JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

Class – Ist Year – I/II Semester: B.Tech. (Civil Engineering)
Subject –Basic Civil Engineering
UNIT -1 (Introduction)
Presented by –Sudhir Panwar (Assistant Professor)

Vision

To become a renowned center of outcome based learning, and work towards academic, professional, cultural and social enrichment of the lives of individuals and communities.

Mission

M-1: Focus on evaluation of learning outcomes and motivate students to inculcate research Aptitude by project based learning.
M-2: Identify, based on informed perception of Indian, Regional and global needs, areas of focus and provide platform to gain knowledge and solutions.
M-3: Offer opportunities for interaction between academia and industry.
M-4: Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders can emerge in a range of professions.

VISION

To become a role model in the field of Civil Engineering for the sustainable development of the society.

MISSION

1. To provide outcome base education.
2. To create a learning environment conducive for achieving academic excellence.
3. To prepare civil engineers for the society with high ethical values.

CONTENTS (TO BE COVERED)

1. Introduction to surveying

a) objective ,scope of course

b) Outcome of the course

2.Linear measurements

a) Introduction

b) various instruments used

c) Procedure of chain surveying

d) various types of error & corrections

3. Compass surveying

a) Introduction

b) various instruments used

c) Procedure of compass surveying

d) various types of error & corrections

4. Traversing with chain and compass

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Introduction to surveying

Surveying is defined as the science of making measurements of the earth specifically the surface of the earth. This is being carried out by finding the spatial location (relative / absolute) of points on or near the surface of the earth.

Different methods and instruments are being used to facilitate the work of surveying.

The primary aims of field surveying are :

- to measure the **Horizontal Distance** between points.
- to measure the **Vertical elevation** between points.
- to find out the **Relative direction** of lines by measuring horizontal angles with reference to any arbitrary direction and
- to find out **Absolute direction** by measuring horizontal angles with reference to a fixed direction.

These parameters are utilised to find out the relative or absolute coordinates of a point / location.

Objectives of Surveying

- To collect field data;
- To prepare plan or map of the area surveyed;
- To analyse and to calculate the field parameters for setting out operation of actual engineering works.
- To set out field parameters at the site for further engineering works.

Outcome of surveying

After studying surveying students will be able to learn the following **Operations**

Planning
Field Observation
Office Works
Setting out Works

1.Planning

To decide

- the methods to be adopted for surveying;
- the resources (instruments & personnel) to be used;
- the control points / stations to be used (those already available and/ or to set up).

The planning operation needs a-priori field visit and this is known as reconnaissance.

2. Field Observation

It involves

- Collection of field data by making necessary measurements;
- Recording of observed data in a systematic manner.

Before starting any field observation, the permanent adjustments of all the instruments need to be checked thoroughly by trained personnel and if required, it must be adjusted.

3.Office Work

It involves

- Processing, analysing and calculation of observed data;
- Preparation of necessary data (for making plan or map of the area);
- Making of a plan or map of the area;
- Computation of relevant field parameters as per design for setting out engineering works at site.

4.Setting out Works

To locate and establish different parameters / dimensions at the site as per design for further engineering works.

Linear Measurements

- The determination of the distance between two points on the surface of the earth is one of the basic operation of surveying. Measurement of horizontal distances or measuring linear measurement is required in chain surveying, traverse surveying and other types of surveying.

Methods of making linear measurements

- Direct methods
- Optical methods
- E.D.M methods
- In the direct method, the distance is actually measured during field work using a chain or a tape. This is the most commonly used method for linear measurements.

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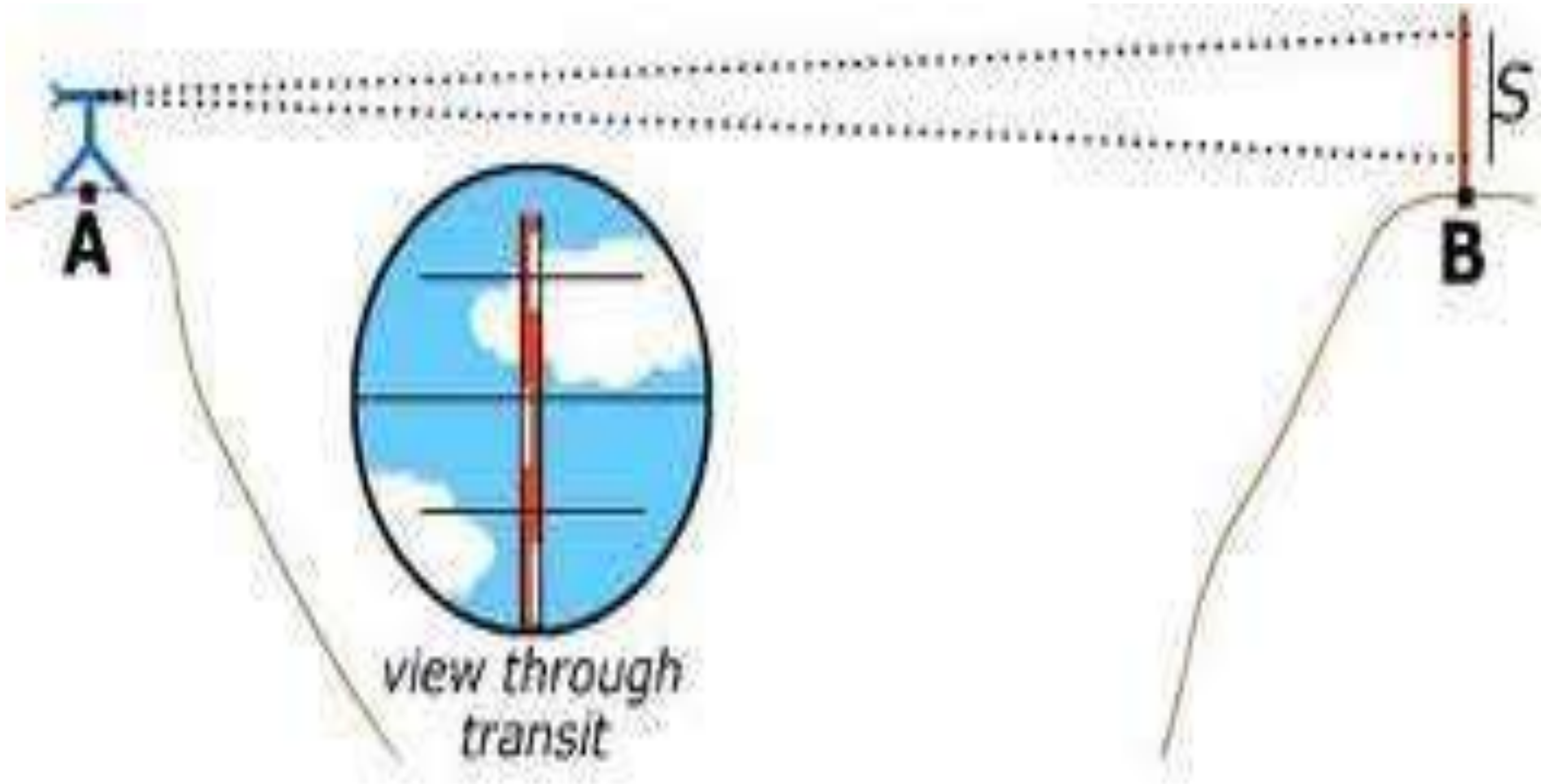
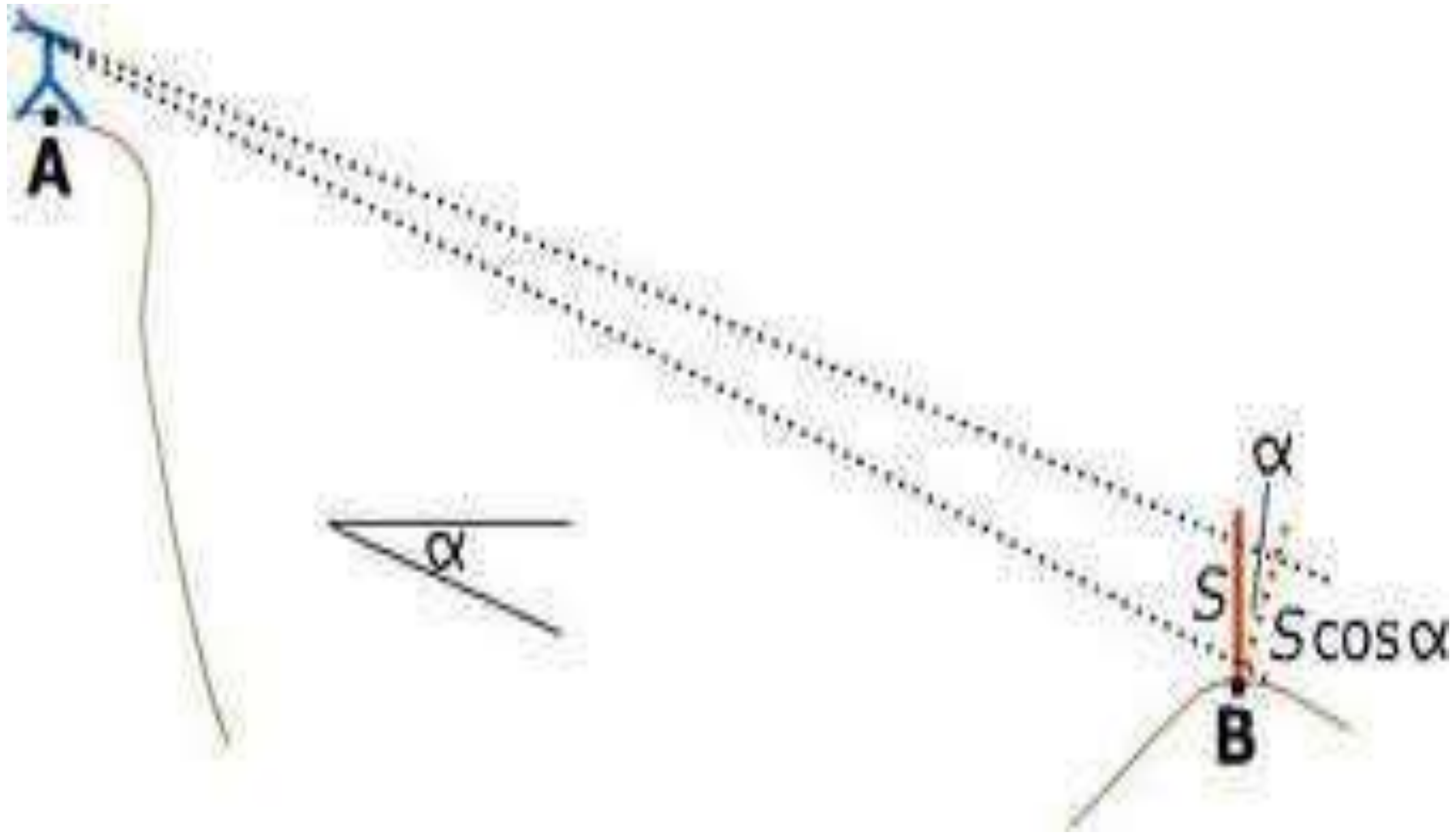
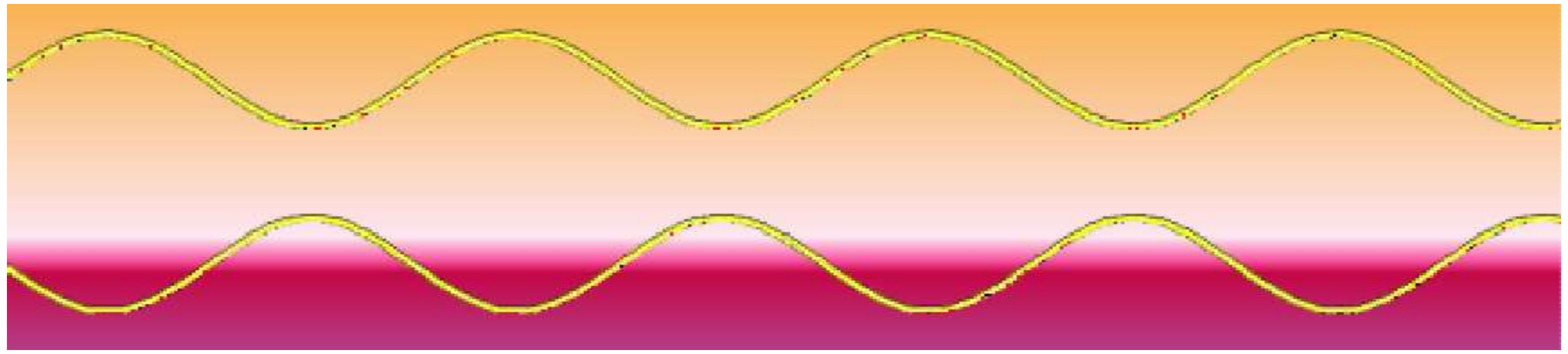
Optical methods

