Geomatics Engineering

For

Civil Engineering

By

www.thegateacademy.com

✆ 080-40611000

Syllabus for Geomatics Engineering

Principles of Surveying; Errors and Their Adjustment; Maps-Scale, Coordinate System; Distance and Angle Measurement-Levelling and Trigonometric Levelling; Traversing and Triangulation Survey; Total Station; Horizontal and Vertical Curves.

Photogrammetry-Scale, Flying Height; Remote Sensing - Basics, Platform and Sensors, Visual Image Interpretation; Basics of Geographical Information System (GIS) and Geographical Positioning System (GPS).

Previous Year GATE Papers and Analysis

GATE Papers with answer key

thegateacademy.com/gate-papers

Subject wise Weightage Analysis

thegateacademy.com/gate-syllabus

Contents

"Losers visualize the penalties of failure.

Winners visualize the rewards of success."

.... Rob Gilbert

CHAPTER 1

Introduction to Surveying

Learning objectives

After reading this chapter, you will know:

1. Glossary
2. Classification Based on Nature of Survey
3. Choice of Scale of Map

Definition

Surveying is the art of determining the relative positions of points on, above or beneath the surface of earth by means of direct or indirect measurements of distance.

Objectives

- Collect & record data on relative position of points on surface of earth.
- Compute areas & volumes using this data for various purposes.
- Prepare plan & maps required for various activities.
- Layout, using survey data, various engineering work in correct position.

Basic Principles of Surveying

There are two main basic principles of surveying

(a) Working from whole to part

(b) Establishing any point by least two independent measurements

Glossary

(a) **Earth**: Earth is one of planet of solar system. Shape of earth is oblate spheroid (Obtained by rotating ellipse about minor axis) equatorial diameter of earth is greater than polar diameter.

(b) **Meridian**: A meridian is the line of interaction of a plane passing through poles with the surface of earth Fig.(a)

(c) **Latitude and Longitude**: Latitude of point is angle subtended at the centre from equatorial plane along the meridian through that point. The longitude of a point is the angular distance of that point east or west of the Greenwich meridian Fig (b)

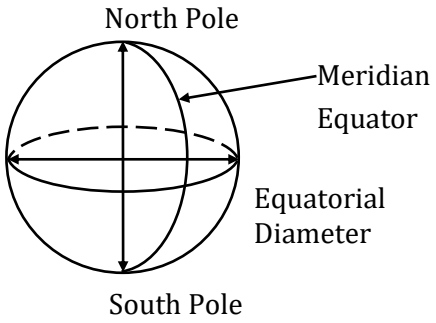

Fig. (a): Earth

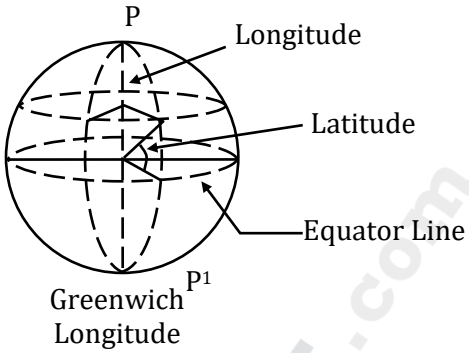

Fig.(b): Latitude & Longitude

(d) **Level Line:** Level line is the line which lies on the mean spheroidal surface of the earth.
(e) **Plumb Line:** A plumb line is a vertical line perpendicular to level line at a point. All plumb lines should meet at centre of earth.
(f) **Elevation:** The elevation of a point is the vertical height of point with reference of a datum level plane measured on plumb line.
(g) **Horizontal Plane:** Plane tangential to point on earth's surface.
(h) **Great Circle:** It is the plot intersection of plane passing through the centre of the earth with the surface of earth.

