

CE 303 ENGINEERING MEASUREMENTS

Lecture 6 – Angles & Directions (Ch. 4)

2013

Developed by Nasir G. Gharaibeh, Ph.D., P.E.
Zachry Department of Civil Engineering
Texas A&M University

1

Traverse

- A series of connected lines of known lengths and related to one another by known angles.
- Types of traverse:
 - Closed Traverse
 - Open Traverse

The open traverse diagram shows a path starting at station 0, going to station 17 + 42.86, then to station 38 + 14.53, and finally to station 50 + 77.62. The interior angles are 18° 26' L and 40° 12' 30" R.

2

Traverse Angles

- Interior angle
- Exterior angle
- Deflection angle
 - Left deflection
 - Right deflection

The traverse diagram shows stations at 00, 3 + 71.26, 7 + 60.20, 10 + 42.63, and 16 + 08.09. The angles are 90° 10' (interior), 9° 31' R (interior), 24° 52' L (interior), and 11° 32' R (interior). A control station is shown at station #631 and #632.

3

Direction of Traverse Sides

- Azimuth angle
- Bearing angle

4

Azimuth

- Azimuth: Clockwise angle from the north end of the reference meridian to the line in question.
- Back Azimuth (opposite to survey direction of progress)
- Commonly measured in the field and used in surveying computations.

The diagram shows two vertical reference meridians, NS and N'S'. A line segment AB is drawn between them. The azimuth is the clockwise angle from the north end of the first meridian to the line AB. The back azimuth is the clockwise angle from the north end of the second meridian to the extension of line AB.

5

Forward Azimuth vs. Backward Azimuth

- If Forward Azimuth < 180°,
Back Azimuth = Azimuth + 180°
- Example:
Azimuth LP =
Azimuth PL =
- If Forward Azimuth > 180°,
Back Azimuth = Azimuth - 180°
- Example:
Azimuth CD =
Azimuth DC =

The first diagram shows a line segment LP with a forward azimuth of 85°. The second diagram shows a line segment CD with a forward azimuth of 320°.

Answers: Az LP=85°; Az PL=265°; Az CD=320°; Az DC=140°

6

Azimuth Examples

What are the Azimuths of lines 0-1, 0-2, 0-3, and 0-4?

(a)

Answers: Az 0-1 = 52°; Az 0-2 = 121°; Az 0-3 = 202°; Az 0-4 = 325°

Bearing

- Bearing: Smallest angle which the line in question makes with the reference meridian.
- Horizontal angle measured from (north or south) toward (east or west)
 - Bearing OA = N 70° E
- Used in legal descriptions and documents.
- Not convenient for computers.

Back Bearing

- Back Bearing (opposite to the survey's direction of progress):
 - Change N to S (and visa versa) and E to W (and visa versa) [i.e., switch letters]
 - Example: (Solved in class)

Bearing AB =
Bearing BA =

Bearing

What are the Bearings of lines 0-5, 0-6, 0-7, and 0-8?

Solved in class

Given Data

Answers: Bg 0-5 = N 52° 20' E; Bg 0-6 = S 24° 50' E; Bg 0-7 = S 27° 30' W; Bg 0-8 = N 10° 45' W

Converting Azimuth to Bearing

Convert the Following Azimuth to Bearing: Solved in class

Converting Azimuth to/from Bearing

Converting from Azimuths to Bearings		
Azimuth	To Bearing	
0° to 90°	none	
90° to 180°	180° - Azimuth	
180° to 270°	Azimuth - 180°	
270° to 360°	360° - Azimuth	
Example		
Azimuth	Calculation	Bearing
54°	no action needed	N 54° E
112°	180° - 112° = 68°	S 68° E
231°	231° - 180° = 51°	S 51° W
345°	360° - 345° = 15°	N 15° W

Crawford, pbonline.com, 2000.

Vertical Angles

- Vertical Angle
 - Angle measured in vertical plane from a horizontal line upward (positive value) or downward (negative value).
 - Positive value referred to as elevation.
 - Negative value referred to as depression.
 - Vertical angle lies between 0° and $\pm 90^\circ$.
- Zenith Angle
 - Angle measured in a vertical plane downward from an upward directed vertical line through the instrument.
 - Zenith angle lies between 0° and 180° .