- In the principles of optics are used. The distance is not actually measured in field but it is computed indirectly. The instrument used for making observations is called tacheometer.





Electronic Distance Measuring (E.D.M)



Ranging

When the distance to be measured is more than a tape length, a straight line is required to be laid between the points/ stations along which measurements are to be carried out. The process of laying out a straight line between points is known as ranging.

Direct Ranging
Indirect Ranging

Direct Ranging

When the end stations are inter visible, ranging is being carried out directly. The intermediate points are placed at distances having interval less than one tape length. The intermediate points are found by moving a ranging pole in transverse direction and thus, points are selected in such a way that the end points and the intermediate points lie in a straight line . In this method, two flags, one ranging pole and a bunch of pegs are required in a team of at least one surveyor and one assistant.

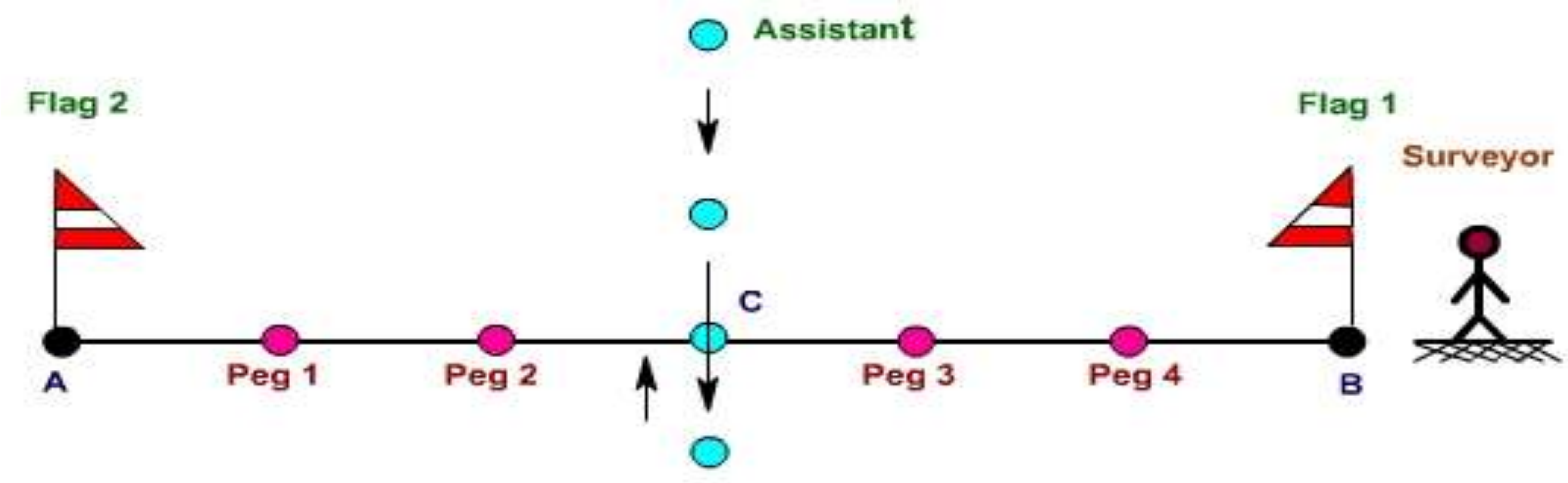


Figure 8.1 Direct Ranging

Indirect Ranging

When the end stations between which a straight line is to be laid, are not inter visible, indirect method of ranging is being adopted. It is being carried out either by reciprocal method or by random line method.

- Reciprocal Ranging
- Random Line Method

Reciprocal Ranging

Below Figure shows the field operations involved in reciprocal ranging. Let A and B are the two end points whose distance is required to be found and are not inter visible. To fix the intermediate points in a straight line between these points, two more points say C and D are chosen in such a way that D & B are visible from C and C & A from D. Then, direct ranging is being carried out alternatively along DCA and CDB for a number of times so that ACDB lie in a straight line.

