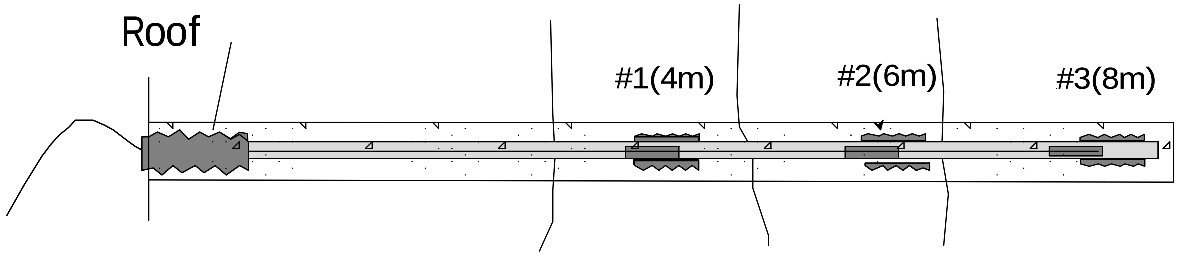
BOREHOLE EXTENSOMETER INTERPRETATION NOTE

This note is designed to provide some guidelines on how to interpret borehole extensometer data.

Assume we have a 3 point extensometer with anchors at 4m, 6m and 8m from the roof of the excavation. For all YieldPoint extensometers Anchor #1 is nearest to the head.



Some hypothetical readings are shown in the following table. Notice that the readings (in mm) are larger for the more distant anchors even though we intuitively know these points have physically moved less (i.e. things appear the wrong way around).

Anchor	Roof	#1 (4m)	#2 (6m)	#3 (8m)
T=0	N/A	24.34	16.71	13.35
T=7 days	N/A	24.65	20.23	17.65
T=14 days	N/A	25.13	23.75	21.65

RAW EXTENSOMETER DATA

Firstly, referencing the displacements to their values at t=0, we obtain:

Anchor	Roof	#1 (4m)	#2 (6m)	#3 (8m)
T=0	0	0	0	0
T=7 days	0	0.31	3.52	4.30
T=14 days	0	0.79	7.04	8.30

TIME REFERENCED (TR) EXTENSOMETER DATA

Now we need to “invert” the time-referenced extensometer data based on the fact that Anchor #3 at 8m has moved least. This results in:

Anchor	Roof	#1 (4m)	#2 (6m)	#3 (8m)
T=0	0	0	0	0
T=7 days	4.30	3.99	0.78	0
T=14 days	8.30	7.51	1.26	0

SPATIALLY REFERENCED (SR) EXTENSOMETER DATA(inverted)

The inversion expressions are simply:

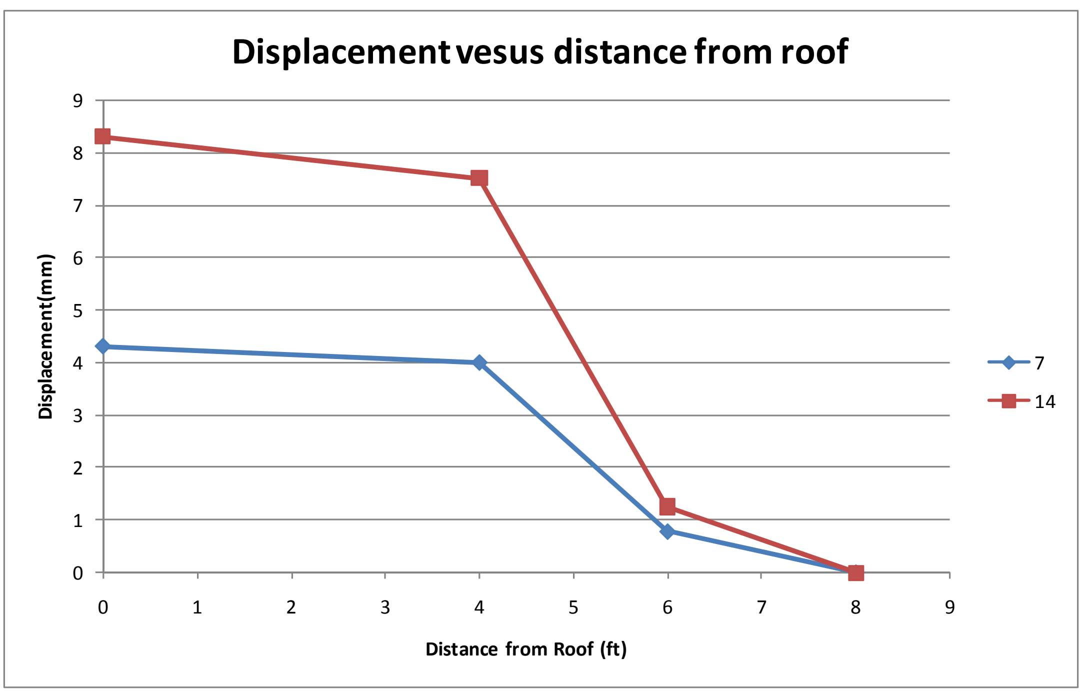
SR displacement (4m) = TR displacement (8m)-TR displacement(4m)
SR displacement (6m) = TR displacement (8m)-TR displacement(6m)
SR displacement (8m) = TR =0

And

SR displacement (Roof) = TR displacement (8m)

Since this is the relative displacement between the 8m anchor(new reference) and the roof.

