UNIT - II

MEASUREMENT OF DISTANCES

MAIN METHODS OF DETERMINING DISTANCE

- Direct measurement – distances are actually measured on the ground with the help of different instrument.eg. Chain, tape etc.
- Computative measurement – distances are obtained by calculations. Eg. tacheometry, telemetry, triangulation.

DIRECT MEASUREMENT

- Pacing – the method consists of walking over a line and counting the number of paces. The length of pace varies with the individual and also with age, height, physical condition, nature of the ground (up and down), slope of the country & speed of pacing. Usually approximate results are obtained.

- Passometer- it is a pocket instrument which automatically records the number of paces taken in pacing a given distance.
- Pedometer- it measures the distance traversed by the person carrying it.
- Odometer- this instrument is attached to the wheel of any vehicle and registers the number of revolutions.

  The distance traversed= number of revolutions x circumference of the wheel.

- Speedometer- the speedometer of an automobile may be used to measure distances approximately.
- Perambulator- it consists of a single wheel, a dial and a handle. The distance traversed is automatically registered on the dials when it is wheeled along the line of the length.

- Judging distance- a rough method to estimate distance of details in reconnaissance survey.
- Time measurement- knowing the average time per km for a person at walk or a horse at trot, the distance traversed is obtained.
- Chaining- the most accurate method of all. For ordinary precision, chain is used. Where great accuracy is required, steel tapes are used.

INSTRUMENTS FOR MEASURING DISTANCE

- Chain- composed of 100 or 150 pieces of galvanized mild steel wire 4 mm in diameter called links. The ends of each link are bent into a loop and connected together by three oval rings. The outside of the handle is the zero point or the end point of the chain. Metallic tags or tallies are fixed at distinctive points (for metric chains) to facilitate quick reading of fractions of a chain.

TYPES OF CHAIN

- Metric surveying chains- available in lengths 20m & 30 m. To read the fractions of the chain, tallies are fixed at every 5m length and small brass rings are provided at every m length. A grove is cut on the outside surface of the handle to facilitate holding the arrows in position. The length of the chain is marked over the handle.

- Steel band- consists of a ribbon of steel with a brass swivel handle at each end. It is 20m or 30m long and 16mm wide. It is wound on an open steel cross. The band is divided by brass studs at every 0.2m and numbered at every 1m and last link being subdivided into cm and mm. Brass tallies are fixed at every 5m. It is lighter and easier to handle than the chain however it is easily broken. It cannot be easily read and also cannot be easily repaired in the field.

Chains used for unit of measurement foot:

- Gunter's or surveyor's chain: it is 66ft long and has 100 links. Easy to measure in miles, furlong and acre.
- Revenue chain: it is 33ft long and divided into 16 links. Used for measuring fields in cadastral survey.
- Engineer's chain- 100 ft long with 100 links. Used on all engineering surveys.

