EWCE-103

SURVEYING

What we discussed in last class:

Precision and Accuracy

What we are going to learn today:

Linear Measurement

- Direct Measurement.
- Instruments of Chaining.
- Ranging.
- Errors in Chaining

LINEAR MEASUREMENTS

Definition: Linear measure is defined as a **measurement** of length.

Methods:

- **Direct Measurement-** distances are actually measured on the ground with help of a **chain or tape** or any other instruments.

- **Measurement by optical means-** observations are taken through a **telescope** and calculations are done for the distances.

- **Electromagnetic methods-**distances are measured with instruments that relay on the radio wave/light wave/infrared **waves propagation**, reflection and sub sequent reception.

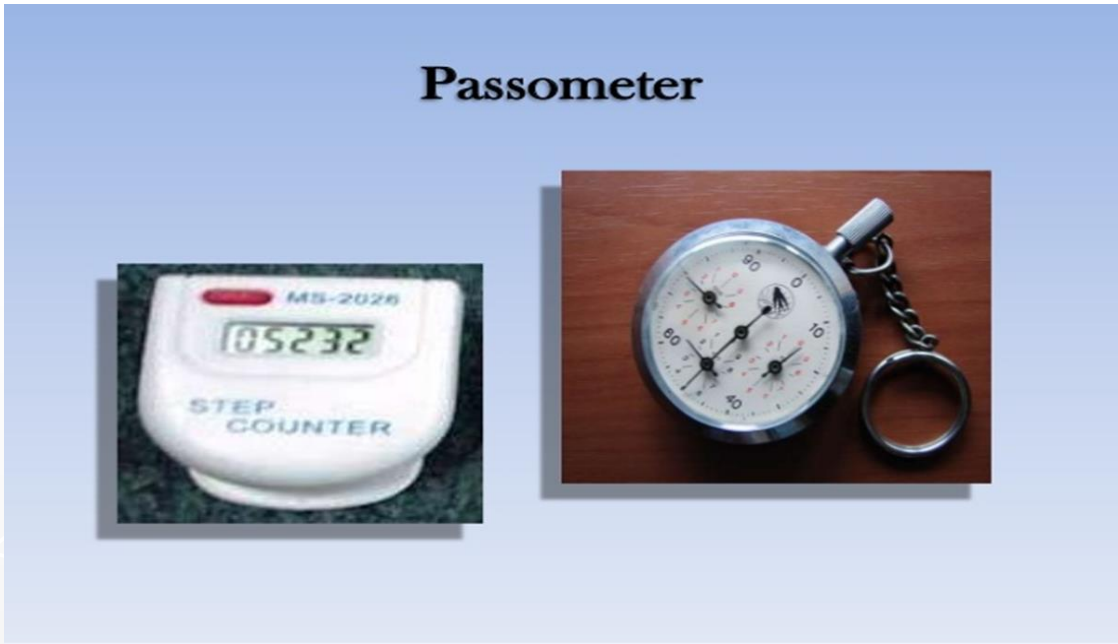
Direct Measurement

- **Pacing**
- **Passometer**
- **Pedometer**
- **Odometer and Speedometer.**
- **Chaining**

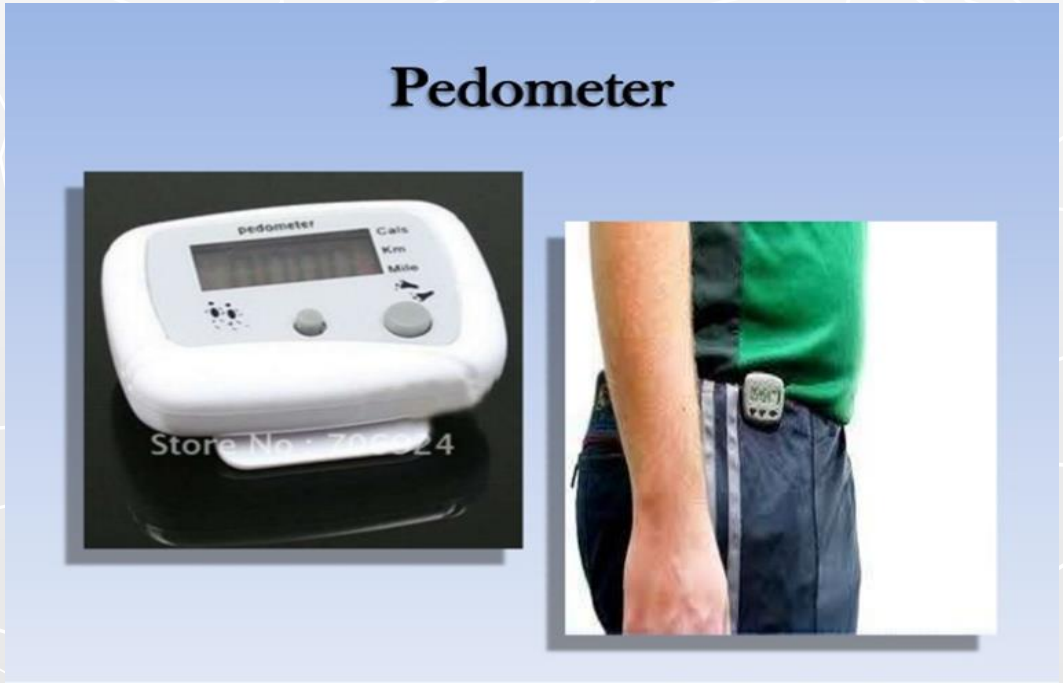
Pacing: Distances are measured by counting the number of **walking steps of a man**



Passometer: Measurements are taken with a instrument like stopwatch**, kept in pocket or attached to legs.**

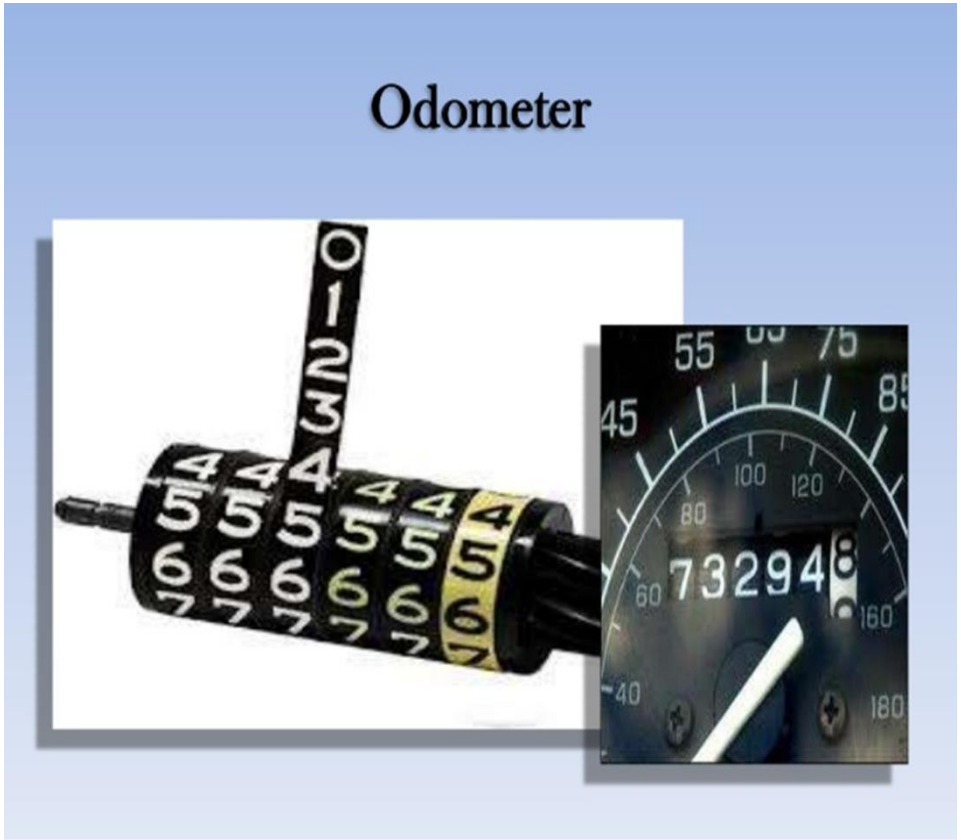


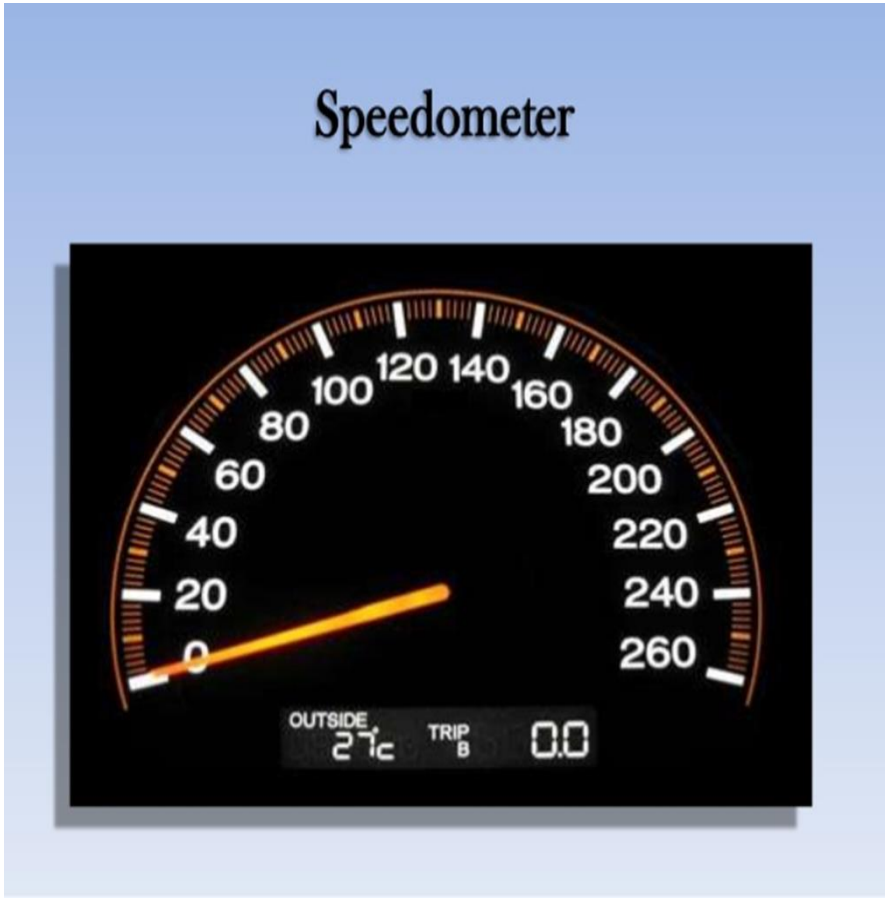
Pedometer : Pedometer is a device similar to Passometer.
But pedometer **counts the total distance when adjusted to the length of one pace**.



