II. COMPASS SURVEYING AND PLANE TABLE SURVEYING:


Compass Surveying.

The branch of surveying in which direction of survey line are determine by a compass and their length by a chain or tape is called compass surveying. This type of survey can be used to measure large areas with reasonable speed and accuracy.

prismatic compass

Prismatic compass is a instrument used to measure the bearing of a line. It consists of a magnetic needle pivoted at the center and is free to rotate. The area below the magnetic needle is graduated between 0 to 360 degrees. The instrument cover consists of a sighting vane and vertical hair to align the compass along the instrument station and the staff station.

Traverse

A series of connected straight lines each joining two points is called traverse. Traverse may be either a closed traverse (or) open traverse. Traversing using compass is done by observing magnetic bearings of surrounding points from a point and shifting the point of observation along the traverse direction.

Fore and Back bearing

A line may be expressed by two bearings observed from the either end of the line. Both the bearings expressed in whole circle bearing deter each other by 180°. The bearing of the line in the direction of progress of survey is called fore or Forward bearing while the bearing opposite to the direction of the progress of survey is known as reverse of Back bearing.
closing error

When a close traverse is plotted from the field measurements the ends stations of a traverse generally doesn’t coincide exactly in the starting station. This is due to the error in field observations such an error of traverse is known as closing error or error of closer.

local attraction in determining bearing of a line

Bearing of a line is determined using a magnetic needle. In certain locations presence of high voltage cables, railway tracks, etc alters the orientation of the magnetic needle towards the north, there by erroneous readings are observed. This can be minimized by taking back bearings to the same line or by taking observations from intermediate points in between the stations.

Dip

When a magnetic needle is suspended freely it always points north. Due to certain factors magnetic needle may not point true north, it points at a direction away from north called magnetic north. The included angle between magnetic north and true north is called dip or declination.

Plane table surveying

The principle of plane tabling in based on the fact that the lines jointing the points in the plane table are made to line parallel to the corresponding lines joining the points while working at each station. In this method observations and plotting are done simultaneously minimizing error and time.

Name the methods employed in Plane table surveying.

This surveying may be carried by one of the following method:-

(i) Radiation
(ii) Traversing
(iii) Intersection
(iv) Resection method

Plane table traversing

Method of traversing by a plane table is similar to that of compass traverse. In plane table traverse a table is set at each successive station a fore site is taken to the next station and it’s location is plotted by measuring
the distance directly between the two stations. Sometimes a resection may be drawn from the location between the two stations to minimize the error.

true and magnetic meridian.

True meridian is the angle between the observed line and actual north. This is the bearing observed in the absence of local attraction or magnetic declination.

Magnetic meridian is the angle between the observed line and magnetic north. Magnetic north may deviate from true north due to local attraction or magnetic declination.

\[
\text{True Meridian} = \text{Magnetic Meridian} \sim \text{Dip}
\]

Compass Surveying:-

The branch of surveying in which direction of survey line are determine by a compass and their length by a chain or tape is called compass surveying.

The method of chain surveying is used for small areas of survey. If the area to be surveyed is comparatively large with undulations compass survey is adopted, before recommending the compass survey for any area, it must be ascertained the area is not magnetically declined.

Traverse:-

A series of connected straight lines each joining two points is called traverse. Traverse may be either a closed traverse (or) open traverse. Traversing using compass is done by observing magnetic bearings of surrounding points from a point and shifting the point of observation along the traverse direction.

Designation of bearings:-

Bearings of survey lines are design as

(i) Whole circle bearing
(ii) Quadrental bearing

Whole Circle Bearing (WCB)

In this method bearings of lines are observed from magnetic north and are observed directly from the prismatic compass.
Quadrental Bearing (QB)

These are bearings of lines from north or south towards east or west.
These values are usually reduced from observed whole circle bearing for the ease of calculation of included angles and plotting.

Convert the following whole circle bearing to quadrental bearing.

