LECTURE NOTE

ON

SURVEYING-I (TH.3)

4TH SEMESTER IN CIVIL ENGG.

PREPARED BY

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Chapter - 1

Introduction to Surveying, Linear Measurements:

"Surveying is the technique of determining the relative position of different features on, above or beneath the surface of earth by means of direct or indirect measurements and finally representing them on a sheet of paper known as plan or map."

Objectives of Surveying:-

→ To determine the relative position of any objects or points of the earth.
→ To determine the distance and angle between different objects.
→ To prepare a map or plan to represent an area on a horizontal plan.

Principles of surveying:-

1. To work from whole to part
2. To locate a point by at least two measurements

1. "To work from whole to part" means to localize the errors and prevent their accumulation. The total area is divided into large triangles with greatest accuracy and then they are divided into small triangles with less accuracy.
2. In order to locate a new point from at least two points of reference, the positions of which have already been fixed.

Classification of Surveying :-

According to degree of Accuracy:

1. Plane Surveying :- In this, the portion of the earth being surveyed is considered as plane. The area is to be taken is about 250KM^2.
2. Geodetic surveying :- In this, the shape and size of the earth area considered. This type of survey is suited for large areas and long lines and is used to find the precise location of basic points needed for establishing control for other surveys. The area is to be taken is greater than 250Km^2.

According to purpose of survey :-

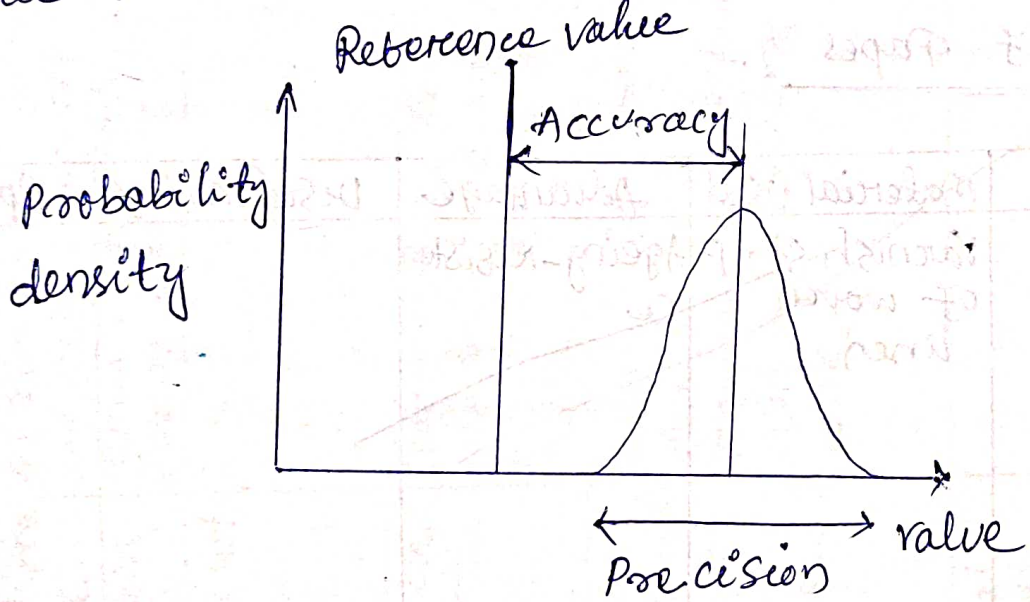
1. Topographical survey
2. Cadastral survey
3. City survey
4. Mine survey
5. Route survey
6. Hydrographic survey

According to equipement used :-

1. Chain survey
2. Compass survey
3. Plane table survey
4. Levelling survey
5. Theodolite survey
6. Tacheometric survey
7. Aerial photographic survey
8. Electronic Distance Meter survey.

Precision :- It is referred to as the degree of fineness and care with which any physical measurement is made

Accuracy :- It is the degree of perefection obtained for a set of measurements to be considered accurate value, when it has value close to the true value.



Methods of Linear Measurement :-

1. By pacing or stepping
2. By passometers
3. By speedometers
4. By perambulators
5. By chaining.

Different types of chains :-

1. Metric chain
2. Steel Band
3. Engineers chain
4. Gunter's chain
5. Revenue chain

Chain type	Length	Number of links	Length of link	Application
Metric chain	20m	100	0.2	Measureing distance
	30m	150	0.2	field Survey
Gunter's chain	66ft	100	0.6ft	Land Measurment
Engineering chain	100ft	100	1ft	field Survey
Revenue chain	33ft	16	2.062ft	Measuring field in cadastral survey

(b) Negative Errors :- When the measured length of the line is less than the actual length (when the chain is too long) the error is said to be negative. The reasons are:

i) The opening of ring joints
ii) The applied pull being much greater than the standard pull.
iii) Wearing of connecting rings
iv) Elongation of the links due to heavy pull.

