UNIVERSITY OF NEW SOUTH WALES

SCHOOL OF SURVEYING

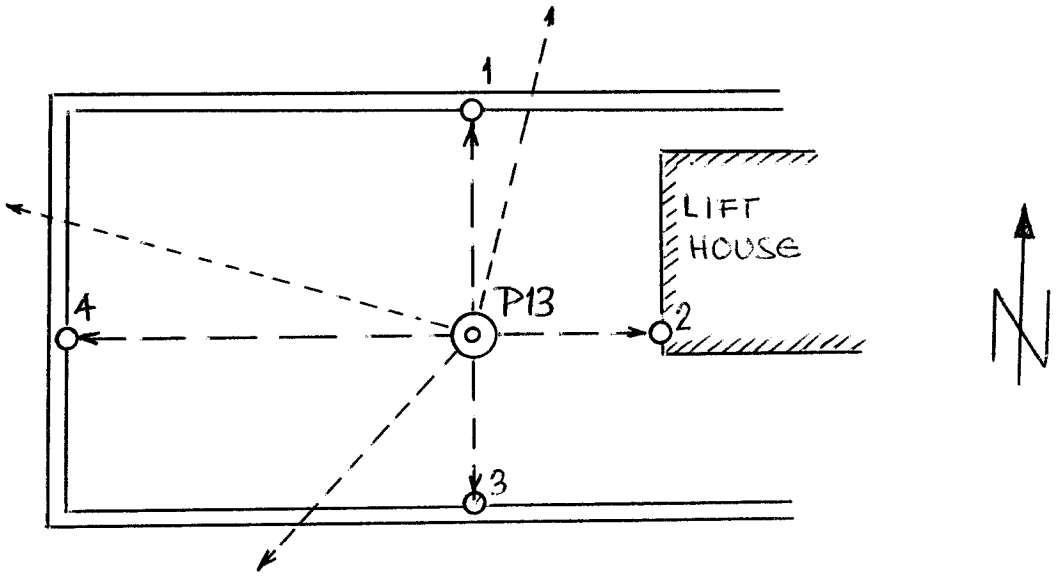
29.032/29.103G

PRACTICAL: Monitoring Diurnal Pillar Movement

1. AIM

To demonstrate the accuracy of relocation of pillars from recovery marks by resection and to investigate possible diurnal pillar movements with respect to x, y movements and to the tilt of the pillar top and due to sun exposure.

2. LOCALITY AND NETWORK (GAS Roof)



3. EQUIPMENT

1 Wild T2 1" Theodolite (new model)
1 Wild T16 0.1' Theodolite (new model)
2 Umbrellas Without Steel Base
1 Clipboard
1 30m Steel Band
1 3m Pocket Tape
1 Spring Balance

4. PREPARATIONS

4.1 Shade Pillar 13 with umbrella, making sure that only the super structure (bronze) but not the concrete of the pillar is shaded.

4.2 Attach T2 and level carefully (using plate bubble).

4.3 Measure the zenith distances to all four recovery marks, 2 times each (in 2 faces).

4.4 Measure the slope distance from the T2 trunnion axis (orientate to target) to the four recovery marks with 30m tape at 50N (5 kgf). Make 2 readings each.

4.5 Select 3 distant targets depending on the visibility of the day.

GOOD VISIBILITY:	POOR VISIBILITY:
140 East Lake	103 Applied Science
141 Broadway	133 Monastery
142 Piccadilly	131 Showground

5. MEASUREMENTS

5.1 Check levelling of T2. Relevel if necessary. Please note that, after that, the foot screws of the T2 tribrach should NOT be touched under any circumstances. No relevelling from now onwards.

5.2 Measure one arc of directions with T2 as follows:

Starting with the left most distance target (most southerly) in F.L., measure to all distant targets first and then to all four recovery marks, always proceeding ↷ (your turn therefore more than 360°!), change face, change circle setting by small and arbitrary amount, proceed ↶ through all recovery marks and then through all distant targets.

NOTE: Circle setting to first target (F.L.) should be approx. 0°00'30".

5.3 Without touching the foot screws, remove T2 from tribrach. Take T16 out of tribrach (T16) and mark one of the 3 centring pins of the T16 with felt pen and mark one of the 3 holes in the T2 tribrach the same way. Put T16 in T2 tribrach, mark over mark in F.L., sight to recovery mark No. 1 (north), and set hor. circle to zero. Clamp vertical clamp whilst cross hairs on recovery mark No. 1. Do not unclamp or move telescope until whole of 5.3 is complete.

