Contact Details:
Mobile: +260 968 324 284
Email:
Bwalya.kawimbe@unza.zm/
bkawimbe@gmail.com

Department of Geomatic Engineering
School of Engineering

Mr. Bwalya J. Kawimbe
Office: B.Eng. Main Building, 1st Floor, Former Zagis Offices, Room 2.

Point Determination

Contents

- ✓ Single point determination
- ✓ Multiple point determination
- ✓ Polar and Joins

Single Point Determination

There are 3 types of elementary measurements. These are Distance, Bearing and Angle. Bearings can be measured either directly by the use of a compass or indirectly by a known bearing + angle. Under this section, two types of single point positioning techniques are discussed. These are: Intersection and Resection.

INTERSECTION

With intersection a minimum of two known points is needed to coordinate a third point, and the unknown point is just measured to. There are a number of combinations of quantities to be measured. These are:

Distance + distance

Distance + bearing

Distance + angle

Bearing + bearing

Bearing + angle

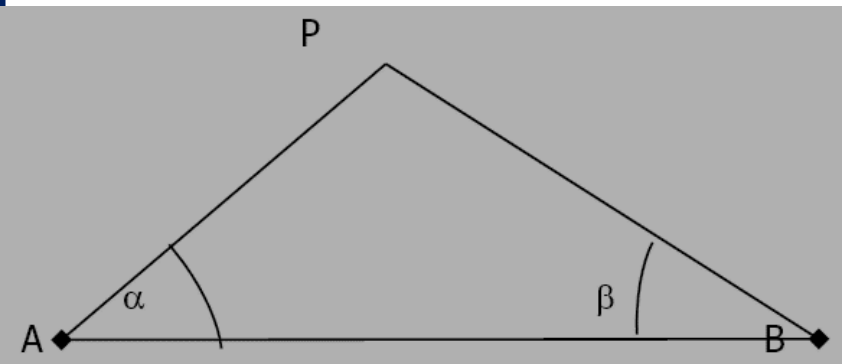
Angle + angle

This method of coordinating a point is suitable in cases where the point to be coordinated can not be set on. Such points as radio masts, electricity poles, aerials, etc.

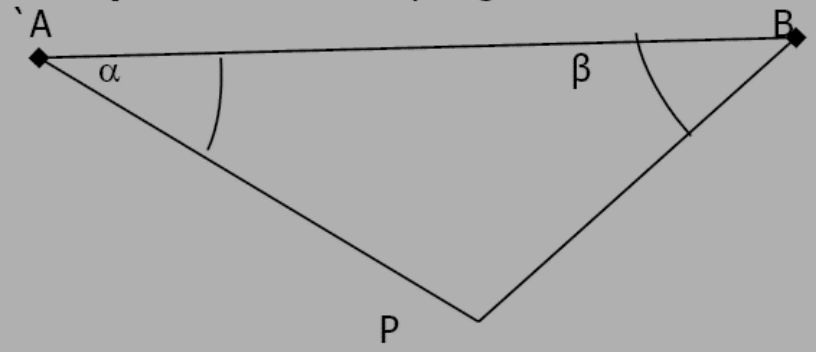
Single Point Determination

Given:

- (Ea, Na) and (Eb, Nb)
- Measured or Derived: α and β
- Wanted: Ep, Np)



Example: Intersection by angles.



Known points

A 174.86 (E) 967.01(N)
B 551.49 (E) 684.54(N)

Measured angles

α 53° 06' 42″
B 64° 17' 20″

Solution:

- Compute a join between A and B i.e. distance and bearing
- Compute the bearing to P from A and P from B i.e.

$$\varphi_{AP} = \varphi_{AB} + \alpha$$

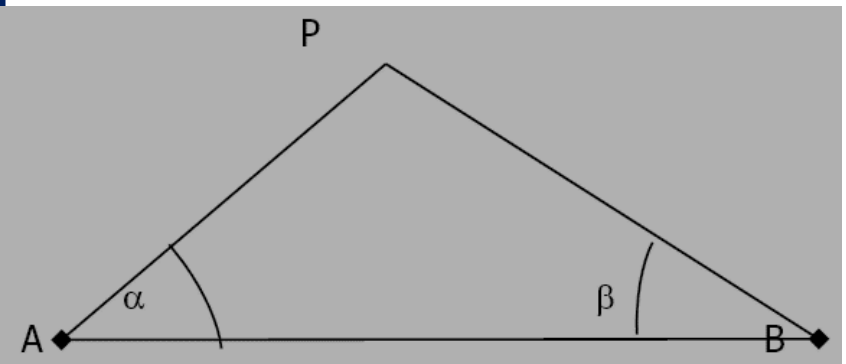
$$\varphi_{BP} = \varphi_{AB} \pm 180° - \beta$$