3. Mistakes :- The common mistakes are:

i) Displacement of arrow.
ii) A full chain length may be omitted or added.
iii) Reading may be taken from the wrong end of the chain.
iv) Wrong entry in field book
v) Some numbers may be called wrongly

Precautions Against Errors and Mistakes :-

1. The point where the arrow is fixed on the ground should be marked with a cross (X).
2. The zero end of the chain or tape should be properly held.
3. During chaining, the number of arrow taken by the leader and follower should always tally with total numbers of arrows taken.
4. Ranging should be done accurately.
5. No measurement should be taken with chain in suspension.

Chain and Tape Correction :-

Tape correction

1. Temperature correction (C_t) This is necessary because the length of the tape or chain may be increased or decreased due to rise or fall of temperature during measurement.

$$C_t = \alpha (T_m - T_0) L$$

where, C_t = Correction for temperature, in metens.

α = Co-efficient of thermal expansion

T_m = Temperature during measurement in degree centigrade or celsius.

T_0 = Temperature at which tape was standardised, in degree centigrade or celsius

L = Length of tape, in metens.

The sign of correction may be positive or negative according as T_m is greater or less than T_0.

α value for steel tape = 11×10^{-6} per $^{\circ}C$

2. Pull Correction :- During measurement, the applied pull may be either more or less than the pull at which the chain or tape was standardised. Due to the elastic property of materials, the strain will vary according to the variation of applied pull, and hence necessary correction should be applied.

$$C_p = \frac{(P_m - P_0) L}{A \times E}$$

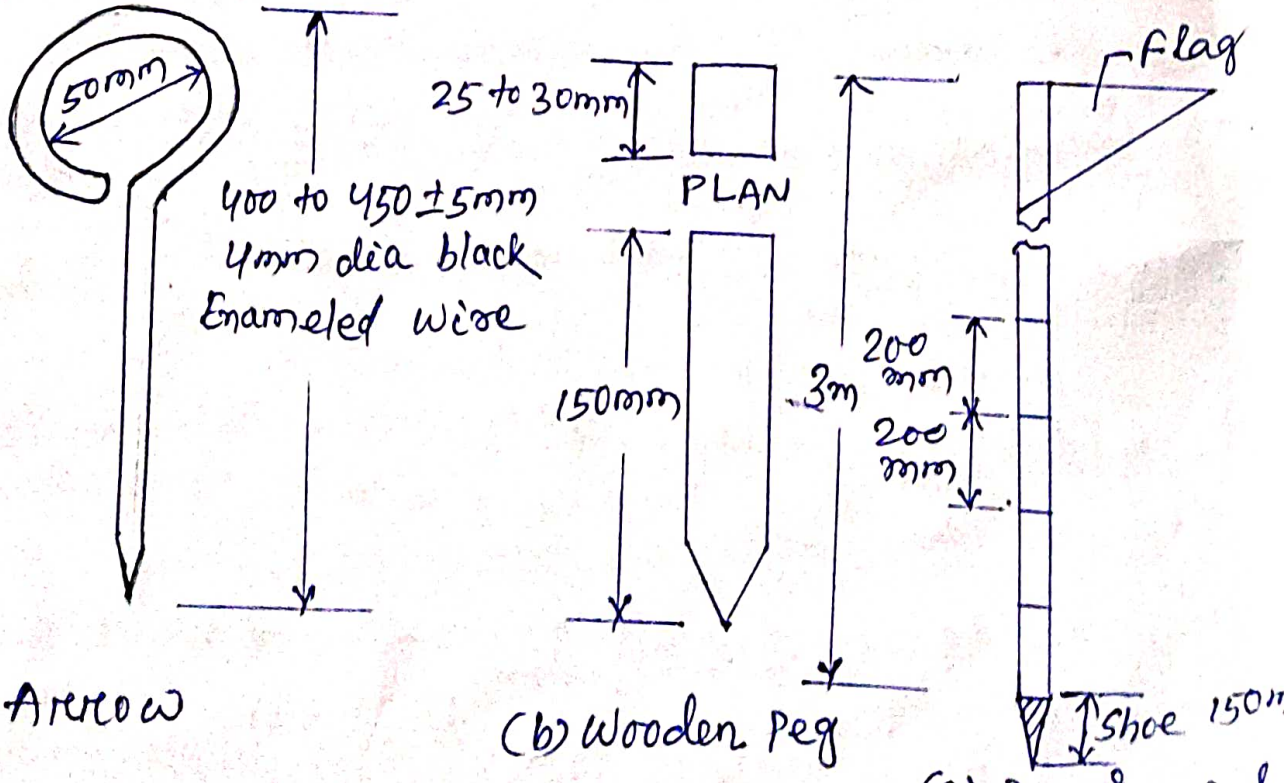
Chapter-2

CHAINING AND CHAIN SURVEYING

In addition to chain or tape, several other auxiliary equipment are required in a chain surveying.

