

# Field testing of LineSmarts

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This report details and discusses two field tests, which compared LineSmarts tension results against dynamometer tension measurements.

## Helium AAAC conductor stringing in Balclutha, New Zealand, 12/03/15

Two devices were used to perform LineSmarts measurements:

- Samsung Galaxy TAB Pro 8.4 (SM-T320) - a mid-range tablet device
- Samsung Galaxy S4 Mini (GT-I9195) - a budget phone

Both devices were running LineSmarts version 10. Both devices had previously been calibrated. A Truepulse 200X laser rangefinder was used to measure the distances. It was set to record horizontal distance.



Figure 1: LineSmarts measurement being made

On arrival at site the top circuit had been strung and terminated. The second circuit had been strung and was sitting in come-along clamps at approximately the correct tension. All three phases had dynamometers attached. Two LineSmarts measurements were recorded before the conductors were adjusted to the target tension of 190kg. The penultimate and

terminal spans were then measured using LineSmarts as the Linesmen worked to terminate the conductors. Table 1 shows the percentage variation between the target tension and the tension recorded using LineSmarts.

Table 1: Tension percentage variance

Device	Time	Span length (m)	Phase tension variance		
			Btm Left	Btm Mid	Btm Right
Samsung Galaxy TAB Pro 8.4 (SM-T320)	12/03/2015 16:52	78.59	15.6%	15.1%	6.3%
Samsung Galaxy TAB Pro 8.4 (SM-T320)	12/03/2015 16:56	78.76	16.4%	11.7%	6.2%
Samsung Galaxy S4 Mini (GT-I9195)	12/03/2015 17:00	78.74	-0.5%	3.4%	0.2%
Samsung Galaxy TAB Pro 8.4 (SM-T320)	12/03/2015 17:11	78.62	2.9%	7.4%	4.6%
Samsung Galaxy TAB Pro 8.4 (SM-T320)	12/03/2015 17:12	148.55	-2.7%	-5.8%	-1.5%
Samsung Galaxy S4 Mini (GT-I9195)	12/03/2015 17:19	148.75	0.1%	-3.0%	0.1%

The first two measurements indicate that the tensions were 6-16% in excess to the 190kg. This is consistent with expectations, since those measurements were collected before the conductors were adjusted to their final tensions. The subsequent measurements were made, using both devices, on adjacent spans which were supported in between by rollers. A couple of things can be observed from the results. The phone produced extremely accurate results, while the tablet was out by a couple of percent. Caution should be exercised in forming conclusions from such a small sample of measurements. It appears that the tablet either requires further adjustment of its calibration or suffers from some hardware bias.



Figure 2: Surveyed conductor positions captured by LineSmarts

Another issue with the results is that both devices show a discrepancy between physical and LineSmarts tension measurements for the middle phase. This is not unexpected. LineSmarts does not currently allow individual definition of attachment offsets for the structures at either

end. In the spans measured, the attachment point switched from one side of the pole on the first structure, to the other on the second pole. Thus a correct offset could not be entered resulting in an error being introduced. The amount of error could be minimised by making measurements positioned perpendicular to the span centre.

The difference between the minimum and maximum span distances were 0.2% and 0.1% for the short and long span respectively.

### Nitrogen AAAC conductor stringing in Balclutha New Zealand, 16/04/15

Three devices were used to perform LineSmarts measurements:

- Samsung Galaxy TAB Pro 8.4 (SM-T320) - a mid-range tablet device
- Samsung Galaxy S6 (SM-G920I) – a top-tier smartphone
- Nextbook 8 (NX785QC) – a terrible, terrible, budget tablet

All devices were running calibrated, version 11, LineSmarts. A Truepulse 200X laser rangefinder was used to measure the distances. It was set to record horizontal distance.



Figure 3: Dynamometers set up to measure tension

Dynamometers were fitted to 2 phases, the left and centre phases. The third phase was sagged by eye to match the other two. Measurements were taken from 4 different locations and at various stages during the process of tensioning up and terminating the conductors. The LineSmarts measurements are shown in Table 2, arranged in the order they were collected. The positions from which the measurements were taken are shown in Figure 5, with examples of the images given in Figure 6. The same set of range measurements were used at each site.

