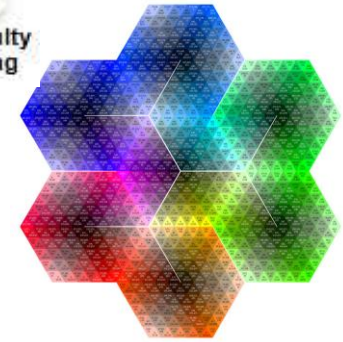
Benha University

Shoubra Faculty of Engineering



Surveying Engineering
Lecture 5: Traversing-2

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Contents

1. Traverse Errors
2. Angular Closing Error
3. Traverse Linear Closing Error
4. Closed Traverse
5. Connected Traverse

Traverse Errors

Error exists in surveying observations due to:

Personal errors: pointing, centering, distances

Instrumental errors: index error, creep of Hz circle

Natural errors: Refraction of line of sight, temperature

We Should correct angular and linear errors:

Closed Traverse:

If angles given:

δ (angular closing error)= $\sum$ measured internal angles - (n-2)*180

= $\sum$ measured external angles - (n+2)*180

$\delta_{allowable}$ (allowable angular closing error)= $C\sqrt{n}$ ″

Angular Closing Error

Where C is a constant depends on the degree of the traverse:

Taken C = 30 (unless stated)

IF $\delta > \delta_{allowable}$ ➡ traverse angles ➡ **STOP**

➡ rejected repeat

IF $\delta < \delta_{allowable}$ ➡ observations traverse

➡ angles accepted ➡ distribute angular error equally over angles

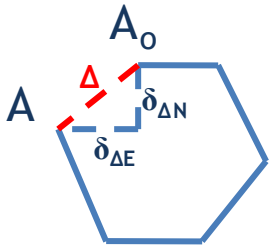
Corrected angle = measured angle - $\frac{\delta}{n}$

Repeat for all angles….. and calculate bearings of all lines ABC = α_{BC} - α_{BA} …….and so on

Traverse Linear Closing Error Closed Traverse

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		$\sum L$		$\delta_{\Delta E}$	$\delta_{\Delta N}$
				$\sum \Delta E_{comp.}$	$\sum \Delta N_{comp.}$

Summation of traverse lengths



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

Δ (*linear closing error*)

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

Allowable Relative Error

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

Taken $RE_{allowable}$ = 1:5,000 (unless stated)

IF $RE > RE_{allowable}$ ⇒ traverse rejected ⇒ **STOP**

⇒ repeat observations

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

⇒ distribute error using:

Linear Error Correction

BOWDITCH Method

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

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

Error distributed according to length of each line

For each traverse line

COMPONENT Method

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

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

Error distributed according to component of each line

For each traverse line

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		

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

Connected Traverse

Note that: If bearings are given then start directly by calculating components, while if angles are given, then calculate bearings using the known equation:

$ABC = \alpha_{BC} - \alpha_{BA}$ .....and soon

$N_B = N_A + \Delta N_{AB}$

$E_B = E_A + \Delta E_{AB}$

Point	Side	Length	Bearing	ΔE	ΔN	E	N
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	DE	L_{DE}	α_{DE}	$L_{DE}\sin\alpha_{DE}$	$L_{DE}\cos\alpha_{DE}$	√	√
E						E_E	N_E

Connected 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	DE	L_{DE}	α_{DE}	$L_{DE}\sin\alpha_{DE}$	$L_{DE}\cos\alpha_{DE}$	√	√	√	√
E								E_E	N_E
		$\sum L$		$\sum\Delta E_{comp.}$	$\sum\Delta N_{comp.}$	$\Sigma=E_L-E_F$	$\Sigma=N_L-N_F$		

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

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

As Given Coordinates

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

Solved Example

For the following closed traverse, calculate the balanced 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
		∑L=569.45		**-0.067**	**0.026**	**∑=Zero**	**∑=Zero**		

As Given Coordinates

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

$$\Delta E_{ABcorr.} = 106.646 - (-0.067) * \frac{150.50}{569.45} = 106.664m$$

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

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

Supplementary files:

- https://www.youtube.com/watch?v=gx9HpICYEhw
- https://www.youtube.com/watch?v=Ww7EcE3w_x4
- https://www.youtube.com/watch?v=Zzps6Rz4Cqw

Thanks

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