	RAW DATA			TIME REFERENCED(TR) mm			SPATIALLY REFERENCED(SR) mm			
DAYS	Anchor 1	Anchor 2	Anchor3	Anchor 1	Anchor 2	Anchor3	Roof	Anchor 1	Anchor 2	Anchor3
	4	6	8	4	6	8	0	4	6	8
0	24.34	16.71	13.35	0	0	0	0	0	0	0
7	24.65	20.23	17.65	0.31	3.52	4.3	4.3	3.99	0.78	0
14	25.13	23.75	21.65	0.79	7.04	8.3	8.3	7.51	1.26	0



STRAIN CALCULATION

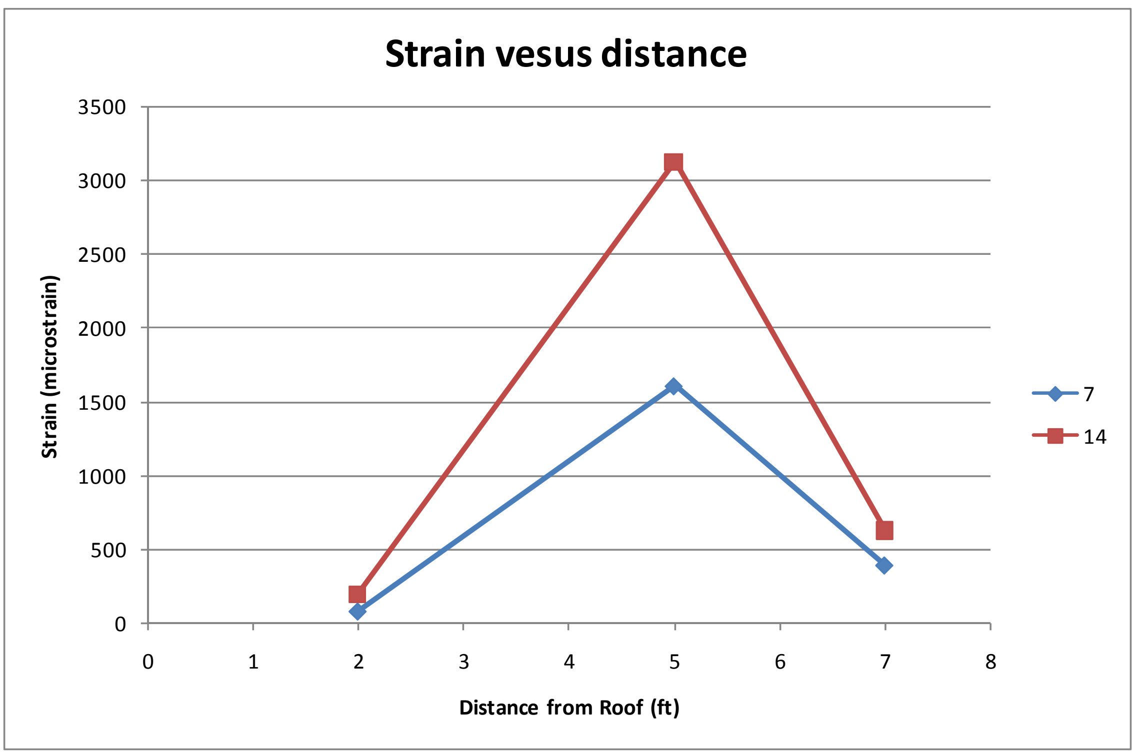
An excel spreadsheet can be developed and spatial plots can be generated with each line representing a snapshot for a given date (7 and 14days in this case).

The slope of the 2 plots is the average strain between the anchor points. Notice this is greater between the 10ft and 36ft anchor than between 0 and 10ft.The strain (in microstrain) can be calculated from:

Average strain (#1-#2) = 100000(Spat Ref. Disp (#1-4m)-Spat Ref Disp(#2-6m)/((4-6)*1000)

This gives:

STRAIN microstrain		
Roof-> 4	4-> 6	6->8
2	5	7
0	0	0
77.5	1605	390
197.5	3125	630



Notice that the strain values is plotted midway between the anchor points.

Strain is often a good indicator of crack density and indicates whether the deformation is truly distributed or localized at specific structures. In a continuous rock mass, strain should decay with distance from the roof but if discontinuities are contributing to movement higher strains may be observed at specific horizons.