- Compute the distance AP and BP using Sine rule
- After that the coordinates of P are:

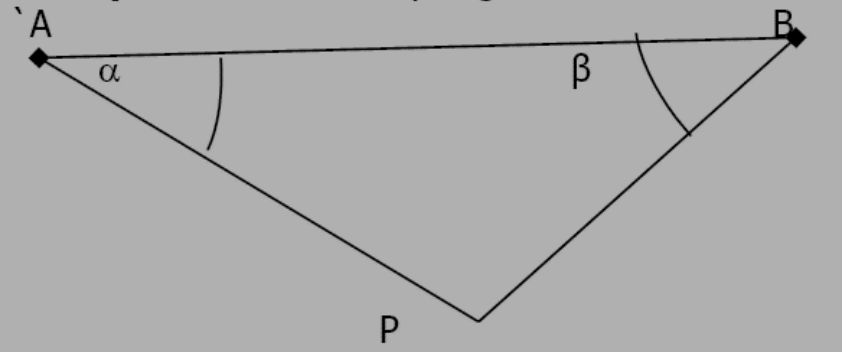
Single Point Determination

Given:

- (Ea, Na) and (Eb, Nb)
- Measured or Derived: α and β
- Wanted: Ep, Np)



Example: Intersection by angles.



Known points

A 174.86 (E) 967.01(N)
B 551.49 (E) 684.54(N)

Measured angles

α 53° 06' 42"
B 64° 17' 20"

Solution

$$X_P = X_A + d_{AP}\cos\varphi_{AP}$$
$$Y_P = Y_A + d_{AP}\sin\varphi_{AP}$$

From point A

$$X_P = X_B + d_{BP}\cos\varphi_{BP}$$
$$Y_P = Y_B + d_{BP}\sin\varphi_{BP}$$

From point B

The final set of coordinates is the average of the two.

Multiple Point Determination

Introduction

Traversing is one of the many multiple point positioning methods. The positions of the control points (survey stations) are fixed by measuring the horizontal angles at each station, subtended by the adjacent stations and the horizontal distance between consecutive pairs of stations.

Traverse networks are used:

1. As control for topographic detail surveying
2. As control for setting out surveys such as roads, railways, etc.
3. For ground control for photogrammetric mapping
4. In cadastral surveys

Multiple Point Determination

Types of traverses

There are two categories of traverses. Depending on the way the network starts and ends, it can be open or closed.

Open Traverse

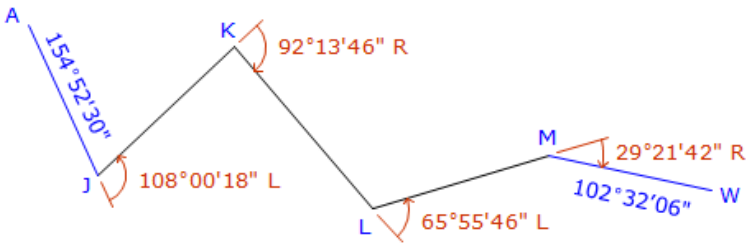
This type of traverse network starts at known points and ends on unknown point. These type of traverses are used in exceptional circumstances since there is no external check on the measurements. However, open traverses are used mainly in tunneling work where the physical situation prevents closure on known points. It is important therefore that measured angles, distances and instrument centering be very carefully checked.