Odometer and Speedometer:

- Used in automobiles for recording distances.
- Record the number of revolutions.
- Inaccurate in undulating ground.





Speedometer measures how fast something is going and **odometer** measures how far.

Chaining : Distances are **measured in the field** by **chain or tape**, for ordinary precision or for the higher precision.



Instruments for chaining:

- Chain or tape
- Arrows
- Pegs
- Ranging rods
- Offset rods
- Plumb bob.

Chain

Chain - galvanized mild steel with brass handle

Types of Chains:

- **Metric Chain.**
- **Gunter's Chain or Surveyor's Chain.**
- **Engineer's Chain.**
- **Revenue Chain.**
- **Steel band / band chain**

Chain - galvanized mild steel with brass handle

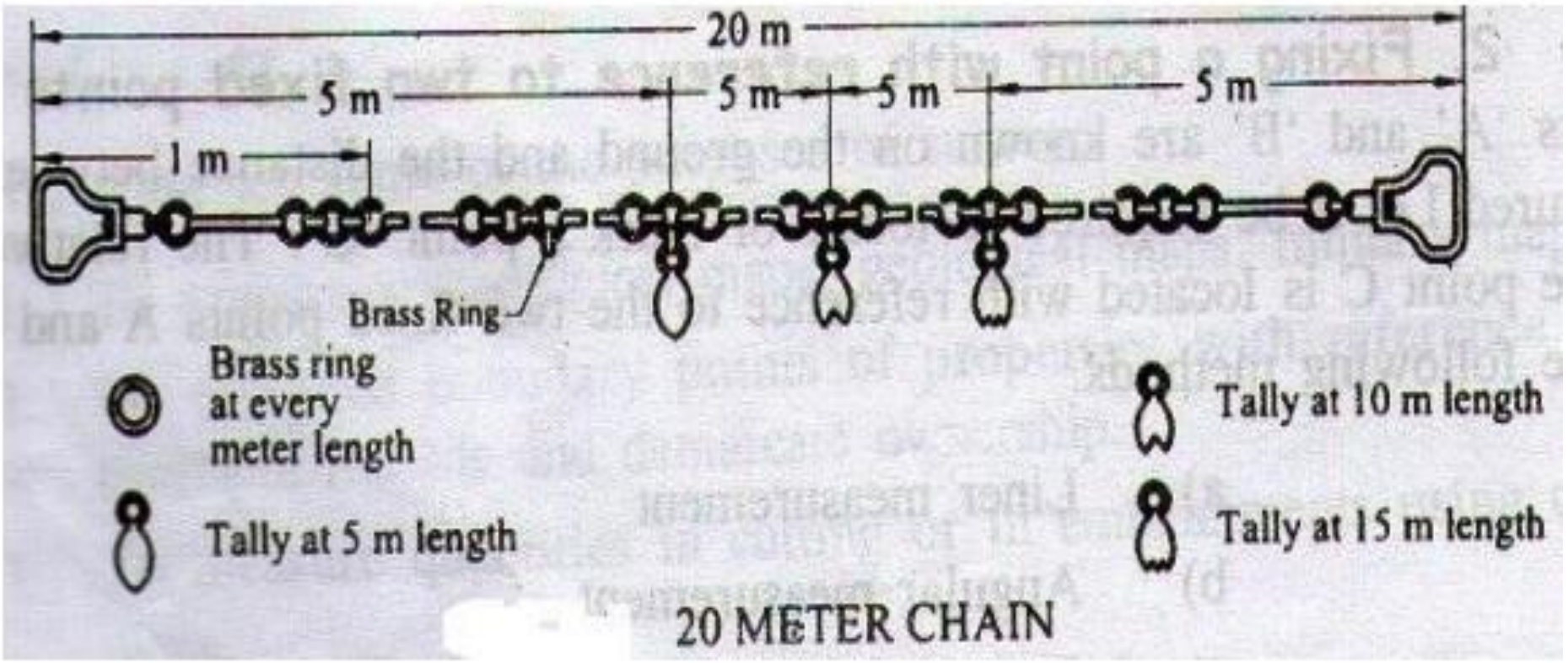
Types of Chains:

Metric Chain-to measure length in SI units.

- available in lengths of **5m,10m**,**20m** and 30m.
- **Brass tags** are at every 5m & 10m etc.
- **Brass rings** are every 1m.



Metric Chain



Gunter's Chain or Surveyor's Chain:

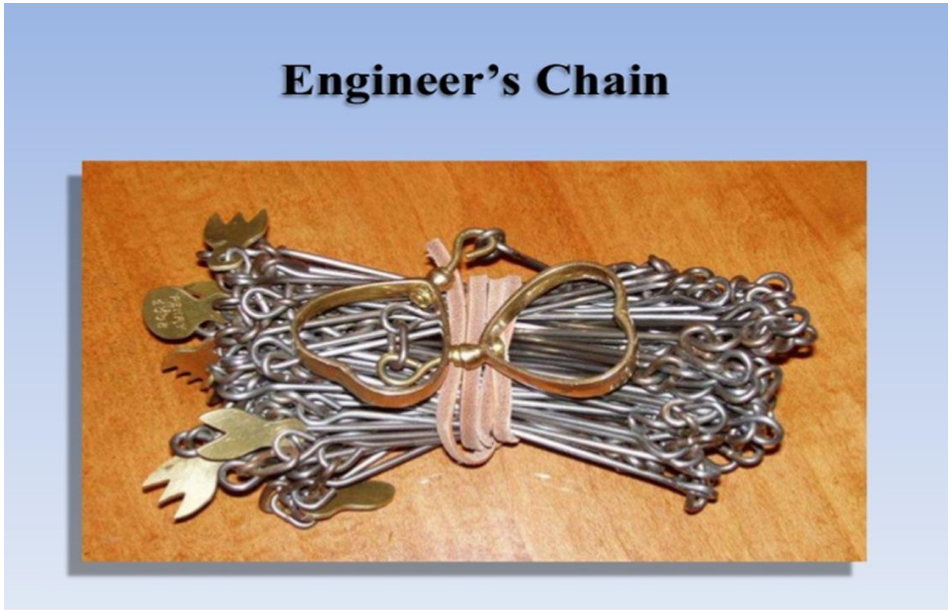
- **Length: 66 feet**
- No. of links: 100
- Each link=0.6 inch
- Conventional to land measurement
- **10 Sq Chains= 1 acre =(66x66)x10**

  =43560 sq ft = 4840 sq yds
- 10 Gunter Chain= 1 furlong = 660 feet
- **80 Gunter Chain**=5280 feet =1760 yds



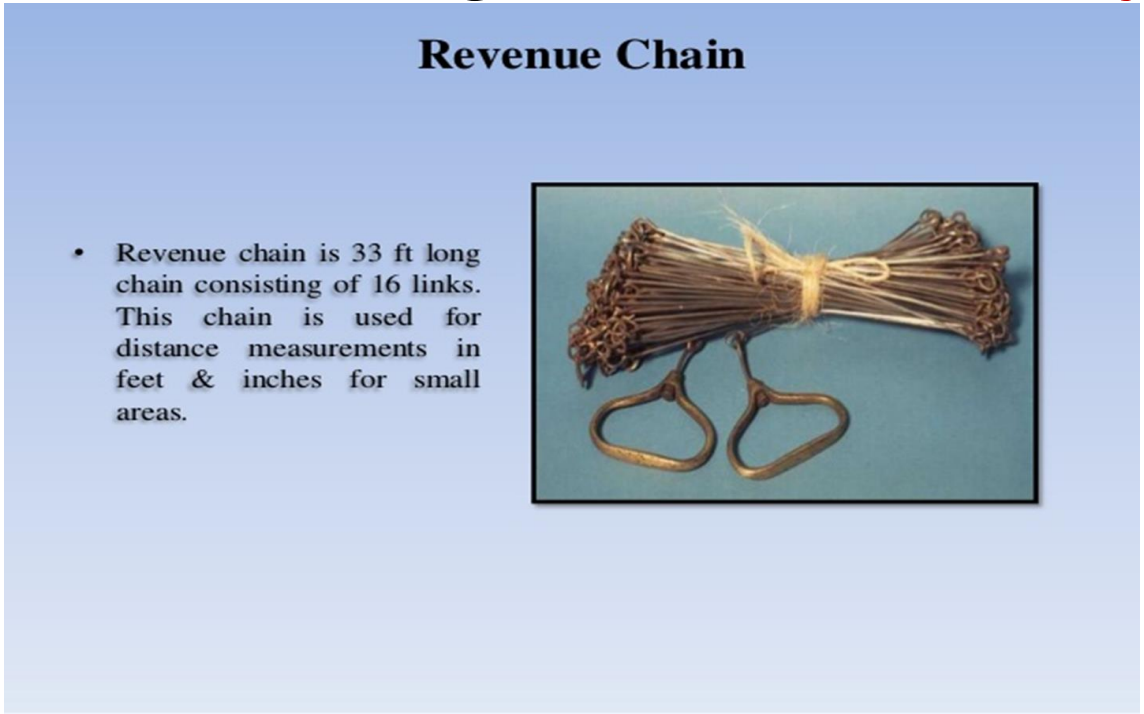
Engineer's Chain:

- **Length**=100 feet
- Links=100 no.
- Each link=1 foot
- Brass tags at every 10 links, indicating 10 link segments.
- Distance measured recorded in feet and decimal



Revenue Chain:

- **Length**=33 feet
- Links=16 nos.
- Each Link=$(2\frac{1}{16})$ feet
- Used for measuring's in **cadastral survey**.