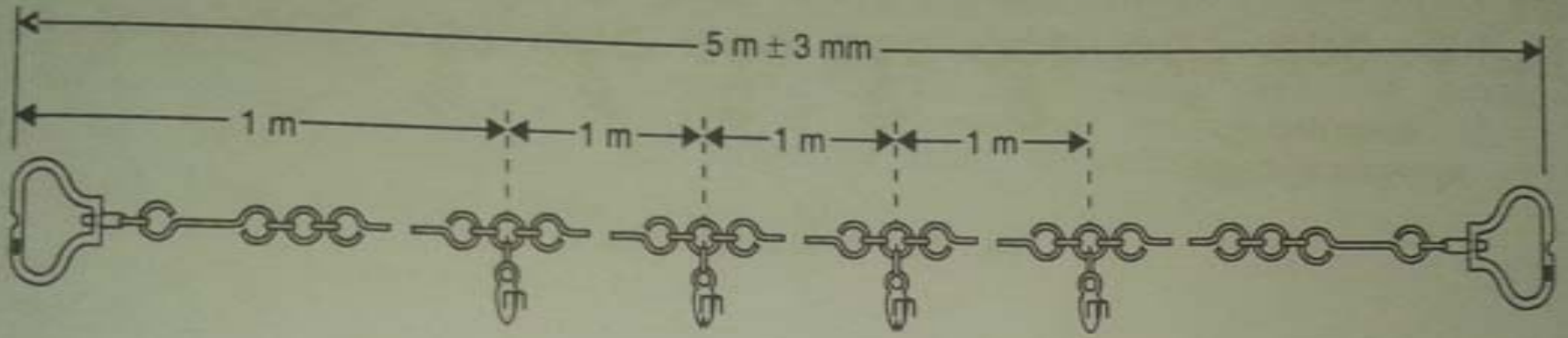


FIG. 3.2. 5-METRE CHAIN

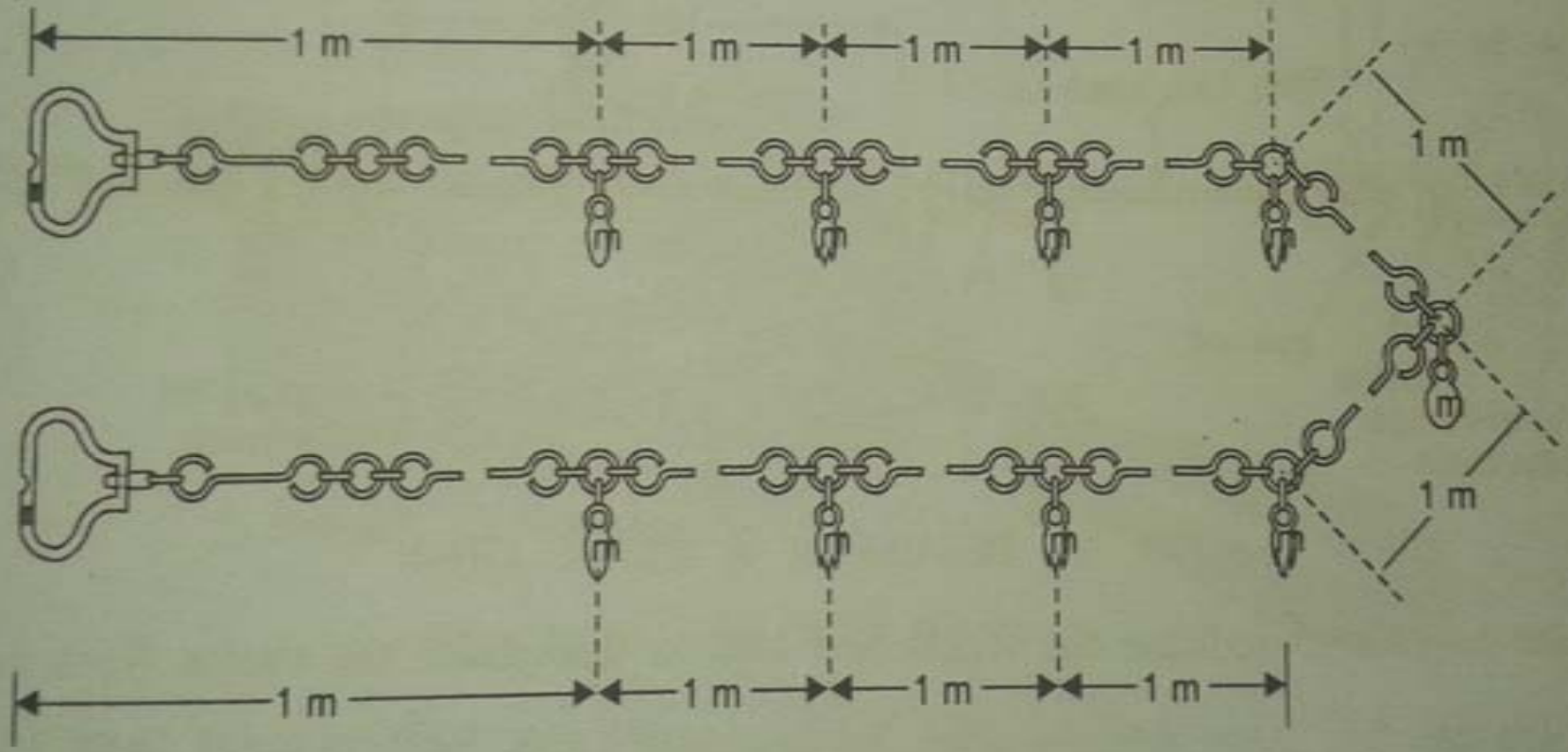


FIG. 3.3. 10-METRE CHAIN

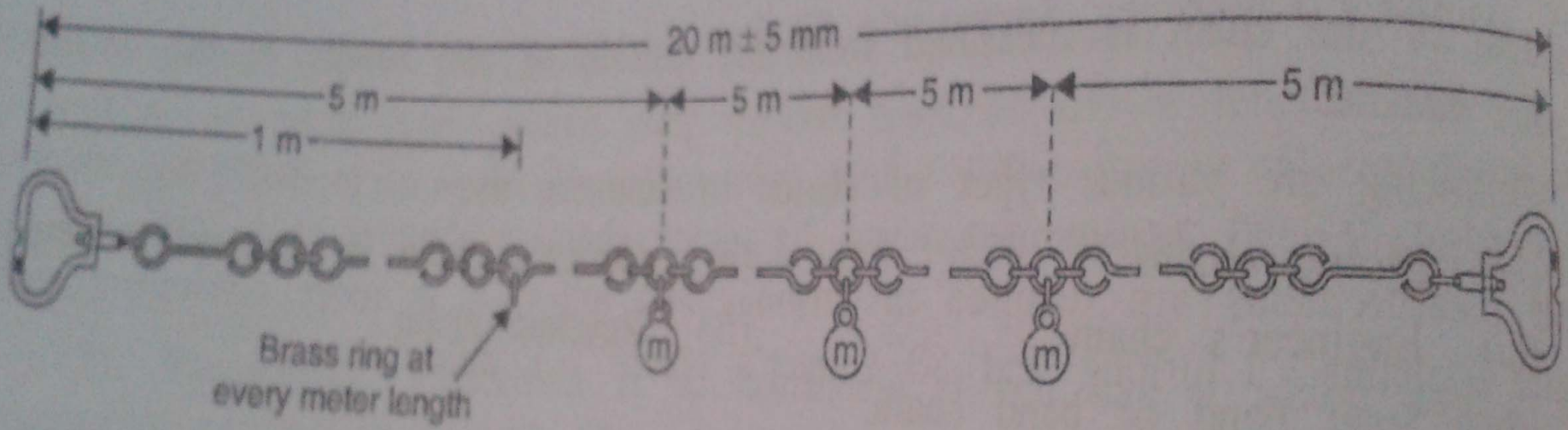


