

UNIVERSITY OF NEW SOUTH WALES

SCHOOL OF SURVEYING

29.005 SURVEYING V

FIELD EXERCISE: Measurement of Directions and Zenith Distances

1. AIM

To familiarise students with the levelling of one second theodolites, The plane bearing from T.S.1 (Geodetic Pillar on CE Bldg) to T.S. 103 (Applied Science) [or another trig station specified by the supervisor] is to be determined by measurement of arcs of directions. Data supplied are the co-ordinates of T.S. 1 and a number of other trig stations as well as approximate co-ordinates of T.S. 103 (see Appendix).

2. EQUIPMENT

Per Group:

- 1 One Second theodolite KERN DKM 2A
Wild T2E or ZEISS(Oberkochen) Th 2.
- 1 KERN Centring Plate (in case of KERN theodolite)
- 1 Umbrella (tiltable)
- 1 20m/30m steel tape
- 1 knife and 10 m of string
- 1 Clip Board

3. EXERCISE

Groups of 2 students are formed for this exercise.

- 3.1 Each student is to observe 3 arcs of directions to 4 distant targets one of which is T.S 103 (or another T.S specified by the supervisors), the other three being stations of known co-ordinates which are to be used for orientation. The instruments being set up eccentric to T.S 1 on the other pillars, T.S 1 is to be included in at least 2 arcs (as last direction in the arc, measure to both sides of the tube). The distance between T.S 1 and eccentric pillar is to be measured at least 3 times to mm.

The six different zeros are to be chosen as to divide the main circle and the micrometer interval into equal parts, for example:

0^o00'50"
30^o09'10"
60^o07'30"
90^o02'30"
120^o04'10"
150^o05'10" (for 10' micrometer)

Definition: One arc of directions consists of a face left pointing to each target in turn, proceeding clockwise, reversing on the last target, and a face right pointing on each station in turn proceeding anticlockwise.

First order observing routine should be used as specified in briefing.
Use umbrella in sunny or rainy conditions!!

3.2 Each student is to observe 4 arcs of zenith distances to T.S 103 or another well defined targ. specified by the supervisor. Each arc is to consist in pointing in F.L. and F.R. Measuring sequence: FL - FR - FR-FL The first 2 arcs of zenith distances are to be measured before the first arc of directions, the second 2 arcs before the 3rd arc. of direction with each student.

3.3 Book directions and zenith distances on different forms. Book time of every arc.

4. REPORT

Group reports (groups of 2 students) are required. Submission two weeks after field session, together with field books and forms.

4.1 Reduce directions and zenith distances as observed on eccentric station.

4.2 From results of 4.1, compute the precision of a single direction (in 2 faces) and a single zenith distance (in 2 faces) and the precisions of their respective means.

4.3 Compare the observed precisions as calculated in 4.2 with the established value for the instrument using the Fisher-Test (F-Test).

Assume $\sigma_{s.o} = \pm 1.5''$

4.4 Reduce observed directions to T.S 1 (Centre).

4.5 Orientate directions and list "measured" plane bearing to T.S 103. Use co-ordinates listed in appendix (NSW Integrated Survey Grid, Zone 56/I).

4.6 Determine the precision of an orientated direction (as per 4.5).

4.7 Plot measured zenith distances and index errors of vertical circle against time. Comment on the result.

J.M. RUEGER
FEBRUARY, 1980

HORIZONTAL DIRECTION MEASUREMENT

Station: Declination

Date: 24/3/1946

Weather: O'cast No wind

Instrument: Wild T2 S/N

Observer: I. Newton

Booker: J. Kepler

Arc	Station	Face Left	Diff	Face Right	Mean	Red. Mean	q	v	vv
I	Omega	0 00 06	+ 3	180 00 09	0 00 08	0 00 00	0	+1.6	2.56
	T.4	21 46 29	+ 4	201 46 33	21 46 31	21 46 33	-1.3	+0.3	0.09
	Astro	63 17 21	+ 5	243 17 26	63 17 24	63 17 16	-1.8	-0.2	0.04
	Wild	100 24 01	+ 4	280 24 05	100 24 03	100 23 55	-2.8	-1.2	1.44
	RA	142 10 53	- 5	322 10 48	322 10 50	142 10 42	-2.0	-0.4	0.16
							-7.9	+0.1	
II	Omega	45 02 08	+ 5	225 02 13	45 02 10	0 00 00	0	-1.6	2.56
	T.4	66 48 26	+ 9	246 48 35	66 48 30	21 46 20	+1.7	+0.1	0.01
	Astro	108 19 17	+ 6	288 19 23	108 19 20	63 17 10	+4.2	+2.6	6.76
	Wild	145 26 00	0	325 26 00	145 26 00	100 23 50	+2.2	+0.6	0.36
	RA	187 12 55	- 9	7 12 46	187 12 50	142 10 40	0	-1.6	2.56
							+8.1	+0.1	
III	Omega	40 05 07	+ 3	270 05 10	90 05 08	0 00 00	0	+0.2	0.04
	T.4	111 51 33	- 2	291 51 31	111 51 32	21 46 24	-2.3	-2.1	4.41
	Astro	153 22 24	- 2	333 22 22	153 22 23	63 17 15	-0.8	-0.6	0.36
	Wild	190 28 55	+ 4	10 28 59	190 28 57	100 23 49	+3.2	+3.4	11.56
	RA	232 15 48	+ 2	52 15 50	232 15 49	142 10 41	-1.0	-0.8	0.64
							-0.9	+0.1	
IV	Omega	135 07 10	+12	315 07 32	135 07 16	0 00 00	0	0	0
	T.4	156 53 38	- 4	336 53 34	156 53 36	21 46 20	+1.7	+1.7	2.89
	Astro	198 24 29	+ 7	18 24 36	198 24 32	63 17 16	-1.8	-1.8	3.24
	Wild	235 31 11	0	55 31 11	235 31 11	100 23 55	-2.8	-2.8	7.84
	RA	277 17 51	+ 4	97 17 55	277 17 53	142 10 37	+3.0	+3.0	9.00
							+0.1	+0.1	

