# FUNDAMENTTAL CONCEPT ABOUT SURVEYING

## SURVEYING

- It deals with the methods of obtaining the relative positions of points on, above or beneath the surface of the earth.
- The relative positions are determined by measuring horizontal and vertical distances and angles using surveying instruments.

## CLASSIFICATION OF SURVEYING

### A. Main Classification:/ primary classification

- It is based on whether curvature of earth is considered or not.
- Shape of earth is an oblate spheroid which is an ellipsoid of revolution, flattened at poles and bulging at the equators.

**Note:** The polar axis (12713800 m) is shorter than the equatorial axis (12756750 m) by 42.95 km.

#### (1) Plane surveying:

- Surface of the earth is considered as flat and the spherical shape is neglected.
- Suitable for area < 250 sq. km.
- All distances and angles are projected onto a horizontal plane *i.e.* a curve line on the surface of the earth is considered as straight.
- Triangles formed by survey lines are plane triangles.

#### (2) Geodetic Surveying:

- Curvature of the earth is taken into consideration.
- Standard of accuracy is very high.
- Used for larger area.
- Very precise instruments are required.

### B. Based on the nature of the filed server:

#### 1) Land surveying or cadastral survey

- Most general type of surveying.
- Used to determine boundaries and dividing land into small plots.
- Also called as property surveys.

#### 2) Marine or hydrographic survey

- Conducted on or near water bodies such as lakes, rivers, bays etc.
- Important works are to locate shore lines.

**3) Astronomical survey**

- Conducted for the determination of latitudes, longitudes, azimuth, local time etc for various places on the earth by observing heavenly bodies.

**4) Topographical Survey:**

- Conducted to obtain data and to make map indicating inequalities of land surface by measuring elevations and locating the natural and artificial features of earth.
- Their scale ranges from 1 : 25000 – 1 : 1000000

**C. Based on the object of surveying**

**1) Engineering survey**

- Used for collecting data for the designing and planning of engineering works like roads, bridges, dams etc.

**2) Military survey**

- Used to determine the routes and points of strategic importance.

**3) Mine survey**

- Used to plan the working of mines and to compute the volume of material in mines.

**4) Geological survey**

- To find the information about different strata of earth's surface for geological studies.

**5) Archaeological survey**

- To unearth relics of antiquity.

**D. Based on the instruments used**

**1) Chain survey**

- Simplest type of surveying.
- Only linear measurements are taken with a chain or a tape.

**2) Theodolite survey**

- Theodolite is an instrument used for taking horizontal and vertical angles.
- It is of two types : (*a*) Traverse (*b*) Triangulation

**3) Tacheometric survey**

- Tachometer is a modified form of theodolite with a stadia diaphragm having two horizontal cross hairs in addition to the central horizontal hair.
- Horizontal angles and distances and elevations are measured. With the help of tacheometer.
- Although not very accurate in plane area, but these are extremely convenient and gives better result than theodolite surveys in rough terrain.

**4) Plane table survey**

- Measurements and plotting are done simultaneously in the field.
- Less time is required for complete work.

- Accuracy is low.

**5) Photogrammetric survey**

- Science of taking measurements with the help of photographs.
- Used for areas which are difficult to reach.

**6) Compass Survey:**

- Horizontal angles are measured with the help of magnetic compass, in addition to this, linear measurements are taken with chain or tape.
- More accurate than chain survey.

**7) Levelling**

- In this type of survey, a leveling instrument is used for determination of relative elevations of various points in the vertical plane.

**8) EDM Survey**

- Trilateration is a type of triangulation in which all the three sides of each triangle are measured accurately with the help of EDM instruments.
- Then angles are computed indirectly from the known sides of the triangle.

## PRINCIPLES OF SURVEYING

1) Working from whole to part: - To prevent the accumulation of errors and to control and localize minor errors.

**Note:** If we work from part to whole, the errors accumulate and expand to a greater magnitude in the process of expansion of survey.

2) Locate a point by atleast two measurements.

