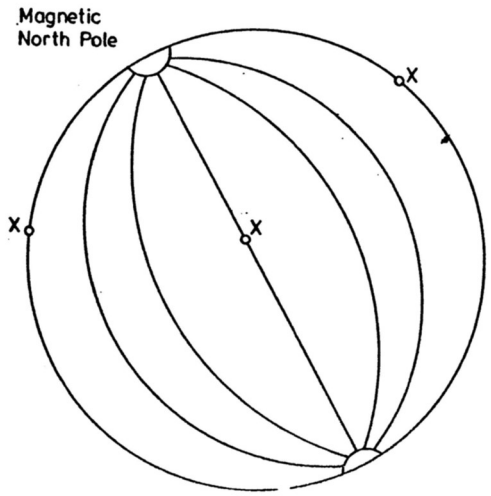
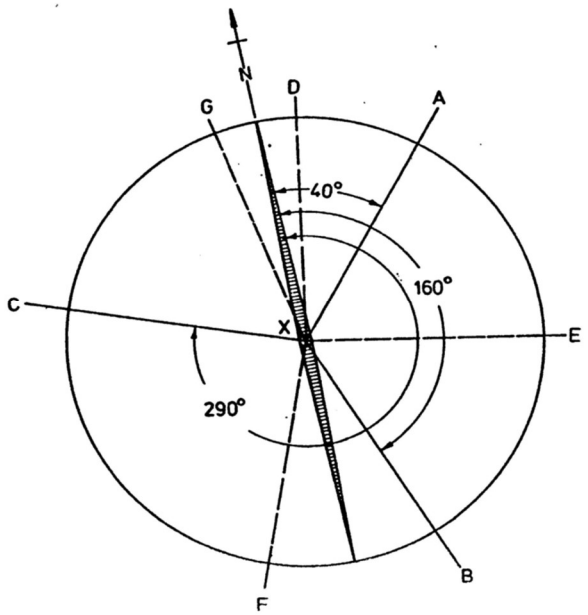
COMPASS AND BEARINGS

INTRODUCTION

On all compasses, there is a magnetic needle, which, when suspended freely, or when allowed to swing freely on a pivot, will settle in the magnetic meridian. That is it will point to the magnetic north.



Compass



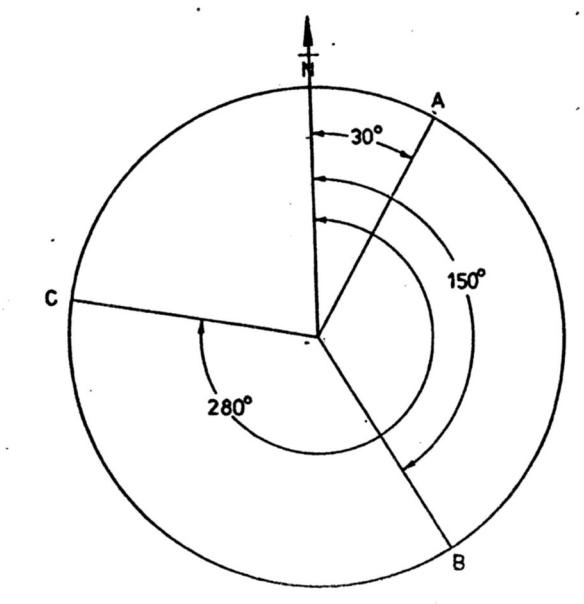
The line XA makes an angle of 40^0 with the magnetic meridian, while line XB makes an angle of 160^0respectively. The maximum value of any angle is 360^0. The angle of 160^0formed by the meridian XN and the line XB is the whole circle magnetic bearing of line XB.

The whole circle magnetic bearing of a line is defined as the angle measured in a clockwise direction from the magnetic meridian to the line.

The whole circle magnetic bearing of the XA and XB are $40^0$and 160^0respectively.

True Bearing

Any angle measured in a clockwise direction from the true meridian to a line is a true whole circle bearing



The true whole circle bearing of line XA, XB and XC are 30^0,$150^0$and 280^0respectively.

