Horizontal Control Techniques

Traverse computation

The various steps in traverse computation will now be carried out, with reference to the traverse shown in Figure (1). The observed horizontal angles and distances are shown in columns 2 and 7 of Table (1)

A common practice is to assume coordinate values for a point in the traverse, usually the first station, and allocate an arbitrary bearing for the first line from that point. For instance, in Figure (1), point A has been allocated coordinates of E 0.00, N0.00, and line AB a bearing of $0° \ 00' \ 00''$.

This has the effect of establishing a plane rectangular grid and orientating the traverse on it. As shown, AB becomes the direction of the N-axis, with the E-axis at 90° and passing through the grid origin at A.

The computational steps, in the order in which they are carried out, are:

The computational steps, in the order in which they are carried out, are:

(1) Obtain the angular misclosure *W*, by comparing the sum of the observed angles (α) with the sum of error-free angles in a geometrically correct figure.

(2) Assess the acceptability or otherwise of *W*.

(3) If *W* is acceptable, distribute it throughout the traverse in equal amounts to each angle.

(4) From the corrected angles compute the whole circle bearing of the traverse lines relative to *AB*.

(5) Compute the coordinates ΔE, ΔN) of each traverse line.

(6) Assess the coordinate misclosure $\Delta' E$, $\Delta' N$).

(7) Balance the traverse by distributing the coordinate misclosure throughout the traverse lines.

(8) Compute the final coordinates (*E*, *N*) of each point in the traverse relative to *A*, using the balanced values of ΔE, ΔN per line.

The above steps will now be dealt with in detail.

(1) Distribution of angular error.

On the measurement of the horizontal angles of the traverse, the majority of the systematic errors are eliminated by repeated double-face observation. The remaining random errors are distributed equally around the network, as follows.

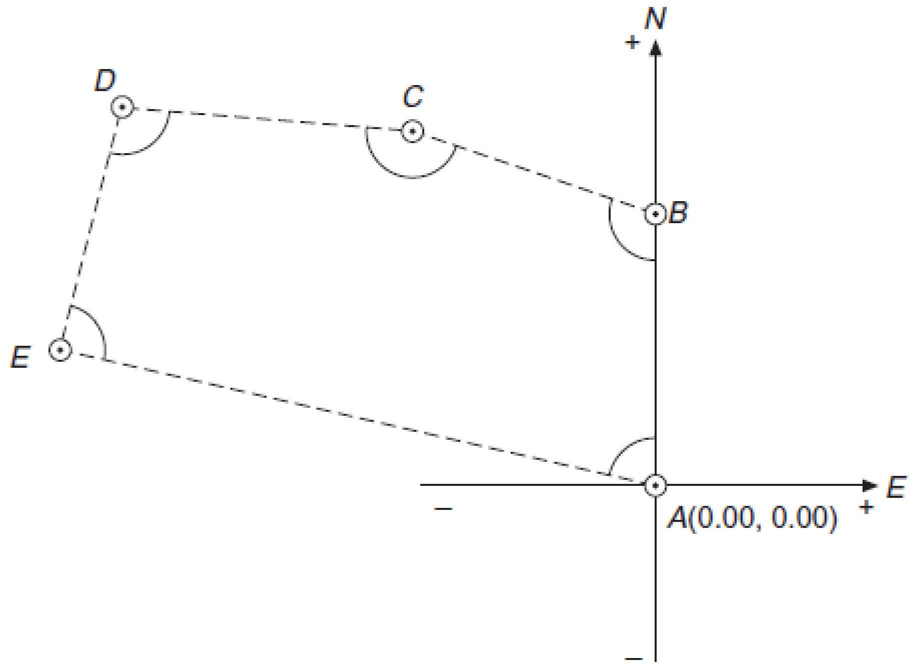


Fig.(1) Polygonal traverse

Table (1)

Angle	*Observed horizontal angle*			*Corn.*	*Corrected horizontal angle*			*Line*	*W.C.B.*			*Horiz. Length*	*Difference in coordinates*				*Corrected Values*		*Final Values*		
	°	′	″	″	°	′	″		°	′	″	*m*	ΔE	ΔN	δE	δN	ΔE	ΔN	E	N	Pt.
(1)	(2)			(3)	(4)			(5)	(6)			(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14) 0.00	(15) 0.00	(16) A
ABC	120	25	50	+ 10	120	26	00	AB	000	00 (Assumed)	00	155.00	0.00	155.00	0.07	0.10	0.07	155.10	0.07	155.10	B
BCD	149	33	50	+ 10	149	34	00	BC	300	26	00	200.00	−172.44	101.31	0.09	0.13	−172.35	101.44	−172.28	256.54	C
CDE	095	41	50	+ 10	095	42	00	CD	270	00	00	249.00	−249.00	0.00	0.11	0.17	−248.89	0.17	−421.17	256.71	D
DEA	093	05	50	+ 10	093	06	00	DE	185	42	00	190.00	−18.87	−189.06	0.08	0.13	−18.79	−188.93	−439.96	67.78	E
EAB	081	11	50	+ 10	081	12	00	EA	098	48	00	445.00	439.76	−68.08	0.20	0.30	439.96	−67.78	0.00	0.00	A
Sum (2n−4)90°	539 540	59 00	10 00	+ 50	540	00	00	AB	000	00	00 ΣL =	1239.00	−0.55	−0.83	0.55	0.83	0.00 Sum	0.00 Sum			
Error			−50								Correction =		+0.55 Δ′E	+0.83 Δ′N							