Arrows :- These are made of stout steel wire 4mm in diameter, 400 to 450 mm long and black enameled. These are used to mark the end of each chain length.

Wooden Pegs :- These are made of stout timber generally 25 to 30 mm square or circular size and 150 mm long. These are normally used to mark station on ground on a quasi-permanent state. These are tapered at one end so that they can be driven in the ground with a hammer. These are kept about 40mm projecting above the ground.

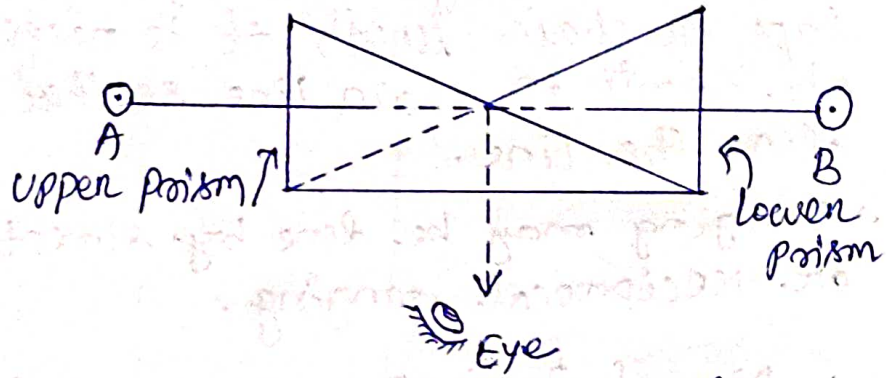


(a) Arrow

(b) Wooden Peg

(c) Ranging Rod

(d) Plumb Bob



(e) Line Ranger

Ranging Rods :- These are octagonal or circular in plan normally 25 to 30mm diameter straight timber or tubular steel rod, 3m in length and provided with an iron shoe at lower end. These are painted in black and white alternate bands and normally have a flag at the top for easy recognition and identification from a distance.

B Plumb-bob :- It is usually heavy spherical or conical ball, of metal and is used to transfere points on ground by suspending it with the help of a strong thread. It is used in measuring distance on sloping ground by stepping.

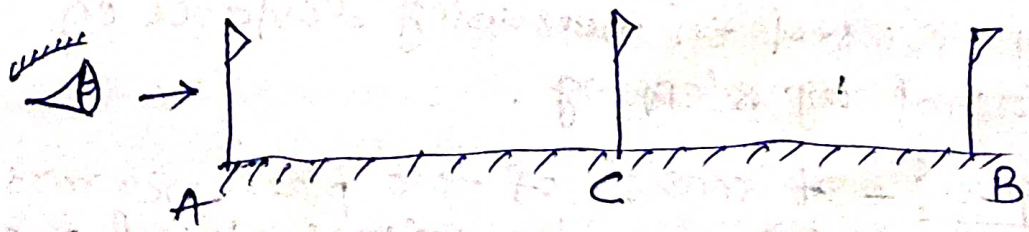
Line Ranger :- It consists of two plane mirrors or two right angled isosceles prisms placed one above the other as depicted in figure. The diagonal of both prisms are silvered so as to reflect the incident rays. It is used to draw offset on a chain line.

Ranging:- It is a method of obtaining intermediate station points on survey line. If the length of survey line is greater than the length of tape or chain length, it is necessary to align intermediate points on chain line so that the measurements are along the line.

→ Ranging may be done by direct ranging and indirect or reciprocal ranging.