Assumed Bearing

On local surveys of small building site and engineering works, it may not be necessary to relate the survey to either magnetic or true north. Some arbitrary point is chosen as a reference object and treated as being the equivalent of the North Pole. Common reference object are tall Chimneys, Church Towers, and Pegs hammered into the ground at some points where they can be easily found. The whole circle bearings are therefore the clockwise angles measured from the reference object to any points.

Forward and Back Bearings

To obtain back bearing from forward bearings, or vice versa, add or subtract 180^0.

Example 1

The forward bearing of four lines are shown below. Calculate the back bearings.

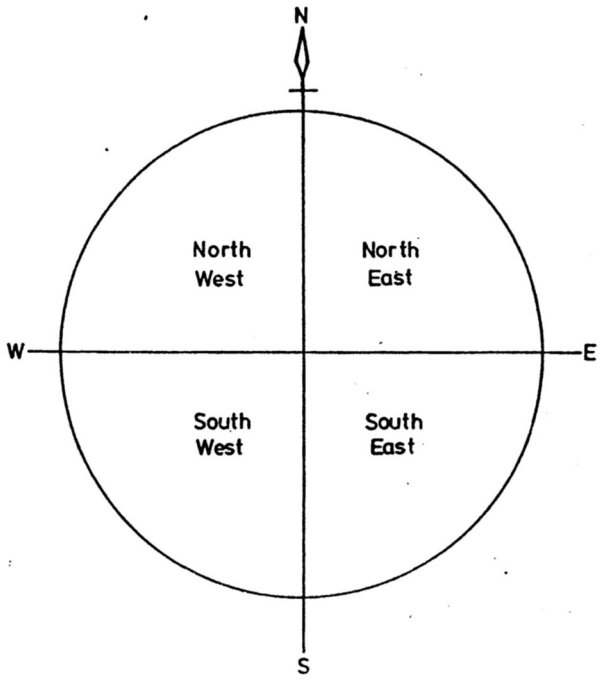
AB=31^0; BC=$157^0$30'; CD=200^0; DE=$347^0$15';

Solution to Example 1

Line	Forward bearing		Back Bearing
AB	$31^0$00'	+180^0 00'	$211^0$00'
BC	$157^0$30'	+$180^0$00'	$337^0$30'
CD	$200^0$00'	-$180^0$00'	20^0 00'
DE	$347^0$15'	-$180^0$00'	$167^0$15'

Quadrant Bearings or Reduced Bearings

If the cardinal points of the compass are drawn and labeled North, East, South and West respectively, the whole circle 360^0circle will have divided into four quadrants of 90^0.



The quadrant bearing are known as the north-east, south-west and north-west quadrants. The angle is given the name of the quadrant into which it falls.

Examples 2

The whole circle bearings of four lines AB, AC, AD, and AE are 40^0, 121^0, $242^0$and 303^0respectively. What are the quadrat bearings of these lines?

Solution to Example 1

Lines	WCB		QB
AB	40^0		$N40^0E$
BC	121^0	180^0-121^0	$S59^0E$
CD	242^0	242^0 -180^0	$S62^0W$
DE	303^0	360^0 -303^0	$N57^0$ W

The conversion of WCB to QB sometimes called the RB (Reduced Bearing) can be readily carried out by the following rules:

1. When the WCB lies between $0^0$and 90^0, it's QB has the same numerical value and lies in the NE quadrant.
2. When the WCB lies between $90^0$and $180^0$the QB is (180^0-WCB) and lies in the SE-quadrant
3. When the WCB lies between $180^0$and $270^0$the QB is (WCB-180^0) and lies in the SW-quadrant.
4. When the WCB lies between $270^0$and $360^0$the QB is (360^0-WCB) and lies in the NW-quadrant.

TRAVERSING

INTRODUCTION

A traverse survey is a type of control survey which involves the establishment of a series of points that are linked together by lines to form a framework. The series of straight lines that connect the successive points are called traverse lines. The ends that defined each traverse line are called traverse stations or traverse points. The framework formed by connected survey lines of known length and direction is called a traverse.

In the figure-1 below, A, B, C and D are traverse stations. AB, BC, and CD are traverse lines.