Steel band / band chain

- Narrow strip of **blue steel**
- Width: 12-16mm
- Thickness: 0.3 to 0.6 mm



Advantages of Steel Band:

- Accurate work
- Careful chainman
- Lighter than chain
- Easier to handle
- Unalterable in length
- Not liable to kink when in use

Disadvantages:

- Easily broken
- Difficult to repair

Adjustment of Chain

Testing and Adjustment of Chain:

During continuous use, length gets altered:

- **Length shortened**-due to bending links
- **Length elongated** –by stretching the links & joints and opening out the small rings.

Test the length and make the adjustment.

How?

- Test with reference to the **standard chain**.
- Test with reference to **a steel tape**.
- Test with the reference to **permanent gauge**.

Adjustment of Chain.

Found to be Long on Testing:

- **Closing joints** of rings (if opened up)
- **Reshaping** the elongated rings
- **Removing** one or more small circular rings
- **Replacing** worn out rings
- **Adjustmen**t of links at end.

Found to be Short on Testing:

- **Straighten** the links
- **Flattening** the circular rings
- **Replacing** some rings with bigger one.
- **Inserting** additional circular rings
- **Adjusting** the links at end.

In both cases, **adjustment must be done symmetrically** so that positions **of central peg** does not alter.

Measuring Tape

Tapes are used for more accurate measurements.

Classification based on the materials they are made:

- Cloth or linen cloth
- Metallic tape
- Steel tape
- Invar tape

Cloth or Linen Tape:

- **Length**: 10m, 15m, 20m and 30m
- **Width** is 12-15mm
- **Closely woven linen & varnished** to resist moisture
- **Light and flexible**
- **Used for measuring offset**
- **Small brass tag at end** whose length included in the tape.

Cloth or Linen Tape

Rarely used for accurate measurement because:

- Easily affected by moisture & shrinks
- Length gets altered by stretching
- Likely to twist and tangle
- Not strong enough

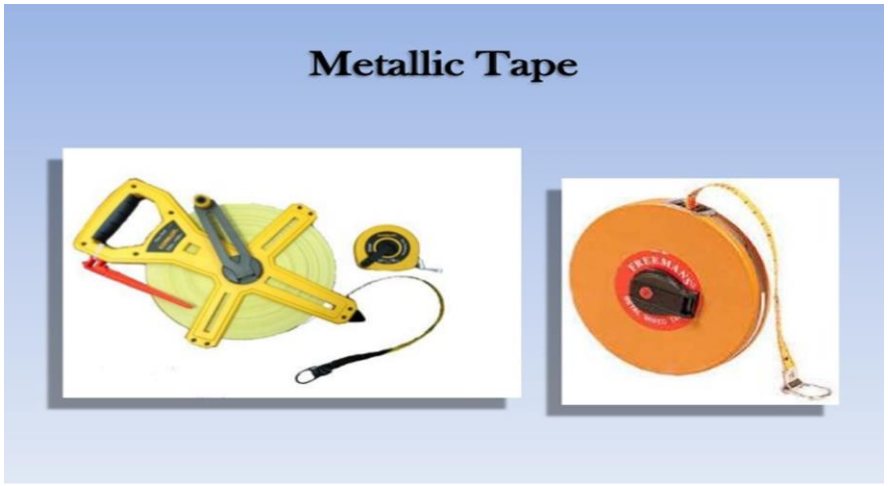
Before winding, tape should be cleaned and dry.



Metallic Tape

- Linen tape **reinforced with copper** or brass wire.
- **Prevent stretching** and **twisting** of fiber.
- Varnished strip of waterproof linen interwoven with small brass, copper or bronze wire, are visible to naked eye.
- Supplied in **leather case with a winding device**
- **Light and flexible**, not easily broken.
- Commonly used for **taking offset** in chain surveying.

After use-wiped clean, dried and oiled.



Steel Tape

- Made of **steel ribbon** of width varying 6 to 16 mm.
- Available length are 10m, 15m, 20m, 30m, and 50m.
- Superior to metallic or cloth Tape
- **Delicate and very light**.
- Used **for accurate measurement** of distance

After use-wiped clean, dried and oiled.



Invar Tape

- **Invar**, also known generically as **FeNi36** (**64FeNi** in the US), is a **nickel–iron alloy** notable for its uniquely low coefficient of thermal expansion (CTE or α).

- Name **Invar** comes from the **word invariable**, referring to its **relative lack of** expansion or contraction with temperature changes.

Invar tape:

- Width 6mm and lengths are 30m, 50m and 100m
- Used for very **high degree precision as base lines.**
- Very low thermal coefficient.



Ranging

Ranging:

Process of **fixing or establishing intermediate points** between two main points along survey line when:

- **distance exceeds** the length of one chain/tape and
- two ends of survey lines are **not inter visible**.

Two methods of ranging:

-Direct Ranging &

- Indirect or reciprocal ranging

Ranging Equipment:

- **Ranging Rods**.
- **Offset rods**.
- **Arrows**
- **Pegs**
- **Plum-bob**

Ranging Rods:

- used for **ranging some intermediate points** on the survey lines.
- generally **2 to 3m** in length.
- painted in alternative **bands of black or red** and **white** color of lengths of 20cm.
- If distance is too long, **ranging poles** of **4 to 6m** long are used.

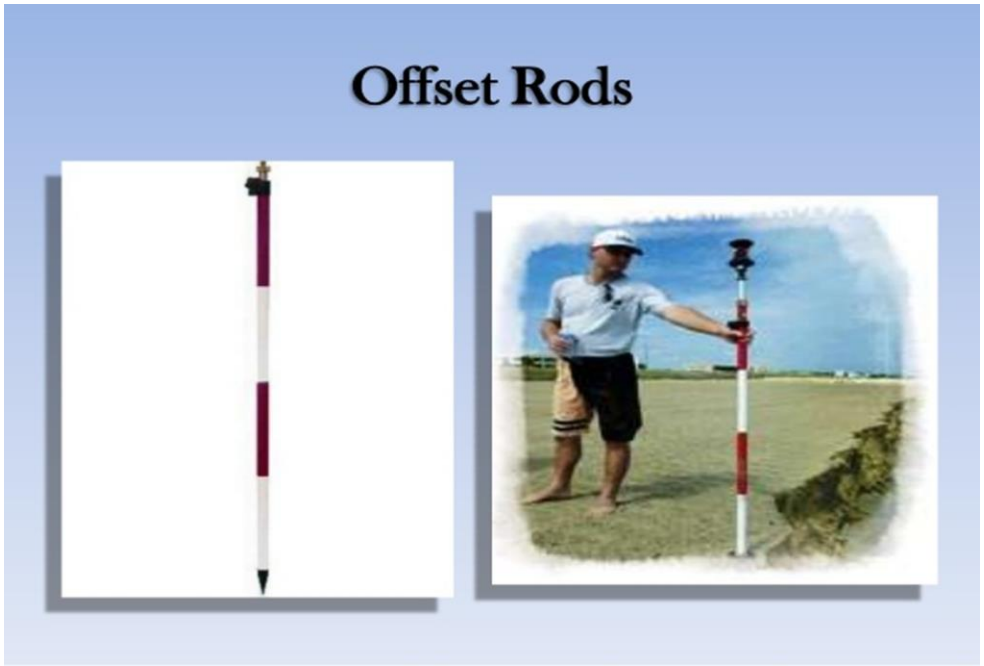


Offsets Rods:

- similar to ranging rods **exception is that a hook** is provided at the top.

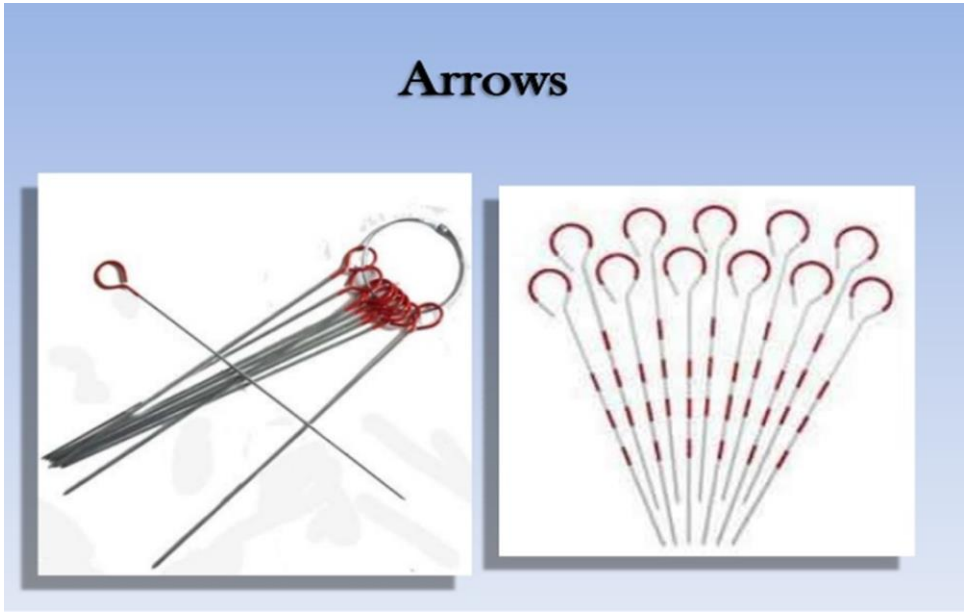
- hook is **used for pushing or pulling** the chain or the tape.

- used for measuring **small offsets**.