The results show that the discrepancy between the target installation tension of 700kg, and the tension measured using LineSmarts varied widely between phases and substantially changed for the last 6 measurements. The first three measurement positions were acquired after the left hand phase had been adjusted to the final tension. The remaining phases had only been pulled into position and not adjusted. The final 6 measurements taken from position 4 were performed after the right hand phase had been adjusted to its final tension. This is consistent with the tensions for the left hand phase being close to the target in all the measurements, the right hand tensions being close for the last 6 measurements, and the central phase never being close in the measurements collected.

Table 2: Tension percentage variances

Measurement position #	Device	Time	Span length (m)	Phase tension variance		
				Left	Mid	Right
1	Samsung Galaxy S6 (SM-G920I)	16/04/2015 14:26:24	143.21	-8.1%	-6.7%	-4.3%
	Samsung Galaxy S6 (SM-G920I)	16/04/2015 14:26:35	143.08	-4.9%	-0.7%	-0.2%
2	Samsung Galaxy S6 (SM-G920I)	16/04/2015 14:29:03	141.92	-7.6%	-6.4%	-1.9%
	Samsung Galaxy S6 (SM-G920I)	16/04/2015 14:29:13	141.91	-5.2%	-3.9%	-1.4%
	Samsung Galaxy TAB Pro 8.4 (SM-T320)	16/04/2015 14:30:50	141.59	-9.1%	-6.9%	-1.1%
	Samsung Galaxy TAB Pro 8.4 (SM-T320)	16/04/2015 14:31:03	141.61	-8.0%	-5.1%	0.7%
	Nextbook 8 (NX785QC)	16/04/2015 14:32:05	140.87	-7.8%	-4.8%	-4.7%
	Nextbook 8 (NX785QC)	16/04/2015 14:32:26	140.85	-5.8%	-4.3%	-4.2%
3	Samsung Galaxy S6 (SM-G920I)	16/04/2015 14:33:28	141.81	-4.2%	-4.2%	1.6%
	Samsung Galaxy S6 (SM-G920I)	16/04/2015 14:33:36	141.82	-7.3%	-3.8%	-0.6%
	Samsung Galaxy TAB Pro 8.4 (SM-T320)	16/04/2015 14:34:30	141.79	-7.3%	-1.4%	-2.6%
	Samsung Galaxy TAB Pro 8.4 (SM-T320)	16/04/2015 14:34:43	141.80	-8.8%	-4.9%	-0.5%
	Nextbook 8 (NX785QC)	16/04/2015 14:35:48	141.78	-7.9%	-4.7%	-0.7%
	Nextbook 8 (NX785QC)	16/04/2015 14:36:10	141.80	-4.0%	-5.1%	0.5%
4	Nextbook 8 (NX785QC)	16/04/2015 14:40:11	142.20	0.2%	-13.4%	3.4%
	Samsung Galaxy TAB Pro 8.4 (SM-T320)	16/04/2015 14:40:21	141.92	-1.7%	-14.3%	-0.2%
	Samsung Galaxy TAB Pro 8.4 (SM-T320)	16/04/2015 14:40:31	142.24	-1.6%	-13.0%	2.2%
	Nextbook 8 (NX785QC)	16/04/2015 14:40:32	142.13	-0.7%	-12.2%	1.4%
	Samsung Galaxy S6 (SM-G920I)	16/04/2015 14:41:16	142.52	-1.8%	-13.6%	1.4%
	Samsung Galaxy S6 (SM-G920I)	16/04/2015 14:41:27	141.91	-3.2%	-14.3%	-0.7%

The precision and accuracy of the measurements were not as good on this occasion as for those collected on 12/03/15. There are a few potential reasons for this. One being that in this case the end structures were at line deviations. Linesmarts currently calculates tensions on the assumption that the attachment points are arranged at right angles to the span direction. On angle structures crossarms tend to bisect the angle, so are not at right-angles to the incoming line. This may be part of the reason for the change in tension for the right hand phase when measured from position 4. Another influencing factor may have been that as the linesmen made changes to the tension of one phase it will have in turn had an effect on the tension of the other phases.