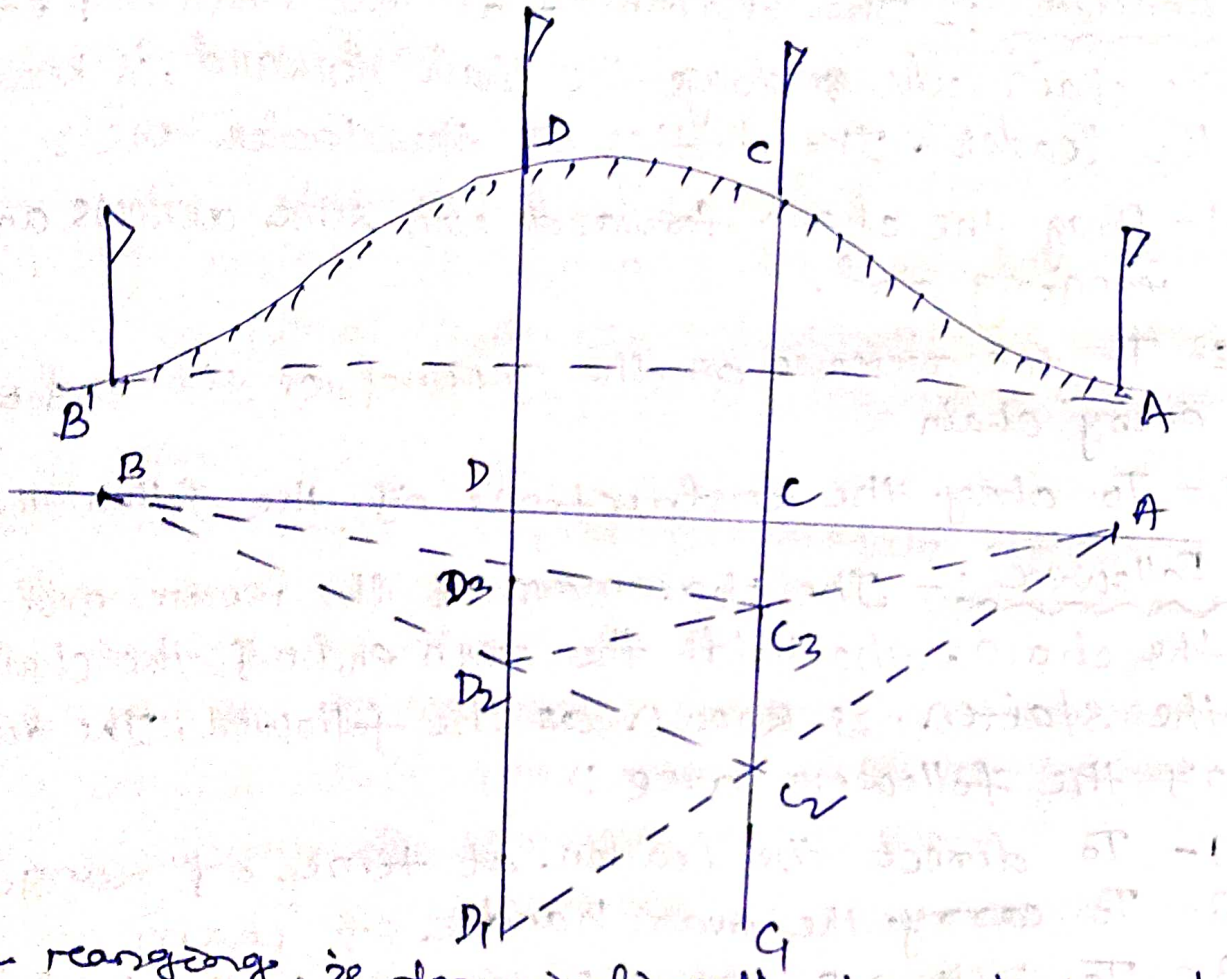
1. **Direct Ranging**:- It is used when the two end points of survey line are intervisible.

Let A & B are two intervisible station points and intermediate point C is to be located. Point C is selected at a distance slightly less than a chain length. At points A & B ranging rods are fixed. The assistant holds another ranging rod near C. Surveyor positions himself approximately 2m behind station A and looking along line AB directs the assistant to move at right angles to the line AB till he aligns the ranging rod along AB. Then surveyor instructs the assistant to mark that point and stretch the chain along AC.