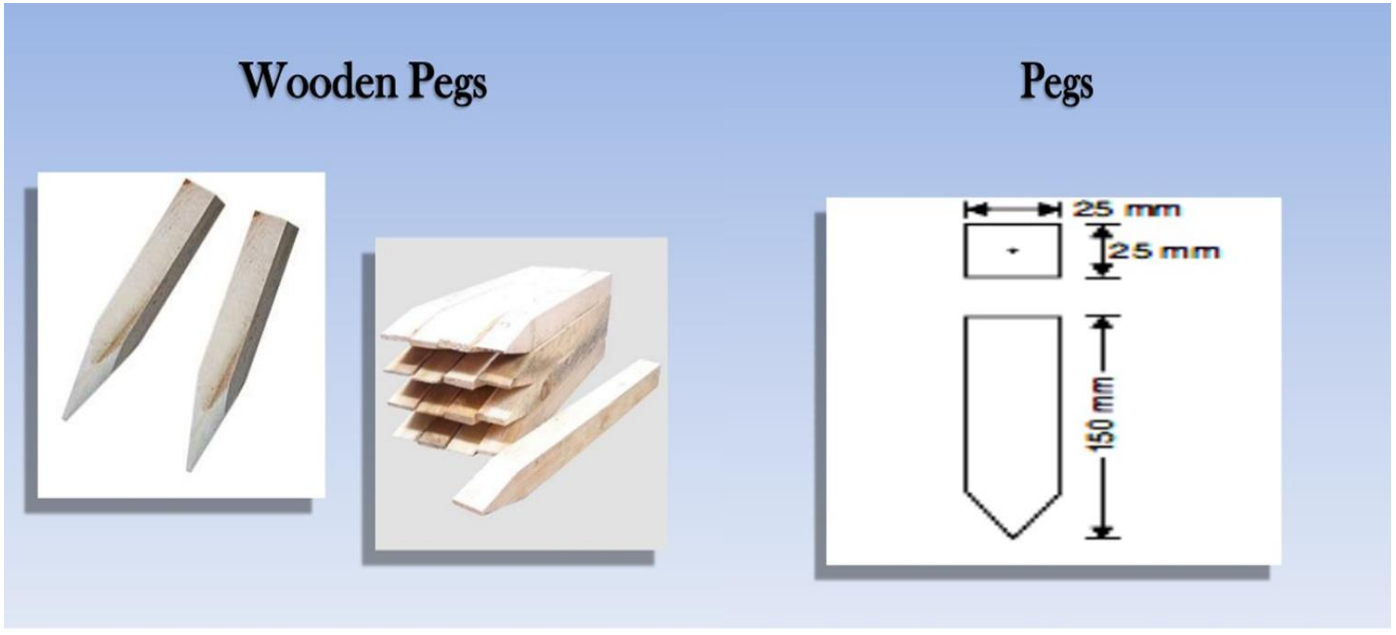
Arrows:

- made of **tempered steel** wire of 4mm dia.
- **one end is bent into ring of 50mm dia and other end is pointed.**
- overall length is 400mm.
- **used for counting the number of chains while measuring a chain line,**
- an **arrow is inserted into the ground after every chain** line is measured..



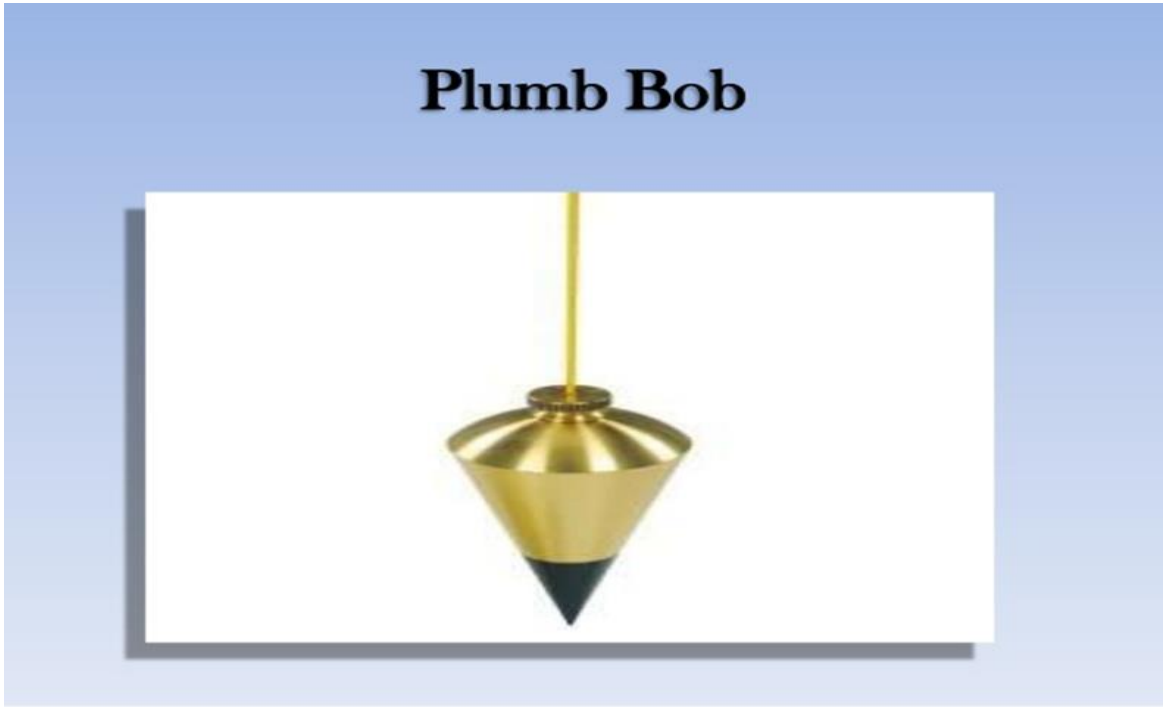
Pegs:

- made of **normally timber.**
- wooden pegs are **15cm long**.
- driven into the ground with the help of hammer.
- used to **mark the position of stations or terminal points** of survey line.



Plumb Bob:

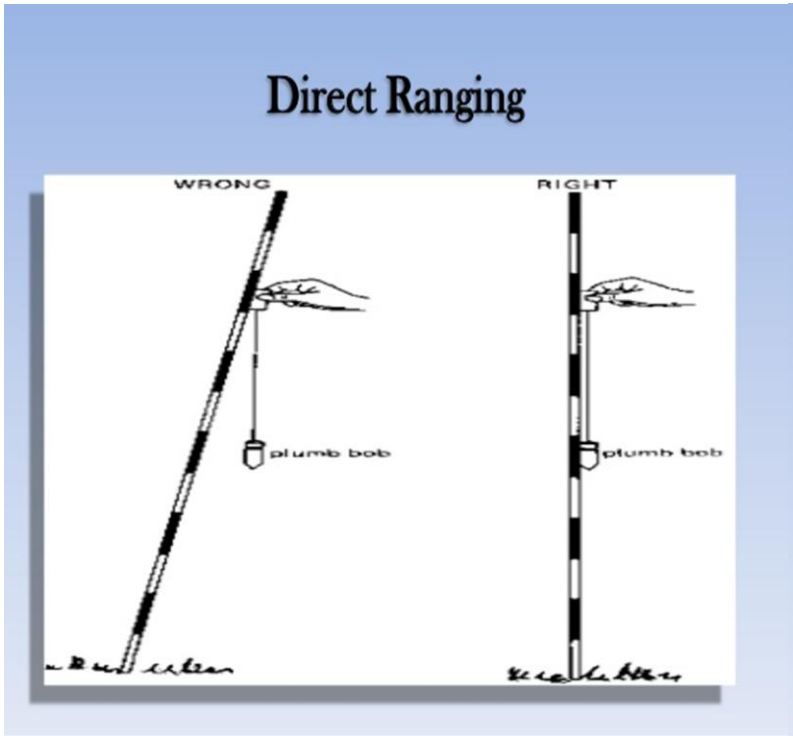
- used for **transfer points** on the ground and vis a vis.
- used for **fixing the instruments exactly over the station point** marked on the ground .
- used for **centering aids** of theodolite and plane table.

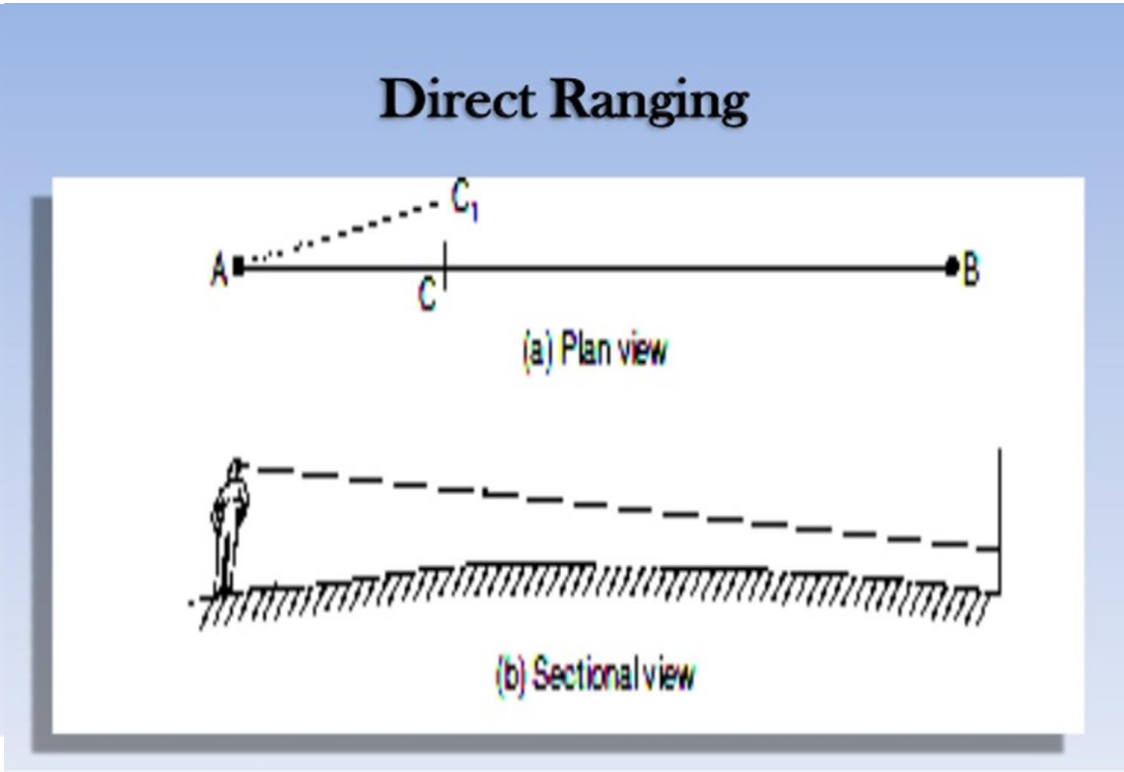


Ranging out survey Lines

Direct Ranging –the 1st point and the last point of the chain line is **inter-visible.**