For the centre phase the current absence of a means to specify structure specific attachment offsets is the source of some error. Other potential sources of error might include some non-verticality of the supports, use of the parabolic sag model and also the tensioning of the left hand phase appears to have been inexact, as might be expected having been sagged by eye on a span containing supports which are not in-line.



Figure 4: Right hand phase tension measurement on 16/04/15

Probably the most significant factor affecting the precision of the measurements on this occasion was the visibility of the conductor. Identifying the position of the conductor was made difficult by the fairly long span, that half the span had a dark background of trees and because during the stringing process it is difficult to reliably estimate the attachment point. Also it appears that there might be a bug with LineSmarts that means it does not always achieve the optimal focus. Experiments taking photos on the S6 using both LineSmarts and the native camera app indicate that the photos taken using the camera app had much better focus. The significantly better focus would make it far easier to select detail in the image. The issue has not previously been so apparent because earlier testing has used smaller cameras, which are less sensitive to focus accuracy.

Despite all these factors, the tension measured by LineSmarts was generally within 2% of the dynamometer readings, where they were performed. Overall the measured tensions had a standard deviation of less than 2% for all phases.

The span measurements were precise with a standard deviation 0.3% excluding the first two measurements. The span length reported in the first two measurements was approximately 1.5m too long. The likely reason for this is that was an error made in the range measurement for one of the structures.

### Conclusion

Testing indicates that it is possible to achieve highly accurate and precise tension measurements. It also highlighted factors which currently limit the accuracy and precision that can be achieved. The following developments are recommended to improve the accuracy of LineSmarts:

- Improved calibration tools to facilitate the more reliable acquisition of accurate calibration

- Add ability to measure and specify structure orientations
- Add ability to measure line angle and default structure orientation to bisect the angle
- Add ability to specify different attachment offsets at each end structure
- Improve LineSmarts camera focusing