FIG. 3.4. 20-METRE CHAIN

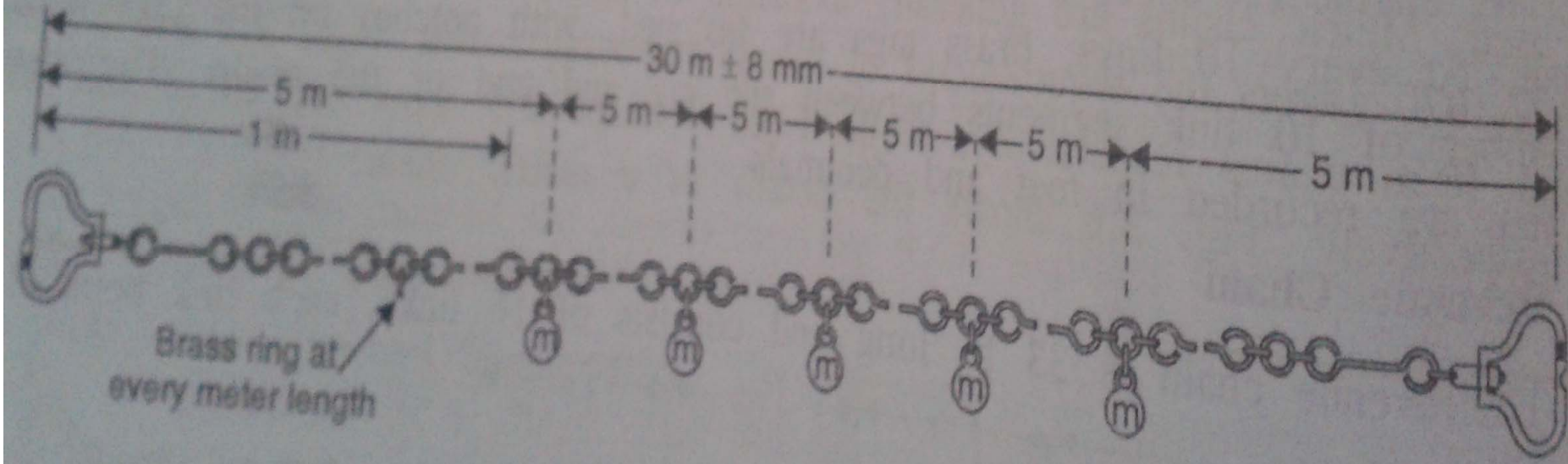


FIG. 3.5. 30-METRE CHAIN

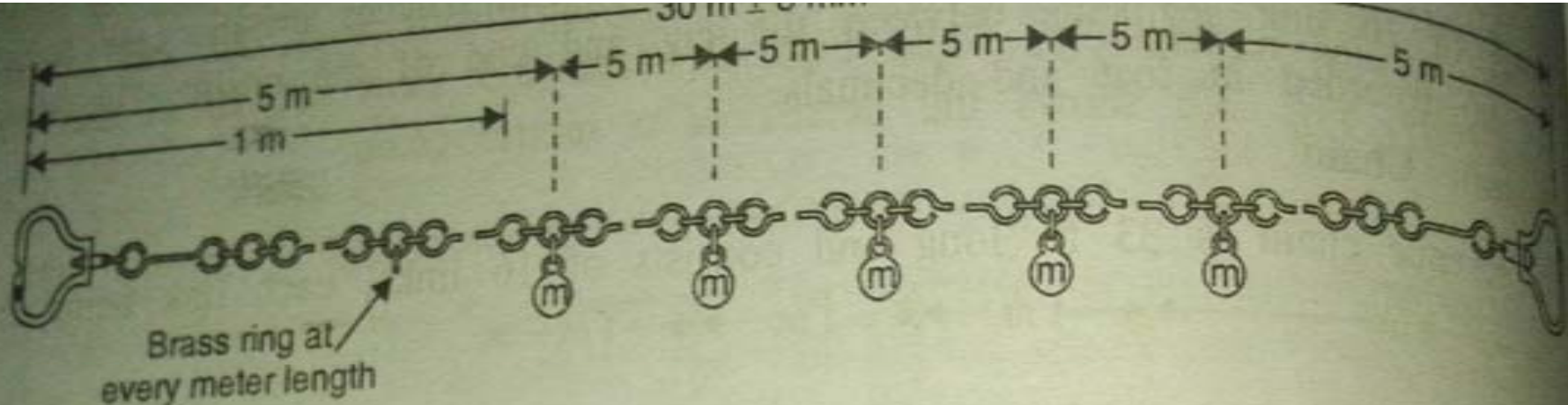
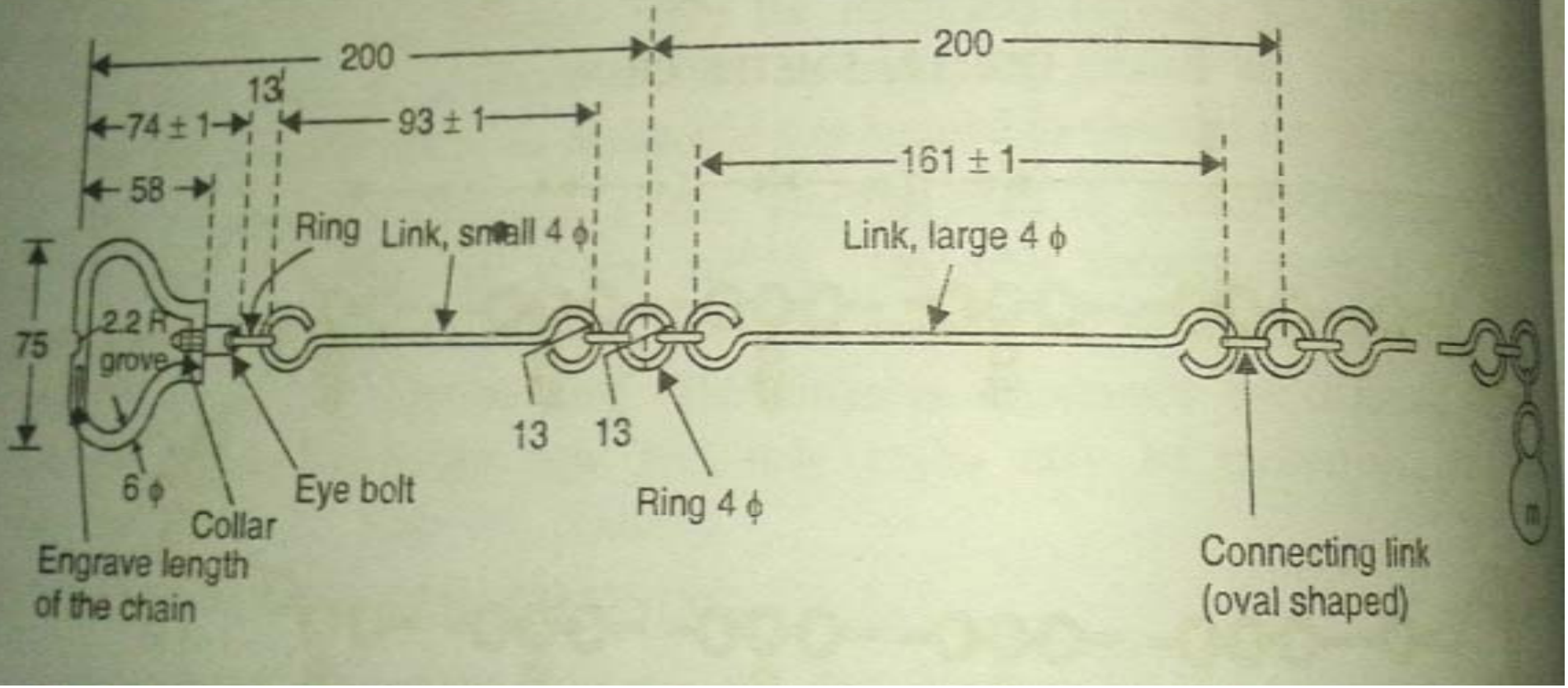


