Surveying
Unit-II

Important Questions

- Define Surveying and Leveling
- Differentiate between Surveying and Leveling.
- Explain fundamental Principles of Surveying.
- Explain Plain and Diagonal Scale.
- What is Surveying? What are object of surveying and its application?
- Differentiate between plain survey and geodetic survey.
- Examples on scales

Syllabus

- **Surveying and leveling**, Object and uses, Primary divisions, Fundamental principles, Classification of surveying, Plans and maps, Scales, Units of measure.
- **Linear measurements**: Methods, Instruments used in chaining; Chain surveying, Ranging, Errors in chaining, Conventional symbols.
- **Compass surveying**: Types and uses of compass, Bearings, Whole Circle Bearings and Reduced Bearings, Computation of angles; Meridians & its related examples; declinations and dip of needle; Chain and compass surveying field work.
- **Elevation measurements**: Leveling, object and uses, terms used in leveling, leveling instruments, methods of leveling, recording and methods of reducing, errors in leveling & examples related to leveling, contours; characteristics and applications.
- **Areas and volumes**; use of a Planimeter
- **Modern Tools of Surveying and Mapping**:
- Introduction to Global Positioning System, Remote Sensing and Geographic Information System

Surveying & Leveling

- **Surveying and leveling**, Object and uses, Primary divisions, Fundamental principles, Classification of surveying, Plans and maps, Scales, Units of measure

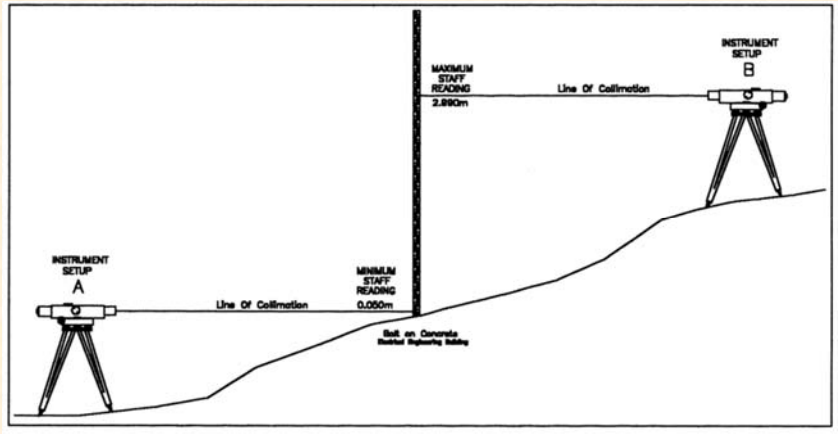
Surveying

- "*Surveying is an art of determining relative position of point on above or below the surface of the earth by measuring the horizontal and vertical distances, angles and taking details of these points and by preparing a map or plan to suitable scale*".
- Thus in surveying, the measurements are taken in the horizontal and vertical planes.

Leveling

- "*Leveling is a branch of surveying which deals with the measurement of relative heights of different points on above or below the surface of the earth*".
- Thus in leveling, the measurements are taken in vertical plane.

Leveling



Object of Surveying

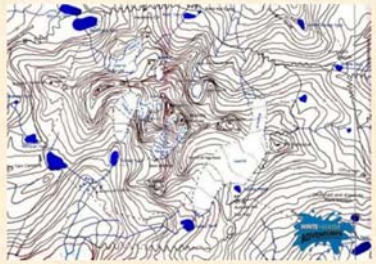
- The Object of surveying is to prepare a map or plan to show relative positions of the objects on the surface of the earth.
- The plan or map is prepared to some suitable scale. It shows boundaries of state and countries too. It also includes details of different engineering features such as buildings, roads, railways, dams, canals etc.

Plan and Map

Uses of Surveying

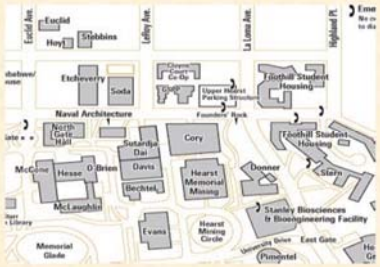
- Surveying may be used for the following purposes:
- To prepare topographical map which shows the hills, valleys, rivers, forests, villages towns.
- To prepare a cadastral map which shows the boundaries of fields, plots, houses and other properties.
- To prepare an engineering map which shows the position of engineering works, such as buildings, roads, railways, dams, canals, etc.
- To prepare a contour map to know the topography of the area to find one of the best possible site for roads, railways, bridges, reservoirs, canals, etc.
- Surveying is also used to prepare military map, geological map, archaeological map.etc.
- For setting out of works and transferring details from the map on the ground.

