Branch : Civil Engineering.

Semester : 4^{th}.

Subject : Land Surveying – I

Chapter : 1

Topic : Introduction To Surveying, Linear Measurements

Faculty :

INTRODUCTION TO SURVEYING

Definition:

- Surveying is the art of determining the relative position of different objects on the surface of earth by measuring the horizontal distance between them, and by preparing a map to any suitable scale.

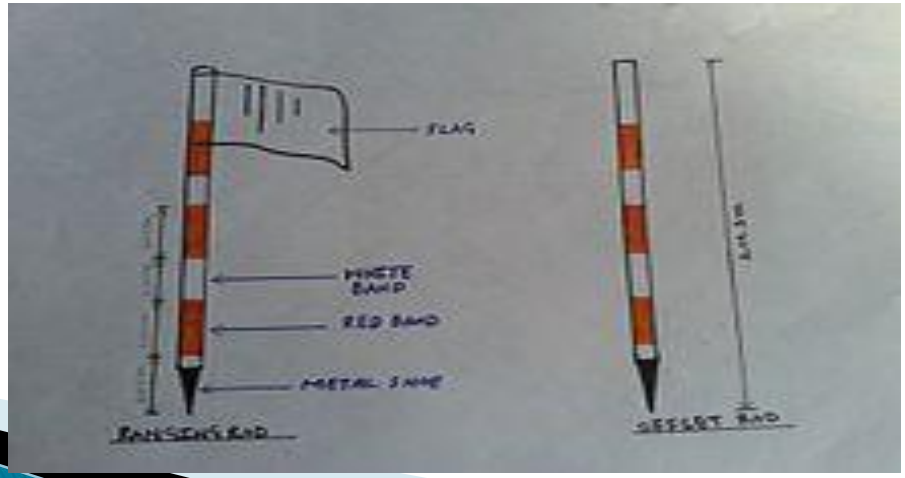
Aims and objectives :The aim of surveying is to prepare a map to show the relative positions of the objects on the surface of the earth. The map is drawn to some suitable scale. It shows the natural feature of a country, such as towns, villages, roads, railways, rivers etc. Map may also include details of different engineering works, such as railways, roads, irrigation canals, etc.

- Principles of survey:
- To work from whole to part
- To locate a new station by at least two measurements (linear or angular) from fixed reference points.

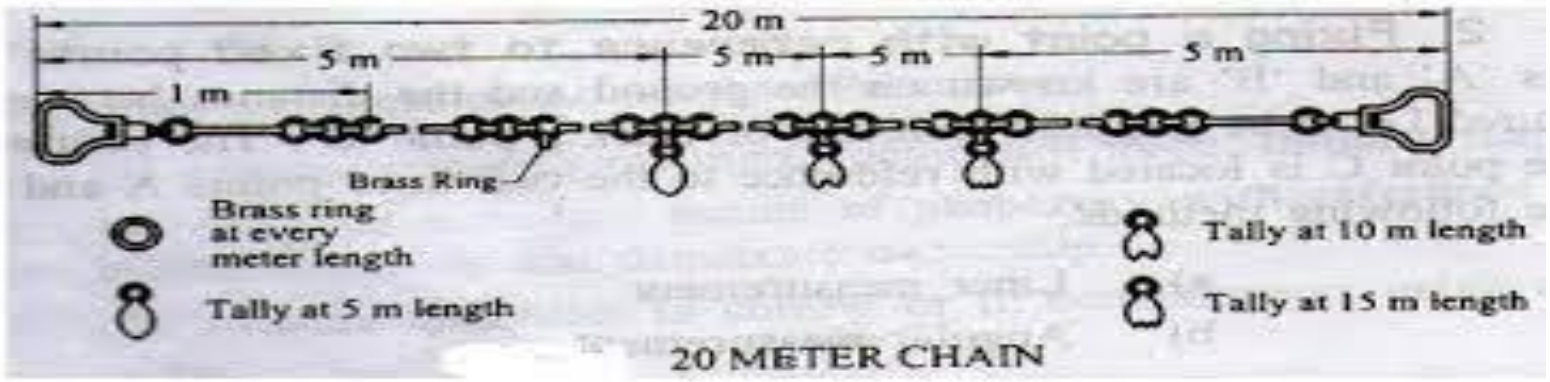
- Plane surveying : Plane surveying is a specific type of surveying where the surface of the earth is considered as plane and the curvature of the earth is not taken into account.
- The line connecting any two points is a straight line and the angles of polygons are plane angles.
- Geodetic Surveying : Geodetic surveys study Earth's geodynamical phenomena (e.g., crustal motion, gravitational field) using a satellite-borne global positioning system (GPS) in conjunction with terrestrial base stations. Geodetic surveys measure three-dimensional changes in crustal motion at the mm-scale..
- Instrumental surveying : The surveying based on instruments is called instrumental surveying.\
- Chain surveying,
- Compass surveying,