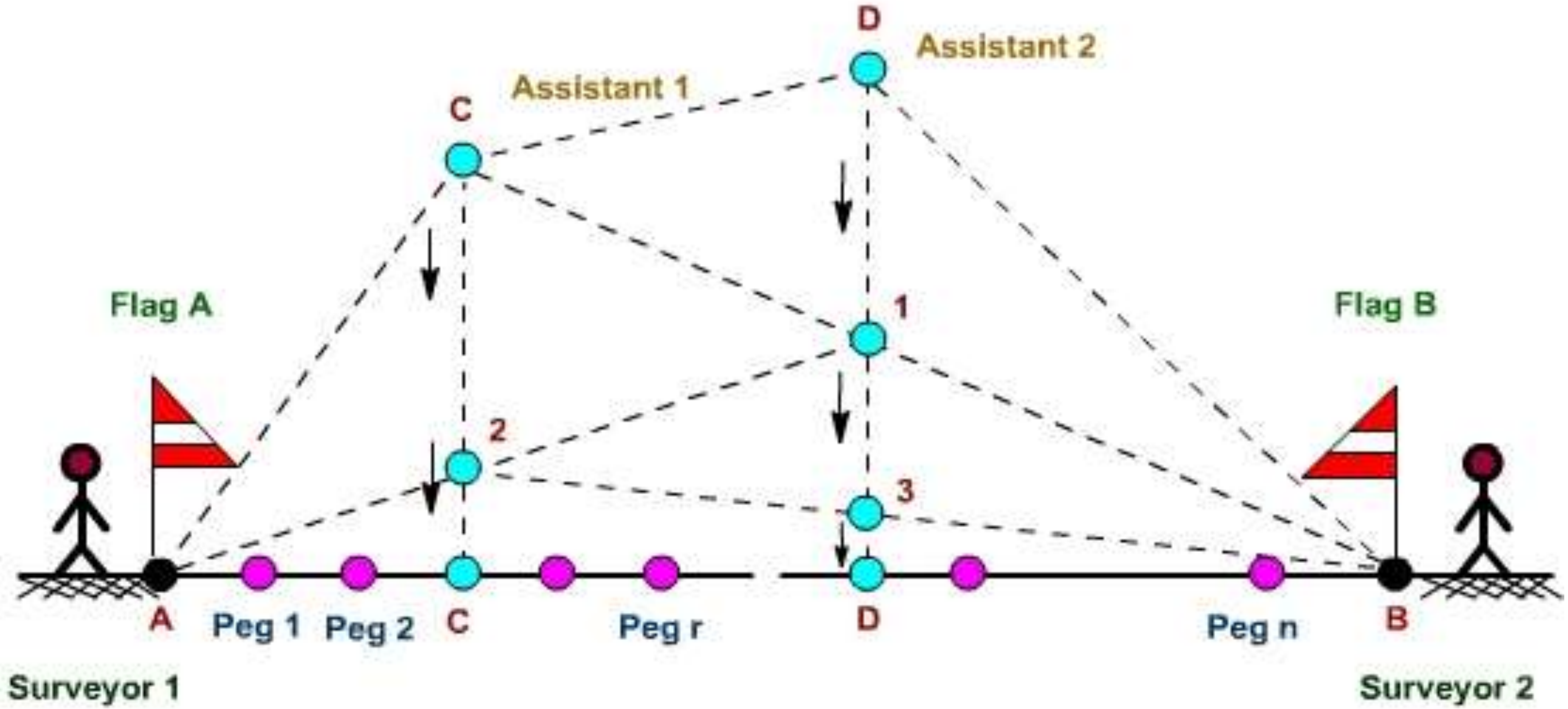


Figure 8.2 Reciprocal Ranging

Ranging by Random Line Method

In this method, (Figure 8.3) a random line such as BQ is being laid such that R is visible from Q. A perpendicular QR is being erected at Q and measure its distance. Then the desired distance BR is being calculated using distance formula

$$BR = \sqrt{BQ^2 + QR^2}$$

In laying the line BR, intermediate points are established first. These are laid by taking offset from the random line at distances calculated by using the method of similar triangle such a

$$XX_1 = \frac{QR}{BQ} \times BX$$

$$YY_1 = \frac{QR}{BQ} \times BY$$

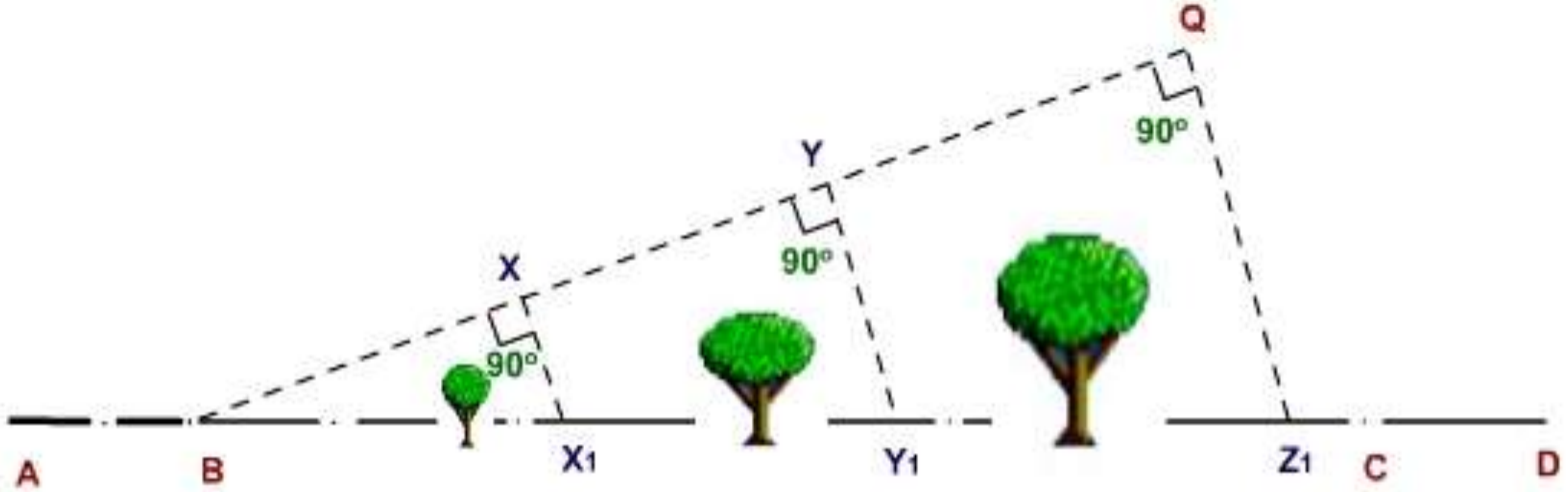


Figure 8.3 Ranging by Random Line Method

After locating the intermediate points on the line BR, the obstructions get cleared to make the end points intervisible. Then, direct ranging is being carried out to obtain an extended continous straight line.

Taping

Taping involves measurement of the distance with tapes (steel/linen), either by placing it on the ground or sometimes by getting it suspended between points. Additional equipments employed during taping are plumb bob, the hand level, pegs/ pins and range pole (or flag or ranging rod) etc. The precision of distance measured with tapes depends upon the degree of refinement with which measurements are taken.

PROBLEMS occurs during chaining

During measurement of distance, various obstacles may be encountered in the field. Depending upon the type of obstacle, a suitable geometrical figure has to be framed and an equivalent distance has to be measured or computed. Obstacles encountered in the field can be divided into three broad categories.

Type I : Ranging along obstacle is possible but not measurement such as pond, river etc.

To carry measurement along the type of obstacles where measurement round the obstacle is possible, perpendicular offsets are drawn from the line one at each side of the obstacle, as shown in Figure 8.4(a). Then, a parallel distance equivalent to distance along the obstacle is measured. In some cases, the distance is being calculated either adopting basic principle of geometry and/or trigonometric relations Figure 8.4(b).