Topographical Map

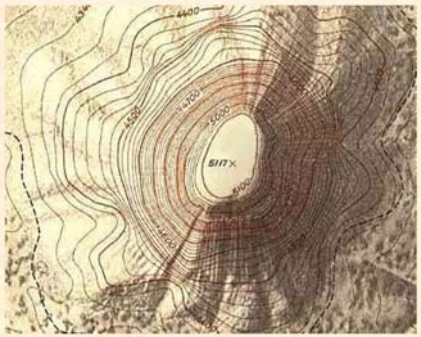


Cadestral Map

Engineering Map



Contour Map



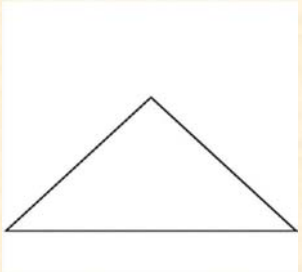
Primary Divisions of Surveying

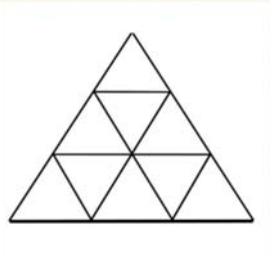
- Surveying is primarily divided into two types considering the curvature of the earth's surface.
- Plane Surveying
- Geodetic Surveying

Plane Surveying

- The plane surveying is that type of surveying in which earth surface is considered as a plane and the curvature of the earth is ignored. In such surveying the line joining any two stations is considered to be straight. The triangle formed by the three points is considered as a plane triangle and the angles of the triangle are considered as plane angle.
- Plane surveying is carried out for a small area of less than 250 km^2. It is carried out by local or state agencies like Irrigation department, Railway department., etc.

Plane Triangle

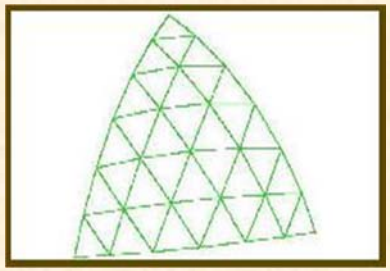


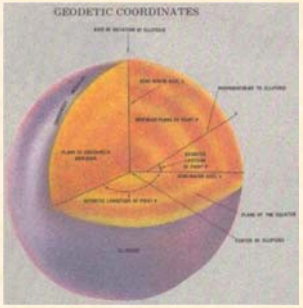


Geodetic Surveying

- The geodetic surveying is that type of surveying in which the curvature of the earth is taken into account. It generally extends over larger area. The line joining any two stations is considered as a curved line. The triangle formed by any three points is considered as spherical and the angles of the triangles are considered to be spherical angles. Geodetic surveying is carried out by survey of India department and is carried out for a large area exceeding 250 km^2.

Geodetic Triangle





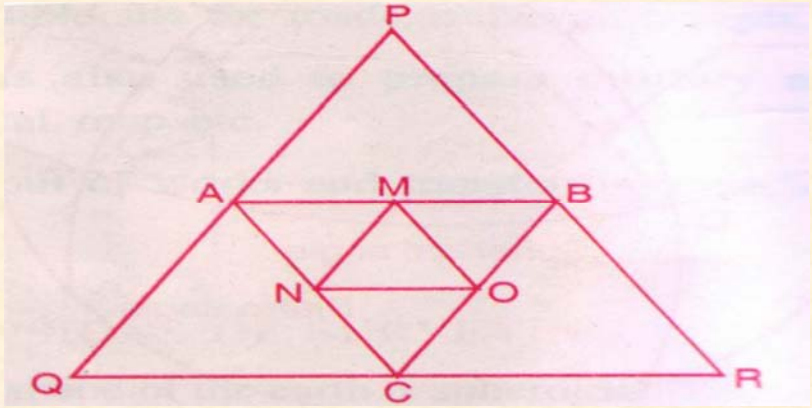
Plane surveying Vs Geodetic surveying

No.	Plane Surveying	Geodetic Surveying
1	The earth surface is considered as a plane surface	The earth surface is considered as curved surface
2	The curvature of the earth is ignored	The curvature of the earth is not ignored
3	The line joining any two stations is considered to be straight line	The line joining any two stations is considered as a curved line
4	The triangle formed by any three points is considered as a plane	The triangle formed by any three points is considered as spherical.
5	The angles of the triangles are considered as plane angles	The angles of the triangles are considered to be spherical
6	Carried out for a small area < 250 km2	Carried out for a larger area > 250 km 2

Fundamental Principles of Surveying

- Two basic principles of surveying are:
- Always work from whole to a part.
- To locate a new station by at least two measurements (linear or angular) from fixed reference points.

Work from whole to a part



Always work from whole to the part

- According to the first principle, the whole are is first divided into a number of divisions by forming well conditioned triangles.
- The main survey lines are measured very accurately with precise survey instruments. Then the remaining sides of triangle are measured. The purpose of this method of working is to control accumulation of errors. During measurement, if there is any error, then it will not effect the whole work. But if the reverse process is followed then the minor error in measurement will be magnified.