FIG. 3.5. 30-METRE CHAIN



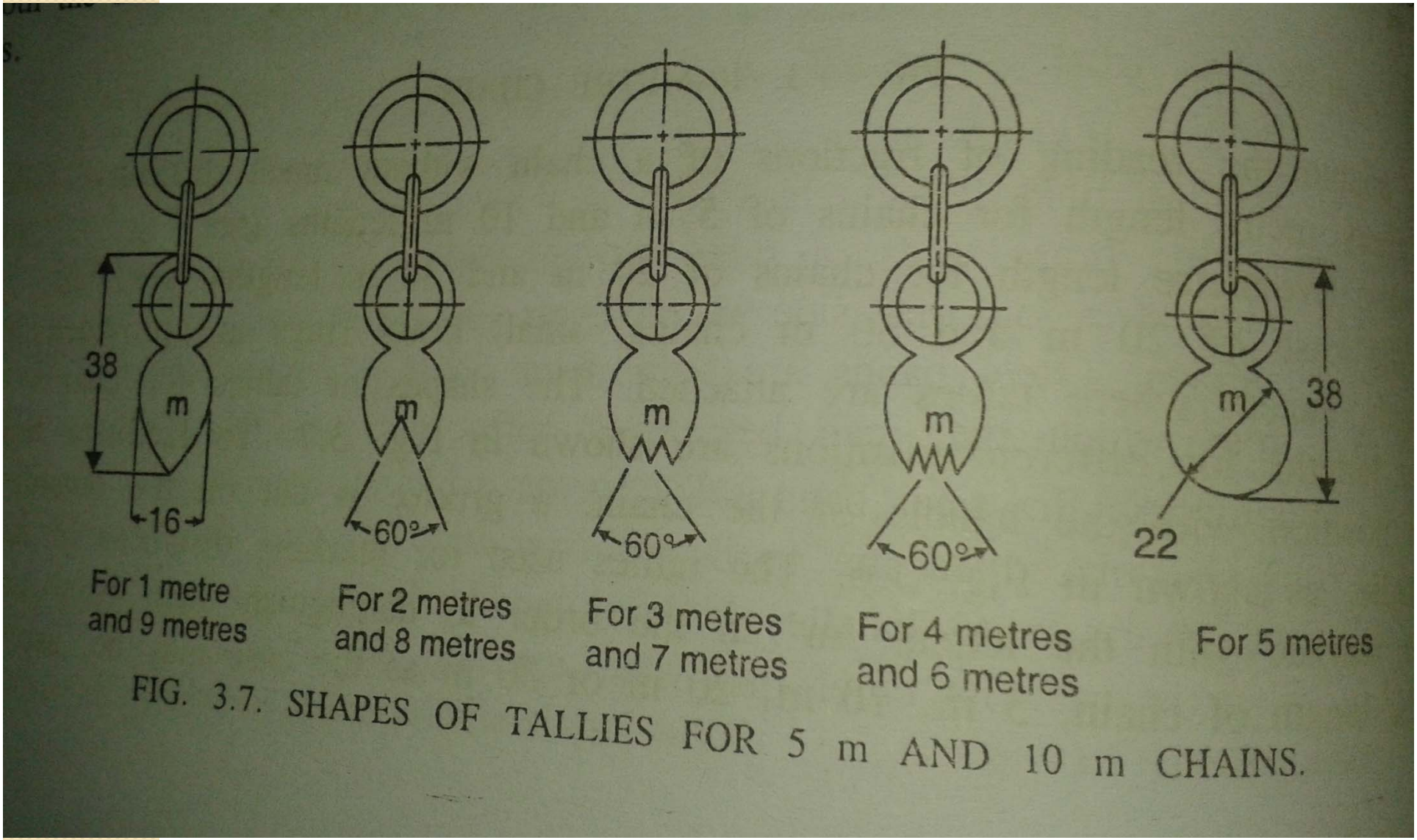


FIG. 3.7. SHAPES OF TALLIES FOR 5 m AND 10 m CHAINS.

TESTING THE CHAIN

When measured with a tension of 8 kg and checked against a steel band or tape standardized at 20°C, every metre length shall be accurate to within 2 mm and overall length should be within following limits:

20 metre chain ± 5 mm

30 metre chain ± 8 mm

Chains are tested by comparison. The chains are adjusted also for too long and too short length.