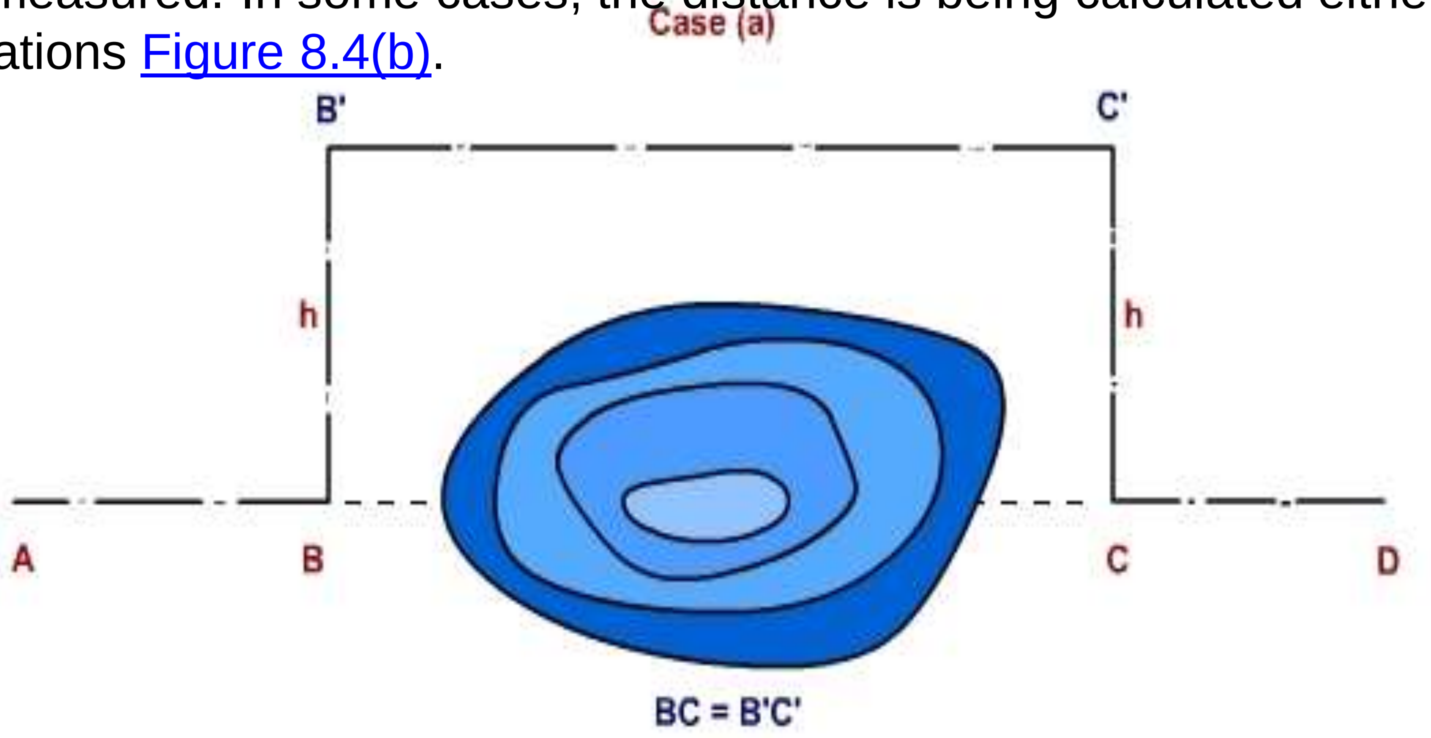


Figure 8.4a Measurement Obstructed Ranging round the Obstacle

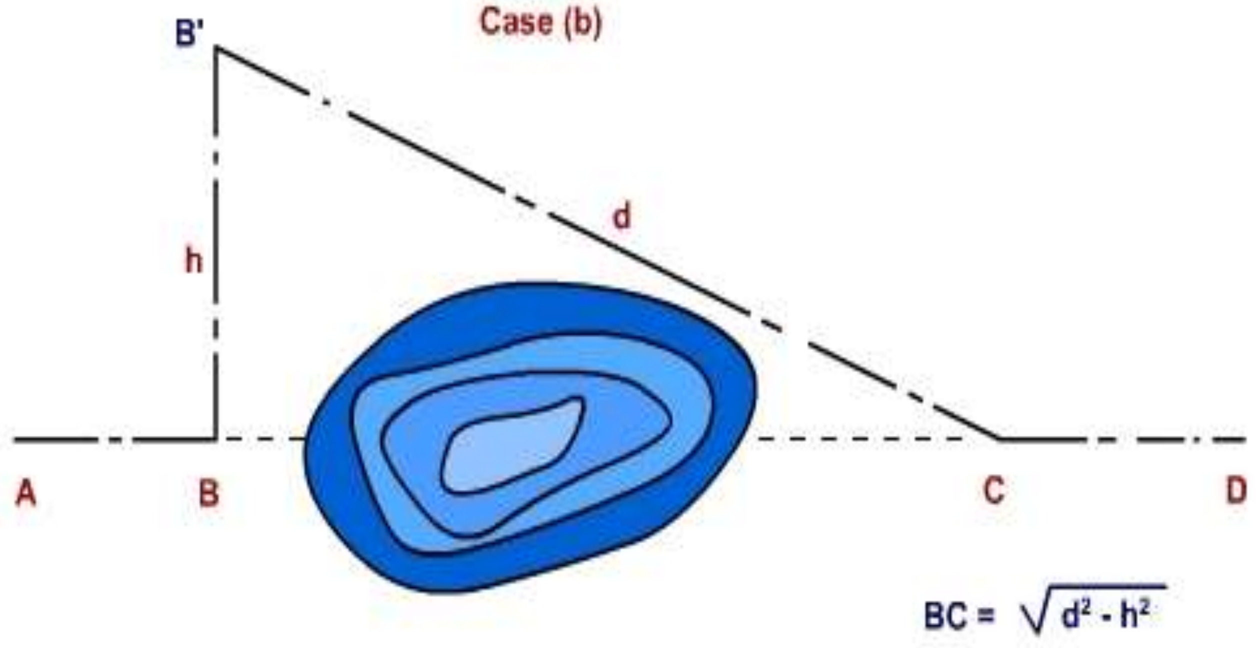


Figure 8.4b Measurement Obstructed Ranging round the Obstacle

CHAIN SURVEYING

This is the simplest and oldest form of land surveying of an area using linear measurements only. It can be defined as the process of taking direct measurement, although not necessarily with a chain.

EQUIPMENTS USED IN CHAIN SURVEYING

These equipments can be divided into three, namely

(i)Those used for linear measurement. (Chain, steel band, linear tape)

(ii) Those used for slope angle measurement and for measuring right angle (Eg. Abney level, clinomater, cross staff, optical squares)

(iii)Other items (Ranging rods or poles, arrows, pegs etc).

1.Chain:-

The chain is usually made of steel wire, and consists of long links joined by shorter links. It is designed for hard usage, and is sufficiently accurate for measuring the chain lines and offsets of small surveys.

Chains are made up of links which measure 200mm from centre to centre of each middle connecting ring and surveying brass handless are fitted at each end. Tally markers made of plastic or brass are attached at every whole metre position or at each tenth link. To avoid confusion in reading, chains are marked similarly form both end (E.g. Tally for 2m and 18m is the same) so that measurements may be commenced with either end of the chain

There are three different types of chains used in taking measurement namely:

i. Engineers chain

ii. Guntur chain

iii Steel bands

Steel Bands:

This may be 30m, 50m or 100m long and 13mm wide. It has handles similar to those on the chain and is wound on a steel cross. It is more accurate but less robust than the chain. The operating tension and temperature for which it was graduated should be indicated on the band.

Tapes:

Tapes are used where greater accuracy of measurements are required, such as the setting out of buildings and roads. They are 15m or 30m long marked in metres, centimeter and millimeters. Tapes are classified into three types;

1.Linen or Linen with steel wire woven into the fabric;

These tapes are liable to stretch in use and should be frequently tested for length. They should never be used on work for which great accuracy is required.

1.Fibre Glass Tapes: These are much stronger than lines and will not stretch in use.

2.Steel tapes: These are much more accurate, and are usually used for setting out buildings and structural steel works. Steel tapes are available in various lengths up to 100m (20m and 30m being the most common) encased in steel or plastic boxes with a recessed winding lever or mounted on open frames with a folding winding lever.

Arrows:

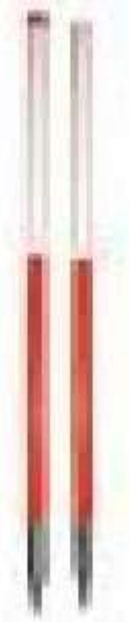
Arrow consists of a piece of steel wire about 0.5m long, and are used for marking temporary stations. A piece of coloured cloth, white or red ribbon is usually attached or tied to the end of the arrow to be clearly seen on the field.

Pegs

Pegs are made of wood 50mm x 50mm and some convenient length. They are used for points which are required to be permanently marked, such as intersection points of survey lines. Pegs are driven with a mallet and nails are set in the tops.

Ranging Rod:

These are poles of circular section 2m, 2.5m or 3m long, painted with characteristic red and white bands which are usually 0.5m long and tipped with a pointed steel shoe to enable them to be driven into the ground. They are used in the measurement of lines with the tape, and for marking any points which need to be seen.