**Instruments used for Different Measurements**

1. **Horizontal distances:** Chains, tapes, tacheometers, E.D.M. etc.
2. **Vertical distances:** Levelling instruments, tacheometers.
3. **Horizontal angles:** Magnetic compasses, theodolites, sextants.
4. **Vertical angles:** Theodolites, clinometer, sextants.

**Plan and Map**

**(*i*)** **Plan:** it graphically represents the features on or near the earth's surface as projected on a horizontal plane. It is drawn on a relatively larger scale.

**(*ii*)** **Map:** If the scale of the graphical projection on a horizontal plane is small, the plan is termed as map.

**PLAN**

A plan is a graphical representation to some scale, of the features on, near or beneath the surface of the earth as projected on a horizontal plane.

- The representation is called a **map** if the scale is **small**, but it is called as **plan** if the scale is **large**.

## SCALE OF AMAP

➢ It is the fixed ratio that every distance on the plan bears with corresponding distance on the ground.

### Scale can be represented as:

**1)** **Engineer's Scale:** It is indicated by a statement. For example: 1 cm = 10 m, it means 1 cm on the map is equal to 10 m on the ground.

**2)** **Representation fraction (R.F.):** It is the ratio of map distance to the corresponding ground distance it is independent of units of measurement

e.g. – If engineer scale is 1cm = 50 m.

$$\therefore \quad R.F. = \frac{1}{50 \times 100} = \frac{1}{5000}$$

i.e. one unit of length on the plan represents same number of same units of length on the ground.

**3)** **Graphical scale:**-A graphical scale is a line sub-divided into plan distance corresponding to some units of length on the ground.

| Type or purpose of survey | Engineers' scale | R.F. |
|---|---|---|
| (a) Topographic Survey | | |
| 1. Building sites. | 1 cm = 10m or less | $\frac{1}{1000}$ or less |
| 2. Town planning schemes, reservoirs etc. | 1 cm = 50m to 100 m | $\frac{1}{5000}$ *to* $\frac{1}{10000}$ |
| 3. Location surveys | 1 cm = 50m to 200m | $\frac{1}{5000}$ *to* $\frac{1}{20000}$ |
| 4. Small scale topographic maps | 1 cm = 0.25km to 2.5 km | $\frac{1}{25000}$ *to* $\frac{1}{20000}$ |
| (b) Cadastral maps | 1 cm = 5m to 0.5 km | $\frac{1}{500}$ *to* $\frac{1}{5000}$ |
| (c)Geographical maps | 1 cm = 5km to 160 km | $\frac{1}{500000}$ *to* $\frac{1}{16000000}$ |
| (d) Longitudinal sections | 1 cm = 10m to 200 m | $\frac{1}{1000}$ *to* $\frac{1}{20000}$ |
| 1. Horizontal scale | 1 cm = 1m to 2m | |
| 2. Vertical scale | | |
| (e)Cross-sections (Both horizontal and vertical scales equal) | 1 cm = 0.25km to 2.5 km | $\frac{1}{25000}$ *to* $\frac{1}{20000}$ |

**Errors caused by Map Shrinkage**

Drawing paper shrinks due to change in atmospheric conditions like temperature, humidity etc. Due to this all lines marked on it also shrinks.

So there will be error in measurements taken from the map.

The ratio of shrunk length of a line on the map to the actual length is termed as shrinkage ratio or shrinkage factor.

Shrunk scale of a map = Original scale × Shrinkage factor

$$\text{Correct distance} = \frac{\text{Measured distance}}{\text{Shrinkage factor}}$$

$$\text{Correct area} = \frac{\text{Measured area}}{(\text{Shrinkage factor})^2}$$

**Errors caused by Wrong Measuring Scale**

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

$$\text{Correct area} = \left(\frac{\text{R.F. of wrong scale}}{\text{R.F. of correct scale}}\right)^2 \times \text{Measured area}$$

Where, R.F. = Representative fraction

**Types of scale:**

Scales are required for the preparation of plans. Following types of scales are used for this purpose.