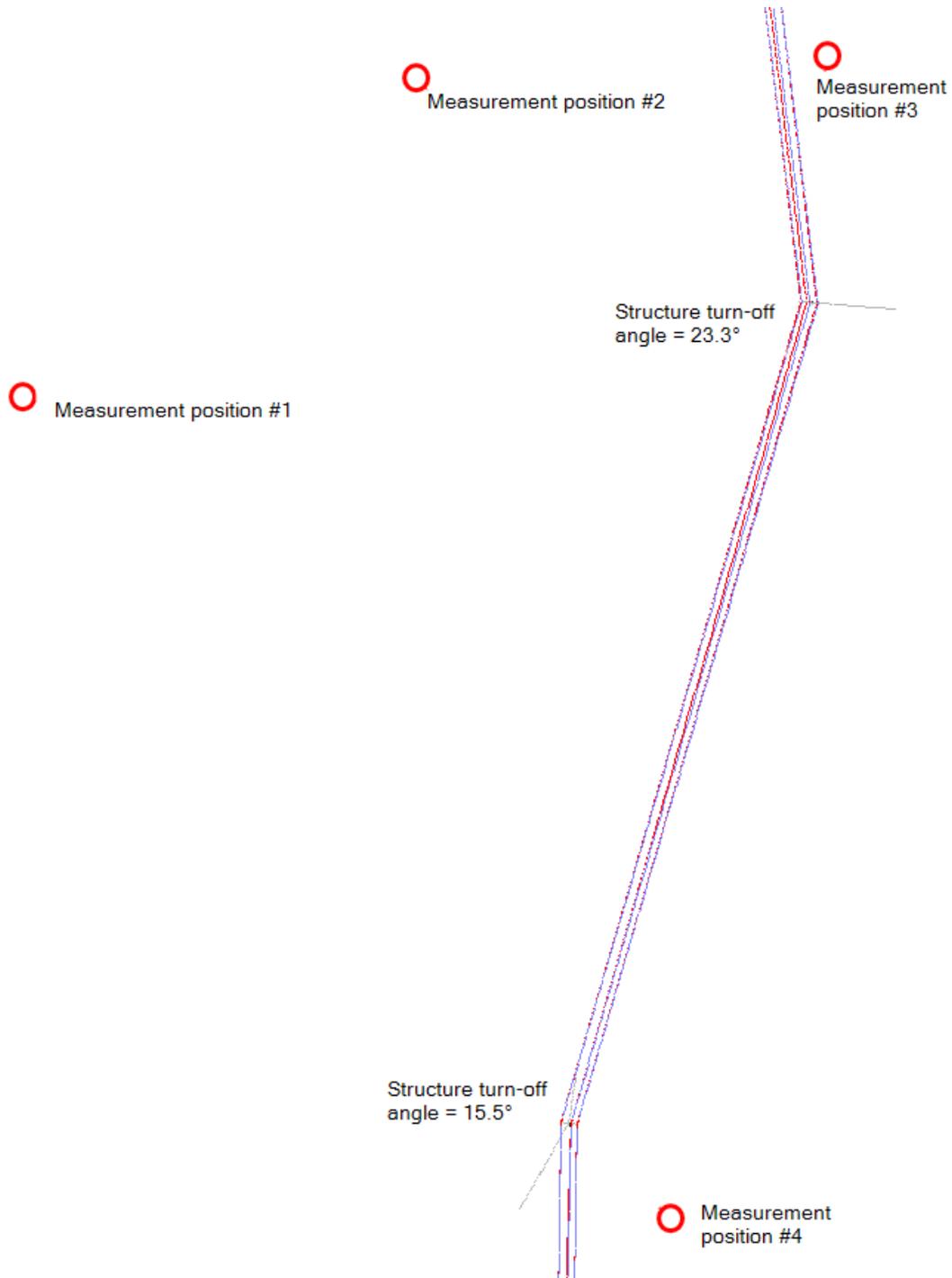


Figure 5: Measurement locations

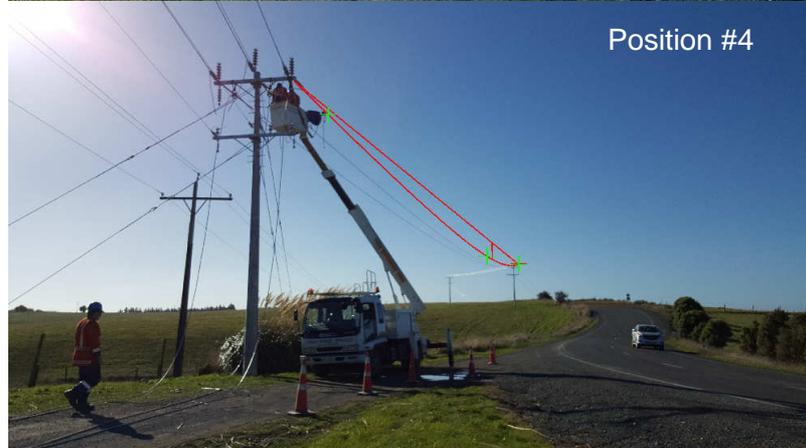
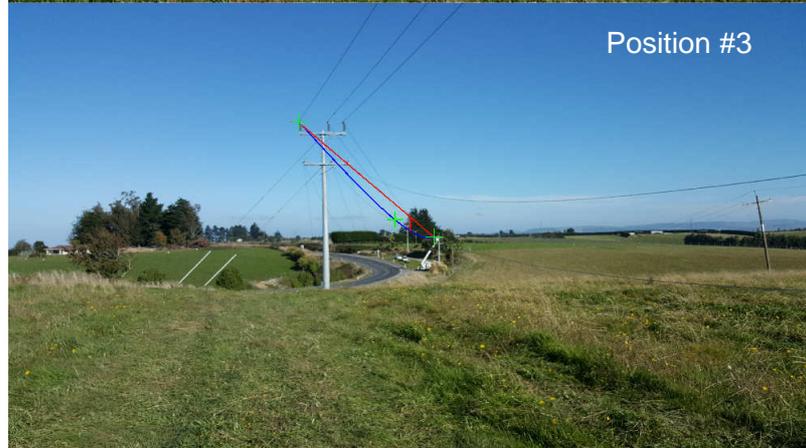


Figure 6: Images from 16/04/15 using the Samsung Galaxy Tab Pro 8.4 tablet