- May be done by **open eye or by line ranger.**
  - **-Ranging by Eye**
  - **-Ranging by line ranger**





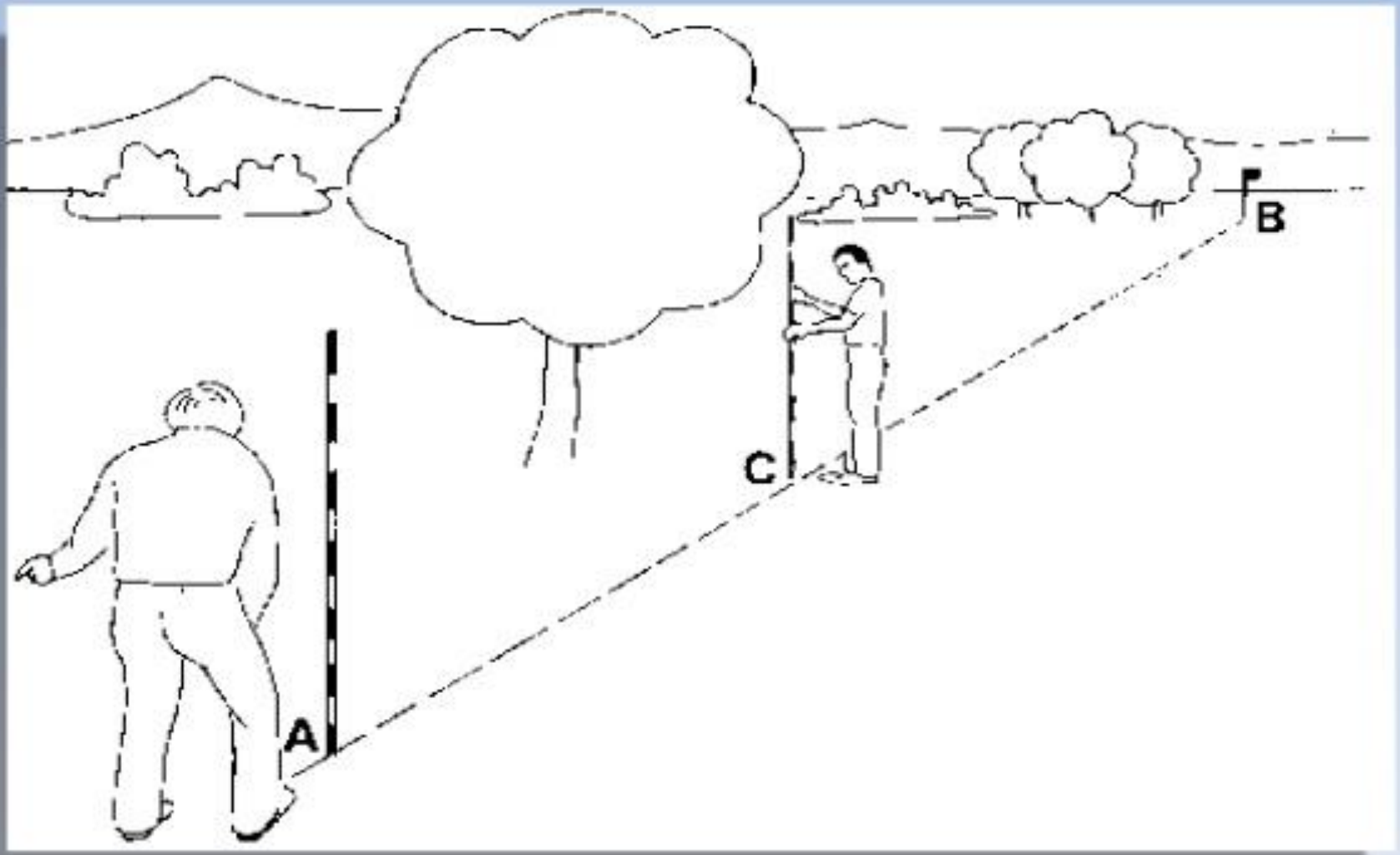
Ranging by Eye

- Stations A and B, within which an intermediate points C is to be located.
- C point is selected at a distance slightly less than a chain length.
- At points A and B, ranging rods are fixed with plumb bob.

- Assistants hold another ranging rods near point C.
- Surveyor positioned himself **about 2 m** behind the ranging rods at A in line with the ranging rod at B.
- Then surveyor **directs the assistant** to move traverse to the chain line along AB, **till his ranging rod is in line with A and B**.

- Surveyor directs assistant then to **mark point C**.
- Similarly other intermediate points can be established.

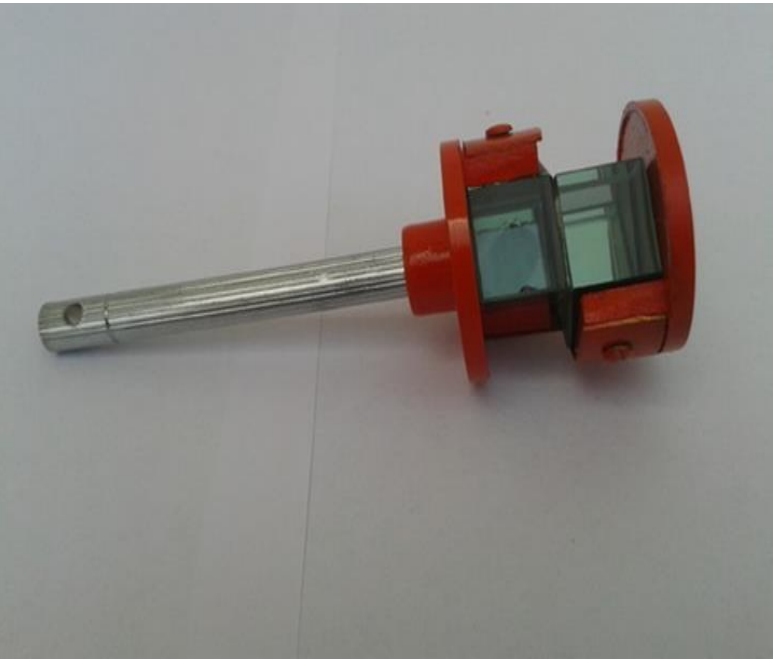
Direct Ranging

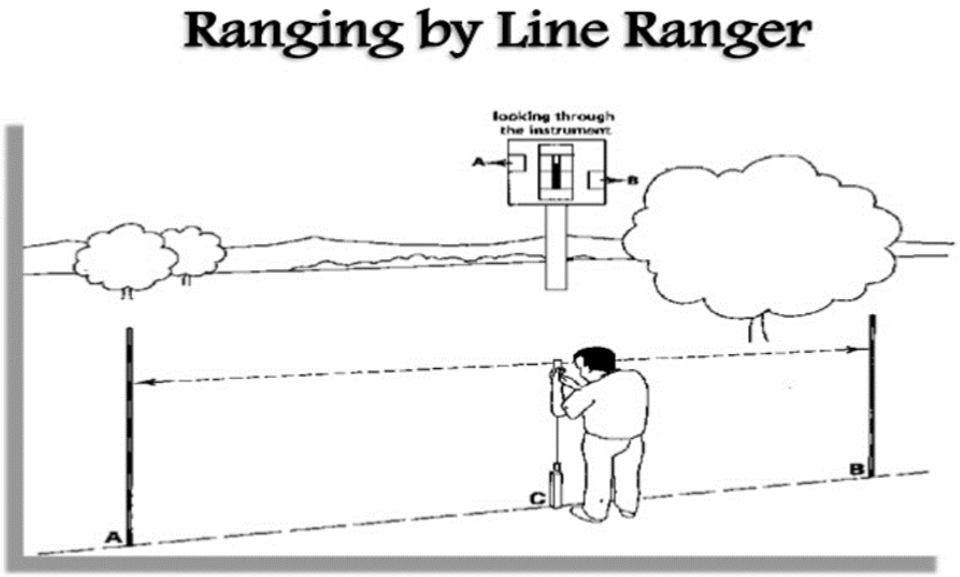


Direct Ranging by Line Ranger

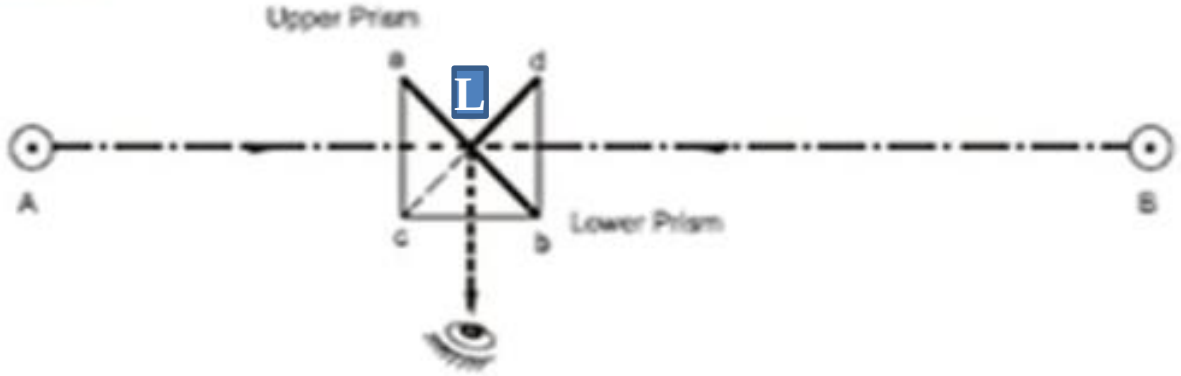
What is a line ranger?

- Consists of **two mirrors or two isosceles prisms placed one above other.**
- **Diagonals of two prisms are silvered** to reflect incidental rays.
- A **handle with a hook** is provided at the bottom to hold the instruments in hand and also to transfer the point on the ground with the help of plumb bob.