(i) 12° 45’  (ii) 160° 10’  (iii) 285° 15’

(i) 12° 45’
Quadrental bearing of 12° 45’ is N12° 45’E

(ii) 160° 10’
Quadrental bearing of 160° 10’ is S19.50’E

(iii) 285° 15’
Quadrental bearing of 285° 15’ is N 74° 45’ W

Convert the follow quadrental bearing to whole circle bearing

(i) N 30° 30’E  (ii) S 70° 42’ E  (iii) N 85° 10’ W

(i) N 30° 30’E
Whole circle bearing of N 30° 30’E is 30° 30’

(ii) S 70° 42’ E
Whole circle bearing of S 70° 42’ E is = 180° - 70° 42’
= 109° 18’

(iii) N 85° 10’ W
Whole circle bearing of N 85° 10’ W is = 360° - 85° 10’
= 274° 50’

Fore and Back bearing:-

A line may be expressed by two bearings observed from the either end of the line. The bearing of the line expressed along the line of traverse is called fore bearing and bearing observed opposite to the line of traverse is
called back bearing. Both the bearings expressed in whole circle bearing deter each other by 180°. The bearing of the line in the direction of progress of survey is called fore or forward bearing while the bearing opposite to the direction of the progress of survey is known as reverse of Back bearing.

By observation of fore bearing and back bearing of a line two observations are made to a line minimizing error and improving the accuracy. This also helps in identifying local attraction, if the difference between the fore and back bearing expressed in whole circle bearing is not exactly 180°, then one or both of the observation points suffers local attraction.

The fore bearing of travels site are as follows:

- AB = 85° 10’
- BC = 155° 30’
- CD = 265° 51’
- DE = 355° 30’

Find their Back Bearings?

Back bearing of AB

\[ = 180° + 85° 10’ \]
\[ = 265° 10’ \]

Back bearing of BC

\[ = 180° + 155° 30’ \]
\[ = 335° \]

Back bearing of CD

\[ = 360° \]
\[ = 265° 5’ – 180° \]
\[ = 85° 5’ \]

Back bearing of DE

\[ = 355° 30’ – 180° \]
\[ = 175° 30’ \]

Precautions to be taken during compass surveying for maximum accuracy of the observations.

Precautions to be taken in compass survey.

(i) Setup & level the compass carefully.
(ii) Stop the vibration of the needle by gently pressing the break pin so that it may come to rest soon.
(iii) Always lift along the needle and not across to avoid parallax.

(iv) When the instrument is not in use its magnetic needle should be kept above the pivot. If, not the pivot is subjected to unnecessary wear which may cause sluggishness of the magnetic needle. Before taking a reading the compass box should be gently tapped to ensure the magnetic needle is freely swinging and has not come to rest due to friction of the pivot.

(v) Station’s should be selected such that they are away from sources of local attraction.

(vi) Fore & Back bearing of each line should be taken to guard against the local attraction, if the compass cannot be set at the end of line, the bearings may be taken from any intermediate point along the line.

(vii) Avoid taking a reading in the wrong direction.

(viii) If the glass cover has been dusted with hand kerchief. The glass cover may be charged with electro static current and needle adheres to the glass cover. This may be avoided by applying moist finger to the glass.

(ix) Objective and the eye piece must be straight before making observations.

Compute magnetic declination for the following observations.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Station</th>
<th>F.B</th>
<th>B.B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>AB</td>
<td>80° 45’</td>
<td>260°</td>
</tr>
<tr>
<td>2.</td>
<td>BC</td>
<td>130° 30’</td>
<td>311° 35’</td>
</tr>
<tr>
<td>3.</td>
<td>CD</td>
<td>240° 15’</td>
<td>60° 15’</td>
</tr>
<tr>
<td>4.</td>
<td>DA</td>
<td>290° 30’</td>
<td>110° 10’</td>
</tr>
</tbody>
</table>

AB => 260° - 80° 45’ = 179° 15’
BC => 130° 30’ ~ 311° 35’ = 181° 5’
DA => 290° 30’ ~ 110° 10’ = 180° 20’
Magnetic error 1° 30’ w