- Arrows – To mark the end of each chain during the process of chaining. They are made of hardened and tempered steel wire 4mm in diameter and minimum tensile strength of 700 n/mm^2. They are 400mm in length and pointed at one end to insert in the ground and bent like ring at the another end for facility of carrying.

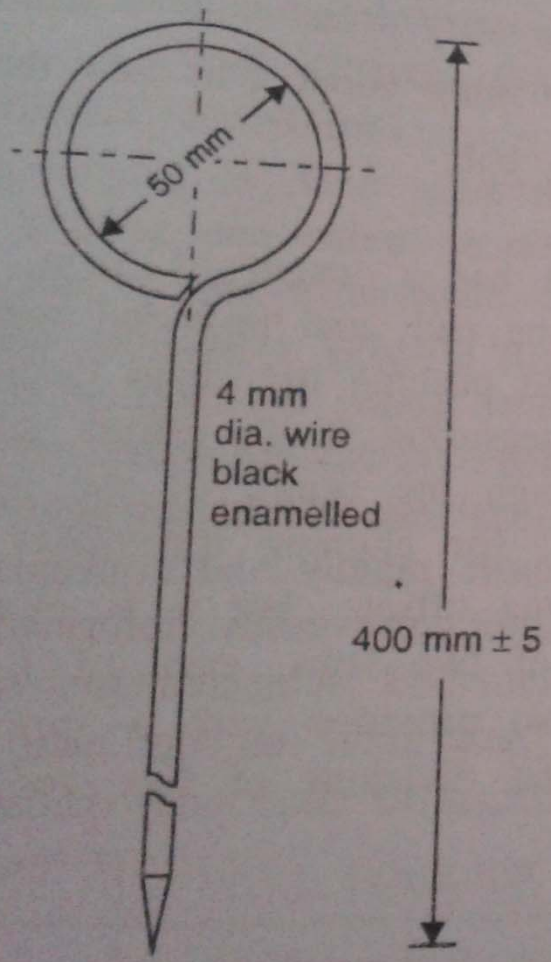


FIG. 3.15. ARROW.

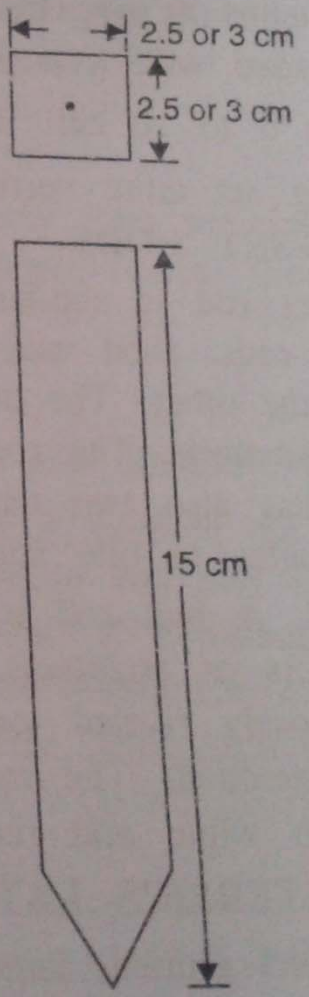


FIG. 3.16. WOODEN PEG.

- Tapes:

(1)cloth or linen tape- very light and handy but easily affected by damp. Used for taking subsidiary measurements like offsets.

(2)metric woven metallic tape- available in lengths of 2,5,10,20,30 and 50m. The tape is reinforced over a length of atleast 10cm by leather strip or plastic material.

(3) metric steel tape measures- available in 1,2,10,30 and 50m. It is made of steel. Divisions are available in mm, cm, m. The tape automatically rewinds into the case when finger is released.

(4) invar tape- used for high precision works such as base lines. Made of alloy of steel and nickel (36%) and has very low thermal expansion. Available in lengths of 30m, 50m and 100m. It is expensive and cannot be used for ordinary works.

(5) synthetic tapes- made of glass fiber with PVC coating. Convenient for measuring short lengths. They maintain their lengths well.