7. **Optical Square:**

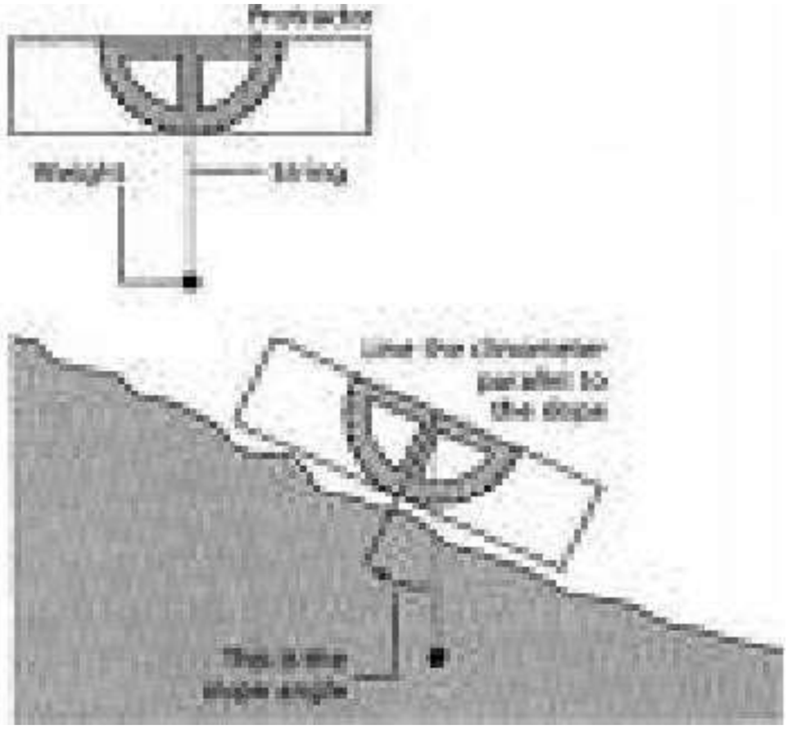
This instrument is used for setting out lines at right angle to main chain line. It is used where greater accuracy is required. There are two types of optical square, one using two mirrors and the other a prism.

- The mirror method is constructed based on the fact that a ray of light is reflected from a mirror at the same angle as that at which it strikes the mirror.
- The prism square method is a simplified form of optical square consisting of a single prism. It is used in the same way as the mirror square, but is rather more accurate.

8 Cross Staff:

This consists of two pairs of vanes set at right angle to each other with a wide and narrow slit in each vane. The instrument is mounted upon a pole, so that when it is set up it is at normal eye level. It is also used for setting out lines at right angle to the main chain line.

9. Clinometer



This instrument is used for measuring angles of ground slopes (slope angle). They are of several form, the common form is the **WATKING'S CLINOMETER,** which consist of a small disc of about 60mm diameter. A weighted ring inside the disc can be made to hang free and by sighting across this graduated ring angle of slopes can be read off. It is less accurate than abney level.

10.Abney Level

This instrument is generally used to obtaine roughly the slope angle of the ground. It consists of a rectangular, telescopic tube (without lenses) about 125mm long with a graduated arc attached. A small bubble is fixed to the vernier arm, once the image of the bubble is seen reflected in the eyepiece the angle of the line of sight can be read off with the aid of the reading glass.

NECESSARY PRECAUTIONS IN USING CHAIN SURVEYING INSTRUMENTS

1. After use in wet weather, chains should be cleaned, and steel tapes should be dried and wiped with an oily rag.
2. A piece of colored cloth should be tied to arrow (or ribbon – attached) to enable them to be seen clearly on the field.
3. Ranging rods should be erected as vertical as possible at the exact station point.
4. The operating tension and temperature for which steel bands/tapes are graduated should be indicated.
5. Linen tapes should be frequently tested for length (standardized) and always after repairs.
6. Always keep tapes reeled up when not in use.

GENERAL PROCEDURE IN MAKING A CHAIN SURVEY

1.Reconnaissance: Walk over the area to be surveyed and note the general layout, the position of features and the shape of the area.

2.Choice of Stations: Decide upon the framework to be used and drive in the station pegs to mark the stations selected.

3.Station Marking: Station marks, where possible should be tied - in to a permanent objects so that they may be easily replaced if moved or easily found during the survey. In soft ground wooden pegs may be used while rails may be used on roads or hard surfaces.

4.Witnessing: This consists of making a sketch of the immediate area around the station showing existing permanent features, the position of the stations and its description and designation. Measurements are then made from at least three surrounding features to the station point and recorded on the sketch.

The aim of witnessing is to re-locate a station again at much later date even by others after a long interval.

5.Offsetting:- Offsets are usually taken perpendicular to chain lines in order to dodge obstacles on the chain line.

6.Sketching the layout on the last page of the chain book, together with the date and the name of the surveyor, the longest line of the survey is usually taken as the base line and is measured first.

CRITERIA FOR SELECTING A SURVEY LINES/OFFSETS

During reconnaissance, the following points must be borne in mind as the criteria to provide the best arrangement of survey lines,

a. **Few survey lines:** the number of survey lines should be kept to a minimum but must be sufficient for the survey to be plotted and checked.

b. **Long base line:** A long line should be positioned right across the site to form a base on which to build the triangles.

c. **Well conditioned triangle with angles greater than 30^o and not exceeding 150^o:** It is preferable that the arcs used for plotting should intersect as close as 90^o in order to provide sharp definition of the stations point.

d. **Check lines:** Every part of the survey should be provided with check lines that are positioned in such a way that they can be used for off- setting too, in order to save any unnecessary duplication of lines.

e. Obstacles such as steep slopes and rough ground should be avoided as far as possible.

f. **Short offsets to survey lines (close feature preferably 2m) should be selected:** So that measuring operated by one person can be used instead of tape which needs two people.

g. Stations should be positioned on the extension of a check line or triangle. Such points can be plotted without the need for intersecting arcs.

Ranging:

Ranging involves placing ranging poles along the route to be measures so as to get a straight line. The poles are used to mark the stations and in between the stations.

Corrections to Linear Measurement and their Application:-

The following corrections are to be applied to the linear measurements with a chain or a tape where such accuracy is required.

(i) Pull correction,
(ii) Temperature correction
(iii) Standard length correction
(iv) Sag correction
(v) Slope correction
(vi) Mean sea level correction.

Pull Correction :-

A chain or tape of nominal length 'L' having cross sectional area of the link or that of a tape, as the case may be, equal to A and standardized under a pull P_s is employed to measure a length at a pull P_F. If Young's modulus of elasticity of the material is E the extension of its length is = $\frac{(P_F - P_S)L}{AE}$

The recorded length is less than the actual by this extension. The error is here, -ve, the actual length is obtained by adding the extension to L. the correction is +ve. If P_F is less than P_S the error will be +ve and correction –ve.

Temperature Correction :-

A chain or a tape of nominal length 'L' standardized at temperature T_S and having cross sectional area A is employed to measured length at temperature T_F being the coefficient of linear expansion of the material of the chain or tape per unit rise of temperature

Temperature Correction = $C(T_F - T_S)L$.

If T_F is more than T_S, recorded length is less than the actual by the amount of extension. The error is –ve and the correction to the length L is +ve by the amount of extension. If the field temperature T_F is less than T_S the error is =+ve and the corrections is –ve.

Sag Correction :-

In case of suspended measurement across a span L the chain or tape sag to take the form of curve known as catenary.

Sag Correction = (W^2×l)/(24n^2p)

Where w= weight of the tape per metre length
W= Total weight of the tape P=pull applied (in N)

l_1 = The length of tape suspended between two supports
l = length of the tape = n l_1 (in m) Sag correction is always negative.

COMPASS SURVEYING

Introduction:

Another type of survey instrument that forms the subject of this section is the compass. Here, we will explain the meaning, types of compass survey and also introduce and discus the concept of bearing.

Objectives

·To introduce the students to the meaning and types of compass survey
·To enable students understand the concept of bearing. Meaning and types of compass survey

In compass survey, the direction of the survey line is measured by the use of a magnetic compass while the lengths are by chaining or taping. Where the area to be surveyed is comparatively large, the compass survey is preferred, whereas if the area is small in extent and a high degree of accuracy is desired, then chain survey is adopted. However, where the compass survey is used, care must be taken to make sure that magnetic disturbances are not present. The two major primary types of survey compass are: the prismatic compass and surveyors compass

Compass surveys are mainly used for the rapid filling of the detail in larger surveys and for explanatory works. It does not provide a very accurate determination of the bearing of a line as the compass needle aligns itself to the earth's magnetic field which does not provide a constant reference point.

THE PRISMATIC COMPASS

This is an instrument used for the measurement of magnetic bearings. It is small and portable usually carried on the hand. This Prismatic Compass is one of the two main kinds of magnetic compasses included in the collection for the purpose of measuring magnetic bearings, with the other being the Surveyor's Compass. The main difference between the two instruments is that the surveyor's compass is usually larger and more accurate instrument, and is generally used on a stand or tripod.

- The prismatic compass on the other hand is often a small instrument which is held in the hand for observing, and is therefore employed on the rougher classes of work. The graduations on this prismatic compass are situated on a light aluminum ring fastened to the needle, and the zero of the graduations coincides with the south point of the needle. The graduations therefore remain stationary with the needle, and the index turns with the sighting vanes. Since the circle is read at the observer's (rather than the target's) end, the graduations run clockwise from the south end of the needle (0º to 360º), whereas in the surveyor's compass, the graduations run anti-clockwise from north.

