UNIT 5

TRAVERSING

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Introduction

Traversing is the method of using lengths and directions of lines between points to determine positions of the points. Traversing is normally associated with the field work of measuring angles and distances between points on the ground. Closed traverses provide the primary method used in checking surveying field work. Traverse closure and adjustment procedures are used to distribute error in measurements. Mathematical traverses performed on a computer are used to check surveying work such as mapping and legal descriptions.

Performance Expected on the Exams

Explain the difference between the precision and accuracy of a traverse.

Identify the sources of error in traversing.

Compute angular misclosure in a traverse and distribute the error.

Compute adjusted coordinates for a traverse given angles and distances measured in the field.

Key Terms

Traverse
Closed figure traverse
Closed linear traverse
Open traverse
Radial traverse
Direct angles
Deflection angles
Ordered surveys
Precision
Accuracy
Collimation error
Systematic error
Random error
Blunder
NAD 1927
NAD 1983
Basis of bearings
Ground distance
Grid distance
Combination factor
Latitudes
Departures
Closure
Balancing angles
Transit rule
Crandall rule
Compass rule
Least squares adjustment

Video Presentation Outline

Purpose and Types of Traverses

- The use and purpose of traversing
- Closed traverses
- Open traverses

Traverse Basics

- Angle and distance measurement
- Basis of bearings
- Coordinate datums
- Standards of accuracy
- Accuracy/precision
- Traverse errors

Traverse Computations

- Sum of angles in closed figures
  $\sum$ interior angles = (n-2) 180°
  $\sum$ exterior angles = (n+2) 180°

  Where:
  n = number of sides

- Distance measurements
  Conversion factors:

  $\frac{12}{39.37}$ U.S. survey feet = meters

  $\frac{39.37}{12}$ meters = U.S. survey feet

- Computing latitudes and departures
  Latitude = cos bearing x length of course
  Departure = sin bearing x length of course

  $\text{tan bearing} = \frac{\text{Dep}}{\text{Lat}}$

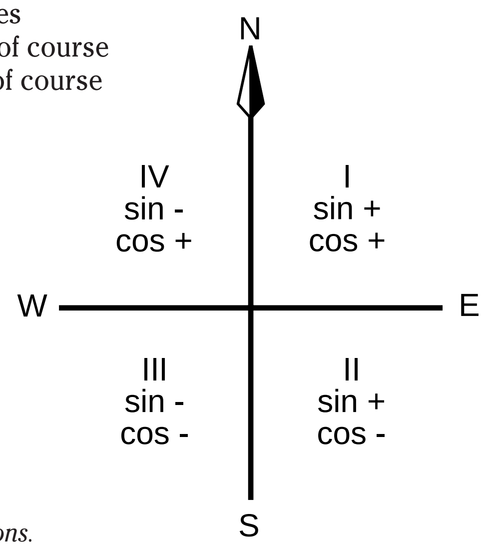


Figure 5-1. *Signs of cosine and sine functions.*

Traverse Closure and Adjustment

- Balancing angles
- Slope reduction of distances

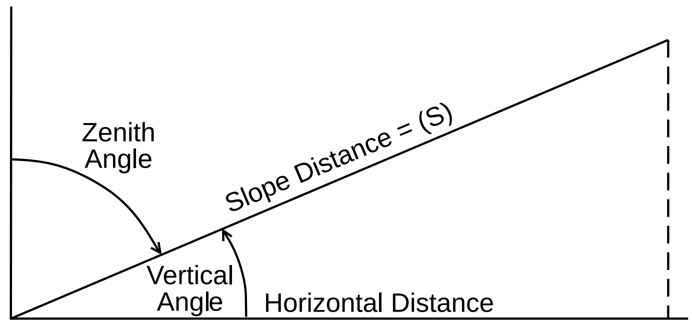


Figure 5-2. *Slope reductions.*

Hor. Dist. = S (cos vertical angle)
or
= S (sin zenith angle)