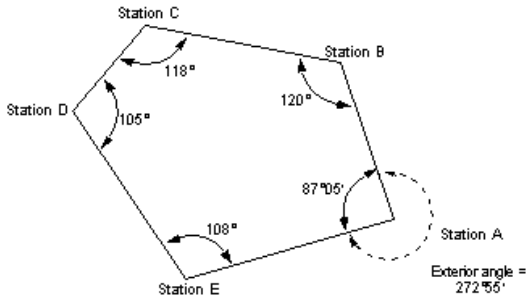
Closed Traverse

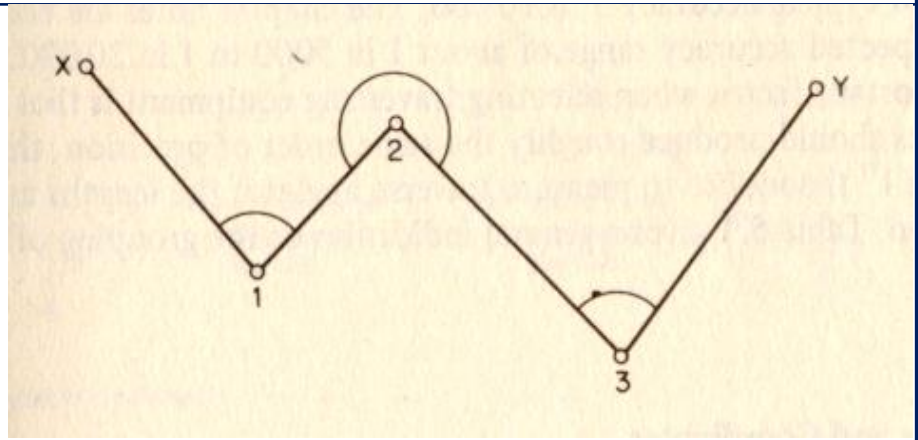
A closed traverse network is one, which starts and ends on the known points. There are two types of closed traverses: a closed link traverse and a closed loop traverse (see figure 1 below). A closed link traverse starts from known points, say A and B and ends at other known points C and D where as the closed loop traverse starts from known points, say A and B and ends at the same points A and B.

Multiple Point Determination

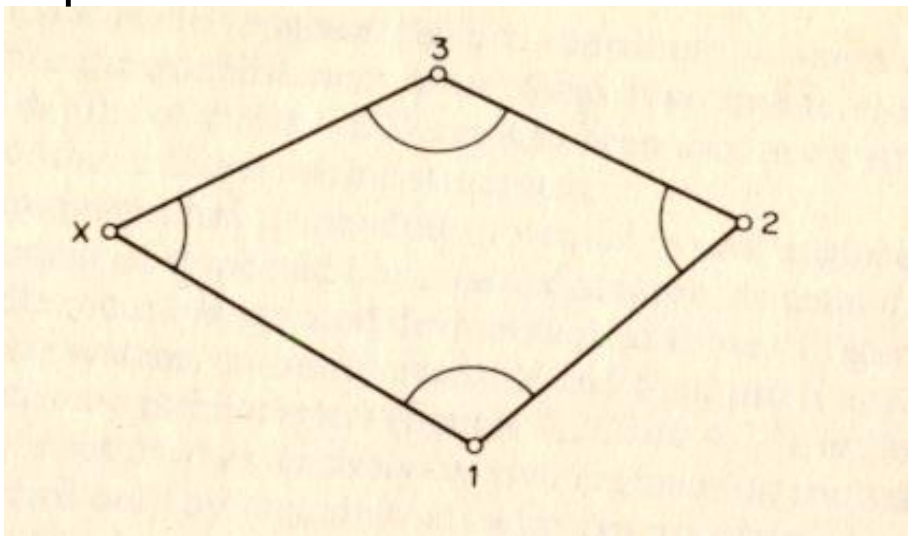
The advantage of both the above traverses is that there is an external check on the measurements since the traverses start and end on known points.







