1st Year Civil

(Plane Surveying)
CEP 111

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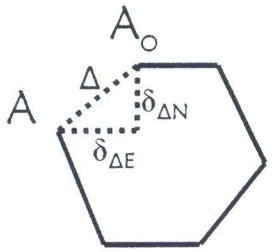
Traverse II

Linear Closing Error - Closed Traverse

given or calculated

Point	Side	Length	Bearing	$\Delta E_{comp.}$	$\Delta N_{comp.}$
A	AB	L_{AB}	α_{AB}	$L_{AB}\sin\alpha_{AB}$	$L_{AB}\cos\alpha_{AB}$
B	BC	L_{BC}	α_{BC}	$L_{BC}\sin\alpha_{BC}$	$L_{BC}\cos\alpha_{BC}$
C	CD	L_{CD}	α_{CD}	$L_{CD}\sin\alpha_{CD}$	$L_{CD}\cos\alpha_{CD}$
D	DA	L_{DA}	α_{DA}	$L_{DA}\sin\alpha_{DA}$	$L_{DA}\cos\alpha_{DA}$
A		$\sum L$		$\delta_{\Delta E}$	$\delta_{\Delta N}$
				$\parallel$	$\parallel$
				$\sum\Delta E_{comp.}$	$\sum\Delta N_{comp.}$

Summation of traverse lengths



$$\Delta = \sqrt{(\delta_{\Delta E})^2 + (\delta_{\Delta N})^2}$$

Δ (*linear closing error*)

$$\text{RE (Relative Error)} = \frac{\Delta}{\sum L}$$

Allowable Relative Error

Where $RE_{allowable}$ depends on the degree of the traverse:

$RE_{allowable}$ = 1:25,000 (1st degree)

$RE_{allowable}$ = 1:10,000 (2nd degree) Taken $RE_{allowable}$ = 1:5,000

$RE_{allowable}$ = 1:5,000 (3rd degree) (unless stated)

$RE_{allowable}$ = 1:2,000 (4th degree)

IF RE > $RE_{allowable}$ ⟹ traverse rejected ⟹ STOP

⟹ repeat observations

IF RE < $RE_{allowable}$ ⟹ traverse accepted

⟹ distribute error using:

BOWDITCH Method

OR

COMPONENT Method

Linear Error Correction

BOWDITCH Method

Error distributed according to length of each line

$$\Delta E_{corr.} = \Delta E_{comp.} - \delta_{\Delta E} * \frac{L}{\sum L}$$

$$\Delta N_{corr.} = \Delta N_{comp.} - \delta_{\Delta N} * \frac{L}{\sum L}$$

For each traverse line

COMPONENT Method

Error distributed according to component of each line

$$\Delta E_{corr.} = \Delta E_{comp.} - \delta_{\Delta E} * \frac{|\Delta E_{comp.}|}{\sum |\Delta E_{comp.}|}$$

$$\Delta N_{corr.} = \Delta N_{comp.} - \delta_{\Delta N} * \frac{|\Delta N_{comp.}|}{\sum |\Delta N_{comp.}|}$$

For each traverse line

Traverse II

Calculation of Coordinates - Closed Traverse

Point	Side	Length	Bearing	$\Delta E_{comp.}$	$\Delta N_{comp.}$	$\Delta E_{corr.}$	$\Delta N_{corr.}$	$E_{corr.}$	$N_{corr.}$
A	AB	L_{AB}	α_{AB}	$L_{AB}\sin\alpha_{AB}$	$L_{AB}\cos\alpha_{AB}$	√	√	E_A	N_A
B	BC	L_{BC}	α_{BC}	$L_{BC}\sin\alpha_{BC}$	$L_{BC}\cos\alpha_{BC}$	√	√	√	√
C	CD	L_{CD}	α_{CD}	$L_{CD}\sin\alpha_{CD}$	$L_{CD}\cos\alpha_{CD}$	√	√	√	√
D	DA	L_{DA}	α_{DA}	$L_{DA}\sin\alpha_{DA}$	$L_{DA}\cos\alpha_{DA}$	√	√	√	√
A								E_A	N_A
		$\sum L$		$\delta_{\Delta E}$	$\delta_{\Delta N}$	Σ=Zero	Σ=Zero		

Check

As Given Coordinates

Note: If bearings in closed traverse are given directly, then do not calculate angles backward.....Start directly with calculation of components

Traverse II

Connected Traverse

No Angular Error in Connected Traverse (No Closed shape)