(i) * Turn alidade to 0°00'00" on hor. circle
→ read vertical circle (after pushing of compensator button)
→ Z^{o}_{N}

* Turn alidade to 90°00'00" (hor. circle)
→ read v.c. (→ E reading) → Z^{o}_{E}

* Turn alidade to 180°00'00" (hor. circle)
→ read v.c. (→ S reading) → Z^{o}_{S}

* Turn alidade to 270°00'00" (hor. circle)
→ read v.c. (→ W reading) → Z^{o}_{W}

(ii) Turn T16 120° ↷ in tribrach, set circle to zero for recovery mark No. 1 (do not touch vert. motion clamp or screw). Repeat (i) with new base setting.
→ Z^{120}_{N}, Z^{120}_{E}, Z^{120}_{S}, Z^{120}_{N}

(iii) Turn T16 again 120° ↷ in tribrach, set circle to zero for recovery mark No. 1 (do not touch vert. slow motion screw or clamp!). Repeat (i) with third base setting.
→ Z^{240}_{N}, Z^{240}_{E}, Z^{240}_{S}, Z^{240}_{W}

NOTE: Read 0.1' and book 0", 6", 12"... or 54".

5.4 Without touching foot screws (no levelling) replace T16 by T2. Set circle to 0°00'30" to first "long range" target. Repeat procedure 5.2.

5.5 Repeat 5.3.

5.6 Repeat 5.4.

5.7 Repeat 5.3.

5.8 If the weather is sunny (or intermittently sunny), shade the entire pillar with the umbrella. Use second, if one not sufficient.

5.9 Repeat 5.4.

5.10 Repeat 5.3.

5.11 Repeat 5.4.

5.12 Repeat 5.3.

5.13 Repeat 5.4.

5.14 Repeat 5.3

and so on, and so on.

IMPORTANT:

(1) Do not touch foot screws after 5.1. If you do, then you lose the reference for the pillar tilt observation where, in fact, changes in the tilt of the tribrach are recorded.

(2) During a measurement according to 5.3, do not touch vert. slow motion clamp. During the total of 12 zenith distance obs. (if you do by accident, start again with Z_N^o!).

It is recommended to keep the telescope clamped throughout 5.3, 5.5, 5.7, 5.10, 5.12, 5.14 + ..., thus allowing straight comparisons between sets.

(3) Record time, temp., press (in weather hut!) and weather (particularly sun exposure) during whole exercise.

6. ANALYSIS

5.1 Reduce the four slope distances to horizontal.

5.2 Compute the plane bearings from Pillar 13 to the three distant targets. Use "Campus Network 1980" coordinates:

P13 E = 321 255.370m N = 1245 339.419m

6.3 Orientate first arc (viz. 5.2) and derive the plane bearings from P13 to recovery marks. Compute E, N of all four marks (to 5 decimal places).

6.4 Using Prof. Allman's program SVY003, compute the E, N of Pillar 13 for all epochs (5.2, 5.4, 5.6, 5.9, 5.11, 5.13) simultaneously by giving P13 a different number in all epochs:

fixed coord.	-	3 distant trigs.
	-	4 recovery marks
unknown	-	one orient unknown,) per epoch
	-	E, N of P13)
observations	-	one arc of direction per epoch
		→ NO distances

ALL coordinates must be input in terms of decimetre (not metre) to increase computer output accuracy. Compute output accuracy. Compute in PLANE COORD. SYSTEM and select 0.01mm as cut-off point of iterations. Assume centring accuracy of ±0.01mm.

6.5 Repeat 5.4, using only rays to the four targets on the roof, thus ignoring the distant rays. Analyse the differences in the results of 6.4 and 6.5.

6.6 Plot change of position of P13 in large scale. Plot (average) error ellipse and (average) 95% confidence ellipse relative to first epoch's position. (If you measured 6 epochs, multiply the semi axes of the error ellipse by a factor 2.45 to get the 95% confidence ellipse of a single point determination.

Assess the significance of any pillar movement on the basis of the 95% confidence ellipse of a coordinate difference between 2 epochs (multiply 95% confidence point ellipse by $\sqrt{2}$).

6.7 Discuss result, including standard deviation of direction measurement, size of residuals etc. Accuracy of relocation of pillar from recovery marks.

6.8 For each data set of 12 zenith distances (after 5.3), compute pillar tilt in N-S and E-@ direction after my equations:

$$\Omega N = \frac{1}{6} (Z_N^0 - Z_S^0 + Z_N^{120} - Z_S^{120} + Z_N^{240} - Z_S^{240})$$

$$\Omega E = \frac{1}{6} (Z_E^0 - Z_W^0 + Z_E^{120} - Z_W^{120} + Z_E^{240} - Z_N^{240})$$

Ω pos. = tilt towards N or E (measurement in F.L.).

Ω neg. = tilt towards S or W (measurement in F.L.).

6.9 Plot the tilt vectors in a suitable manner against time. Make an estimate of the precision of an Ω determination and discuss the significance of change of pillar tilts.

6.10 Correlate results of pillar tilt observations with coordinate observations. Investigate if there is a change in trend after the first 3 epochs, namely after shading the whole pillar.

6.11 Follow 29.005 instructions on report writing but ignore requirement for "report to client". Full discussion of all results and full appraisal of techniques used is important.

J. M. RUEGER.

(July, 1981)