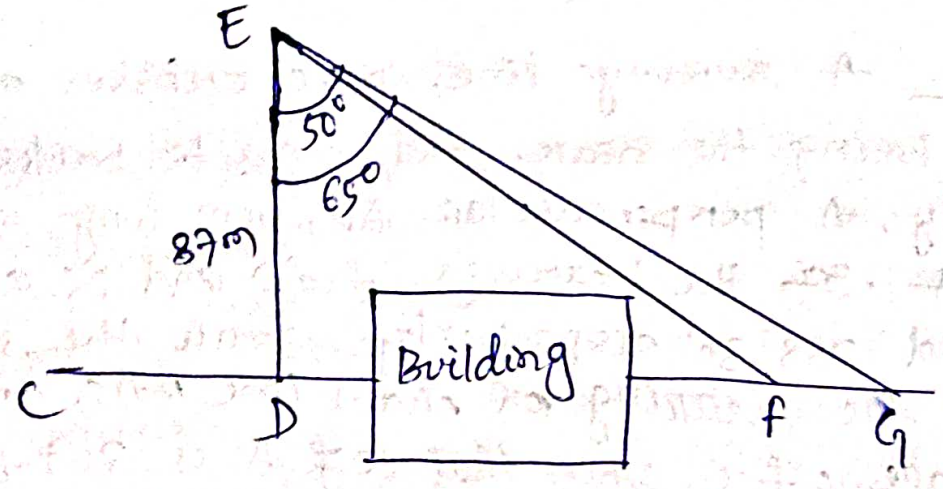


2. **Indirect or reciprocal Ranging**:-

In this method, the end points of survey lines are invisible due to high intervening ground and distances between these station points are long.



The ranging is done indirectly by selecting two intermediate points C_1 and D_1 very near to the chain line such a way that from C_1 both D_1 and B are visible and from D_1 both C_1 and A are visible. Let A and B are two end survey stations. Surveyor stands with line ranger in hands on point C and D approximately along line AB. Surveyor at point C observes images of ranging rods at point D and B in line ranger, and surveyor at D observes images of ranging rods at point C and A in line ranger. Both points C and D move perpendicular to line AB till the images of ranging rods coincide. Same process is repeated until all four points reach in one straight line.



from Δ DEF, $\frac{DE}{EF} = \cos 50°$

$EF = \frac{DE}{\cos 50°} = \frac{87}{\cos 50°} = 135.345\,m$

and $\frac{DF}{DE} = \tan 50°$

$\Rightarrow DF = DE \tan 50° = 87 \times 1.1918 = 103.68\,m$

from Δ DEG1

$\frac{DE}{EG_1} = \cos 65°$

$\Rightarrow EG_1 = \frac{DE}{\cos 65°} = \frac{87}{0.4226} = 205.9\,m$

Principle of chain Surveying :-

The Principle of chain surveying is triangulation This means that the area to be surveyed is divided into a number of small triangles which should be well conditioned.

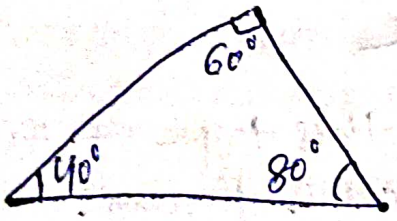
well-conditioned triangle :-

A triangle is said to be well-conditioned when no angle is less than 30° or greater than 120°. An ideal triangle is considered to be best

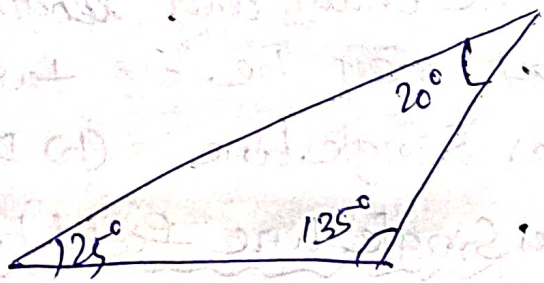
conditioned are ideal triangle well. conditioned triangle are preferred because their apex points are very sharp and can be located by single dot.

III - conditioned triangle :-

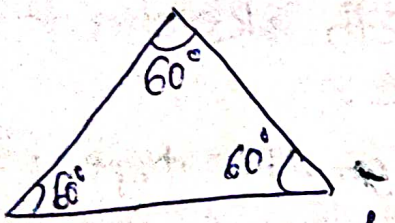
A triangle in which an angle is less than 30° and greater than 120° is said to be ill conditioned triangle. These triangles are not used in chain surveying.



(well-conditioned triangle)



(ill-conditiond triangle



(ideal triangle)