Point	Side	Length	Bearing	$\Delta E_{comp.}$	$\Delta N_{comp.}$	$\Delta E_{corr.}$	$\Delta N_{corr.}$	$E_{corr.}$	$N_{corr.}$
A	AB	L_{AB}	α_{AB}	$L_{AB}\sin\alpha_{AB}$	$L_{AB}\cos\alpha_{AB}$	√	√	E_A	N_A
B	BC	L_{BC}	α_{BC}	$L_{BC}\sin\alpha_{BC}$	$L_{BC}\cos\alpha_{BC}$	√	√	√	√
C								√	√
D	CD	L_{CD}	α_{CD}	$L_{CD}\sin\alpha_{CD}$	$L_{CD}\cos\alpha_{CD}$	√	√	√	√
E	DE	L_{DE}	α_{DE}	$L_{DE}\sin\alpha_{DE}$	$L_{DE}\cos\alpha_{DE}$	√	√	E_E	N_E
		$\sum L$		$\sum\Delta E_{comp.}$	$\sum\Delta N_{comp.}$	$\sum = E_L - E_F$	$\sum = N_L - N_F$		

Check

As Given Coordinates

$$\delta_{\Delta E} = \sum \Delta E_{comp.} - (E_{last} - E_{first}) \qquad \Delta = \sqrt{(\delta_{\Delta E}^2) + (\delta_{\Delta N})^2}$$

$$\delta_{\Delta N} = \sum \Delta N_{comp.} - (N_{last} - N_{first}) \qquad RE\ (\text{Relative Error}) = \frac{\Delta}{\sum L}$$

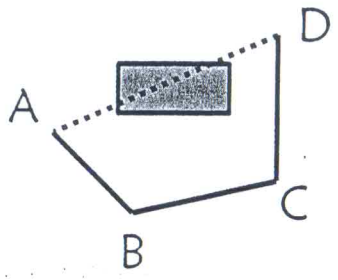
Compare with $RE_{allowable}$ as in closed traverse

Missing Traverse Information

This could be in the form of (missing length and bearing) or (missing two lengths) or (missing two bearings) i.e. two unknowns

To overcome this: the conditions of the closed or connected traverse are used to solve for missing data

Side	Length	Bearing	ΔE	ΔN
AB	L_{AB}	α_{AB}	√	√
BC	L_{BC}	α_{BC}	√	√
CD	L_{CD}	α_{CD}	√	√
DA	**?**	**?**	**L sinα**	**L cosα**
			∑ΔE=0	∑ΔN=0



Similar if L_1 and L_2 Or α_1 and α_2

$\sum \Delta E = \sqrt{} + \sqrt{} + \sqrt{} + L \sin\alpha_{DA} = 0$

$\sum \Delta N = \sqrt{} + \sqrt{} + \sqrt{} + L \cos\alpha_{DA} = 0$

Two equations in two unknowns: ΔE & ΔN ⟹ Get L and α

Note that: all traverse errors are propagated into the line DA only

Traverse II

Solved Example

For the following closed traverse, calculate the adjusted coordinates of all Points using Bowditch method, given coordinates of A (500m, 700m)

Point	Side	Length	Bearing	$\Delta E_{comp.}$	$\Delta N_{comp.}$	$\Delta E_{corr.}$	$\Delta N_{corr.}$	$E_{corr.}$	$N_{corr.}$
A	AB	150.50	134°52' 40'	106.646	-106.192	106.664	-106.199	500	700
B	BC	125.25	54°31' 40"	102.003	72.684	102.018	72.678	606.664	593.801
C	CD	170.00	314°56' 20"	-120.336	120.08	-120.316	120.072	708.682	666.479
D	DA	123.70	225°36' 00'	-88.380	-86.548	-88.366	-86.554	588.366	786.551
A								500	700
		$\sum L=569.45$		-0.067	0.026	$\sum$=Zero	$\sum$=Zero	As Given Coordinates	

$$\Delta = \sqrt{(-0.067)^2 + (0.026)^2} = 0.071\text{m} \qquad RE = \frac{0.071}{569.45} = \frac{1}{7975} < \frac{1}{5000} \quad \text{ok}$$

$$\Delta E_{ABcorr.} = 106.646 - (-0.067) * \frac{150.50}{569.45} = 106.664\text{m}$$ and so on for $\Delta N_{ABcorr.}$ and all lines

Solved Example

If component method, then calculate:

$$\sum|\Delta E_{comp.}| = 106.646 + 102.003 + 120.336 + 88.38 = 417.365m$$

$$\sum|\Delta N_{comp.}| = 106.192 + 72.684 + 120.08 + 86.548 = 385.50m$$

$$\Delta E_{CDcorr.} = -120.336 - (-0.067) * \frac{120.336}{417.365} = -120.316m$$

and so on for $\Delta N_{CDcorr.}$ and all other lines

Note: If not mentioned which method to use, then:

Compass Traverse: Bearings are measured directly by compass or distances measured accurately ⇒ **Use Bowditch method**

Theodolite Traverse: angles are measured directly by theodolite or angles are measured accurately ⇒ **Use Component method**