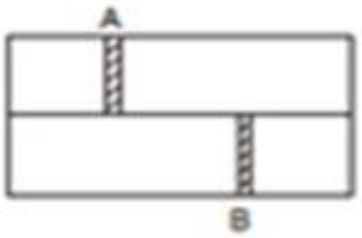




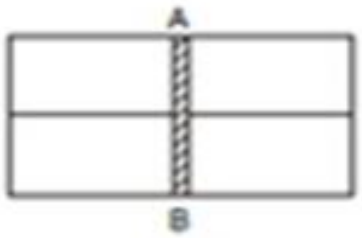
Ranging by Line Ranger



(a)



(b) Incorrect Alignment



(c) Correct Alignment

- Suppose Point L is to be located between points A and B.
- Observer stands in line and place the instrument on a rod or holds it at eye level until the image of rod at A is seen in field view.
- Then surveyor moves with the line ranger.
- **The point where two images A and B coincide in line ranger is the point in line with two fixed ranging rods. At this point a pebble is dropped from the handle of line ranger and point L is traced on ground.**

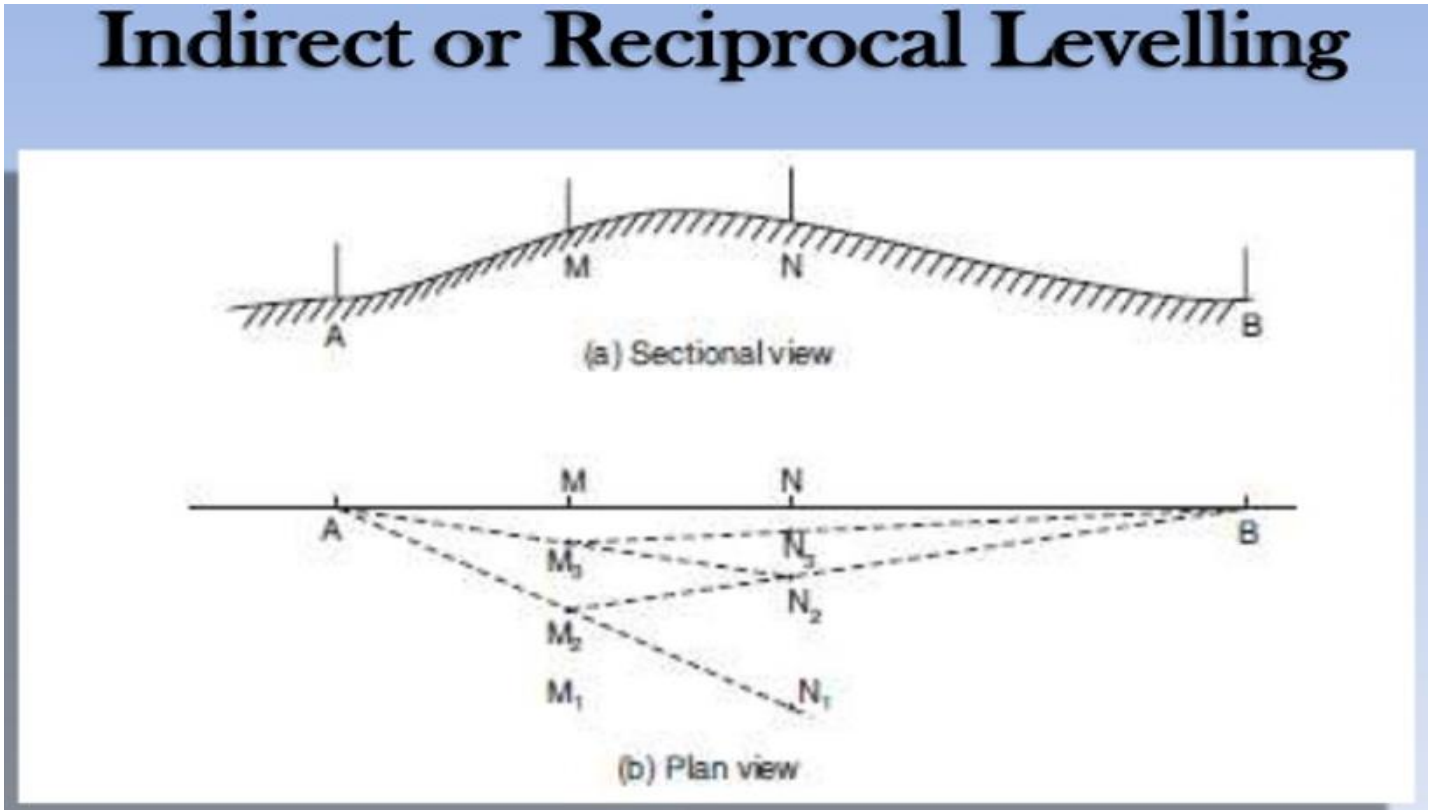
Linear Measurement

Adjustment of line ranger:

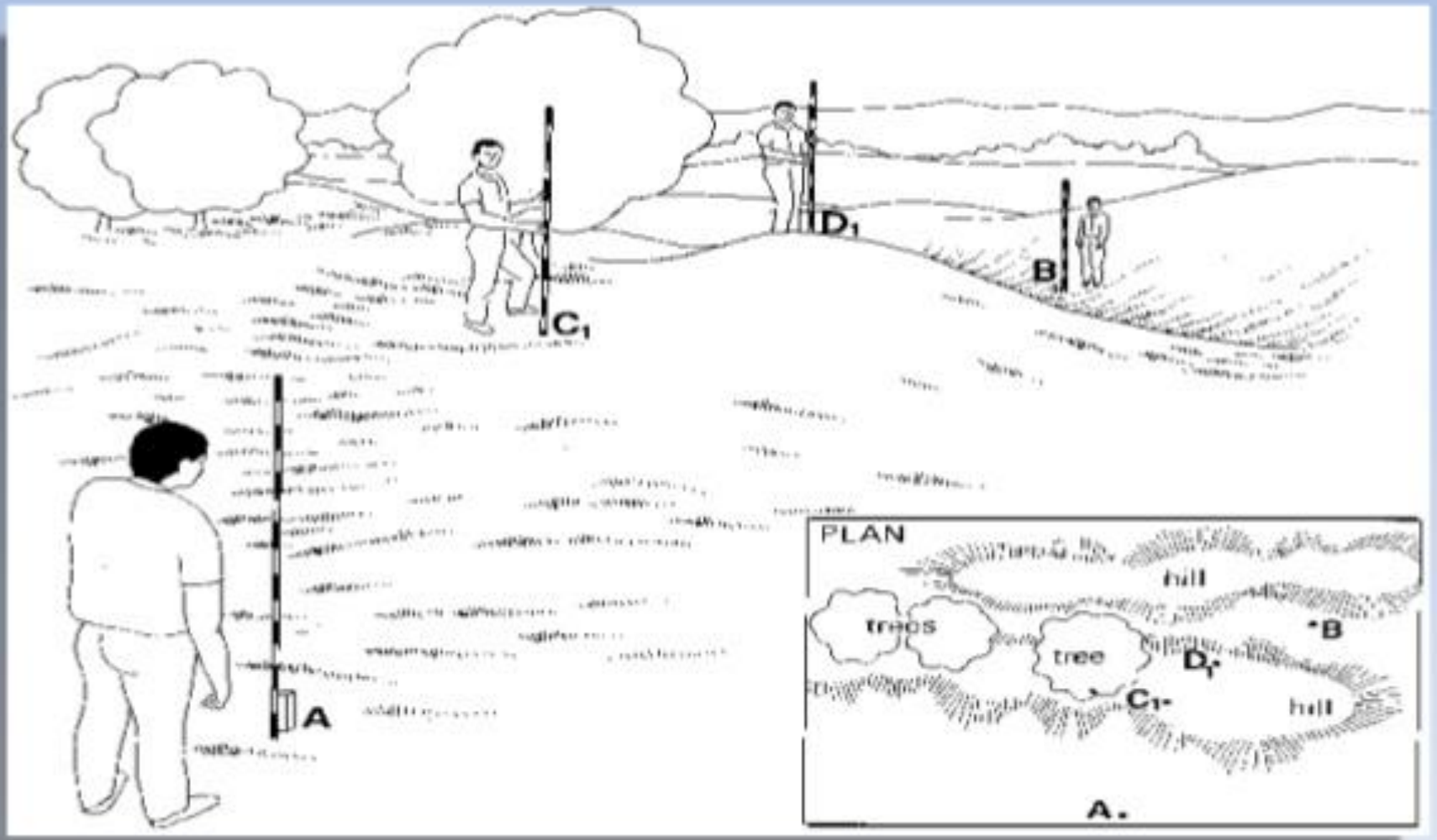
- Actually adjustment of the movable prisms.
- **Poles are ranged accurately by theodolite**
- Line ranger on middle pole
- Two end poles are in exact coincidence.