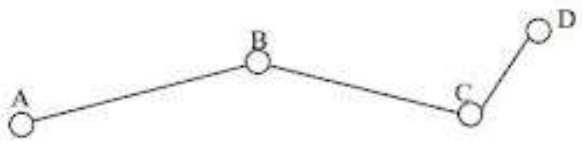


Fig.1. Traverse Survey

In traversing, the surveyor move from one point to other by simultaneously measuring bearings and distances by "dead reckoning". Dead reckoning is the process of calculating current position of some moving object by using a previously determined position.

Scope and Objective of Traverse Survey

Traverse survey is conducted to establish horizontal control in land areas especially in areas where the line of sights (LOS) are short due to heavy built-up areas, where the survey methods triangulation and trilateration are not applicable.

The main objective of traverse survey are:

1. To locate or establish boundaries
2. To achieve horizontal control for topographic surveys

3. To locate and prepare construction layout for highways, railways, and other private and public works
4. To conduct ground control surveys for photogrammetric surveys

Read On: Difference between Triangulation & Trilateration in Surveying

Types of Traverse

The two types of traverse encountered while conducting surveys are:

1. Open Traverse
2. Closed Traverse

Open Traverse

Open traverse is a traverse that starts at a point of known position and terminates at a point of unknown position. An open traverse is suitable for surveying along a narrow strip of land. For example, it is used for surveying roads, railways, canals, rivers, coastline, pipeline, etc.

An open traverse can run from few hundred meters to kilometers. The figure (b) below shows open traverse ABCDEF.

The consistence of angles and distance measurement. Measurement cannot be checked in open traverse. So, in order to minimize the errors, the distances can be measured twice, angles turned by repetition, etc.

Closed Traverse

Closed traverse originates at a point of known position and close on another point of known horizontal position. A closed traverse can be a closed link traverse (where the position of A and D is known) or a closed loop traverse (where the traverse starts and ends at A, whose position is known). A closed traverse is suitable for locating the boundaries of lakes, houses, lawns, gardens and for large areas like towns, residential campus etc.