Open Traverse



Closed Traverse

Units of Measurements

✓ *Length*

There are two systems in use today, the **SI a**nd the **British System,** which are the metre and the foot, respectively. In Zambia a metre is mostly used nowadays.

$$\mathbf{1}\boldsymbol{Foot}\ (\boldsymbol{ft}) = \mathbf{0.304799472}\ \boldsymbol{m} \approx \mathbf{0.305}\ \boldsymbol{m}$$
$$\mathbf{1}\boldsymbol{metre}\ (\boldsymbol{m}) = \mathbf{3.280845583}\ \boldsymbol{ft} \approx \mathbf{3.280}\ \boldsymbol{ft}$$

✓ Area and Volume

For area and volume the SI units are cubic metre (m^3)

Units of Measurements

Angles

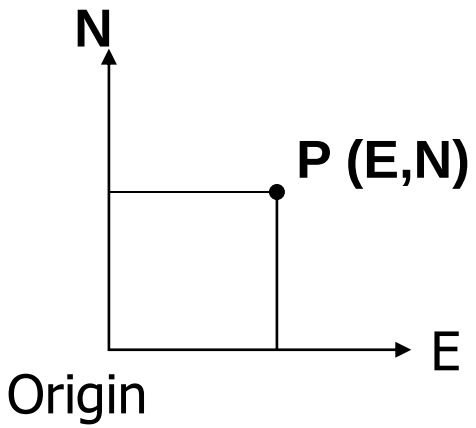
There are three systems used in angular measurements, namely the Sexagesimal, the Centesimal and the radian systems.

In Sexagesimal System, the measurements are degrees, minutes, seconds or decimal degrees, i.e. **1 full**

circle → 360° 00' 00" or 360.0000°

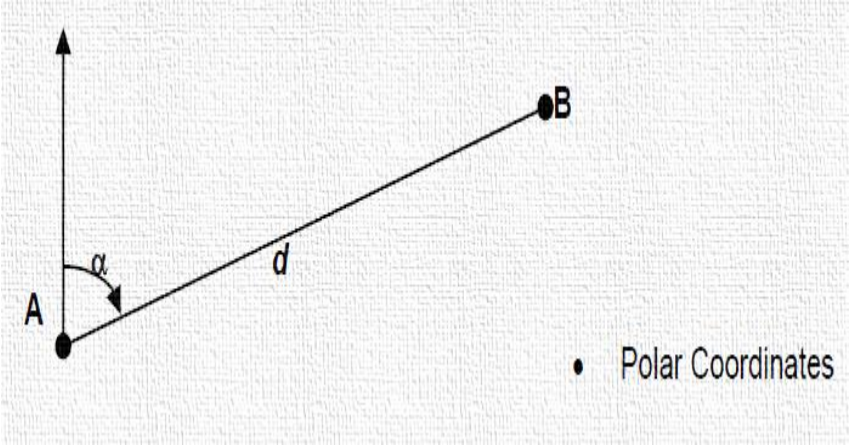
Location of Points-Rectangular Co-ordinate System

The N- axis is defined along the North-South direction and the E- axis along the East-West direction. For example, a point P is expressed as P (E,N).



Location of Points-Polar Co-ordinate System

The relative position of two points can also be given by distance (d) between the points and the bearing (∝) These are referred to as Polar coordinates. (Figure below).



Location of Points-Polar Co-ordinate System

Useful terms

- A Join: making a join means to determine the distance and bearing between two points given their rectangular coordinates.

- A Polar : means the determination of the coordinates of the second point given the coordinates of the first point, and the length and bearing to the second point.

- A Bearing: this is a clockwise angle from the reference direction (say like from the North). This bearing can be defined either as a "Whole Circle Bearing" (WCB), that is between $0° \; and \; 360°$ from the North

direction (reference) or as a Quadrant (Reduced) Bearing, that is between $0° \; and \; 90°$ with respect to the North or South and the line to the point.

Location of Points-Polar Co-ordinate System

$$Bearing = \arctan\frac{\Delta E}{\Delta N}$$

The computation of a bearing as shown above does not show the exact value especially in the second, third and fourth quadrants. The quadrants are numbered clockwise starting from the upper right one. The quadrant where the point lies is determined by the value (+ or -) of the changes in E and E-axes, i.e. ΔE and ΔN in the respective quadrants. The figure below shows the values of the changes and what value has to be added.

Location of Points-Polar Co-ordinate System

Except in the first quadrant, the ratio $\frac{\Delta E}{\Delta N}$ will either be negative or positive depending on the quadrant. Therefore, the correct value is obtained by adding or subtracting an appropriate angle or bearing. i.e.

2nd quadrant: Add 180° (*NB your adjacent is your change in the Northing*).

3rd quadrant: Add 180°

4th quadrant: Add 360°