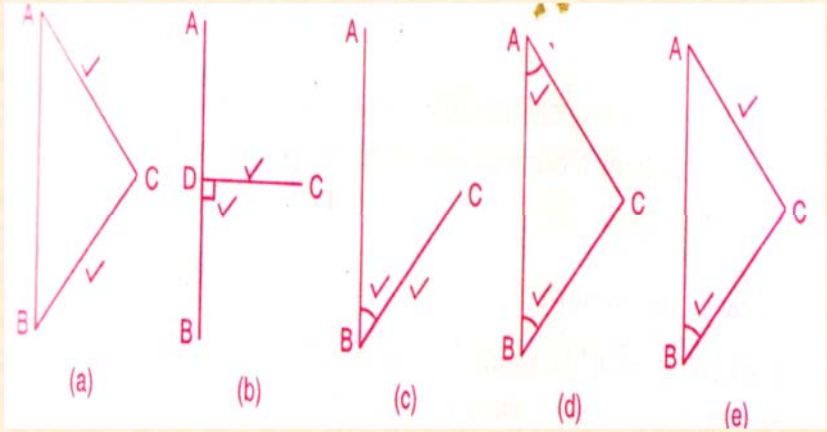
To locate a new station by at least two measurements (linear or angular) from fixed reference points:

- According to the second principle the points or stations are located by linear or angular measurement or by both in surveying. If two control points are established first, then a new station can be located by two linear or two angular measurements or by one linear and one angular measurement. Let A and B are control points. A new point C can be established. Following are the methods of locating point C from such reference points A and B.

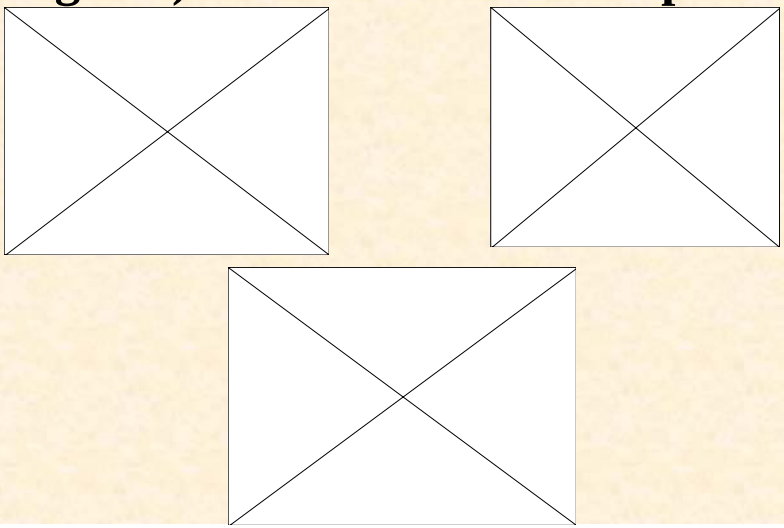
To locate a new station by at least two measurements (linear or angular) from fixed reference points

- The distance AB can be measured accurately and the relative positions of the points can be then plotted on the sheet to some scale.
- a) Taking linear measurements from A and B for C.
- b) Taking linear measurement of perpendicular from D to C.
- c) Taking one linear measurement from B and one angular measurement as angle ABC.
- d) Taking two angular measurements at A and B as angle CAB and angle ABC
- e) Taking one angle at B as angle ABC and one linear measurement from A as AC.

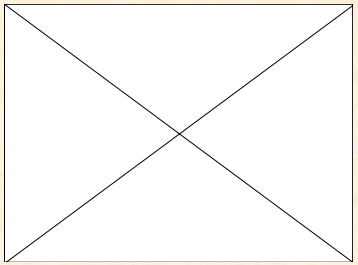
To locate a new station by at least two measurements (linear or angular) from fixed reference points

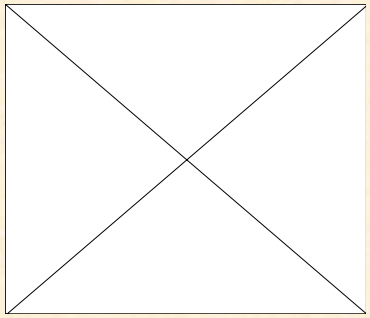


To locate a new station by at least two measurements (linear or angular) from fixed reference points



To locate a new station by at least two measurements (linear or angular) from fixed reference points

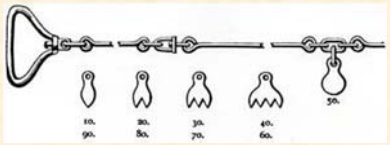




Classification of Surveying

- ***Classification based on Instruments:***
- **Chain Survey**: This is the simplest type of survey in which only linear measurement are made with a chain or a tape.
- **Compass Survey**: In compass survey angles are measured with the help of a magnetic compass.
- **Chain and Compass survey**: In this survey linear measurements are made with a chain or a tape and angular measurements with a compass.
- **Plane Table Survey**: It is graphical method of surveying in which field works and plotting both are done simultaneously.