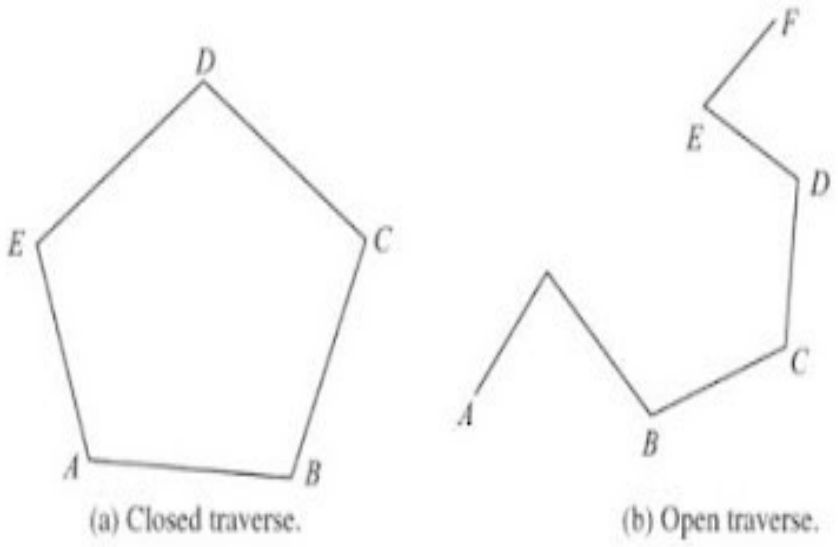


Fig.2. Types of Traverse - Open and Closed Traverse

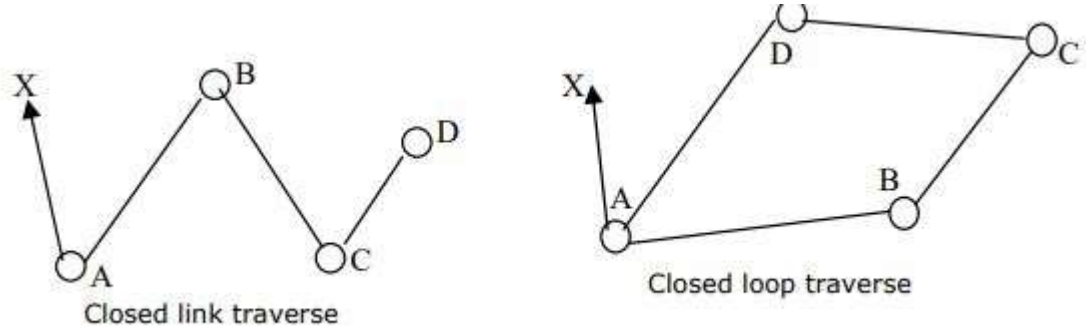


Fig.3. Types of Closed Traverse

How are Traverse Lines Measured?

The traverse lines is either determined by:

1. Direct measurement : Tapes, EDM
2. Indirect measurement: Tachometric Methods
3. Angular measurement : Theodolite

Whenever there is change in direction of the traverse, an angular measurement is taken.

Different Methods of Traversing in Surveying

A traverse survey can be performed in several ways based on the method and the instrument used:

1. Chain Traversing
2. Compass Traversing
3. Interior angle traverse
4. Theodolite Traversing
5. Deflection angle traverse
6. Angle to the right traverse
7. Azimuth traverse
8. Stadia Traversing
9. Plane table and alidade Traversing

What is the Procedure to Perform Traverse Survey?

The steps involved in Traverse Survey are:

1. Reconnaissance
2. Selection of Traverse Stations
3. Linear and Angular Measurements

Step 1: Reconnaissance

Reconnaissance is defined as preliminary field inspection of the entire area that need to be surveyed. This involves:

1. The surveyor go to the field and check the entire area.
2. He decides the best plan of working.
3. He checks the intervisibility of the traverse stations
4. He decides the method of traversing to be adopted
5. Based on the method chosen, the instruments and accessories are selected accordingly.

Step 2: Selection of Traverse Stations

The basic principle followed in surveying is "working from whole to part "and it is adopted.

1. A minimum number of traverse stations should be selected.
2. Take the length of the traverse line as long as possible to reduce the time and centering effect of stations.
3. Try to select stations on a level and firm ground
4. After selecting the stations, mark them using pegs.

Step 3: Linear and Angular Measurements

The distances between the stations are measured using a tape or chain or Tacheometric method or EDM instruments. The angular measurements are done using a compass or theodolite.

Example 1 - Open Traverse

A theodolite traverse PabQ was carried round a hillside to correct stations P and Q. The horizontal lengths were Pa=175.29m, ab=316.78m, bQ= 98.15m.
The horizontal angles, measured clockwise from the back station were;
Pab=117^{0}48'20", abQ=132^{0}21'40'' and the bearing of Pa=255^{0}34' 00". Calculate the length of the quadrant bearing of PQ.

Solution

Hint

1. First determine the WCB and QB of each line.
2. Calculate the northings and eastings of each line.
3. Finally, the length can be calculated.

Accordingly, a WCB can be evaluated by adding the internal angles at a station to the WCB of the previous line applying ±180^0.

		WCB	QB
WCB of line Pa	255^{0}34'00"	255^0 34'00"	S75^0 34'00"W
Angle Pab	117^0 48'20"		
(add)	373^0 22'20"		
(deduct)	180^0 00'00"		

WCB of line ab	193^0 22'20"	$193^0$22'20"	S $13^0$22'20"W
Angle abQ	132^0 21'40"		
(add)	325^0 44'00"		
(deduct)	-$180^0$00'00"		
WCB of line bQ	145^0 44'00"	140^0 44'00"	S $34^0$16'00"E

Line	Length (m)	WCB	QB
Pa	175.29	$255^0$34'00"	S$75^0$34'00"W
Ab	316.78	$193^0$22'20"	S13^0 22'20"W
bQ	98.15	145^0 44'00"	S$34^0$16'00"E

The eastings and northings differences will be calculated in the next chapter.