Compute the included angles.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Station</th>
<th>Fore bearing</th>
<th>Back bearing</th>
<th>Inc Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>AB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>BC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>CD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>DA</td>
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<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>AB</td>
<td>79° 15’</td>
<td>258° 30’</td>
<td>29° 25’</td>
</tr>
<tr>
<td>2.</td>
<td>BC</td>
<td>129°</td>
<td>310° 5’</td>
<td>129° 30’</td>
</tr>
<tr>
<td>3.</td>
<td>CD</td>
<td>238° 45’</td>
<td>58° 45’</td>
<td>71° 20’</td>
</tr>
<tr>
<td>4.</td>
<td>DA</td>
<td>289°</td>
<td>108° 40’</td>
<td>129° 45’</td>
</tr>
</tbody>
</table>

\[ \angle A = 108° 40’ - 79° 15’ = 29° 25’ \]
\[ \angle B = 258° 30’ - 129° = 129° 30’ \]
\[ \angle C = 310° 5’ - 238° 45’ = 71° 20’ \]
\[ \angle D = (360° + 58° 45’) - 289° = 129° 45’ \]

Sum of included angles = 360°

**Closing error.**

**Adjustment of closing errors:**

When a close traverse is plotted from the field measurements the ends stations of a traverse generally doesn't coincide exactly in the starting station.

This is due to the error in field observations such an error of traverse is known as closing error or error of closer. When the angular and linear measurement is of equal proportion graphical adjustment of the traverse may be made. Correction is applied to the length as well as bearing of the lines in proportion to their links. Graphical method is also known as proportionate method of adjustment.

When the closing error is to be adjusted with angles alone equal distribution of error is done to all the observed angles. Total error is calculated, from which total correction is arrived. The correction is equally divided to all the stations eliminating closing error.

**Plane table surveying the methods employed in plane table surveying.**

**Plane table surveying:**

The principle of plane tabling is based on the fact that they lines jointing the points in the plane tube are made to line parallel to the
corresponding lines jointing the around points while working at each station.

**Instrument used in plane table surveying**

(i) Plane table with stand  
(ii) Alidade of straight rule  
(iii) Sprite level  
(iv) Magnetic compass  
(v) Plumping fork  
(vi) Drawing paper

**Methods of plane table surveying:**

This surveying may be carried a by one of the following method:-

(v) Radiation  
(vi) Traversing  
(vii) Intersection  
(viii) Resection method

**Radiation method:**

In method the plane table is set up at any convenient station, details of points are plotted on the paper by orienting line drawn from the location of the instrument station to the ground station. After reducing their respected ground distance on the desired scale of survey the distance between the ground stations are determined. This method is suitable for survey of small areas which can be commanded from a single station.

**PROCEDURE :-**

The following steps are to be followed to locate the points from the instrument station.

(i) Set up the plane table at the station centre and level it accurately.  
(ii) Choose location of point A on the drawing paper at a convinent location.  

(iii) Consider the lay out of the area on the plane table and draw the magnetic north will be of magnetic compass .
(iv) Pivot the alidate about A, the location of instrument station and site the points B, C, D …. Etc., and draw lines along the fiducial edge of the alidate.

(v) Measure the ground distance by direct chaining and plot them on the respective line. If the ground is slopping, slope correction is applied and corresponding horizontal distances are plotted.

**Method of intersection:-**

In this method either the coordinates of at least two stations and inter visible points must be known or the distance between them should be measured directly in the field. These points are plotted on the required convenient scale. The locations of other points are determine by drawing rays from each end station after proper orientation of the table. The inter section of rays gives the location of other points. It is thus evident that it is very essential to have al least two points ie, two locations are plotted before the survey may be started.

The line joining the location of given station is known as base line. In this method no other linear measurement is required except that of the base line.

The point of inter section of the rays drawn from the ends of the base line forms the vertex of the triangle and two rays represent the remaining two sides. The position of the vertex in determined by completing the triangle graphically. This method is also known as graphical triangulation.

**Traversing method:-**

Method of traversing by a plane table is similar to that of compass traverse. In plane table traverse a table is set at each successive station a fore site is taken to the next station and it’s location is plotted by measuring the distance directly between the two stations. Sometimes a resection may be drawn from the location between the two stations to minimize the error.
Resection method :-

The process of determining the location of the station by the plane table by means of drawing rays from stations whose location have been already plotted on the sheet is called resection. This method which is also generally known as interpolation method or fixing method consist of drawing rays from known points whose locations already exist on the sheet. The intersection of these rays will be the instrument station point, if the orientation of the table was correct before the rays are drawn.