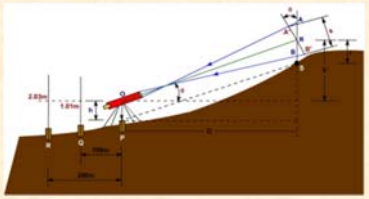
Surveying Based on Instruments

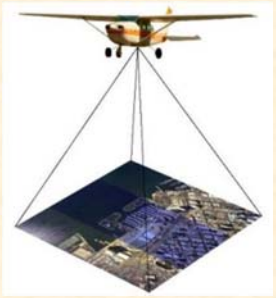


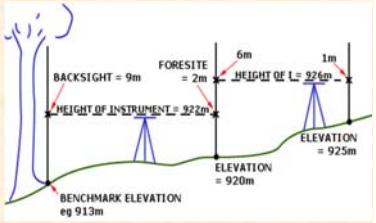
Classification of Surveying

- **Theodolite Survey**: In theodolite survey, the horizontal angles are measured with a theodolite more precisely than compass and the linear measurements are made with a chain or tape.
- **Tachometric Survey:** A special type of theodolite known as tachometer is used to determine horizontal and vertical distances indirectly.
- **Leveling Survey:** This type of survey is carried out to determine the vertical distances and relative heights of points with the help of an instrument known as level.
- **Photogrammetric Survey:** Photogrammetric is a science of taking measurements with the help of photographs taken by aerial camera from air craft.
- **EDM Survey:** In this type of survey, all measurements are made with the help of EDM.

Classification of Surveying



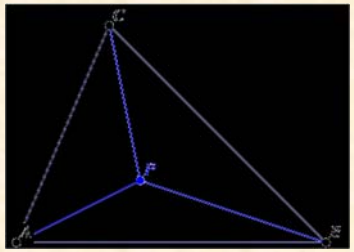




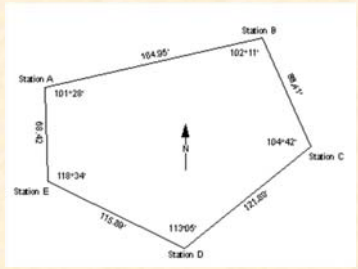
Classification based on methods

- **Triangulation:** Triangulation is a basic method of surveying. When the area to be surveyed is large, triangulation is adopted. The entire area is divided into a network of triangles.
- **Traversing:** A traverse is a circuit of survey lines. It may ne open or closed. When the linear measurements are done with a chain and tape and the directions or horizontal angles are measured with a compass or a theodolite respectively, the survey is called traversing.

Classification by methods



Triangulation



Traversing

Classification based on Purposes

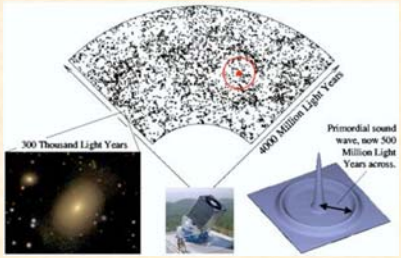
- **Geological Survey:** In this both surface and subsurface surveying are conducted to locate different minerals and rocks. In addition, geological features of the terrain such as folds and faults are located.
- **Mine Surveying:** Mine surveys include both surface and underground surveys. It is conducted for the exploration of mineral deposits and to guide tunneling and other operations associated with mining.
- **Archeological Survey**: It is conducted to locate relics of antiquity, civilization, kingdoms, forts, temples, etc.
- **Military Survey:** It has a very important and critical application in the military. Aerial surveys are conducted for this purpose. It is conducted to locate strategic positions for the purpose of army operations.

Classification based on Purposes

Classification Based on Nature of Fields

- **Land Survey:** Land survey is done on land to prepare plan and maps of a given area. Topographical, city, cadastral survey are some of the examples of land surveying.
- **Hydrographic survey**: This surveys are conducted on or near the body of water such as lake, river, coastal area This survey consists of locating shorelines of water bodies.
- **Astronomic Survey**: The surveys are conducted for the determination of latitudes, longitudes, azimuths, local time, etc. for various places on the earth by observing heavenly bodies.
- **Aerial Survey**: An aerial survey is conducted from aircrafts, aerial cameras take photographs of the surface of the earth in overlapping strips of land. This is also known as photography survey.

Classification based on fields



Plans and Maps

- One of the basic objective of surveying is to prepare plans and maps.
- **Plan:** A plan is graphical representation to some scale, of the features on, near, or below the surface of the earth as projected on a horizontal plane. The horizontal plane is represented by the plane of the drawing sheet on which the plan is drawn to some scale.
- However, the surface of the earth is curved it cannot be truly represented on a plan without distortion.
- A land is drawn on a relatively large scale.

Plans and Maps

- **Map:** If the scale of the graphical projection on a horizontal plane is small, the plan is called a map.
- Thus graphical representation is called a plan if the scale is large while it is called a map if the scale is small.
- On a plan, generally, only horizontal distance and directions or angles are shown. On a topographical map, however the vertical distances are also represented by contour lines.