Indirect or Reciprocal Ranging:

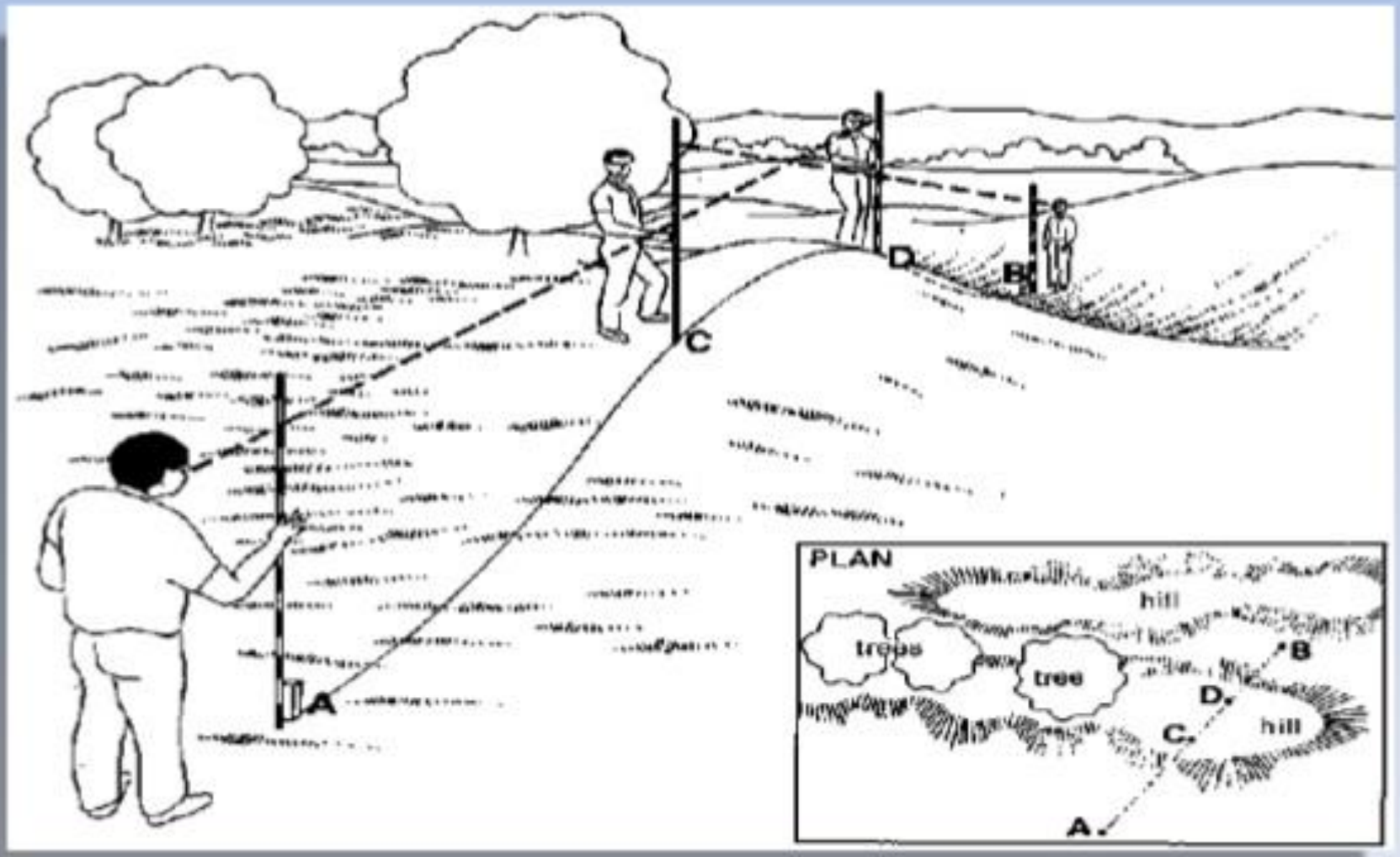
- Resorted when **both ends of survey line** **are not inter visible** either due to **height** of intervening features/ground or due to **long distance**.
- Ranging is done indirectly by **selecting two intermediate points M & N very near to chain line**.
- M & N is fixed by reciprocal ranging.
- Other points may be by direct ranging.



Indirect or Reciprocal Levelling



Indirect or Reciprocal Levelling



Procedure of Chaining:

- **Chaining by chain**
- **Chaining by tape.**

Chaining by chain:

Two chainman are required to measure a line **which is greater than on chain.**

Follower: **More experienced** chainman remain **at the zero** end or **rear end** of the chain.

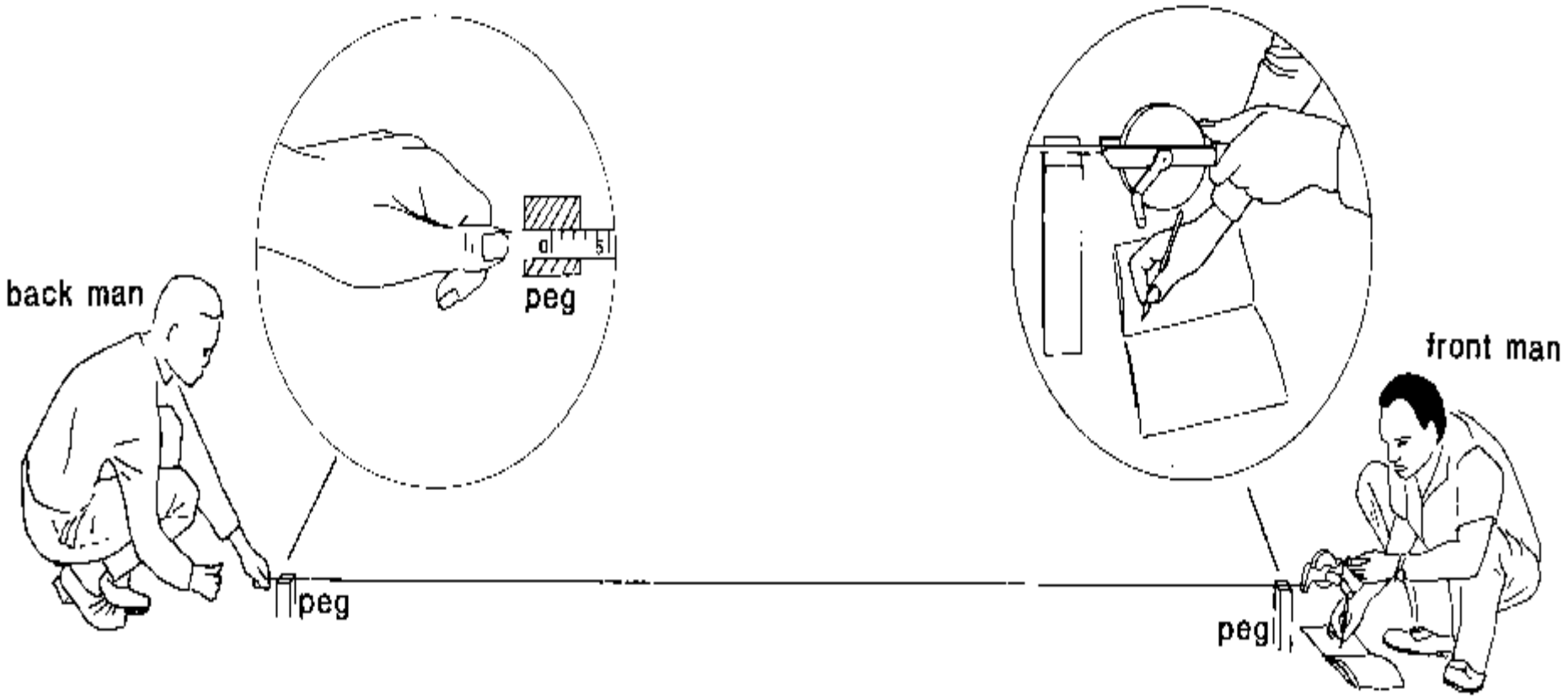
Leader:

- Other chainman **holding the forward handle of the chain**.

- He takes the bundle of arrows, ranging rod/arrows in one hand and handle in next hand and move forward.

Chaining by Chain:

Measurement of distance by chain:



Follower

Leader

Chaining by Tape

Measurement of distance by Tape:

- For **accurate measurements and in all important surveys**, length is measured by tape.
- **Also called chaining** and
- Persons engaged in measurement are called Chainmen ie. Follower and Leader



Error due to Incorrect Chain

Errors due to incorrect chain:

L=true length

L'=Incorrect length

l= Actual measured length

l'=measured length by L'

$$l=l'(L'/L)$$

$$A=A'(L'/L)^2$$

$$V=V'(L'/L)^3$$

If the chain is too short, measured distance will be less. The error will be negative and the correction will be positive.

Similarly, if the chain is **too short**, the measured distance will be more, error will be positive and the correction will be negative.

Chaining on uneven Slopping Ground

Chaining on uneven slopping ground

- **Horizontal distance is required** (for plotting)

  -By **direct measurement**

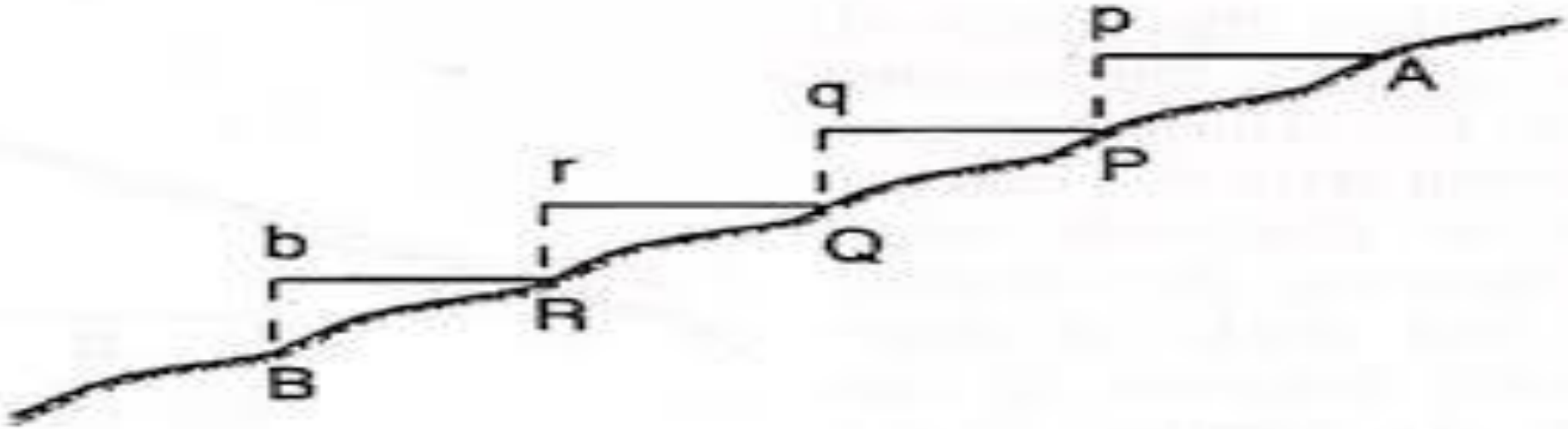
  -by **measuring slopping distance** and reduce it to horizontal distance.