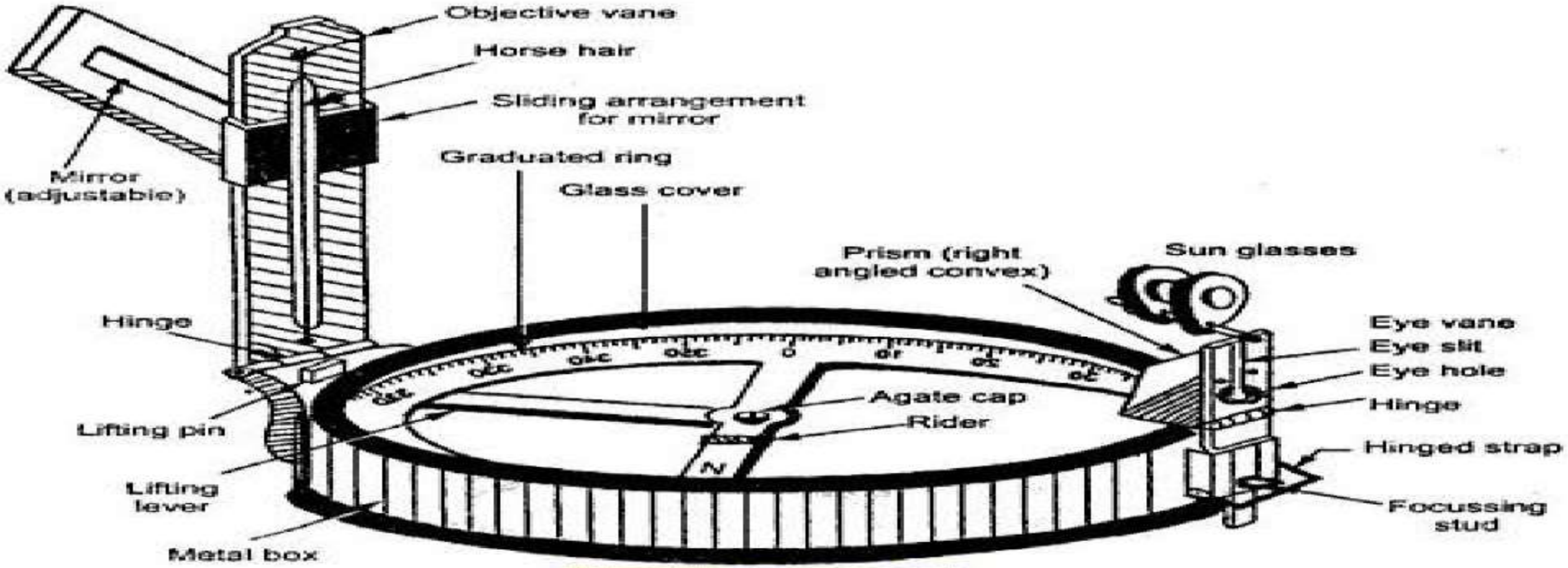
- The prismatic attachment consists of a 45º reflecting prism with the eye and reading faces made slightly convex so as to magnify the image of the graduations. The prism is carried on a mounting which can be moved up and down between slides fixed on the outside of the case.

- The purpose of this up-and-down movement is to provide an adjustment for focusing. The image of the graduations is seen through a small circular aperture in the prism mounting, and immediately above this aperture is a small V cut on top of the mounting, over which the vertical wire in the front vane may be viewed. Using the V cut, the vertical wire and the station whose bearing is required are viewed in one line, the bearing is directly read off the graduated arc at the point immediately underneath the vertical wire.

- The mirror located in front of the forward vane slides up and down the vane, and is hinged to fold flat over it or to rest inclined at any angle with it. This mirror is used for solar observations, or for viewing any very high object, and is not a normal fitting to a compass. The two circular discs in front of the back vane are dark glasses which can be swung in front of the vane when solar observations are being taken.

COMPONENTS OF A PRISMATIC COMPASS

Prismatic compass consists of a non-magnetic metal case with a glass top and contain the following:



Prismatic compass parts

Elements of prismatic compass

- **Cylindrical metal box**: Cylindrical metal box is having diameter of 8to 12 cm. It protects the compass and forms entire casing or body of the compass. It protect compass from dust, rain etc.

- **Pivot:** pivot is provided at the center of the compass and supports freely suspended magnetic needle over it.

- **lifting pin and lifting lever:** a lifting pin is provided just below the sight vane. When the sight vane is folded, it presses the lifting pin. The lifting pin with the help of lifting lever then lifts the magnetic needle out of pivot point to prevent damage to the pivot head.
- **Magnetic needle:** Magnetic needle is the heart of the instrument. This needle measures angle of a line from magnetic meridian as the needle always remains pointed towards north south pole at two ends of the needle when freely suspended on any support.
- **Graduated circle or ring:** This is an aluminum graduated ring marked with 0^o to 360^o to measures all possible bearings of lines, and attached with the magnetic needle. The ring is graduated to half a degree.
- **Prism :** prism is used to read graduations on ring and to take exact reading by compass. It is placed exactly opposite to object vane. The prism hole is protected by prism cap to protect it from dust and moisture.
- **Object vane:** object vane is diametrically opposite to the prism and eye vane. The object vane is carrying a horse hair or black thin wire to sight object in line with eye sight.
- **Eye vane:** Eye vane is a fine slit provided with the eye hole at bottom to bisect the object from slit.
- **Glass cover:** its covers the instrument box from the top such that needle and graduated ring is seen from the top.
- **Sun glasses:** These are used when some luminous objects are to be bisected.
- **Reflecting mirror:** It is used to get image of an object located above or below the instrument level while bisection. It is placed on the object vane.
- **Spring brake or brake pin:** to damp the oscillation of the needle before taking a reading and to bring it to rest quickly, the light spring brake attached to the box is brought in contact with the edge of the ring by gently pressing inward the brake pin

Temporary adjustment of prismatic compass

- The following procedure should be adopted after fixing the prismatic compass on the tripod for measuring the bearing of a line.
- **Centering :** Centering is the operation in which compass is kept exactly over the station from where the bearing is to be determined. The centering is checked by dropping a small pebble from the underside of the compass. If the pebble falls on the top of the peg then the centering is correct, if not then the centering is corrected by adjusting the legs of the tripod.
- **Leveling :** Leveling of the compass is done with the aim to freely swing the graduated circular ring of the prismatic compass. The ball and socket arrangement on the tripod will help to achieve a proper level of the compass. This can be checked by rolling round pencil on glass cover.
- **Focusing :** the prism is moved up or down in its slide till the graduations on the aluminum ring are seen clear, sharp and perfect focus. The position of the prism will depend upon the vision of the observer.

<u>OPERATION PROCEDURE</u>

- Remove the corner and open out the prism and window, holding the compass as level as possible.
- Then focus the prism by raising or lowering its case until the divisions appear sharp and clear. If necessary with the needle on to its pivot.
- Holding the compass box with the thumb under the prism and the forefinger near the stud, sight through the objector station lowering the eye to read the required bearing as soon as the needle comes to rest naturally.
- The bearing read will be a forward bearing and normally a "whole circle" bearing clockwise angle between 0^o to 360^o.

VARIATION IN DECLINATION

The position of the magnetic poles is not fixed and the North magnetic pole tends to wander more than the south causing alterations in the positions of the isogonic lines from time to time. The angle of declination at any point is therefore not constant subject to the following variations;

1. **Secular Variation:**

   This causes the largest variation in magnetic declination. It is a slow continuous swing with a cycle of about 400 to 500 years. Because of this large movement, the date, the declination and the approximate rate of annual change should be given for any magnetic orientation of survey.

2. **Diurnal Variation:**

   This is a swing of the compass needle about its mean daily position.

3. **Periodic Variation:**

   This is a minor variation of the magnetic meridian during the week, a lunar month, year, eleven years, etc.

4. **Irregular Variation:** These are caused by magnetic storms which can produce sudden variations of the magnetic meridian.

Magnetic Bearing

The magnetic bearing of a survey line is the angle between the direction of the line and the direction of the magnetic meridian at the beginning of the line.

Magnetic Meridian

- The magnetic meridian at any place is the direction obtained by observing the position of a freely supported magnetized needle when it comes to rest uninfluenced by local attracting forces.
- Magnetic meridians run roughly north –south and follow the varying trend of the earth's magnetic field. The direction of a magnetic meridian does not coincide with the true or geographical meridian which gives the direction of the true North pole except in certain places.

Angle of Declination:

It is defined as the angle between the direction of the magnetic meridian and the true meridian at any point.

Surveyor's Compass:

Similar to the prismatic compass but with few modifications, the surveyors compass is an old form of compass used by surveyors. It is used to determine the magnetic bearing of a given line and is usually used in connection with the chain or compass survey.

Bearing

The bearing is the angular direction measured clockwise starting from North with reference to the observer. The reference North may be true or magnetic. While the true bearing is the angular direction measured in a place with the direction of true or geographical north; the magnetic bearing is the angle which it makes with the direction of Magnetic North measured in the clockwise direction.