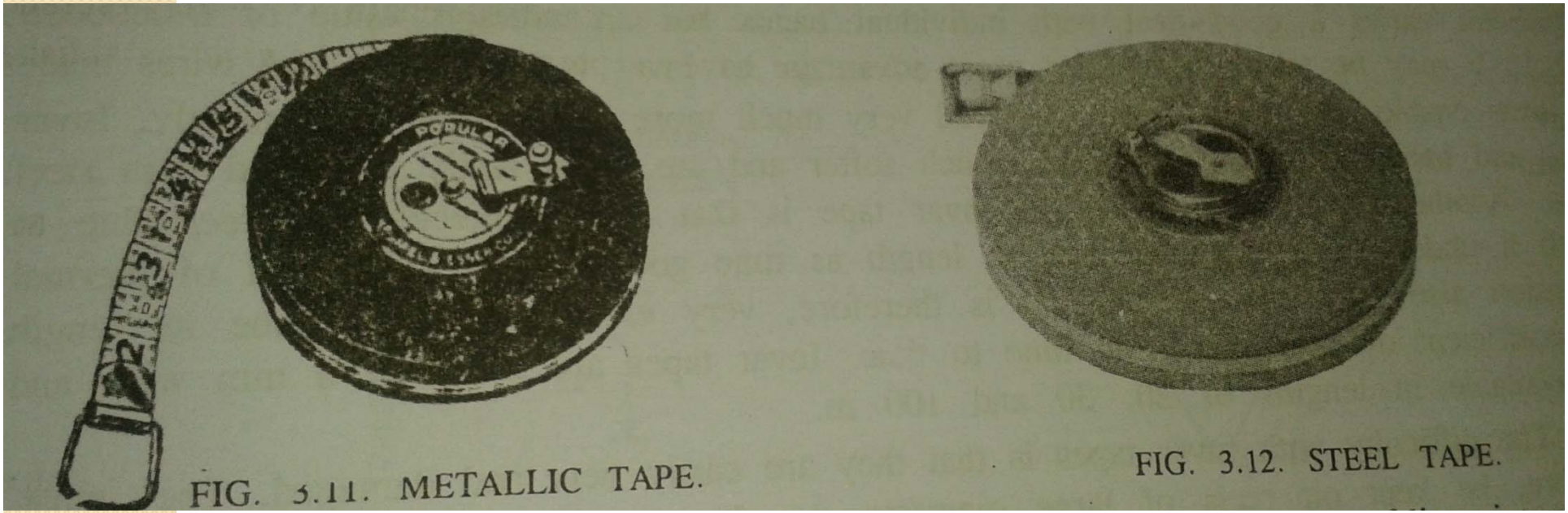


FIG. 3.11. METALLIC TAPE.

FIG. 3.12. STEEL TAPE.

INSTRUMENTS FOR MARKING STATIONS

- Pegs – wooden pegs are used to mark the positions of stations.
- Ranging rods- used for marking the positions of stations and for ranging lines.
- Ranging poles- similar to ranging rods. Used for ranging vary long lines. Length vary 4 to 6 m.
- Offset rods- 3 m long rods with 20 cm divided parts without shoe, used for aligning the offset line and measuring short offsets.
- Laths- 1m rod with shoe for ranging out long lines especially over uneven ground or when forward ranging rods are not visible.
- Whites- useful for temporary marking of contour points or in levelling.
- Plumb bob- used to transfer points to the ground along slopes and for centering of a theodolite and also for testing the verticality of ranging poles.