- Plane table surveying,
- Theodolite surveying,
- Tachometric surveying,
- Photographic surveying.
- Precision and accuracy of measurements :
- Precision : “Precision” refers to how closely repeated measurements or observations come to duplicating measured or observed values.
- Accuracy : To surveyors, “accuracy” refers to how closely a measurement or observation comes to measuring a "true value," since measurements and observations are always subject to error.
- Instruments used for measurement of distance :
- Ranging rod,
- Chains,
- Tapes,
- Arrows

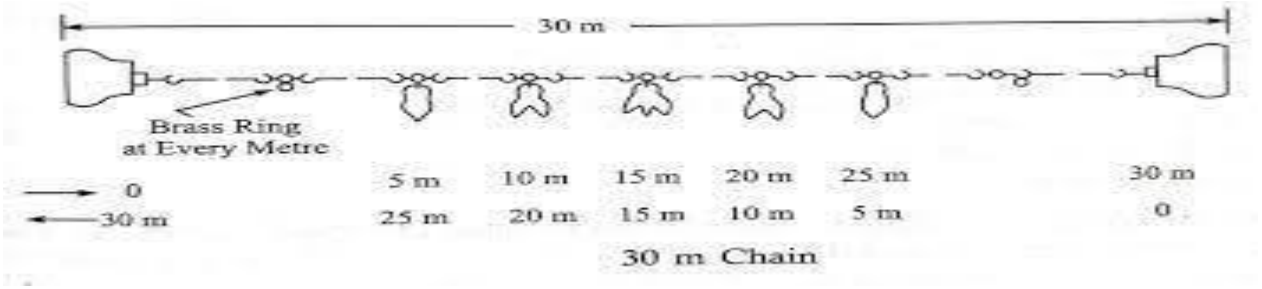
- Ranging Rods : A ranging rod (or range rod) is a surveying instrument used for marking the position of stations, and for sightings of those stations, as well as for ranging straight lines.
- These were made of light, thin and straight bamboo, or of well seasoned wood such as teak, pine or deodar.
- They were shod with iron at the bottom and surmounted with a flag about 250 mm square in size.
- The rods are usually about 30 mm in diameter and 2 m or 3 m long, painted with alternating bands, such as red and white, red and yellow, or black and white, in lengths of 200 mm (i.e. one link length of metric chain), 500 mm, or one foot.



- Chains : A Chain is prepared with 100 or 150 pieces of galvanized mild steel wire of 4 mm diameter.
- The ends of the pieces are bent to form loop.
- Then the pieces are connected together with the help of three oval rings, which make the chain flexible.
- Two brass handles are provided at the two end of the chain.
- Tallies are provided at every 10 or 25 links for facility of counting.
- One link means the distance between the centers of adjacent middle rings.



- There are different types of chains :
- Metric Chain : Matric chains are available 20 m & 30 m in length.
- The 20 m chain is divided into 100 links of 0.2 m.
- Tallies are provided at every 10 links.