- Adjustment methods
- Compass rule example

Field Angles and Distances

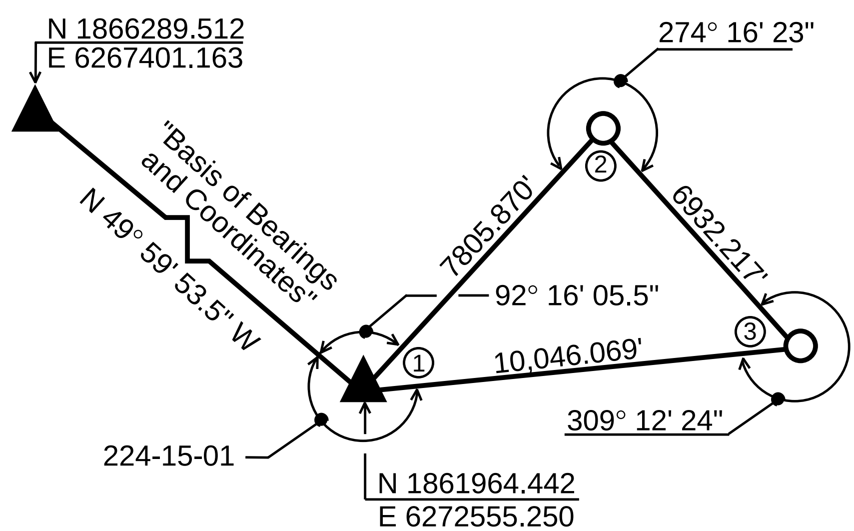


Figure 5-3. *Traverse example.*

Station	Dist.	Bearing	Lat.	Dep.
1	7805.87	N42° 16' 12.5"E	5776.20	5250.44
2	6932.22	S43° 27' 22.4"E	-5032.10	4767.98
3	10046.07	S85° 45' 04.0"W	-744.30	-10018.46
Close	∑ 24,784.16		-0.20	0.04

$$\text{Linear Misclosure} = \sqrt{-0.20^2 + -0.04^2}$$
$$= 0.204$$

- Accuracy (expressed as ratio of closure error):

  0.204/24784.16 = 1/121,491

- Adjustment to latitude of course =

$$\text{Traverse lat misclosure} \times \left(\frac{\text{length of course}}{\text{length of traverse}}\right)$$

- Adjustment to departure of course =

$$\text{Traverse dep misclosure} \times \left(\frac{\text{length of course}}{\text{length of traverse}}\right)$$

Sample Test Questions

1. Answer the following questions true or false.
   A. The terms *precision* and *accuracy* mean the same thing.
   B. A deflection angle is turned from the backsight clockwise to the foresight.
   C. A Record Map is the only valid reference for a basis of bearings.
   D. The compass adjustment method presumes that the angles in a traverse are more accurate than the distances.
   E. The sum of the external angles for a seven-sided figure is 1420 degrees.
   F. To compute the traverse closure accuracy ratio, divide the square root of the sum of the squares of the latitude and departure misclosures by the sum of the horizontal distances of the traverse.
   G. To balance the angles of a traverse, distribute the angular error of closure equally to all the traverse angles.

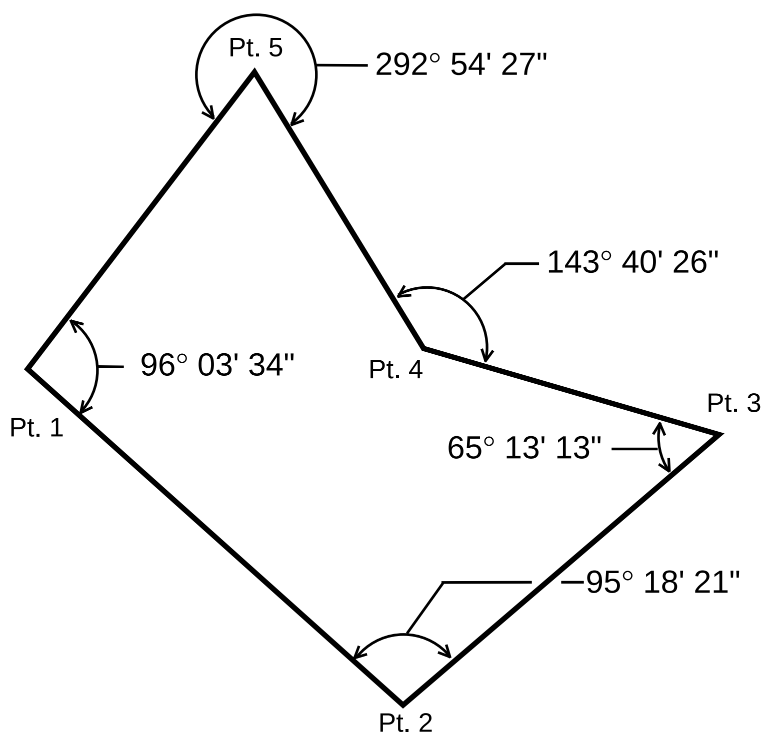
H. According to FGCC standards for Horizontal Traverse Control, a Second Order, Class I Traverse, performed in a metropolitan area, must have a minimum angular closure of not more than 2" per traverse angle, and a minimum linear precision closure of not more than 1:20,000.