Error Vector = $(0.55^2 + 0.83^2)^{\frac{1}{2}} = 0.99(213° 32′)$
Accuracy = 1/1252

In a polygon the sum of the *internal* angles should equal (2*n* – 4)90°, the sum of the *external* angles should equal (2*n* + 4)90°.

$$\therefore \text{Angular misclosure} = W = \sum_{i=1}^{n} \alpha_i - (2n \pm 4)90° = -50''$$

where α = mean observed angle

n = number of angles in the traverse

– (2*n* ± 4)90° = – 50_ (*Table 6.1*)

The angular misclosure *W* is now distributed by equal amounts on each angle, thus:

Correction per angle = *W*/*n* = + 10″ (*Table1*)

However, before the angles are corrected, the angular misclosure *W* must be considered to be acceptable. If *W* was too great, and therefore indicative of poor observations, the whole traverse may need to be re-measured.

(2) Whole circle bearings (WCB)

The concept of WCBs has been dealt with in Chapter 5 and should be referred to for the ‘rule’ that is adopted. The corrected angles will now be changed to WCBs relative to *AB* using that rule.

	Degree	*Minute*	*Second*
WCB *AB*	000	00	00
Angle *ABC*	120	26	00
Sum	120	26	00
	+180		
WCB *BC*	300	26	00
Angle *BCD*	149	34	00
Sum	450	00	00
	–180		
WCB *CD*	270	00	00
Angle *CDE*	95	42	00
Sum	365	42	00
	–180		
WCB *DE*	185	42	00
Angle *DEA*	93	06	00
Sum	278	48	00
	–180		
WCB *EA*	98	48	00
Angle *EAB*	81	12	00
Sum	180	00	00
	– 180		
WCB *AB*	000	00	00

(4) Plane rectangular coordinates

Using the observed distance, reduced to the horizontal, and the bearing of the line, transform this data (polar coordinates) to rectangular coordinates for each line of the traverse. This may be done using the basic formula :

$\Delta E = L \sin WCB$

$\Delta N = L \cos WCB$

The results are shown in columns 8 and 9 of Table1.

As the traverse is a closed polygonal, starting from and ending on point A, the respective algebraic sums of the ΔE and ΔN values would equal zero if there was no observational error present.

However, as shown, the error in ΔE = –0.55 m and in ΔN = –0.83 m and is 'the coordinate misclosure'. As the correction is always of opposite sign to the error.

Correction = –Error

Then the ΔE values must be corrected by +0.55 = Δ′ E and the ΔN values by +0.83 = Δ′ N. The situation is as shown in Figure 6.16, where the resultant amount of misclosure AAis called the 'error vector'. This value, when expressed in relation to the total length of the traverse, is used as a measure of the precision of the traverse.

For example:

$$\text{Error vector} = (\Delta' E^2 + \Delta' N^2)^{\frac{1}{2}} = 0.99 \text{ m}$$

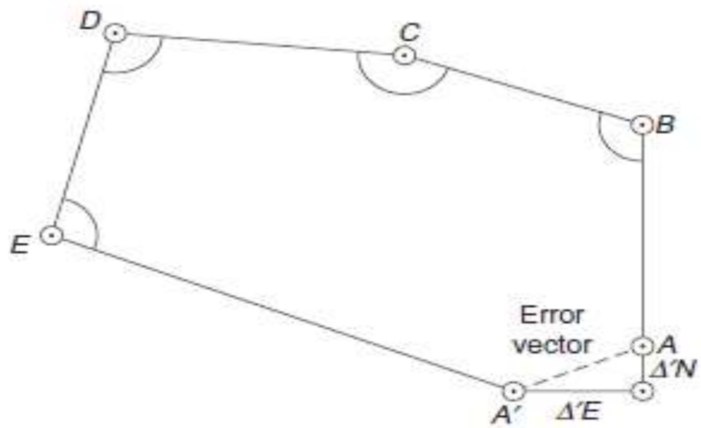
$$\text{Accuracy of traverse} = 0.99/1239 = 1/1252$$

(The error vector can be computed using the R → P keys.)

(4) Balancing the traversing

Balancing the traverse, sometimes referred to as 'adjusting' the traverse, involves distributing ΔE and ΔN throughout the traverse in order to make it geometrically correct.

There is no ideal method of balancing and a large variety of procedures are available, ranging from the very elementary to the much more rigorous. Where a non-rigorous method is used, the most popular procedure is to use the Bowditch rule.



Coordinate misclosure