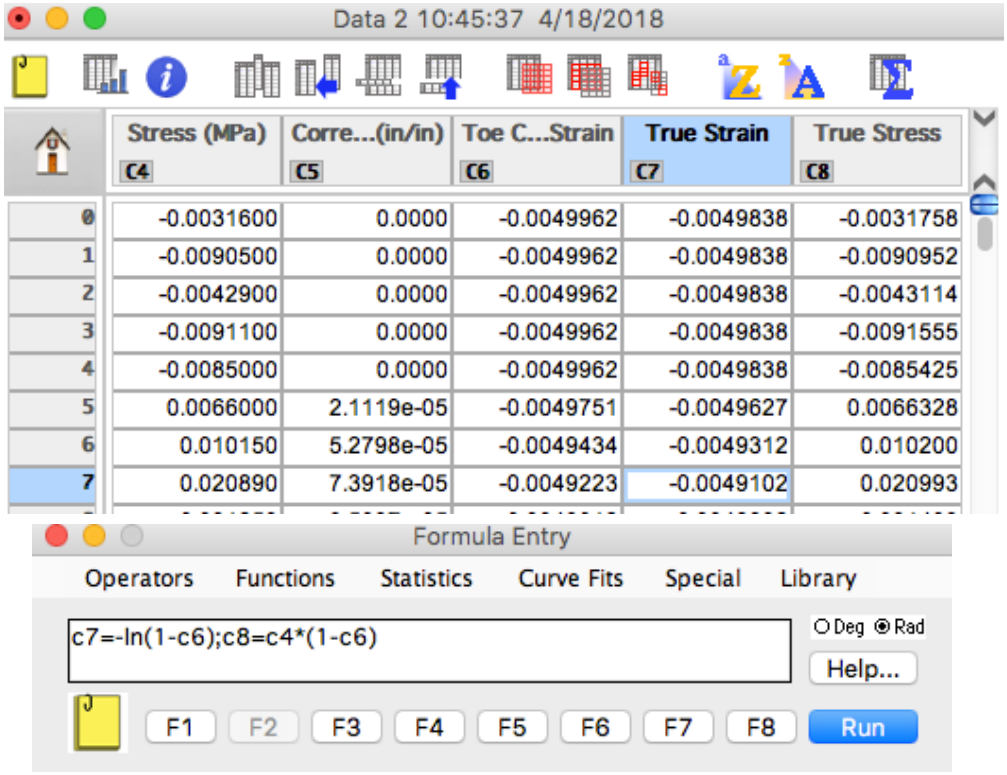
6) Since work of compression is the integral of FdL, Work per volume = d<u>W</u>=(F/A0)d(L/L0)

d<u>W</u>=(StressEng)d(StrainEng)= (TrueStress)*(A/A0)*d(StrainEng)

=TrueStress/(1-StrainEng)d(StrainEng)=TrueStress d(-ln(1-StrainEng))=TrueStress d(TrueStrain)

Where TrueStrain=-ln(1-StrainEng)

7) To express results in True Stress, True Strain terms. Label two columns as such



8) This gives the following