I. To convert U.S. Survey Feet to meters, multiply the distance in feet by 12/39.37.

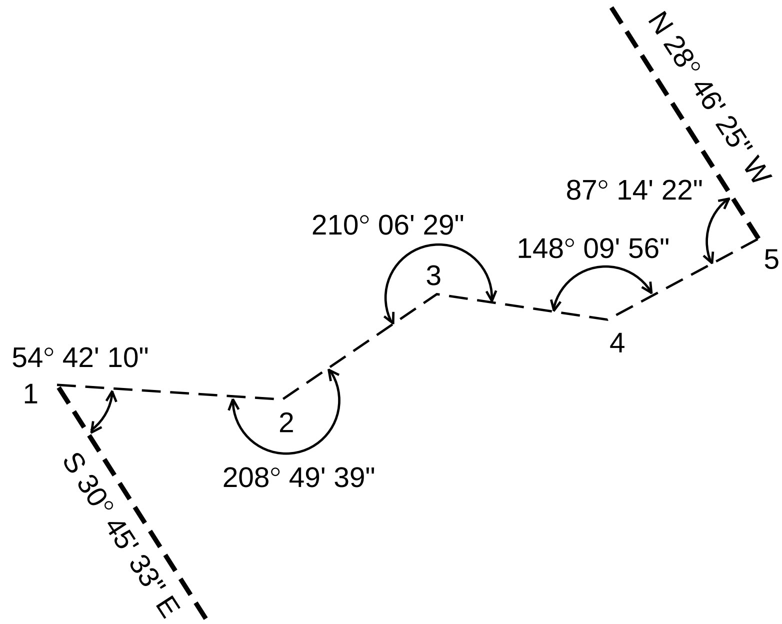
J. Ideally, the algebraic sum of the latitudes of a traverse should equal the algebraic sum of the departures.

K. The latitude of a traverse course is equal to its length, multiplied by the cosine of the bearing of the course.

2. In the sample traverse figure below, calculate the angular error of closure, and balance the traverse angles. Angles shown are unadjusted.

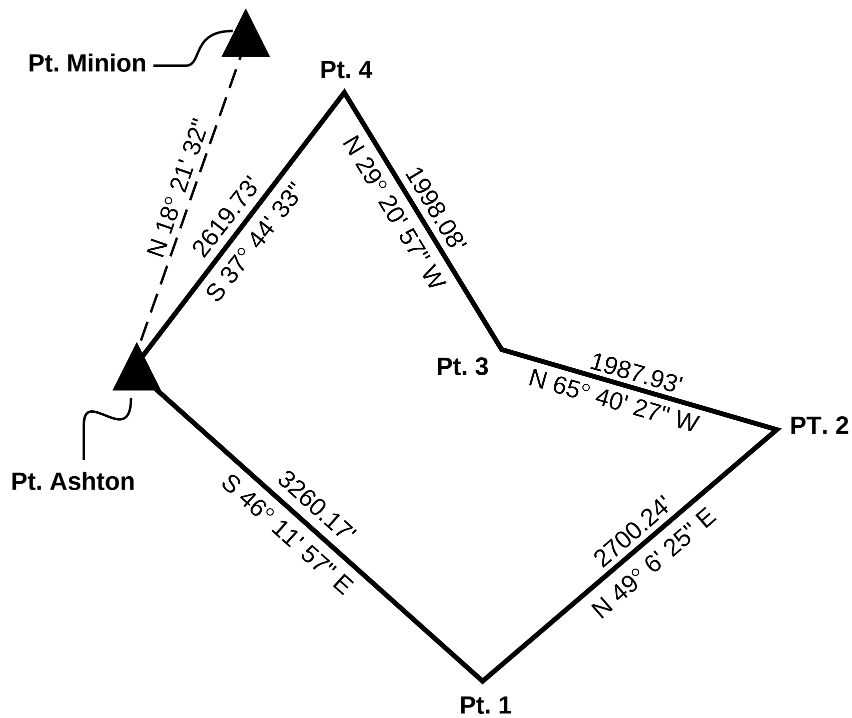


3. Calculate ADJUSTED bearings from field angles:



4. The latitudes of a closed traverse failed to close by -0.27', and the departures failed to close by +0.55'. The sum of the horizontal traverse distances is 8930.27'. What is the error of closure? Express the error of closure as a ratio. Determine the bearing of the error of closure.