WOODEN PEG

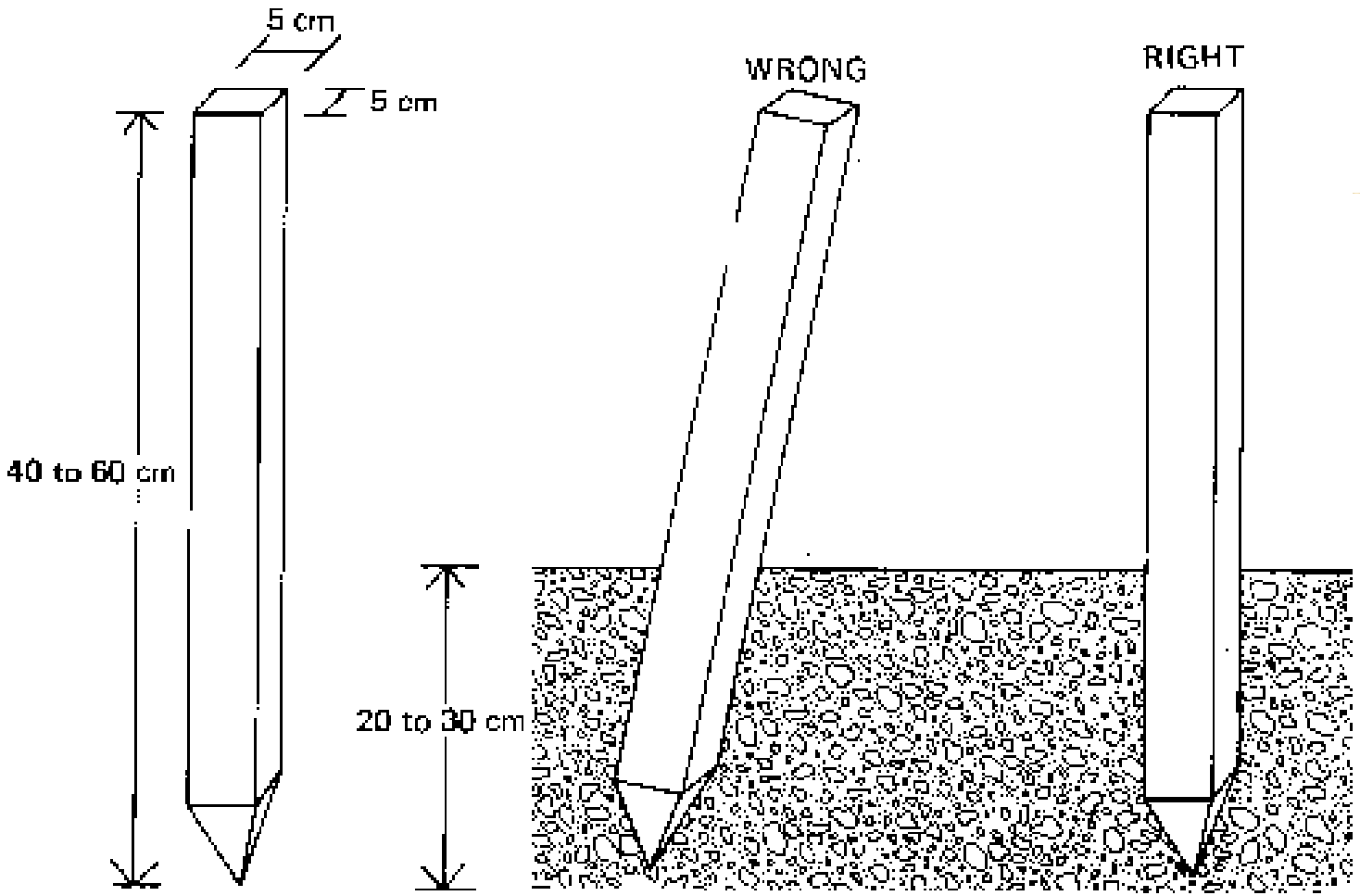


Fig. 12.7 Ranging rod

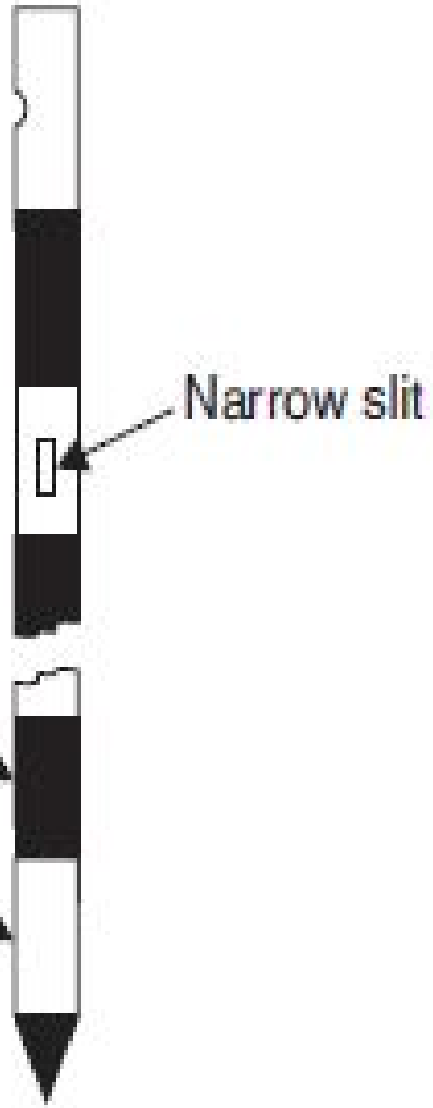
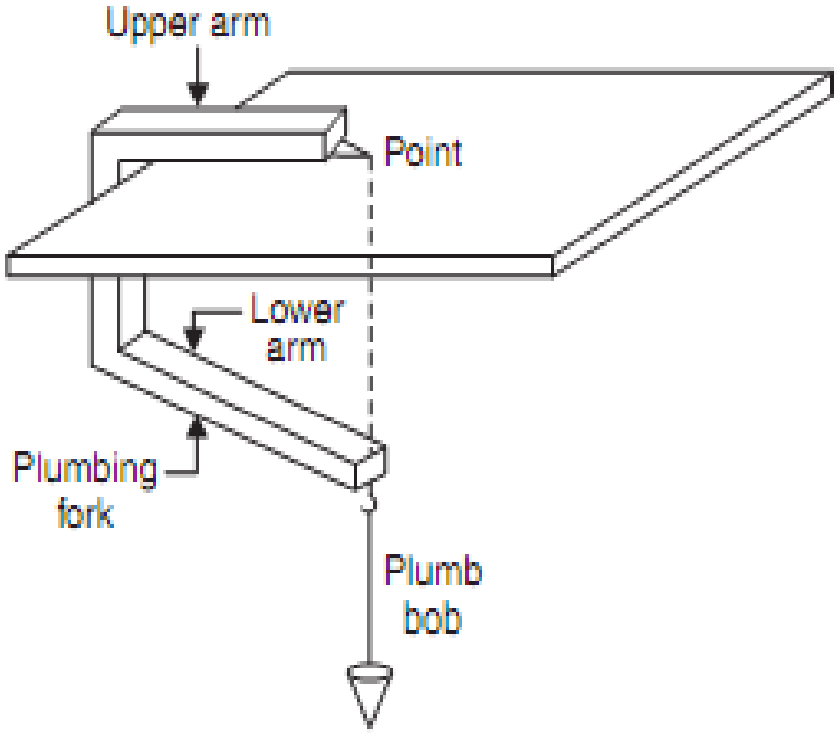
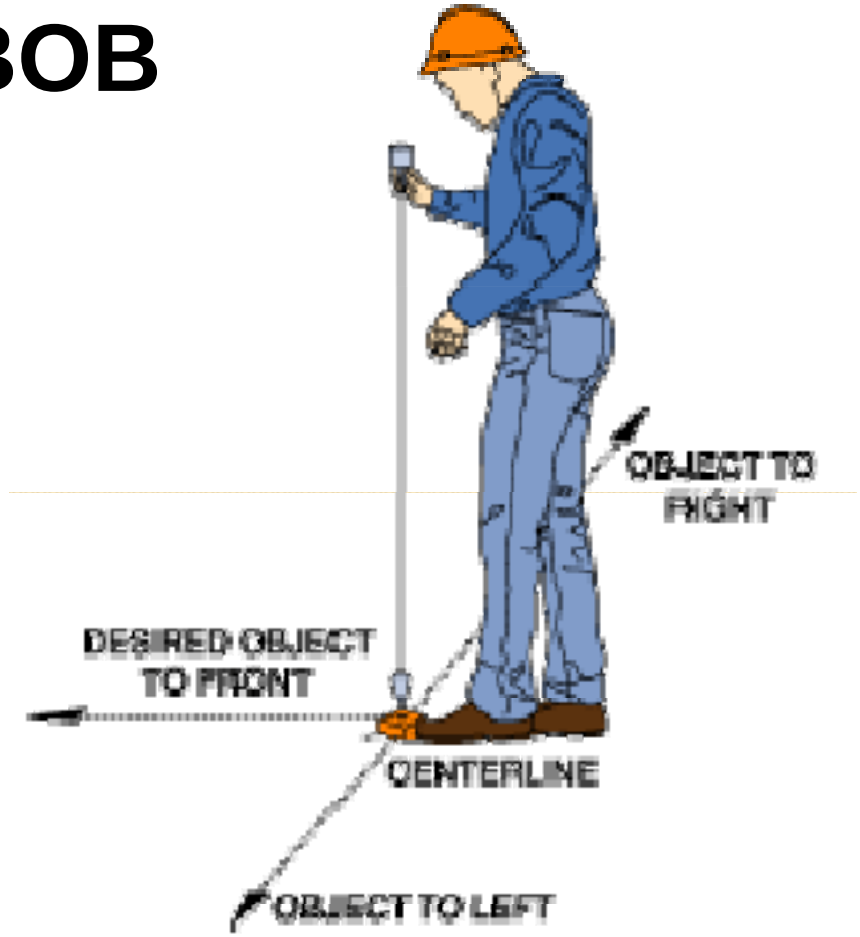