Plan and Map

Scale

- It is basic requirement for the preparation of plans or maps. Scale is used to represent large distance on paper. The ratio by which the actual length of the object is reduced or increased in the drawing is known as the ‘ Scale’
- For ex, if 1 cm on a map represents a distance of 10 m on the ground the scale of the map is said to be 1 cm= 10 m.

SCALES

DIMENSIONS OF LARGE OBJECTS MUST BE REDUCED TO ACCOMMODATE ON STANDARD SIZE DRAWING SHEET.THIS REDUCTION CREATES A SCALE OF THAT REDUCTION RATIO, WHICH IS GENERALLY A FRACTION..
SUCH A SCALE IS CALLED REDUCING SCALE
AND
THAT RATIO IS CALLED REPRESENTATIVE FACTOR.

SIMILARLY IN CASE OF TINY OBJECTS DIMENSIONS MUST BE INCREASED FOR ABOVE PURPOSE. HENCE THIS SCALE IS CALLED ENLARGING SCALE.
HERE THE RATIO CALLED REPRESENTATIVE FACTOR IS MORE THAN UNITY.

FOR FULL SIZE SCALE R.F.=1 OR (1:1) MEANS DRAWING & OBJECT ARE OF SAME SIZE.
Other RFs are described as 1:10, 1:100, 1:1000, 1:1,00,000

USE FOLLOWING FORMULAS FOR THE CALCULATIONS IN THIS TOPIC.

(A) **REPRESENTATIVE FACTOR (R.F.) =** $\frac{\text{DIMENSION OF DRAWING}}{\text{DIMENSION OF OBJECT}}$

$= \frac{\text{LENGTH OF DRAWING}}{\text{ACTUAL LENGTH}}$

$= \sqrt{\frac{\text{AREA OF DRAWING}}{\text{ACTUAL AREA}}}$

$= \sqrt[3]{\frac{\text{VOLUME AS PER DRWG.}}{\text{ACTUAL VOLUME}}}$

(B) **LENGTH OF SCALE = R.F. X MAX. LENGTH TO BE MEASURED.**

Representative Factor (RF)

- The ratio of the distance on the drawing to the corresponding actual length of the object on the ground is known as the representative fraction. i.e.
- RF= Distance of Object on Drawing

  Corresponding actual distance on ground

Representative Factor (RF)

For example,

if a scale is

(i) 1 cm = 10 m.

$$\text{R.F.} = \frac{1}{10 \times 100} = \frac{1}{1000} \text{ or } 1:1000.$$

(ii) 1 cm = 100 m.

$$\text{R.F.} = \frac{1}{100 \times 100} = \frac{1}{10000} \text{ or } 1:10000$$

(iii) 1 cm = 1 km.

$$\text{R.F.} = \frac{1}{1 \times 1000 \times 100} = \frac{1}{100000} \text{ or } 1:100000$$

Example

MPLE-2.1 : A 10 km long road is indicated in a map by a length of 10 m straight line. Calculate the scale and R.F. of a map.

UTION :

10 cm on drawing sheet = 10 km. on ground

∴ 1 cm = 1 km. (scale of a map)

1 cm = 1 km

$$\therefore \text{R.F.} = \frac{1}{1 \times 1000 \times 100} = \frac{1}{100000}$$

or R.F. 1:100000 **(Ans.)**

Example

MPLE-2.2 : An area of 49 cm² of a map represents an area of 2401 km². Find scale and R.F. of a map.

UTION :

49 cm² represents 2401 km²

∴ 1 cm² represents $\frac{2401}{49}$ = 49 km²

1 cm² represents 49 km²

∴ 1 cm represents $\sqrt{49}$ = 7 km.

∴ 1 cm = 7 km. (scale of a map)

$$\text{R.F.} = \frac{1}{7 \times 1000 \times 100} = \frac{1}{700000}$$

or 1:700000 **(Ans.)**

Example

MPLE-2.3 : A plan represents an area of 72,000 m^2 and measures 4.00 cm × 5.00 cm. Find the scale of the map and R.F.

LUTION :

$4.00 \times 5.00\ cm^2$ represents $72{,}000\ m^2$

$\therefore$ $1\ cm^2$ represents $\dfrac{72{,}000}{4.00 \times 5.00} = 3600\ m^2$

or $1\ cm = \sqrt{3600}$

i.e. 1 cm = 60 m (scale of the map)

Graphical Representation of Scale

- Graphical representation of scale on maps has the advantage that if the paper shrinks, the scale will also shrinks accordingly and the distance representations will not be disturbed.

Graphical Representation of Scale :

Another way to mention the scale on maps is by graphical representation. This is shown in Fig. 2.4.

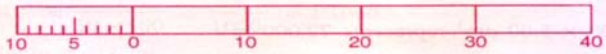


Fig. 2.4 Graphical representation of scale (1 cm = 5 m or R.F. = 1 : 500)

Graphical representation of scale on maps has the advantage that if the paper shrinks, the scale will also shrink accordingly and the distance representation will not be disturbed.