Station	Final Means
Omega	0 00 00.0
T.4	21 46 21.7
Astro	63 17 14.2
Wild	100 23 52.2
RA	142 10 40.0

CALCULATION OF PRECISION

$\sum v^2 = 56.52$ No. of Arcs $n = 4$; No. of rays/arc r
 Variance of single direction (Mean of F.L. & F.R.)

$$S_x^2 = \sum v^2 / (n-1)(r-1) = 4.71$$

Variance of Mean Direction

$$S_x^2 = S_x^2 / n = 1.18$$

Corresponding Standard Deviations

$$S_x = \sqrt{S_x^2} = \pm 2.17'' \quad S_x = \sqrt{S_x^2} = \pm 1.09''$$

VARIANCE TEST $\sigma_x^2 = 3.1$ (established value for T 2)

$$\frac{S_x^2}{\sigma_x^2} = 1.52$$

Hence $\frac{S_x^2}{\sigma_x^2} < F_{\alpha, (n-1), (r-1), \infty}$

$F_{\alpha, (n-1), (r-1), \infty} = F_{.05, 12, \infty} = 1.75$ at 5% level of significance

i.e. Accept $\sigma_x^2 = 3.1$

ORIENTATION

At Stn: 'Declination'

Station	Known Dirn. (1)	Obs Dirn. (2)	Orientation (3)=(1)-(2)	Orientated Dirn. (4)=(2)+(0)	Residual v (5)=(1)-(4)
Omega	82 36 21.4	0 00 00.1	82 36 21.4	82 36 21.5	-0.1"
T.4		21 46 21.7		104 22 43.2	
Astro		63 17 14.2		145 53 35.7	
Wild	183 00 14.8	100 23 52.2	82 36 22.6	183 00 13.7	+1.1"
RA	224 47 00.5	142 10 40.0	82 36 20.5	224 47 01.5	-1.0"
					<hr/> Σ = 0

- (0) = Mean Orientation = 82° 36' 21.5"
- (1) Calculated from coordinates of known stations.
- (5) If the known coordinates are the result of an adjustment of observations of a higher order, the residuals could be used to obtain an independent estimate of the standard deviation of a mean direction (although there will usually be only a small number of such residuals).

$$S_m = \sqrt{\frac{\sum v^2}{k-1}} \quad \text{where } k \text{ is number of known directions.}$$

CONFIDENCE INTERVALS OF MEAN DIRECTIONS

(I) σ Known.

eg. Direction to T4. : 95% C.I.

$$\bar{x} = 104^{\circ} 22' 43.2'' \quad n = 4$$

$$\sigma = \pm 1.76'' \text{ for Wild T 2 (established value)}$$

$$z_{\alpha/2} = z_{.025} = 1.96$$

$$95\% \text{ C.I.} = 104^{\circ} 22' 43.2'' \pm 1.7''$$

(II) σ Unknown

Direction to T4 : 95% C.I.

$$\bar{x} = 104^{\circ} 22' 43.2'' \quad n = 4$$

$$S_x = \pm 2.17'' \text{ from Observations P.1.}$$

$$R = (n-1)(r-1) = 12$$

$$t_{\alpha/2, R} = t_{.025, 12} = 2.18$$

$$95\% \text{ C.I.} = 104^{\circ} 22' 43.2'' \pm 2.4''$$

K.I. Groenhout

January 1980

University of New South Wales

School of Surveying

29.005 Surveying V

1979

Appendix to Field Work DIRECTION MEASUREMENTS

The coordinates given below refer to the N.S.W. Integrated Survey Grid (I.S.G.), Zone 56/1 and are based on computations executed in July 1976. These coordinates are provisional only.

CAMPUS OUTER NETWORK 1976

A.P.H.WERNER

STATION	NUMBER	NORTHING	EASTING
UNSW PILLAR	1	1245423.525	321406.396
MEDICINE	12	1245593.967	321707.302
APPLIED SCIENCE	103	1245540.718	321029.472
SCIENCE BUILDING	121	1245482.041	321559.398
HOWARD RESERVOIR	122	1245012.365	322638.642
ST. SPIRITON	123	1244642.227	320651.837
COOGEE BEACH	124	1245273.240	323973.599
CORNERAKES	125	1242227.893	319294.879
CENTENIAL PARK	126	1248128.074	321559.733
P.O.W.HOSPITAL	127	1245460.663	322019.443
ST. JUDES	128	1246124.498	322327.540
SOUTH RANDWICK	129	1239047.015	322096.732
HARBOUR BRIDGE	130	1252746.294	319388.491
SHOWGROUND	131	1248305.308	320853.424
CHARING CROSS	132	1247366.995	323463.580
MONASTERY	133	1245880.194	320268.765
BELLEVUE HILL	134	1249274.364	323650.253
GREEN SPIRE	135	1245641.481	322232.674
PADDINGTON	136	1249097.240	320796.596
U.11	137	1245823.939	320312.970
LIBRARY	138	1245506.964	321460.804
MAROUDRA	139	1242652.971	322904.065
P.M.26676	676	1244336.093	323650.585