Field Book :-

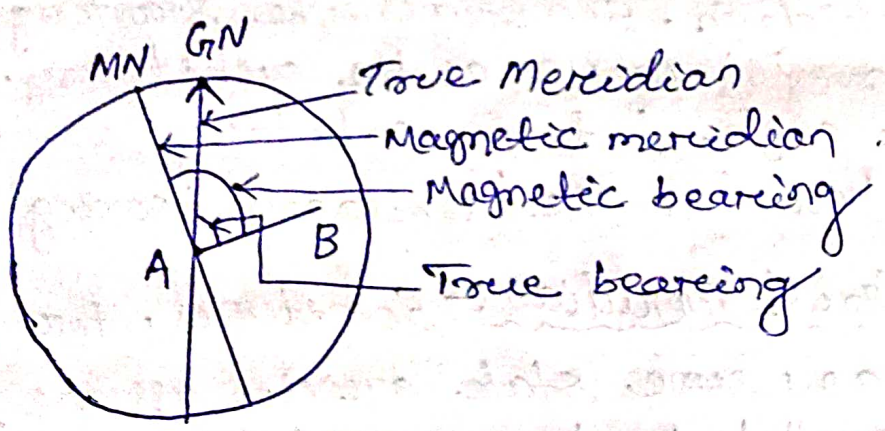
1. The book in which the chain or tape measurement are entered or sketched of details points area recorded is called field book.
2. Its size is 20cm × 12cm. The chain line may is started from bottom of page and work up words.

Chapter-03

ANGULAR MEASUREMENT AND COMPASS SURVEYING

Chain surveying is done for a small area by triangulation and in a fairly level ground. But when area is crowded, large and undulating with many details triangulation is not possible. In such an area, the of traversing is adopted.

Traversing means a series of connected lines. The lengths are measured by chain and tape and the angle is measured with a compass.



(Meridians)

1. True Meridian :- The line or plane passing through the geographical north pole, geographical south pole and any point on the surface of the earth, is known as 'true meridian' or geographical meridian. The angle between the true meridian and a line is known as 'true bearing' of line. It is also known as 'azimuth'.

2. Magnetic Meridian :- When a magnetic needle is suspended freely and balanced properly unaffected by magnetic substances, it indicates a direction. This direction is known as 'magnetic meridian'. The angle between magnetic meridian and a line is known as the 'magnetic bearing' or simply 'bearing' of the line.

3. Arbitrary Meridian :- Sometimes the survey of a small area, a convenient direction is assumed as a meridian, known as 'arbitrary meridian'. Sometimes the starting line of a survey is known as the arbitrary meridian. The angle between arbitrary meridian and a line is known as the 'arbitrary bearing' of the line.

4. Grid Meridian :- Sometimes, for preparing a ~~map~~ map, some state agencies assume several lines parallel to true meridian for a particular zone. These lines are 'grid lines' and the central line is the 'grid meridian'. The bearing of a line with respect to the grid meridian is known as 'grid bearing' of the line.

Types of Compasses :- There are two types of compasses :- 1) The Prismatic compass
2) The surveyor's compass.

1. Prismatic compass :- In this compass, the readings are taken with the help of a prism. The followings are the essential parts of this compass:

(a) Compass Box :- It is a circular metallic box of 8 to 10 cm diameter. A pivot with a sharp point is provided at the centre of the box.

(b) Magnetic needle and Graduated ring :- Magnetic needle is made of a bread, magnetised iron bare. The bare is pointed at both ends. The magnetic needle attached to a graduated aluminium ring. The ring is graduated from 0° to 360° clockwise, and graduations begin from the south end of the needle. Thus, 0° is marked at South, 90° at the West, 180° at the north and 270° at the est.

(c) Sight Vane and Prism :- The sight vane and the reflecting prism are fixed diametrically opposite to the box. The sight vane is hinged with the metal box and consists of a horsehair at the centre. The prism consists of a sighting slit at the top and two small circular holes.

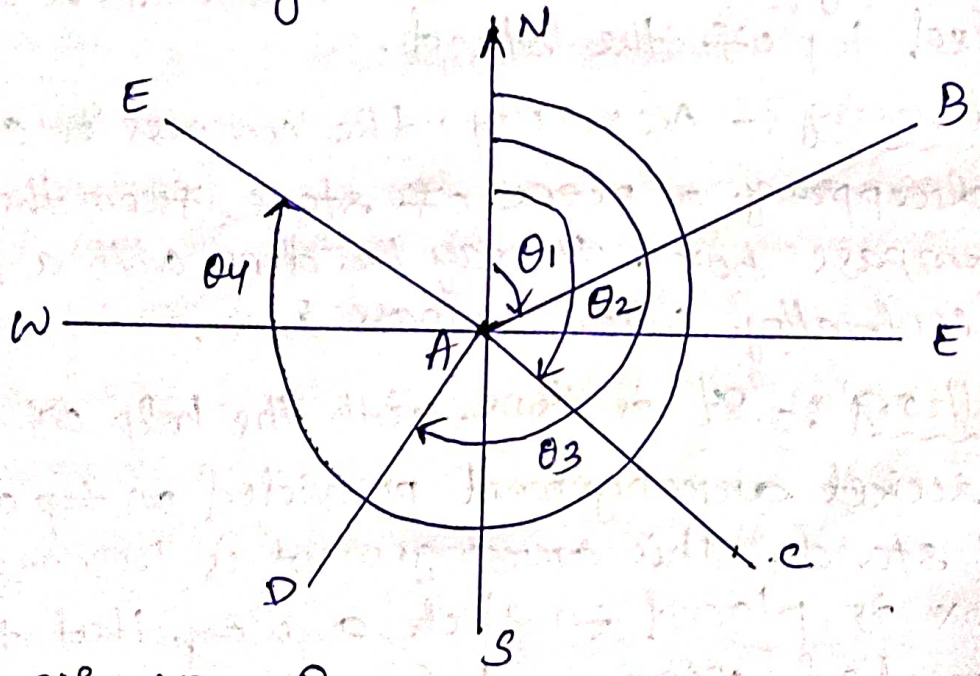
(d) Dark Glasses :- Two dark glasses are provided with the prism. The red glass is meant for sighting luminous objects at night and blue glass for reducing the strain on the observer's eye in bright daylight.