Fig. 12.8. Offset rod

PLUMB BOB


Upper arm
Point
Lower arm
Plumbing fork
Plumb bob


OBJECT TO RIGHT
DESIRED OBJECT TO FRONT
CENTERLINE
OBJECT TO LEFT

RANGING OUT SURVEY LINES

- Direct ranging- when the end stations are inter-visible

(a) Direct ranging by eye

(b) Direct ranging by line ranger

- Indirect ranging- when the end stations are not inter-visible due to high ground or hill intervening. Intermediate points are fixed by reciprocal ranging.

CHAINING A LINE

- Leader- chainman at the forward end of the chain is called leader. The duties of a leader are:-

1. To drag the chain forward.
2. To insert arrows at the end of every chain
3. To obey instructions of the follower

- Follower- chainman at the rear end is called follower. The duties of a follower are:-

1. To place the leader in line with the ranging rod
2. To call out instructions to the leader
3. Always to carry the rear handle in his hand and not to allow it to drag on the ground
4. To pick up the arrows inserted by the leader

- Unfolding the chain
- Method of chaining
- Reading the chain and Folding the chain

CHAINING ON SLOPING GROUND

There are two methods of determining horizontal distances when chaining on uneven or sloping ground:-

- Direct method - by stepping, by using clinometer
- Indirect method- by measuring along the slope and knowing the angle of the slope.

ERRORS IN CHAINING

- Compensating errors- liable to occur in either direction and hence tend to compensate. It is proportional to $\sqrt{l}$. These may be caused by:-

(a) Incorrect holding of chain.

(b) Fractional parts of the chain or tape may not be correct.

(c) During stepping operation crude method of plumbing is adopted.

(d) When chain angles are set out with a chain which is not uniformly adjusted or with a combination of chain & tape.

- Cumulative errors – occur in the same direction and tend to add up or accumulate. It is proportional to length(l).

  (A) positive errors- (making the measured lengths more than the actual) are caused by:-

(i) The length of the chain or tape is shorter than the standard.

(ii) The slope correction is not applied to the length measured along the sloping ground.

(iii) The sag correction is not applied when the chain or tape is suspended in the air.

(iv) Measurements are made along the incorrectly aligned line.

(v) The tape belays out during offsetting when working in the windy weather.

(B) negative errors- (making the measured lengths less than the actual) are caused by:-

The length of the chain or tape is greater than the standard.

MISTAKES IN CHAINING

- Displacement of arrows
- Failure to observe the position of zero point on the tape
- Adding or omitting a full chain or tape length
- Reading from the wrong end of the chain
- Reading numbers incorrectly
- Calling numbers wrongly
- Reading wrong metre marks
- Wrong booking

TAPE CORRECTIONS

- CORRECTION FOR ABSOLUTE LENGTH- $C_a = Lc/l$ WHERE

  C_a= THE CORRECTION FOR ABSOLUTE LENGTH, SIGN DEPENDS ON c.

  L= THE MEASURED LENGTH OF THE LINE

  l = THE NOMINAL OR DESIGNATED LENGTH OF THE TAPE

  c= THE CORRECTION TO A TAPE

- CORRECTION FOR TEMPERATURE- $C_t = \alpha(T_m - T_o)L$ WHERE

  C_t= THE CORRECTION FOR TEMPERATURE IN m, POSITIVE WHEN Tm>To

  α = THE COEFFICIENT OF THERMAL EXPANSION

  T_m = THE MEAN TEMPERATURE DURING MEASUREMENT

  T_o=THE TEMPERATURE AT WHICH THE TAPE IS STANDARDISED

  L = THE MEASURED LENGTH IN m

- CORRECTION FOR TENSION OR PULL- Cp=(P-Po)L/AE WHERE

  Cp= THE CORRECTION FOR PULL IN m, ALWAYS POSITIVE

  P = THE PULL APPLIED DURING MEASUREMENT IN NEWTONS (N)

  Po = THE PULL UNDER WHICH THE TAPE IS STANDARDISED IN NEWTONS (N)

  L = THE MEASURED LENGTH IN METRES

  A = THE CROSS SECTIONAL AREA OF THE TAPE IN sq.cm

  E = THE MODULUS OF ELASTICITY OF STEEL

- CORRECTION FOR SAG- $C_s = l_1(Mg)^2/24P^2$ OR $C_s = l_1(mgl)^2/24n^2P^2$ WHERE

  C_s = THE SAG CORRECTION FOR A SINGLE SPAN IN METRES

  l_1 = THE DISTANCE BETWEEN SUPPORTS IN METRES

  m = THE MASS OF THE TAPE IN KILOGRAMS PER METRE

  M = TOTAL MASS OF THE TAPE IN KILOGRAMS

  P = THE APPLIED PULL IN NEWTONS (N)

  n = THE NUMBER OF SPANS PER TAPE LENGTH

  l = THE LENGTH OF THE TAPE = n l_1. THIS CORRECTION IS ALWAYS NEGATIVE.

- CORRECTION FOR SLOPE OR VERTICAL ALIGNMENT

  $C_{sl} = h^2/2l$ WHERE

  C_{sl} = THE SLOPE CORRECTION FOR ANY ONE SLOPE IN METRES

  h = THE DIFFERENCE IN HEIGHT BETWEEN THE ENDS OF THE SLOPE

  l = THE LENGTH OF ANY ONE SLOPE

THIS CORRECTION IS ALWAYS NEGATIVE.