Types of Scale

- Plain scale
- Diagonal Scale
- Vernier Scale
- **Plain Scale:** The Plain Scale is the most commonly used in maps, the scale is used to represent two successive units, such as tenths, ,metres, decimetres, etc.

PLAIN SCALE:- **This type of scale represents two units or a unit and it's sub-division.**

PROBLEM NO.1:- Draw a scale 1 cm = 1m to read decimeters, to measure maximum distance of 6 m. Show on it a distance of 4 m and 6 dm.

CONSTRUCTION:-

a) Calculate R.F.= $\dfrac{\text{DIMENSION OF DRAWING}}{\text{DIMENSION OF OBJECT}}$

PLAIN SCALE

R.F.= 1cm/ 1m = 1/100

Length of scale = R.F. X max. distance

= 1/100 X 600 cm

= 6 cms

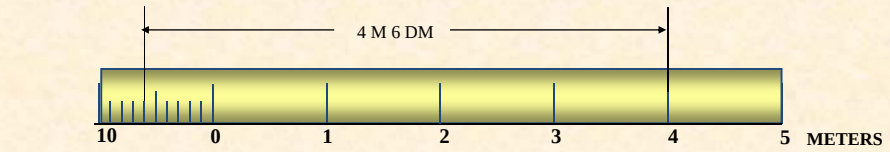
b) Draw a line 6 cm long and divide it in 6 equal parts. Each part will represent larger division unit.

c) Sub divide the first part which will represent second unit or fraction of first unit.

d) Place (0) at the end of first unit. Number the units on right side of Zero and subdivisions on left-hand side of Zero. Take height of scale 5 to 10 mm for getting a look of scale.

e) After construction of scale mention it's RF and name of scale as shown.

f) Show the distance 4 m 6 dm on it as shown.



R.F. = 1/100

PLANE SCALE SHOWING METERS AND DECIMETERS.

Plain Scale

EXAMPLE 2.5 : Construct a plain scale of RF 1/500 to measure upto a metre and represent 37 m on the scale.

SOLUTION :

RF – 1/500 is the same as 1 cm = 5 m or 2 cm = 10 m. Take a line of length 12 cm and divide into six parts. Each part of length 2 cm represents 10 m. (Fig. 2.5). The part on the left extreme is divided into 10 equal parts and each division represences 1 m. The zero of the scale starts from the end of this part and the numbering at each part is marked as shown in the figure. To show or measure 37 m, we start from the 30 m mark and take seven division(fraction) towards the left from the zero. This gives 37 m as shown in Fig. 2.5.

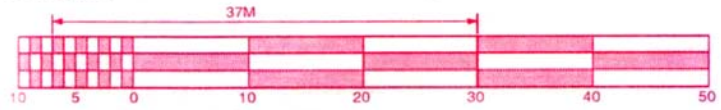


Fig. 2.5 Plain scale (1 cm = 5 m)

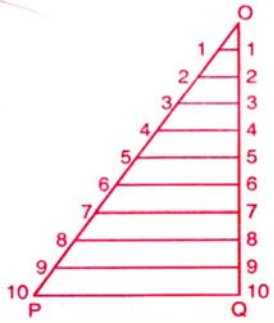
Diagonal Scale

- Using a diagonal scale, one can measure three dimensions such as units, tenths, and hundredths, “metres, decimeter and centimeters” and so on. The diagonal scale is made on the principle of similar triangle.

Diagonal Scale

Diagonal Scale : **(GTU March 2009)**

Using a diagonal scale, one can measure three dimensions such as “units, tenths and hundredths”, “metres, decimeters and centimeters”, and so on. The diagonal scale is made on the principle of similar triangles as shown in Fig. 2.6(a).

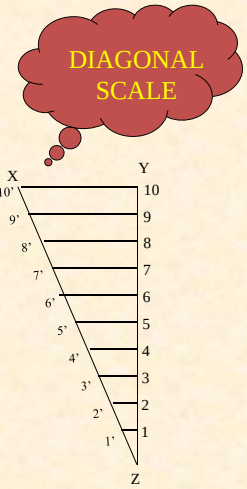


We have seen that the plain scales give only two dimensions, such as a unit and it’s subunit or it’s fraction.

The diagonal scales give us three successive dimensions that is a unit, a subunit and a subdivision of a subunit.

The principle of construction of a diagonal scale is as follows.
Let the XY in figure be a subunit.
From Y draw a perpendicular YZ to a suitable height.
Join XZ. Divide YZ in to 10 equal parts.
Draw parallel lines to XY from all these divisions and number them as shown.
From geometry we know that similar triangles have their like sides proportional.

Consider two similar triangles XYZ and 7’ 7Z,
we have 7Z / YZ = 7’7 / XY (each part being one unit)
Means 7’ 7 = 7 / 10. x X Y = 0.7 XY
:.
Similarly
1’ – 1 = 0.1 XY
2’ – 2 = 0.2 XY
Thus, it is very clear that, the sides of small triangles, which are parallel to divided lines, become progressively shorter in length by 0.1 XY.