Closed Traverse

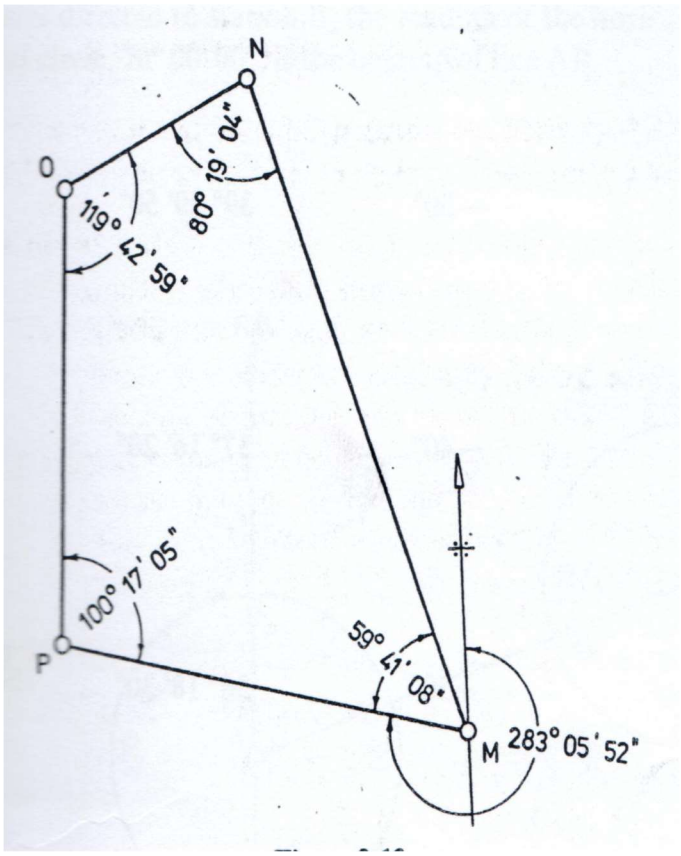
In this type of traverse, the line closed to form a polygon.

Polygonally Closed Traverse

This type of traverse is self-checking to some extent, because the sum of the exterior or interior angles of any polygon should be (2n±4) x90^0. Where n is the number of instrument stations.

Example 2 - Closed Traverse

The figure show the mean observed angles of the closed traverse MNOP. Calculate the whole circle bearings and quadrant bearings of each line.



Solutions

Sum of the interior angle = (2n -4) x 90^0
= 2 x(4) – 4x90^0
= $360^0$00'00"

Sum of Observed Angles = 119^0 42'59"
80^0 19'04"
59^0 41'08"
+ $100^0$17'15"
360^0 00'16"

Angular Error = (360^0 00'00" -360^0 00' 16") = +16''

Correction per angle = $\frac{-16''}{4}$ = - 0.4''

Angle	Obs.Values	Correction	Corrected Angles
PMN	$59^0 41' 08"$	- 0.4	$59^0 41'04"$
MNO	$80^0 19'04"$	- 0.4	$80^0 19'00"$
NOP	$119^0 42'59"$	- 0.4	$119^0 42'00"$
OPM	$100^0 17'05"$	- 0.4	$100^0 17' 01"$
			$360^0 00'00"$

Using the corrected angles

		WCB	QB
True Bearing	$283^0 05'52"$		
	$-180^0 00'00"$		
WCB of line PM	$103^0 05'52"$	$103^0 05'52"$	$S76^0 54'08"E$
Angle of line PMN	$59^0 41'04"$		
(add)	$162^0 46'56"$		
	$+180^0 00'00"$		
WCB of line MN	$342^0 46'56"$	$324^0 46'56"$	$N17^0 13'04"W$
Angle of line MNO	$80^0 19'00"$		
(add)	$423^0 05'56"$		
	$-180^0 00'00"$		
WCB of line NO	$243^0 05'56"$	$243^0 05'56"$	$S63^0 05'56"W$
Angle of line NOP	$119^0 42'55"$		
(add)	$362^0 48'51"$		
	$-180^0 00'00"$		
WCB of line OP	$182^0 48'51"$	$182^0 48'51"$	$S76^0 54'08"E$
Angle of OPM	$100^0 17'01"$		
(add)	$283^0 05'52"$	Starting point	