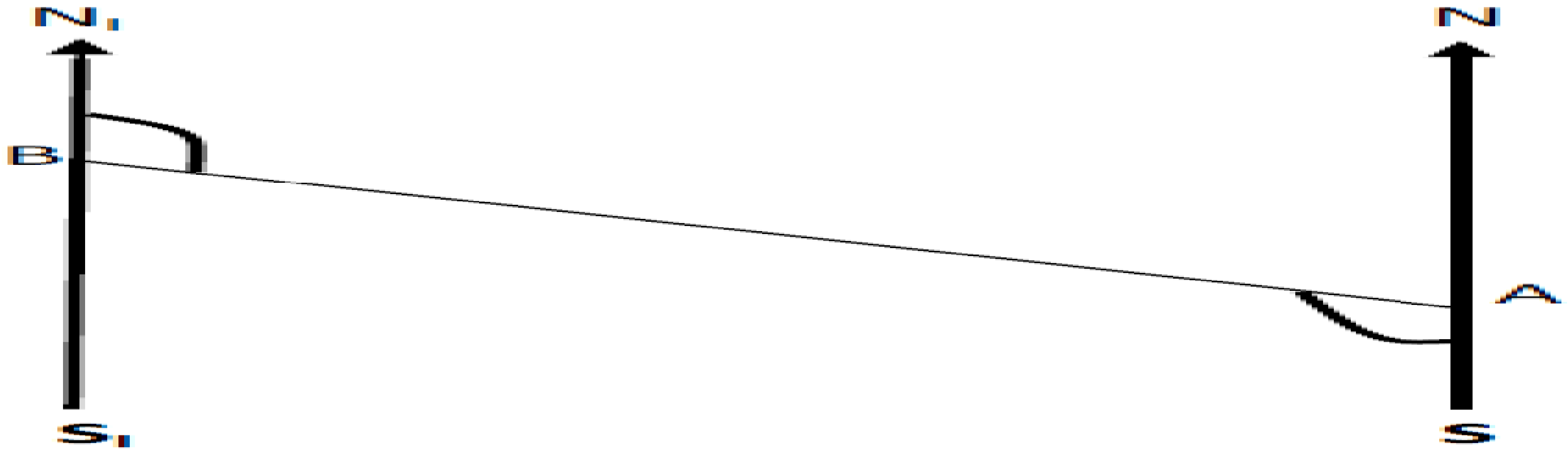
Back and Fore bearing:

Introduction:

In this section, we will examine the back and fore bearing; and the steps to be taken when traversing with compass survey.

Back and fore bearing

Fore bearing is the compass bearing of a place taken from a status to the other in thedirection that the survey is being carried out. The back Bearing bearing in the other hand is the backwards from the next station in the opposite direction i.e. the bearing taken to its preceding station that the fore bearing was taken. The difference between BB and FB is always 180^0.



Back and fore bearing

If B is sighted from an observer at A, and the NS and N_1S_1 are the magnetic NS lines, then Forward bearing (FB) = < N A S + < S A B

Back bearing BA = < N1 B A

:. Back Bearing BA = Forward Bearing AB - 180^0

If the observer relocates to B and observers B, then forward bearing (FB) BA = < N1 BA and back bearing (AB) = < NAS + SAB. Hence, we can conclude that Forward Bearing = < N1 B A + 180^0. As a general rule, if the Fore Bearing is less than 180^0, add 180^0 to get the Back. Bearing, and if the Fore Bearing is greater than 180^0, then subtract 180^0 to get the Back Bearing.

Traversing and plotting with the compass survey:

Traversing with the compass involves taking the bearing along a series of connecting straight lines and in the same time measuring the distances with the tape. The compass is read at each point and a back bearing is equally taken to serve as a check. This continues until the traverse closes.

Choosing a suitable scale, the traverse is then plotted taking into consideration the general shape of the area.

Observing Bearing of Line

- ⦿Consider a line AB of which the magnetic bearing is to be taken.
- ⦿By fixing the ranging rod at station B we get the magnetic bearing of needle wrt north pole.

⦿The enlarged portion gives actual pattern of graduations marked on ring. Designation of bearing

- ⦿The bearing are designated in the following two system:-
- ⦿1) Whole Circle Bearing System.(W.C.B)

⦿2) Quadrantal Bearing System.(Q.B) Whole circle bearing system (W.C.B.)

- ⦿The bearing of a line measured with respect to magnetic meridian in clockwise direction is called magnetic bearing and its value varies between 0^{O} to 360^{O}.
- ⦿The quadrant start from north and progress in a clockwise direction as the first quadrant is 0^{O} to 90^{O} in clockwise direction , 2nd 90^{O} to 180^{O} , 3rd 180^{O} to 270^{O}, and up to 360^{O} is 4th one.

Quadrantal bearing system(Q.B.)

- ⦿In this system, the bearing of survey lines are measured wrt to north line or south line whichever is the nearest to the given survey line and either in clockwise direction or in anti clockwise direction.

Reduced bearing (R.B)

- ⦿When the whole circle bearing is converted into Quadrantal bearing , it is termed as “REDUCED BEARING”.
- ⦿Thus , the reduced bearing is similar to the Quadrantal bearing.

- Its values lies between 0^{O} to 90^{O}, but the quadrant should be mentioned for proper designation.

The following table should be remembered for conversion of WCB to RB.

W.C.B OF ANY LINE	QUADRANT IN WHICH IT LIES	RULES FOR CONVERSION	QUADRANT
0 TO 90	I	RB=WCB	N-E
90 TO 180	II	RB=180-WCB	S-E
180 TO 270	III	RB =WCB-180^{O}	S-W
270 TO 360	IV	RB=360^{O} - WCB	N-W

Error in compass survey (Local attraction & observational error):

Local attraction is the influence that prevents magnetic needle pointing to magnetic north pole

Unavoidable substance that affect are

- Magnetic ore
- Underground iron pipes
- High voltage transmission line
- Electric pole etc.

Influence caused by avoidable magnetic substance doesn't come under local attraction such as instrument, watch wrist, key etc

Detection of Local attraction

- By observing the both bearings of line (F.B. & B.B.) and noting the difference (180^0 in case of W.C.B. & equal magnitude in case of R.B.)
- We confirm the local attraction only if the difference is not due to observational errors.

If detected, that has to be eliminated Two methods of elimination

- First method
- Second method First method
- Difference of B.B. & F.B. of each lines of traverse is checked to note if they differ by correctly or not.
- The one having correct difference means that bearing measured in those stations are free from local attraction
- Correction is accordingly applied to rest of station.
- If none of the lines have correct difference between F.B. & B.B., the one with minimum error is balanced and repeat the similar procedure.
- Diagram is good friend again to solve the numerical problem.

Second method

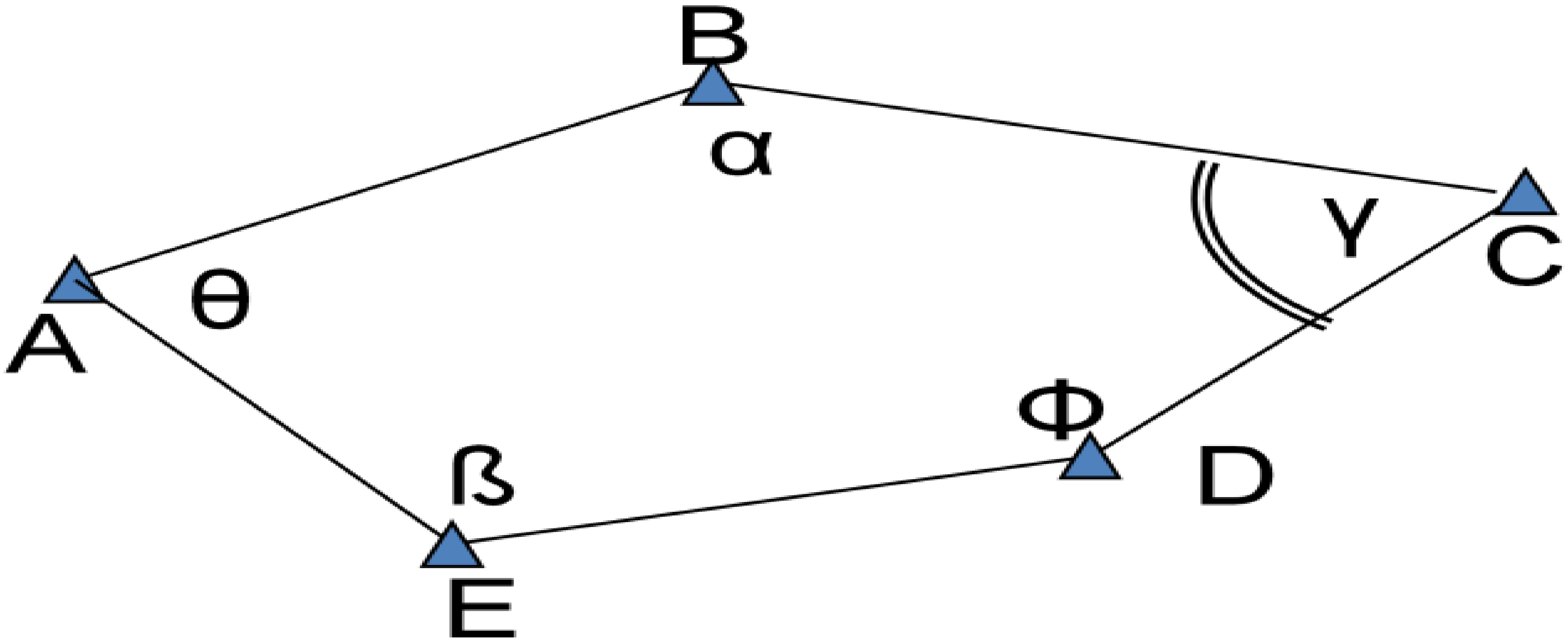
- Based on the fact that the interior angle measured on the affected station is right.
- All the interior angles are measured
- Check of interior angle – sum of interior angles = (2n-4) x right angle, where n is number of traverse side
- Errors are distributed and bearing of lines are calculated with the corrected angles from the lines with unaffected station.