Diagonal Scale

EXAMPLE 2.6 : Construct a diagonal scale 1 cm = 5 m to read metres a decimetres. Represent 45.3 m on the scale.

SOLUTION :

1 cm = 5 m means 2 cm = 10 m. We construct a small scale 12 cm lo as shown in Fig. 2.6(b). The length is divided into six parts. Each part represe 10 m. The left most segment is divided into 10 parts. The vertical width the scale may be kept as 2 cm and divided into 10 parts. The divisions the horizontal legs are joined diagonally. The length of 45.3 m can be measu as shown. (Fig. 2.6(b))

Fig. 2.6(b) Diagonal scale (1 cm = 5 m)

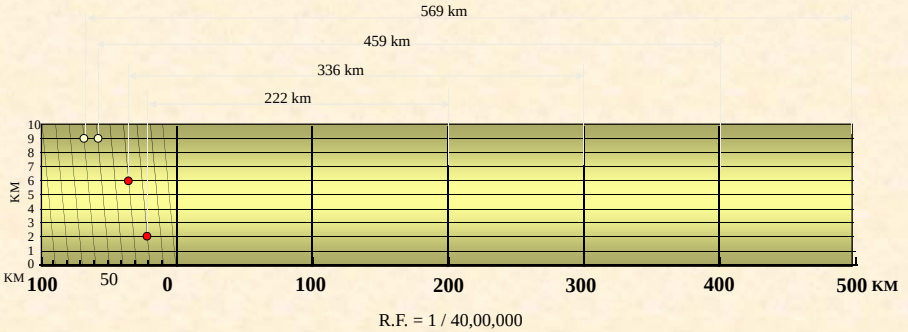
PROBLEM NO. : The distance between Delhi and Agra is 200 km. In a railway map it is represented by a line 5 cm long. Find it's R.F. Draw a diagonal scale to show single km. And maximum 600 km. Indicate on it following distances. 1) 222 km 2) 336 km 3) 459 km 4) 569 km

DIAGONAL SCALE

SOLUTION STEPS: RF = 5 cm / 200 km = 1 / 40, 00, 000

Length of scale = 1 / 40, 00, 000 X 600 X 10^5 = 15 cm

Draw a line 15 cm long. It will represent 600 km.Divide it in six equal parts.(each will represent 100 km.) **Divid**e first division in ten equal parts.Each will represent 10 km.**Draw** a line upward from left end and mark 10 parts on it of any distance. **Name** those parts 0 to 10 as shown.Join 9th sub-division of horizontal scale with 10th division of the vertical divisions. **Then** draw parallel lines to this line from remaining sub divisions and complete diagonal scale.



R.F. = 1 / 40,00,000

DIAGONAL SCALE SHOWING KILOMETERS.

Vernier Scale

- In 1631, Pierre Vernier invented a device for the purpose of measuring fraction parts of a graduated scale. I consists of two approximating scales, one of them is fixed and is called the primary scale, the other is movable and is called the vernier.
- **Direct Vernier Scale:** A direct vernier scale is the one which extends in the same direction as that of the main scale and in which the smallest division on the mail scale, It is so constructed that n divisions of the main scale are equal in length of n+ 1 division of the vernier.
- If ,
- p= value of the smallest division of the primary scale.
- v= value of the smallest division of the vernier scale.
- n= number of divisions of the primary scale of a specified length.
- n+1= number of division of the vernier scale of the same length.
- Least Coun t= $\frac{p}{n+1}$
-

Vernier Scale

EXAMPLE 2.7 : If primary scale is graduated to read 20 minutes, construct a direct vernier read up to 1 minutes and show 23°32'. **(GTU, June 2010)**

SOLUTION : We know that the least count of the vernier.

$$L.C. = \frac{p}{n+1} \quad \ldots(1)$$

p = value of one division of primary scale = 20'

Here required L.C. = 1'

Substituting, values in eq. (1), we get

$$1 = \frac{20}{n+1}$$

$$n + 1 = 20$$

$$n = 19$$

∴ Length of vernier scale = 19 × 20 = 380' = 6° 20'

Take an arc of 6° 20' and divide it into 20 equal parts.

The vernier scale is shown in fig. 2.7.

Man scale reading 23° 20'

Vernier scale reading 12'

Total reading 23° 32'

Vernier Scales:

These scales, like diagonal scales , are used to read to a very small unit with great accuracy.
It consists of two parts – a primary scale and a vernier. The primary scale is a plain scale fully divided into minor divisions.
As it would be difficult to sub-divide the minor divisions in ordinary way, it is done with the help of the vernier.
The graduations on vernier are derived from those on the primary scale.

Figure to the right shows a part of a plain scale in which length A-O represents 10 cm. If we divide A-O into ten equal parts, each will be of 1 cm. Now it would not be easy to divide each of these parts into ten equal divisions to get measurements in millimeters.