Designation of Magnetic Bearing :-

Magnetic bearings are designated by two systems

(a) Whole circle bearing (WCB)
(b) Quadrantal bearing (QB)

(a) **Whole circle Bearing (WCB) :-** The magnetic bearing of a line measured clockwise from the north pole towards the line, is known as 'whole circle bearing' of that line. Such a bearing may have any value between 0° and 360°

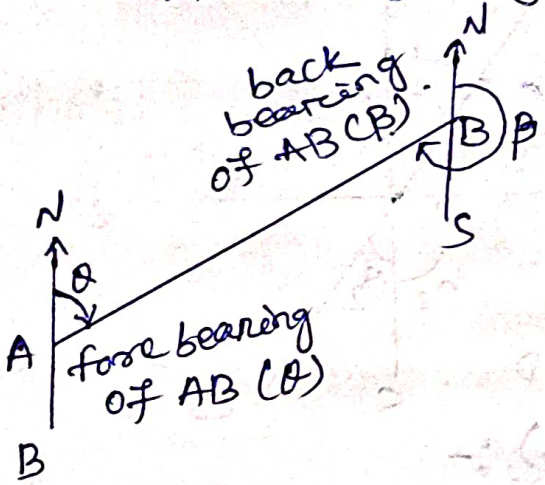


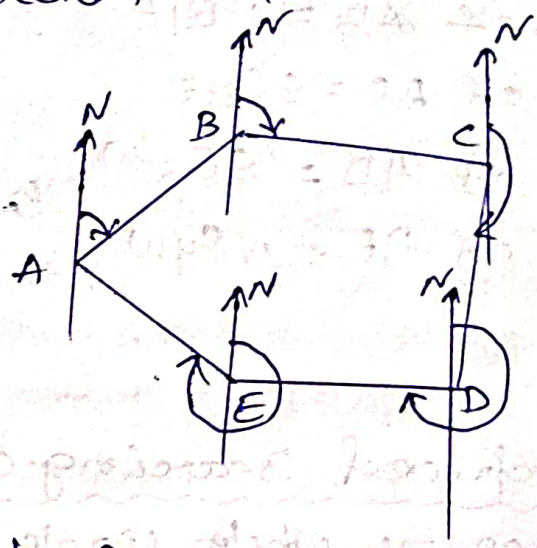
WCB of AB = θ_1
WCB of AC = θ_2
WCB of AD = θ_3
WCB of AE = θ_4

(b) **Quadrantal Bearing (QB) :-** The magnetic bearing of a line measured clockwise or counterclockwise from the North pole or South pole (which ever is nearer the line) towards East or West, is known as 'Quadrantal bearing' This system consists of four quadrants - NE, SE, SW and NW. The value of quadrantal bearing

Back bearing = fore bearing ± 180°

Use + sign if FB is less than 180°
− sign if FB is greater than 180°.





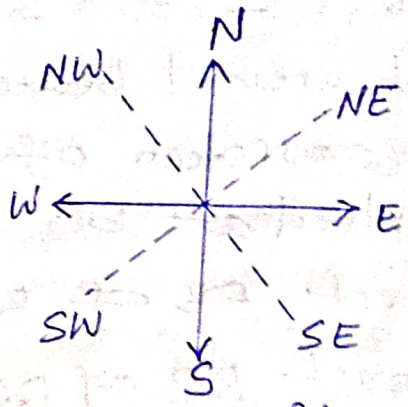
Calculation of included angles from Bearings :-
At the point where two survey lines meet, two angles are formed - an exterior angle and an interior angle. The interior angle or included angle is generally the smaller angle (< 180°), the difference of bearing of two adjacent line is the included angle measured clockwise from the line whose bearing is less.