1. Plain scale
2. Diagonal scale
3. Scale of chords
4. Vernier scale

**Vernier scale**

- It is a device used for measuring the fractional part of smallest division on a graduated scale.
- It consists of a small scale called Vernier scale, which moves along the scale called the main scale.
- Least count is equal to the difference in length of one division of main scale and Vernier scale.
- The vernier carries an index mark which represents the zero of the vernier.
- If the graduations of the main scale are numbered in one direction only, the vernier is called a **single vernier**
- If the graduations of the main scale are numbered in both the directions, the vernier is called a **double vernier**

**Type of vernier:**

1. Direct vernier
2. Retrograde vernier
3. Extended vernier
4. Double folded vernier

**(1) DIRECT VERNIER**

- Direct vernier extends or increases in the same direction as that of the main scale and in which the smallest division on the vernier is shorter than the smallest division on the main scale.

  i.e. (n - 1) divisions of the main scale are equal in length of n divisions of the vernier. i.e., $\boxed{nv = (n-1)s}$

  $\therefore$ Least count (L.C.) = $\frac{s}{n}$

  Where, s = value of one smallest division on main scale

  v= value of one smallest division on the vernier.

**(2) RETROGRADE VERNIER**

- Retrograde vernier extends or increase in opposite direction as that of themain scale and in which the smallest division of the vernier is longer than the smallest division on the main scale.

  i.e. (n + 1) divisions of the main scale are equal in length of 'n' divisions of the vernier. i.e. $\boxed{nv = (n+1)s}$

  $\therefore$ Least count = $\frac{s}{n}$

**(3) EXTENDED VERNIER**

- This is used when the main scale are very close and vernier is of normal length

  (2n - 1) divisions on the main scale are equal to n divisions of the vernier.

  i.e. $\boxed{nv = (2n-1)s}$

  $\therefore$ Least count = $\frac{s}{n}$

**(4) DOUBLE FOLDED**

It is used where the length of the corresponding double vernier is so large as to make it impracticable.

**Accuracy and Precision**

- Accuracy is the closeness of a measurement to its true value.
- The measured value is said to be very accurate if it is very close to the true value.
- Precision of a measurement is its closeness to another measurement of the same quantity.

**Sources of errors**

Depending upon the source, the errors are classified as follows:

1. Instrumental: It occurs due to imperfection and improper adjustment of the instrument used.
2. Personal: It is due to human limitations.
3. Natural: It is due to change in nature such as temperature, wind, humidity, refraction, magnetic field.

**Errors in Surveying**

**(*i*) Mistakes:** It is due to carelessness, inexperience or poor judgement of surveyor.

→ Does not have any fixed pattern.
→ Cannot be eliminated by adopting any standard methods of observations.
**(*ii*) Systematic Errors:** Have well-defined mathematical law or system.
→ Magnitude and sign of such errors can be determined and corrections can be applied.
**(*iii*) Accidental Errors:** Random in nature
→ Don't have any fixed pattern.
→ Can be positive or negative.
→ They have small magnitudes and tend to distribute equally on both sides of true value.
→ Also called as compensating errors.
→Follow the law of probability.
→Random error of mean $\propto \frac{1}{\sqrt{N}}$, where N is the no. of observations made.

**Units of Measurements:**
- 1 ft. = 0.3048 m
- 1 Yard = 3 ft.
- 1 mile = 5280 ft.
- 1 mile = 1.609 km
- 1 sq. mile = $2.590\ km^2$
- 1 acre = 43560 sq. ft.
- 1 Sq. mile = 640 acre
- 1 hectare = 2.471 acre

## Key Points

1. Main classification of surveying
(*i*) Plane surveying (suitable for area < 250 sq. km)
(*ii*) Geodetic surveying.
2. Working from whole to part prevent the accumulation of errors.
3. Shrunk scale of map = Original scale × Shrinkage factor
4. For direct vernier, $(n-1)$ divisions of main scale are equal in length of $n$ divisions of the vernier, *i.e.*,

$$nV = (n-1)\,s$$

$$\therefore \quad \text{Least count} = \frac{s}{n}$$

Where, $s$ = Value of one smallest division or main scale
V = Value of one smallest division or vernier