(i) Back ray method

In this method a plane table is oriented by laying alidate along the line drawn from the previous station. The location of the unknown instrument station is determine by drawing a ray from another station or point whose location is already plotted on the sheet. This method can be suitably employed for the plane table survey when a prominent point such as temple spire, church etc., is available in the center of the area. After setting a plane table successive stations and their locations can be obtained from drawing rays from their corresponding points on the paper. This method is also used for large scale surveys where long rays are drawn. Their accuracy of the survey depends upon the accuracy with which initial setting of the table was done.

points to be noted while using plane table.

The following points are to be taken care of to minimize errors in plane table surveying.

1. The actual plotted location of the station on the sheet must be exact over the ground station mark. A error of 30 cm in centering incase of a std ray of 20m includes an error of one degree in orientation. The error is accumulative.

2. The forward station must be carefully selected and marked by a wooden peg before a forward ray is drawn. The back station must also be similarly mark with a wooden peg. It’s position vertically below the plotted point is transferred before leaving the station.
3. A forward ray should be marked using the full length of alidate so that error is minimized while back orienting in the next station.

4. The same side of the alidate should be used for drawing rays.

**Three point method of Resection** :-

It is used to locate a station by using plane table on a plan by means of sighting three well define points whose locations are previously plotted on the sheet.

**Procedure :-**

In this method the plane table is setup with the help of three known points without visiting them. Let a, b, c represent the location of A, B, C three ground stations and P represent the instrument position the location of which is to be determined on the plan. The table is set to be oriented when rays drawn from three points A, B, C intersect at a point and the drawn rays form a triangle. The point of intersection of three rays is the required location of the instrument station on the plan.

**Two point method :-**

This method is used in location of station occupied by the table by means of sighting two well defined points whose location have previously been plotted on the sheet.

Let the two points A & B whose location have been plotted as points a, b on the sheet. Let c be the instrument position whose location it’s required choose the auxiliary point D such that CD is approximately parallel & roughly equal to AB by eye judgment. Orient the table over point C such that location ‘ab’ like parallel to ground position AB this can be done by eye judgment. Clamp the table pivoting the alidade about ab draw rays to intersect at C. The degree of accuracy of the location ‘C’ thus obtains depends upon the approximation that has been due on the orientation. Transfer the point c as the ground point C with a plumbing fork.

Pivot the alidate about C site the station D and draw again shift the table to the station D and orient accurately with the back ray method. Ensuring that ray CD passes through a point vertically about ground mark D.
Pivot the altitude about ‘ab’ draw resector which will intersecting on the line drawn from C. If orientation was correct, if not pivoting the altitude about the point of intersection of the rays drawn from C and obtained from A site the station B drawn ray to cut cb at b align the alidate along the line b and fix point E in the line of sight at an greater distance, align the alidate along ab and rotate the table until point E is in line of site and clamp the table.

Pivoting alidate about ab draw resectors to intersect at d pivoting alidate about d draw a ray towards C.

Shift the table to capital C oriented with back ray method pivoting the alidate about ab draw rays. The rays intersect the line drawn from D. To give the correct location of the station C.

**Orientation by compass alone:**

Select the base line AB as in case of intersection method measured it accurately and plot it ab on the sheet in a convenient position set up table at station A. centre the location ‘a’ over the ground mark A.

Place the alidate along ‘ab’ orient the table by turning in until the station B is sited. Place the magnetic compass on the table and rotate the compass when the magnetic needle rest in North-south direction draw a line along the longest side of the compass. Shift the table to the next instrument station C and level. Place the compass in the north position and rotate the table till the magnetic needle rest in north south direction. Clamp the table. Pivoting the alidate point ‘a’ and ‘b’, the re-sectors to intersect at C which is required instrument station. This method is suitable only in areas without magnetic declination and when the accuracy required is low. The magnetic compass should be handled with care to get reasonable accuracy.