Classification of Surveying

Surveying is primarily divided into two classes
1. Plane surveying
2. Geodetic surveying

Plane Surveying: Mean surface of earth is assumed horizontal (spheroidal shape is neglected). It is used for small scale survey.
- Safe assumption as the difference between 12 km long are lying on surface of earth and subtended chord is only 1 cm
- Level line is straight
- Plumb lines are parallel to each other

Geodetic Surveying: Type of surveying in which shape of earth is taken into account.
- Lines lying on surface are curved
- Involves spherical trigonometry
- Geodetic survey determines accurate point of widely distant point which forms a control network for the reference (to be used in less precise and plane surveys)

Classification Based on Nature of Survey

1. **Land Surveying :** Further divided as
   (a) **Topographical Surveys:** Made to determine natural features and artificial features of area.
   (b) **Cadastral Surveys:** Regarding property line fixation (legal reasons).
   (c) **City Surveying:** Made in connection with the construction of civil works.
2. **Marine Survey:** Done for the purpose of navigation, water supply, harbour work, determination of mean sea level etc.
3. **Astronomical Survey:** Observation w.r.t heavenly body such as sun or any fixed star, to determine absolute location of any point.

Based on Objective

- **Engineering Survey:** Undertaken in connection in heath some engineering work (Collection of data for design etc.)
- **Military Survey:** Determines points of strategic importance.
- **Mine Survey:** Exploring mineral wealth.
- **Geological Survey:** To determine the geological properties of the area.
- **Archaeological Survey:** Used for obtaining ancient antiquities.

Based on Instruments Used

- Chain survey
- Theodolite survey
- Traverse survey
- Triangulation survey
- Tacheometric survey
- Plane table survey

Plans & Maps

Plans and maps are graphical representations of actual site to some scale. When scale is small, it is called map and when scale is large, it is called plan.

Scales

Scale is the fixed ratio that every distance on the point plan bears with corresponding distance on the ground.

Types of Scales:

1. **Numerical Scales**
   (a) **Engineers Scale:** Unit of distance on plan & ground are different. E.g. km on map representing 10 m on ground.
   (b) **Representative Fraction:** Units of distance as some on map as on ground. The ratio of map distance to corresponding ground distance is representative fraction (R.F).

$$\text{R. F.} = \frac{\text{Distance on map}}{\text{Distance on ground}}$$

2. **Graphical Scales**

Choice of Scale of Map

1. Prospective use of map
2. The extent of territory to be represented

Table Shows the Common Scales for Plans & Maps

Common Scales for Plans & Map

Sl. No.	Types of Map	R.F	Numerical Scale
1	Preliminary survey map for route surveys	1/1000 to 1/6000	1 cm = 10 m to 60 m
2	Building sites	1/1000	1 cm=10 m
3	Small scale topographic maps	$\frac{1}{25000}$ to $\frac{1}{250000}$	1 cm =0.25 to 2.1 cm
4	Cadastral Maps	$\frac{1}{500}$	1 cm = 5 m
5	Geographical Maps	$\frac{1}{16000000}$	1 cm = 1601 cm
6	Longitudinal section 1. Horizontal Scale 2. Vertical Scale	$\frac{1}{1000}$ $\frac{1}{100}$ to $\frac{1}{2000}$	1 cm = 10 m 1 cm = 1 to 2 m
7	Cross –section	$\frac{1}{100}$ to $\frac{1}{200}$	1 cm = 1 to 2 m

Plain Scale: It can measure in two dimensions. Line m & cm etc.

IS- 1491= 1959 Code for plain scales

Diagonal Scale: It is possible to measure three dimensions such as meters, decimeters and centimeters, IS 1562-1962 for diagonal scales.