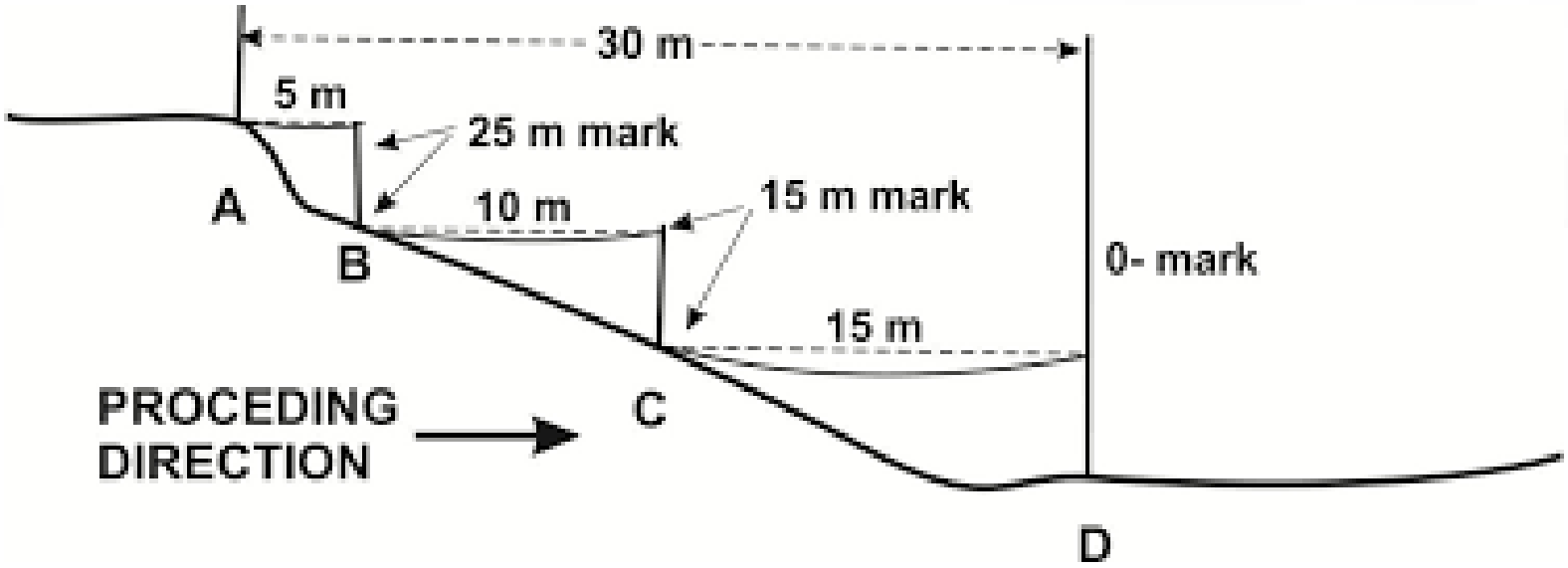
- Methods for **getting the horizontal distance** between two points:

  -Direct Method or Method of stepping.

  -Indirect method- for regular or even slope.

Direct method for Measuring Horizontal Distance on uneven slopping ground -Method of Stepping





Direct Method -Method of stepping

- Suitable for irregular shape of ground.
- Measured in small horizontal stretches or steps.
- Convenient to measure **downhill**
- **Steeper the slope lesser the length**.
- Tape to be kept horizontal either by **eye judgement** or **a hand level.**
- **Sufficient pull** to be applied to avoid sag.

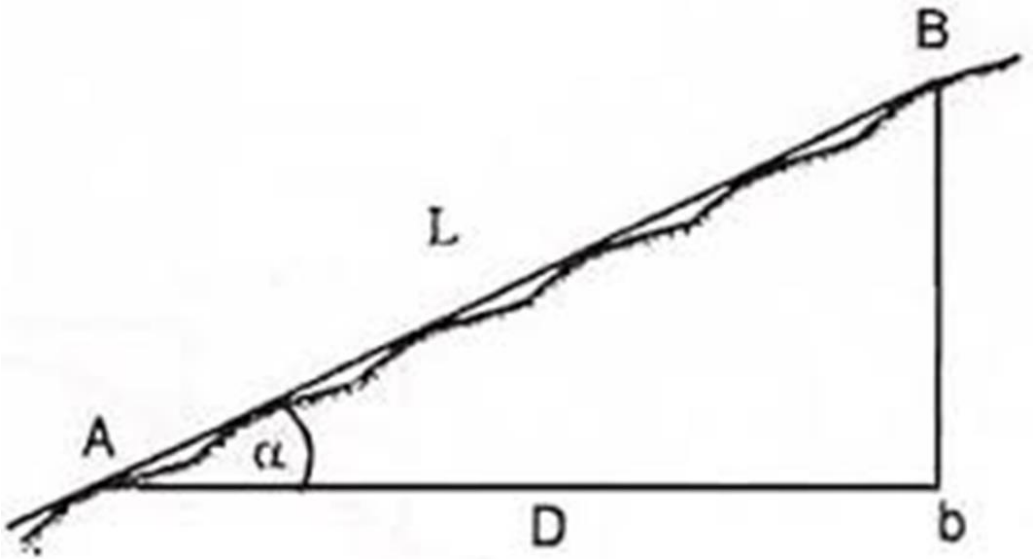
Indirect Method-for regular or even slope:

- Slopping distance measured, and horizontal distance is calculated.

Method-1: Angle measured

- **Sloping distance is measured**
- **Slope is measured by clinometer** and horizontal distance is calculated.

$$D = L \cos\alpha$$

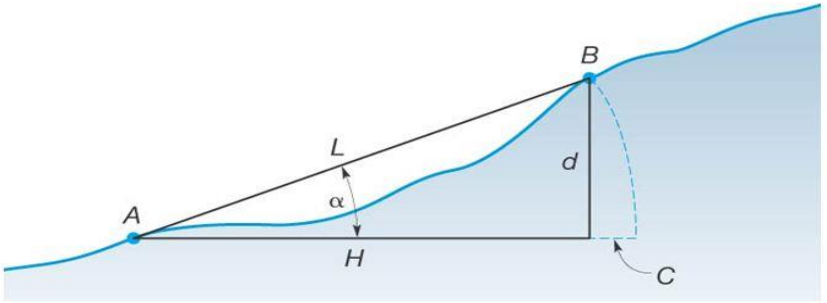


Indirect method-Regular and even slope

Method-2: Difference in level is measured.

- Sloping distance is measured.
- **Difference in level is measured** by **leveling instruments**.
- Horizontal distance is calculated.

Uniformly Sloping Ground



$$d = L \sin\alpha$$
$$H = L \cos\alpha$$

$$H = \sqrt{L^2 - d^2}$$

Hypotenusal Allowance

Method-3: Hypotenusal allowance

- **A correction is applied in the field at every chain length** and at every points **where slope changes**.

- When the **chain, is stretched on a slope**:

  -Arrow is not put at the end of chain but put in **advance of the end**.

  -An amount, which allows for the slope correction.

- Distance **BC** is called hypotenusal allowance.

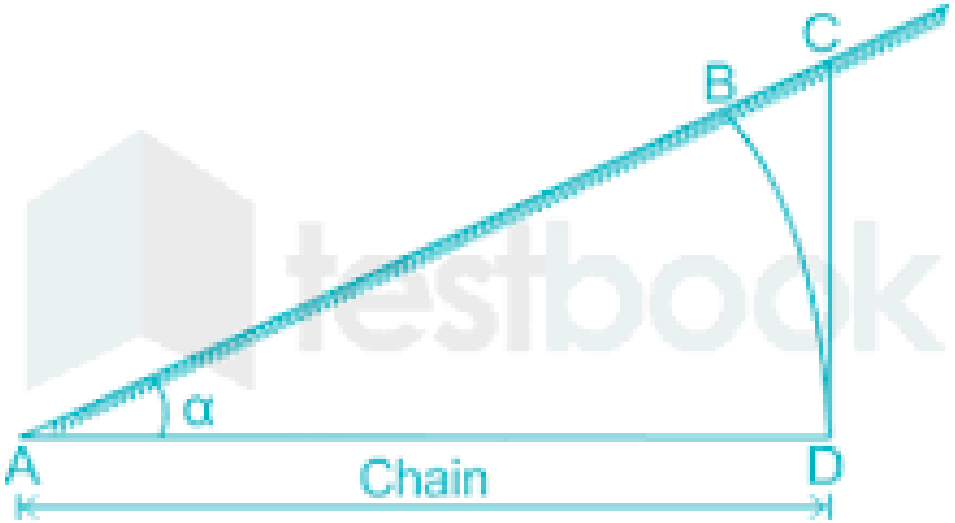
Hypotenusal allowance

Hypotenusal allowance method:

Let α = the angle of slope of the ground and AD = AB = Measured distance.

Then AC = measured distance × sec α and BC = AC – AB = (Sec α - 1) × measured distance.

The amount (sec α – 1) × measured distance is known as a hypotenusal allowance.



Linear Measurement

Errors in chaining

Linear Measurement

Errors in chaining:

Cumulative errors

- Occurs in the **same directions** and **tends to accumulate.**

Compensating errors

- May occur in either directions, and hence tends to compensate.

Linear Measurement

Errors and mistakes in chaining may arise from:

- Erroneous length of chain or tape.
- Bad ranging
- Careless holding and marking
- Bad straightening.
- Non-horizontality
- Sag in chain
- Variation in temperature
- Variation in pull
- **Personal mistakes**

Personal Mistakes

Personal Mistakes in Chaining:

Displacement errors:

- To avoid, a (X) **cross must also be marked** on the ground before inserting the arrows.

Miscounting Chain Length:

- Serious blunder
- Can be avoided by **following systematic procedures** or counting the arrows properly.

Personal Mistakes

Misreading:

- **Confusion** by reading **5m tally to 15m** tally or **6 for 9** or **28.62** for **28.26** etc.

- Can be avoided by **seeing the central tag** and **duplicate observations** by another persons.

Erroneous Booking:

- Surveyor may enter **246** in place of **264** etc.

- To avoid, **chainman first speak out reading loudly**, surveyor to **repeat the same** while entering in the field book.

Linear Measurement

Tape corrections - Corrections applied for in tape measurements.

- **Important and precise works**, **correction must be applied**.
- Most of the cases, **tapes are used for precise surveying**.

Following are the Tape Corrections:

- For absolute length.
- For temperature
- For pull or tensions
- For sag.
- For slope

Thank You