5. Calculate the latitudes and departures for each course in this traverse. Bearings shown are from balanced angles and distances are grid. Coordinates for Ashton: E = 1,861,964.442E, N = 6,272,555.250.



6. Perform a compass rule adjustment on the latitudes and departures in problem 5, and list the balanced latitude and departure for each course.

7. Calculate adjusted bearings, distances, and coordinates for the traverse in problem 5.

Answer Key

1.

A.	False	G.	True
B.	False	H.	False
C.	False	I.	True
D.	False	J.	True
E.	False	K.	True
F.	False		

2.

$$\sum \text{Interior angles} = 540° \ 00' \ 15''$$

$$\text{Angular misclosure} = (5\text{-}2)\ 180° - 540° \ 00' \ 15''$$

$$= -00° \ 00' \ 15''$$

$$\text{Adj. per interior angle} = \frac{-00° \ 00' \ 15'}{5} = -00° \ 00' \ 03''$$

Adjusted Angles

Pt. 1	96° 03' 31"
Pt. 2	95° 18' 18"
Pt. 3	65° 13' 10"
Pt. 4	143° 40' 29"
Pt. 5	292° 54' 30"

3.

From – To:	Field Azimuth	Adjusted Azimuth	Bearing
1-2	94° 32' 17"	94° 32' 19"	S 85° 27' 41" E
2-3	65° 42' 38"	65° 42' 42"	N 65° 42' 42" E
3-4	95° 49' 07"	95° 49' 13"	S 84° 10' 47" E
4-5	63° 59' 03"	63° 59' 11"	N 63° 59' 11" E
5-AZ	331° 13' 25"	331° 13' 35"	N 28° 46' 25" W
	(331° 13' 35")		

Distribute 10" in angular closure error by rotating each field azimth by 02" clockwise.

4. Error of closure $= \sqrt{\sum lat^2 + \sum Dep^2}$

$= \sqrt{0.27^2 + 0.55^2}$

$= 0.61'$

Ratio of error

$$\frac{0.61}{8930.27} = \frac{1}{x} = \frac{1}{14646}$$

1:14640

$$\text{cos bearing closing line} = \frac{\sum \text{Lat error}}{\sum \text{Dep error}}$$

$$= \frac{-.27}{.55}$$

Bearing = N60° 35' 59" W

5.

Station	Bearing	Dist.	Lat.	Dep.
Ashton				
	S 46° 11' 57" E	3260.17	-2256.539	2353.028
1				
	N 49° 06' 25" W	2700.24	1767.710	2041.200
2				
	N 65° 40' 27" W	1987.93	818.879	-1811.437
3				
	N 29° 20' 57" W	1998.08	1741.624	-979.320
4				
	S 37° 44' 33" W	2619.73	-2071.603	-1603.573
Ashton				
	Σ	12,566.15	0.071	-0.102

Closing Line S 34° 50' 27" E 0.124'

Closure 1:101113

6.

Station	Lat.	Dep.	Correction Lat.	Correction Dep.	Balanced Lat.	Balanced Dep.
Ashton						
	-2256.539	2353.028	-0.019	0.027	-2256.558	2353.055
1						
	1767.710	2041.200	-0.015	0.022	1767.695	2041.222
2						
	818.879	-1811.437	-0.011	0.016	818.868	-1811.421
3						
	1741.624	-979.320	-0.011	0.016	1741.613	-979.304
4						
	-2071.603	-1603.573	-0.015	0.021	-2071.618	-1603.552
Ashton						
∑	0.071	-0.102	-0.071	0.102	0.00	0.00

7.

Station	Adjusted Bearings	Dist.	Adjusted N	Adjusted E
Ashton				
	S 46° 11' 57" E	3260.20	6,272555.250	1,861,964.442
1				
	N 49° 06' 27" E	2700.25	6,270,298.692	1,864,317.497
2				
	N 65° 40' 27" W	1987.91	6,272,066.387	1,866,358.719
3				
	N 29° 20' 57" W	1998.06	6,272,885.255	1,864,547.298
4				
	S 37° 44' 31" W	2619.73	6,274,626.868	1,863,567.994
Ashton			6,272,555.250	1,861,964.442

References

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