Now if we take a length BO equal to 10 + 1 = 11 such equal parts, thus representing 11 cm, and divide it into ten equal divisions, each of these divisions will represent 11 / 10 – 1.1 cm.

The difference between one part of AO and one division of BO will be equal 1.1 – 1.0 = 0.1 cm or 1 mm.
This difference is called Least Count of the scale.
Minimum this distance can be measured by this scale.
The upper scale BO is the vernier. The combination of plain scale and the vernier is vernier scale.

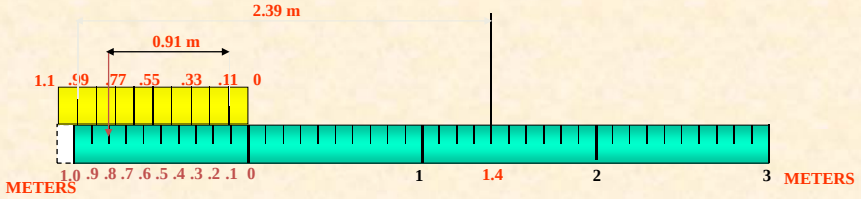
Example:
Draw a vernier scale of RF = 1 / 25 to read centimeters upto 4 meters and on it, show lengths 2.39 m and 0.91 m

Vernier Scale

SOLUTION:
Length of scale = RF X max. Distance
= 1 / 25 X 4 X 100
= 16 cm
CONSTRUCTION: ***(Main scale)***
Draw a line 16 cm long.
Divide it in 4 equal parts.
(each will represent meter)
Sub-divide each part in 10 equal parts.
(each will represent decimeter)
Name those properly.

CONSTRUCTION: ***(vernier)***
Take 11 parts of Dm length and divide it in 10 equal parts.
Each will show 0.11 m or 1.1 dm or 11 cm and construct a rectangle
Covering these parts of vernier.

TO MEASURE GIVEN LENGTHS:
(1) For 2.39 m : Subtract 0.99 from 2.39 i.e. 2.39 - .99 = 1.4 m
The distance between 0.99 (left of Zero) and 1.4 (right of Zero) is 2.39 m
(2) For 0.91 m : Subtract 0.11 from 0.91 i.e. 0.91 – 0.11 =0.80 m
The distance between 0.11 and 0.80 (both left side of Zero) is 0.91 m



Choice of Scale of a Map

- Scale of a map is the ratio of the distance drawn on the map to the corresponding distance on the ground. As the areas involved are rather large, it is essential to select a suitable scale for representing the area on a map. Selection of scale depends upon the purpose, size and the required precision of plotting. The following general rules are followed:
- Choose a scale large enough so that in plotting or in scaling distance from the finished map, it will not be necessary to read the scale closer than 0.25 mm.
- Choose as small a scale as is consistent with a clear delineation of the smallest details to be plotted.
- Scales are generally classified as large, medium and small as under:
- Large scale: 1 cm= 10 m or less than 10 m
- Medium Scale: 1cm = 10 m to 100 m
- Small Scale: 1 cm= 100 or more than 100m

Common Scales for Plan or Map

Type of Map or Plan	Scale	R.F.
(1) Buildings	1 cm = 10 m or less	1/1000 or less
Cadastral maps	1 cm = 10 m to 50 m.	1/1000 to 1/5000
(2) Town planning, reservoir planning etc.	1 cm = 50 m to 100 m	1/5000 to 1/10,000
(3) Route surveys	1 cm = 10 m to 60 m	1/1000 to 1/6000
(4) Longitudinal sections		
(a) Horizontal scale	1 cm = 10 m	1/1000
(b) Vertical scale	1 cm = 1 m to 2 m	1/100 to 1/200
(5) Cross–section	1 cm = 1 m to 2 m	1/100 to 1/200
(6) Land surveys	1 cm = 5 m to 25 m	1/500 to 1/2500
(7) Topographical maps	1 cm = 2.5 km	1/250,000
(8) Geological maps	1 cm = 5 km to 160 km	1/5,00,000 to 1/160,00,000

For most of engineering projects, the scale varies from 1 cm = 2.5 m to 100 m. Small scale topographical maps are usually drawn to a scale 1 cm = 1 km. A scale of 1 cm = 5 m to 50 m is generally used for plans prepared for sub-divisions of land.

Suggested Scales for Different Types of Survey

Serial No	Purpose of Survey	Scale	R.F.
1.	Land Survey	1 cm = 5 m to 50 m	1:500 to 1:5000
2.	Topographical Survey	1 cm = 0.25 km to 2.5 km	1:25,000 to 1:250,000
3.	Building Site	1 cm = 10 m	1:1000
4.	Route Survey	1 cm = 100 m	1:10,000
5.	Town Planning	1 cm = 100 m	1:10,000

References

- NPTEL
- Internet Websites
- Elements of Civil Engineering:

  -Prof. R.B.Khasiya, Ms Rena Shukla

  Mahajan Publication

Thanks