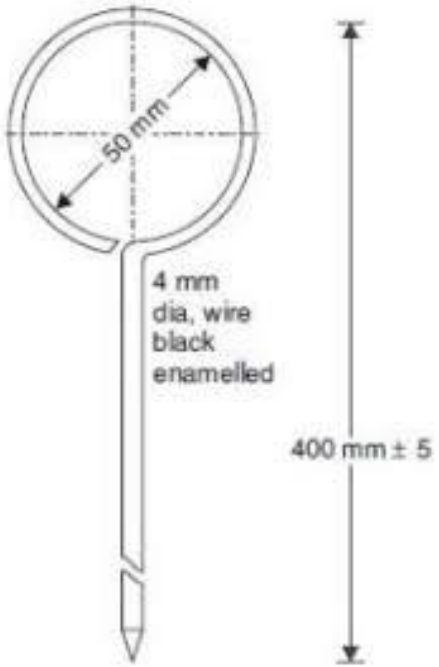
- Steel Band Chain: It This chain is mainly used for measuring fields in cadastral survey. Steel band or Band chain consists of a long narrow strip of blue steel of uniform width of 12 to 16 mm and thickness of 0.3 to 0.6mm.
- Metric steel bands are available in length of 20 or 30 m. During continuous use the length of a chain gets altered.

- Engineers' Chain : This chain comes in 100ft length. Its consist of 100 links each link being 1ft long.
- At every 10 links a brass ring or tags are provided for indication of 10 links. Readings are taken in feet and decimal.
- Gunter's Chain : It is 66ft long and divided into 100 links.
- So each link is of 0.66 ft. It was previously used for measuring distances in miles and furlongs.
- Revenue Chain : The revenue chain is 33ft long and divided into 16 links.
- It mainly used in cadastral survey.

- Tapes : There are different types of tapes :
- Cloth or Linen Tape :Linen tape, also known as cloth tape is a varnished strip made of closely woven linen.
- The width of the strip is about 12 to 16 mm. It is available in different lengths such as 10m, 20m, 30m, and 50m.
- Metallic Tape : The metallic woven tape is an improved version of linen tape. Brass or copper made wires are used as reinforcement for the linen material.
- Hence, it is more durable than normal linen tape.
- A brass ring is provided at the end of the tape which is included in the length of the tape.

- Steel Tape : A steel tape is made of steel or stainless steel. It consists of a steel strip of 6mm to 16mm wide.
- It is available in lengths of 1m, 5m, 8m, 10m, 20m, 30m and 50m. Meters, decimetres, and centimetres are graduated in the steel strip.
- Steel tapes generally came up with the metal case with automatic winding device. The tape is withdrawn from the case by using a hand during measuring and it is rewound into the case by just pressing button provided on the case.
- Invar Tape : Invar tapes are made of an alloy which consists of 36% of nickel and 64% of steel.
- Invar tape contains a 6mm wide strip and is available in different lengths of 30m, 50m, 100m.
- It is generally used in triangulation survey conducted by the survey of india department.

- Arrows : These are also called marking or chaining pins.
- Accompanying each chain are ten arrows, which are used to mark the end of the chain during the process of chaining.
- They are pointed at one end have a ring or eye at the other for the facility of carrying.