Table: Standard Plain & Diagonal Scales

Plain Scales			Diagonal Scale		
Designation	Numerical	R.F	Designation	Length	R.F
A	Full size 50 cm = 1 m	1/1 1/2	A	1050 cm	1/1
B	40 cm =1 m 20 cm = 1 m	½.5	B	100 cm	1/100,000 1/50000 1/25000
C	10 cm = 1 m 5 cm = 1 m	1/10 1/20	C	50 cm	1/100,000
D	2 cm = 1 m 1 cm=1 m	1/50 1/100	D	1500 cm	1/50000 1/25000
E	5 mm = 1 m 2 mm=1 m	1/200 1/500	E	150 cm	1/100000 1/8000
F	1 mm=1 m 0.5 mm = 1 m	1/2000	F	-	1/4000

Vernier Scale

Principle: It is based on the fact that the eye can perceive without strain and with considerable precision when two graduations coincide to form one straight line.

If the graduation of main scale are numbered in one direction, it is called single vernier if the graduations are numbered in both direction, it is called double vernier.

Types of Vernier:

(a) **Direct Vernier:** Smallest division on (VSD) vernier is shorter than the smallest division on the main scale (MSD)

$(n-1)\text{MSD} = n - \text{VSD}$

$\therefore\ \text{VSD} = \left[\frac{n-1}{n}\right]\text{MSD}$

Least count $S\ =\ s - v$

$S - \frac{n-1}{n}s = \left[\frac{S}{N}\right]$

Where,

S/MSD = Main scale division

V/VSD= Vernier scale division

(b) **Retrograde Vernier**

The vernier scale increases in opposite direction as that of main scale and smallest division of vernier is longer than smallest division of main scale.

$\therefore \text{NV} = (1+1)\ s$

$\Rightarrow\ v\ =\ \left[\frac{n+1}{n}\right]s$

Least court $=\ v - s\ =\ \frac{s}{n}$

Remember: Least count of vernier is difference between smallest division on main scale and smallest division on vernier scale.

Scale of Chords

A scale of chord is used to measure or set-off an angle.

Error Due to Wrong Scale

The true length of line drawn on a map with faulty scale is given as

$$\text{Correct length}\ =\ \frac{\text{R. F of wrong scale}}{\text{R. F. of Correct scale}} \times\ \text{Measured length}$$

$$\text{Correct Area}\ =\ \left[\frac{\text{R. F of wrong scale}}{\text{R. F. of correct scale}}\right]^2 \times\ \text{Calculated area}$$

Shrunk Scale: This problem arises when the sheet on which plan is drawn shrinks due to variation in atmospheric condition

- This problem can be solved by drawing graphical scale on the same sheet.
- The shrinkage factor is given as ratio of shrunk length to the actual length
  Shrunk scale = Shrinkage factor × Original scale

"Picture yourself vividly as winning and that alone will contribute immeasurably to success."

.... Harry Fosdick

CHAPTER 2

Measurement of Distance and Direction

Learning Objectives

After reading this chapter, you will know:

1. Liner Measurements
2. Instrumentation for Chaining
3. Measurements of Direction Compass Surveying
4. Variations in Declination

Linear Measurements (Distances)

Methods for linear measurements can be divided into three groups

1. Direct measurement
2. Measurements by optical methods
3. Electro –magnetic distance methods

Direct Measurements

Measuring the distances directly

1. **Pacing :** Done for rough estimate
   Length = No. of paces × Avg. length of single pace
2. **Measurement with Passometer:**
   Passometer counts the no. of paces, kept in pocket attached to pegs.
3. **Pedometer:**
   Given the distance travelled if avg. pace length is provided to it.
4. **Odometer & Speedometer :**
   Based on registering the no. of revolution of a wheel
   Length = No. of revolutions × Circumference of the wheel
5. **Chaining:** Measuring distance with help chain or tape.

Instruments for Chaining

(a) **Chain or Tape**

Chains are formed of straight links or galvanized mild steel wire.

Commonly used chains are

1. **Metric Chain :** Reference code – IS:1492 - 1970 - Available in length 5, 10, 20 and 30 meter
2. **Gunter's Chain :** 66 feet long with 100 links
   10 Square chain = 1 acre
   10 Gunter's chain = 1 furlong
   80 Gunter's chain = 1mile