CVEN303 ENGINEERING MEASUREMENT

Lecture 8 – Balancing Traverse
(Sec. 7.6, 8, & 9)

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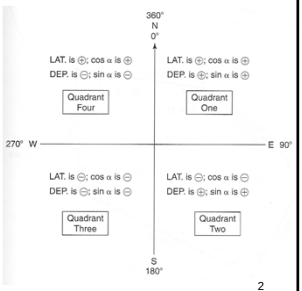
Computing Latitude and Departure using Azimuth

Latitude = D cos α
Departure = D sin α

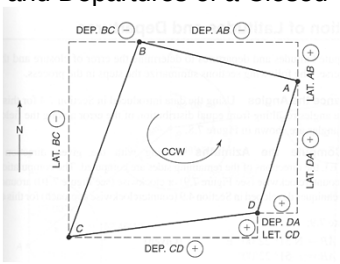
where, D = length of the line; α = Azimuth

Azimuth angle takes care of lat and dep algebraic sign.

(If we use Bearing for computing lat & dep, we have to pay attention to their signs).



Latitudes and Departures of a Closed Traverse



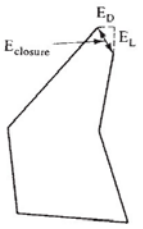
For a closed traverse,
ΣLatitudes = 0
ΣDepartures = 0

Closure Error

Error in Latitude (E_L) = ΣLatitudes
Error in Departure (E_D) = ΣDepartures

What is the total error in closure ($E_{closure}$)?

What is the Accuracy Ratio?



Typical acceptable accuracy is 1/5,000 for rural land, 1/7,500 for sub-urban land, and 1/10,000 for urban land.

Correcting Latitudes & Departures

$$Latitude\ Correction_i = -E_L * \frac{Length_i}{Perimeter}$$

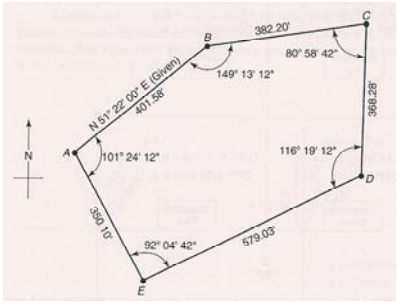
$$Departure\ Correction_i = -E_D * \frac{Length_i}{Perimeter}$$

i is a counter for traverse sides

Compass Rule: the total error is accidental and thus the error in a particular side is directly proportional to its length.

Balancing a Traverse - Example

The interior angles traverse are balanced. We did this in a previous lecture.



Balancing a Traverse – Example (cont.)

Course	Distance (ft)	Azimuth
AE	350.10	152°46′12″
ED	579.03	64°50′54″
DC	368.28	1°10′06″
CB	382.20	262°08′48″
BA	401.58	231°22′00″
	$P = 2081.19$	

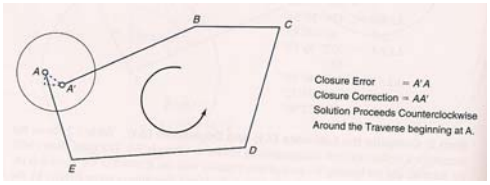
Balancing a Traverse – Example (cont.)

Course	Distance (ft)	Azimuth	Bearing	Latitude	Departure
AE	350.10	152°46′12″	S 27°13′48″E	−311.30	+160.14
ED	579.03	64°50′54″	N 64°50′54″E	+246.10	+524.13
DC	368.28	1°10′06″	N 1°10′06″E	+368.20	+7.52
CB	382.20	262°08′48″	S 82°08′48″W	−52.22	−378.62
BA	401.58	231°22′00″	S 51°22′00″W	−250.72	−313.67
	$P = 2081.19$			Σ lat = +0.06	Σ dep = −0.49

$$E = \sqrt{(\Sigma \text{ lat})^2 + (\Sigma \text{ dep})^2} = \sqrt{0.06^2 + 0.49^2} = 0.49$$

$$\text{Precision ratio} = \frac{E}{P} = \frac{0.49}{2081.19} = \frac{1}{4247} \approx \frac{1}{4200}$$

Balancing a Traverse – Example (cont.)



Balancing a Traverse – Example (cont.)

Course	Distance (ft)	Bearing	Latitude	Departure	C lat	C dep	Balanced Latitudes	Balanced Departures
AE	350.10	S 27°13′48″ E	−311.30	+160.19	−0.01	+0.05	−311.31	+160.27
ED	579.03	N 64°50′54″ E	+246.10	+524.15	−0.02	+0.14	+246.08	+524.27
DC	368.28	N 1°10′06″ E	+368.20	+7.54	−0.01	+0.09	+368.19	+7.60
CB	382.20	S 82°08′48″ W	−52.22	−378.62	−0.01	+0.09	−52.23	−378.53
BA	401.58	S 51°22′00″ W	−250.72	−313.67	−0.01	+0.09	−250.73	−313.58
	$P = 2081.19$		Σ lat = +0.06	Σ dep = −0.49	$\Sigma C_{lat} = -0.06$	$\Sigma C_{dep} = +0.49$	0.00	0.00

$$\text{Latitude Correction}_i = -E_L * \frac{\text{Length}_i}{\text{Perimeter}}$$

$$\text{AE latitude correction} = -0.06 * \frac{350.10}{2{,}081.19} = -0.01\,ft$$

$$\text{Departure Correction}_i = -E_D * \frac{\text{Length}_i}{\text{Perimeter}}$$

$$\text{AE dep correction} = (-) - 0.49 * \frac{350.10}{2{,}081.19} = +0.08\,ft$$

Effect of Traverse Adjustment on the Original Data

In most cases, the adjustment is too small to warrant revising the original data (lengths and directions of traverse sides)

If the data is to be used for layout purposes:

$$\text{New Distance} = \sqrt{(NewLat)^2 + (NewDep)^2}$$

$$\text{New Bearing} = \tan^{-1}\left(\frac{NewDep}{NewLat}\right)$$

Summary of Steps for Balancing Traverse

1. Balance interior angles
2. Compute the azimuth of each side of the traverse (given all interior angles and direction of at least one side)
3. Compute latitude and departure for each side of the traverse
4. Compute total error of closure and accuracy ratio
5. If accuracy ratio is acceptable, correct latitudes and departures using compass rule. Otherwise, redo survey.
6. In some cases (like highly-critical projects), you may need to adjust lengths and directions of the traverse sides using the corrected lat and dep.