- Errors and mistakes in linear measurement :
- Classification :Errors in chaining may be caused due to variation in temperature and pull, defects in instruments etc. They may be either
- 1. Compensating Errors
- 2. Cumulative Errors
- Compensating Errors : Errors which may occurs in both direction (both positive & negative) and which finally tend to compensate are known as compensating error.
- Such errors may be caused by
- Incorrect holding of chain.
- Horizontally and vertically of steps not being properly maintained during the stepping operation
- Inaccurate measurement of right angles with chain and tape

- Cumulative Errors :
- Errors which may occur in the same direction and which finally tend to accumulate are said to be cumulative. They seriously affect the accuracy of the work, and are proportional to the length of line (L). The errors may be positive or negative.
- Positive Errors : When the measured length is more than the actual length the error is said to be positive errors. Such errors occurs due to
- The length of chain or tape being shorter than the standard length.
- Correction for sag not being made.
- Measurement being taken with faulty alignment.
- Negative Errors : When the measured length of lines is less than the actual length, the error is said to be negative. Such errors occurs due to
- The opening of ring joint.
- The applied pull being much greater than the standard pull.
- Elongation of the link due to heavy pull.

- Remedies against Errors : The following precautions should be taken to guard against errors.

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. The chainman should call the measurement from the chain, the teeth of the tally should be verified with respect to the correct end.
4. Measurements should not be taken with the tape in suspension during high winds.
5. Ranging should be done accurately.
6. No measurement Should be taken with the chain in suspension.
7. Care should be taken so that the chain properly extended.
8. In stepping operations, Horizontally and vertically should be properly maintained.

- Corrections to measured lengths due to :-
- Incorrect length :- It is given by the expression
- True length of line (TL)= $(\frac{L'}{L})$ ×Measured Length (ML)

where L= Standard or true length of chain

L′= True length ± error

= L±e (e= error in chain or tape, i.e. when it is too long or too short)

Use the positive sign when the chain or tape is too long, and the negative sign, When it is too shot.

Temperature variation :- The variation is necessary because the length of the Tape or chain may increase or decrease due to rise or fall of temperature during measurement. The correction is given by the expression

$$C_t = \propto (T_m - T_0)L.$$

- Where,

  c_t = Correction for temperature, in metres

  $\propto$ = Coefficient of thermal expansion

  T_m= Temperature during measurement in degrees centigrade or Celsius

  T_o= Temperature at which the tape was standardised, in degrees centigrade or Celsius

  L = Length of tape, in metres

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

When $\propto$ for the steel tape is not given, it may be assumed to be 11×10^{-6} Per degree centigrade or Celsius.

- Pull Correction :- During measurement, the applied pull either more or less than the pull at which the chain or tape was standardised. Due to elastic property of material the strain will vary according to the variation of applied pull. This correction is given by the expression

$$c_p = \frac{(pm - p0)L}{A \times E}$$

Where c_p = Pull correction in metres

p_m = Pull applied during measurement, in kilograms

p_0 = Pull at which the tape was standardised, in kilograms

L = Length of tape, in metre

A = Cross-sectional area of tape, in square centimetres

E = Modulus of elasticity (Young's Modulus)

The sign of correction will be positive or negative according as p_m is greater Or less than p_0.

When E is not given, it may be assumed 2.1×10^6 Kg/cm^2

- **Sag Correction :-** This correction is necessary when the measurement is taken with the tape in suspension (i.e. in the form of a catenary). It is given by the expression.

$$c_s = \frac{L(\omega L)^2}{24n^2 {p_m}^2}$$

when unit weight is given,

and $$c_s = \frac{Lw^2}{24n^2 p_{m^2}}$$

When total weight is given

Where, c_s= Sag correction, in metres

L = Length of tape or chain, in metres

ω = Weight of tape per unit length, in kilograms per metre

W= Total weight of tape, in kilograms

n = Number of spans

p_m= Pull applied during measurement, in kilograms

The sign of correction is always negative.

- Problem on chain and tape correction :-

Problem-1 :- The distance between two points, Measured with a 20 m chain, was recorded as 327 m. It was afterwards found that the chain was 3 cm too long. What was the true distance between the points?

solution Given data:

True length of chain, L= 20 m

Error in chain, e = 3 cm = 0.03 m, too long

L' = L + e = 20 + 0.03 = 20.03 m

Measured length = 327 m

True length of line = $\frac{L'}{L} \times 327$ = 327.49 m (Ans)