Checks in closed Traverse

- Errors in traverse is contributed by both angle and distance measurement
- Checks are available for angle measurement but
- There is no check for distance measurement
- For precise survey, distance is measured twice, reverse direction second time

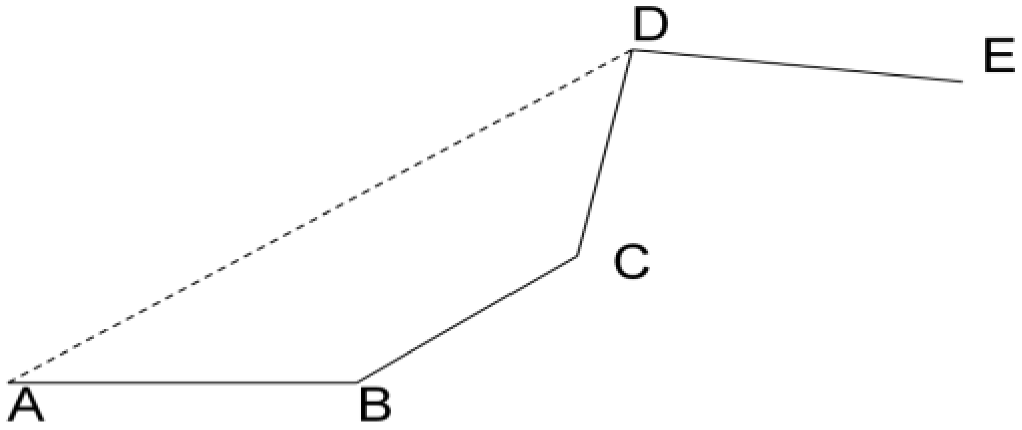
Checks for angular error are available

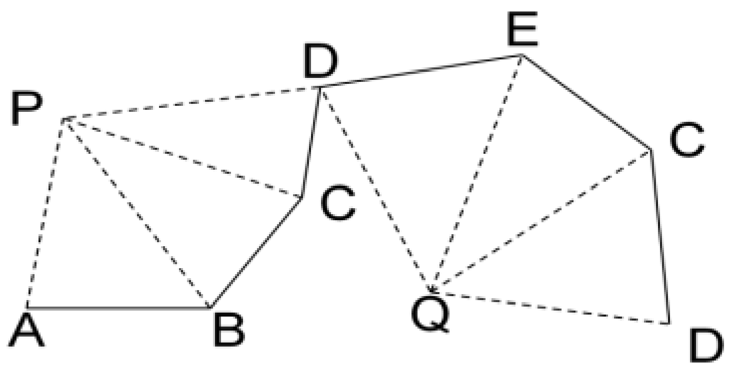
- Interior angle, sum of interior angles = (2n-4) x right angle, where n is number of traverse side
- Exterior angle, sum of exterior angles = (2n+4) x right angle, where n is number of traverse side



Checks in open traverse

- No direct check of angular measurement is available
- Indirect checks
  - Measure the bearing of line AD from A and bearing of DA from D
  - Take the bearing to prominent points P & Q from consecutive station and check in plotting.



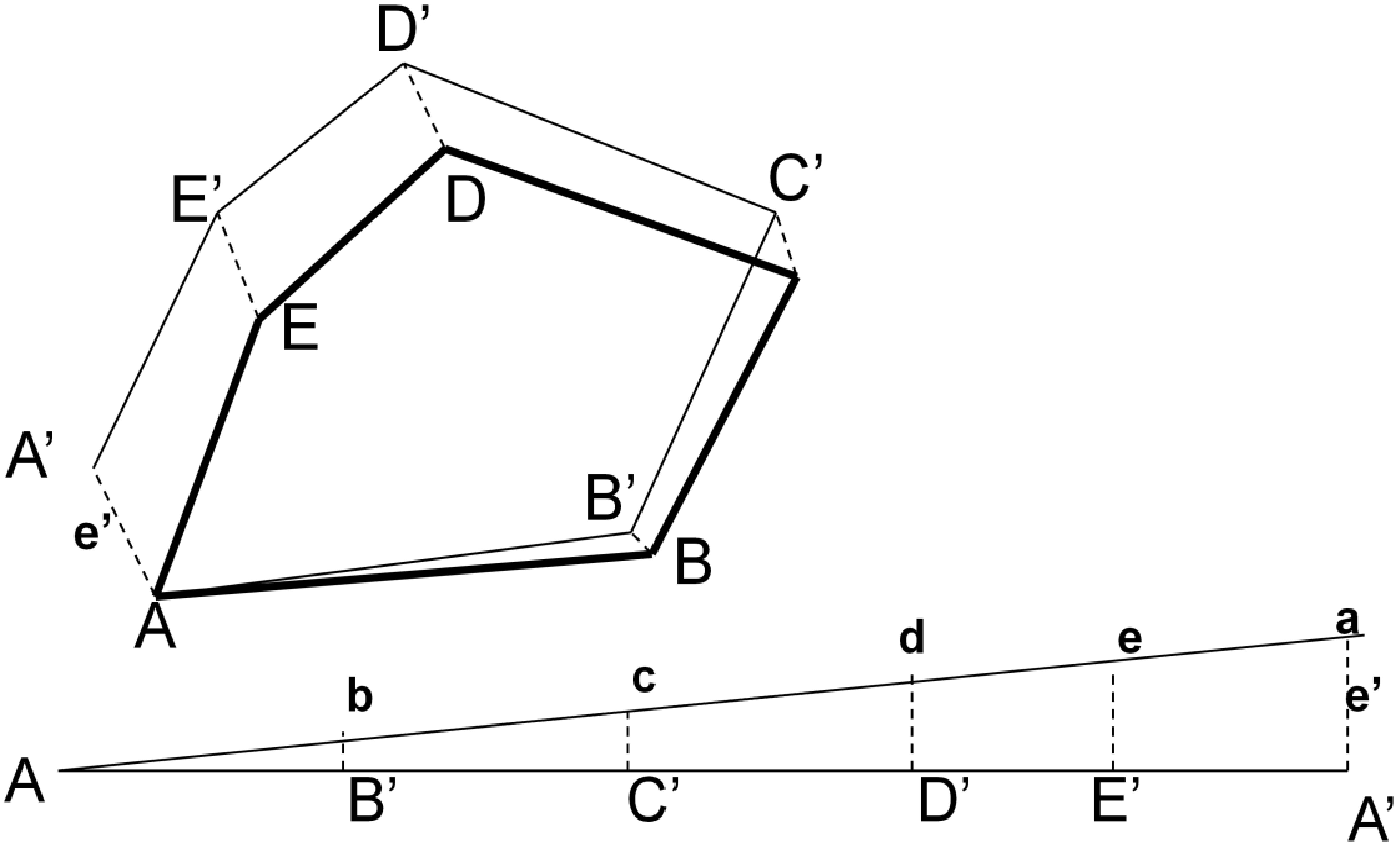


Methods

- Compass rule (Bowditch)
  - When both angle and distance are measured with same precision
- Transit rule
  - When angle are measured precisely than the length
- Graphical method

Graphical rule

- Used for rough survey
- Graphical version of bowditch rule without numerical computation
- Geometric closure should be satisfied before this.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Dear students you can also refer to following Nptel video link for video lectures

https://youtu.be/chhuq_t40rY

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Thank you!