Note :
1 − If a closed traverse run in anticlockwise direction the observed included angles are interior angles.
2 − If a closed traverse run in clockwise direction, the observed included angles are exterior angles.

Magnetic Declination :- The horizontal angle between the magnetic meridian and true meridian is known as 'magnetic declination'.

Ch.4 MAP READING CADASTRAL MAPS & NOMENCLATURE

Study of direction :-



Direction is the way that we have to travel to get from one place or object to another place or object.
North is directly up on standared maps maps; south is directly down; east is directly right and west is directly left.

Scale :- The scale of a map is the ratio of a distance on the map to the corresponding distance on the ground.

→ A map is classified as small scale or large scale or sometimes medium scale.

→ Small scale refers to world maps of large regions such as continents or large nations. They show large areas of land on a small space

→ Large-scale maps show smaller areas in more details, such as country maps or town plans might.

	Range
Large scale —	1:0 — 1:600,000
medium scale —	1:600,000 — 1:2,000,000
Small scale —	1:2,000,000 — 1:∞

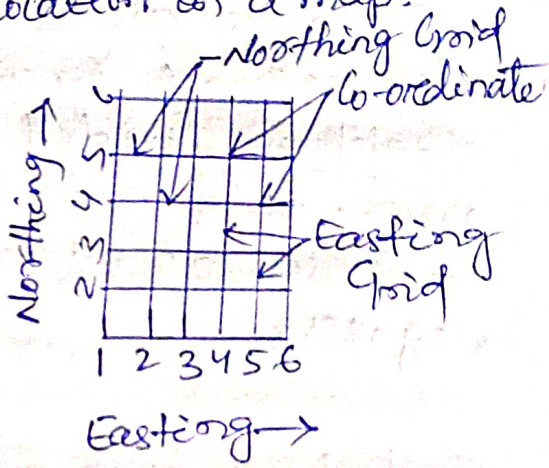
Grid Reference :- It is a geographic coordinate system that defines locations in maps using Cartesian Co-ordinates based on a particular map projection. Grid lines on map illustrate the underelying

coordinate system. Such co-ordinate lines are numbered to provide a unique reference to each location on the map. Grid co-ordinates are normally eastings and northings.

→ Grid is a network of horizontal and vertical lines used to identify exact location on a map.

→ The lines which increase towards North direction is known as Northing grid. (horizontal lines)

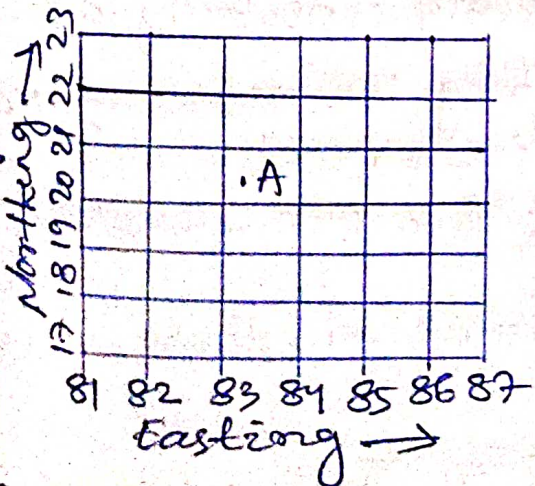
→ The line which increase towards East direction is known as Easting grid. (Vertical lines)

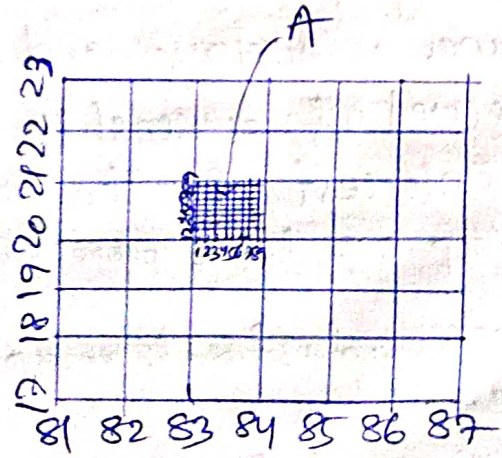


→ A point at which horizontal line and vertical line of grids cross each other is known as co-ordinates.

→ Grid reference is calculated by 2 methods.

1) four figures grid reference line
2) Six figure grid reference line





Four figure grid reference of point A = 8320

Six figure grid reference of point A = 834207