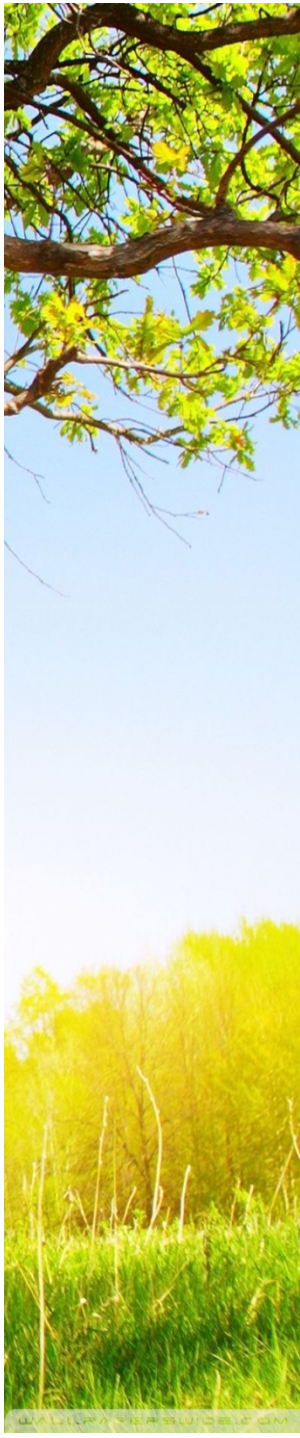
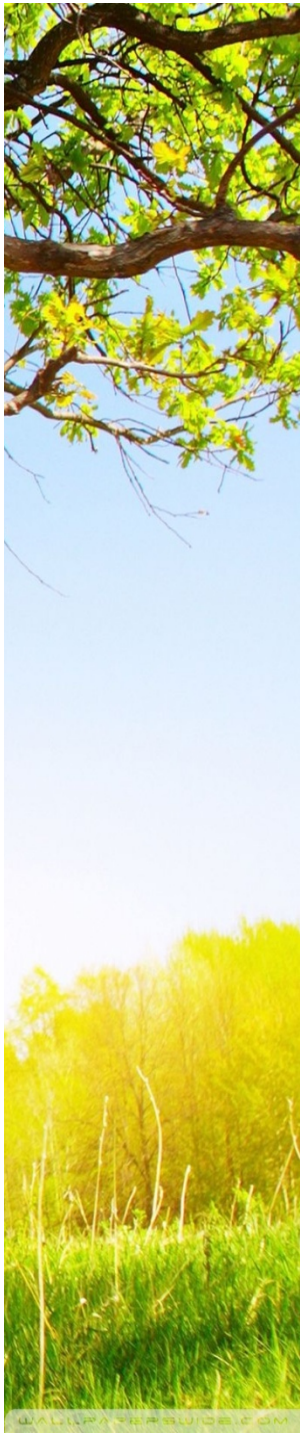
Surveying
Errors in Linear Measurements



Introduction

- In engineering survey, the linear horizontal distance is to be measured to complete a survey. The measurement of this linear horizontal distance between two points on the earth surface is known as linear measurement.



Direct measurement method

- Direct measurement is obtaining the measurement directly which means measuring the length directly using simple equipment and there is no need to solve hard equations..! In the Direct methods, the distance is actually measured during field work using a chain or a tape.
- The following instruments are used while chaining:
- Chains
- Tapes
- Arrows
- Ranging rods and offset rods
- Pegs
- Plumb-bob
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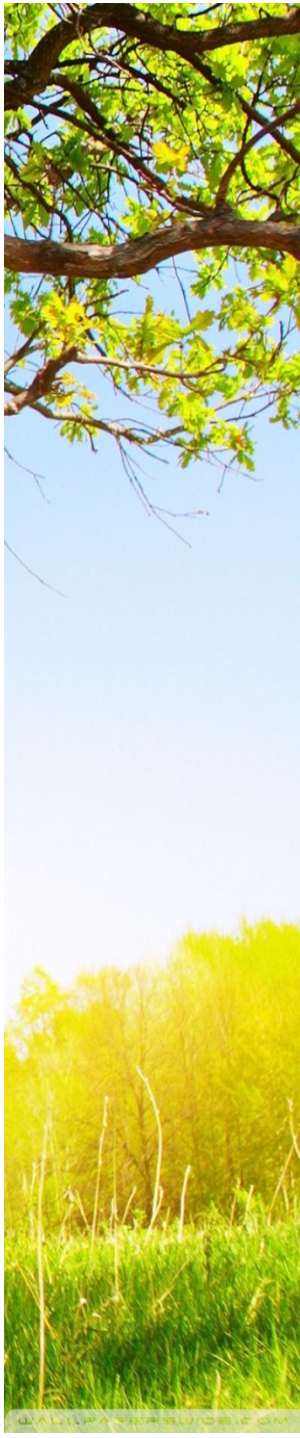
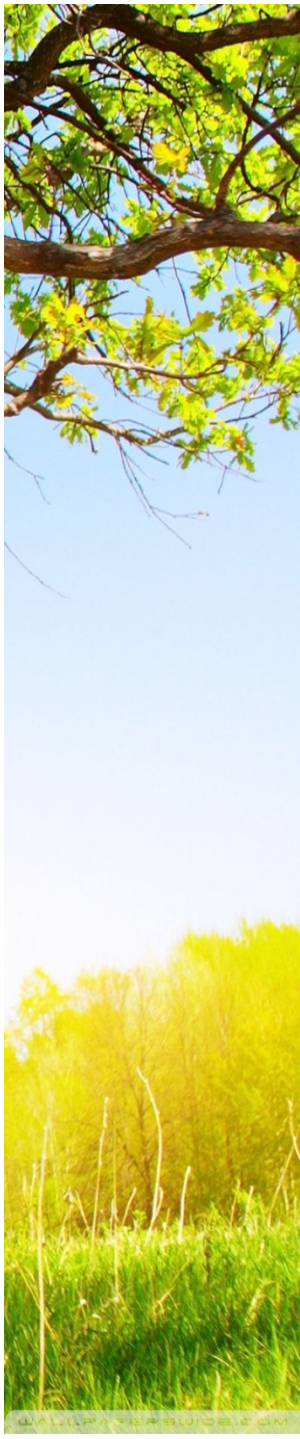


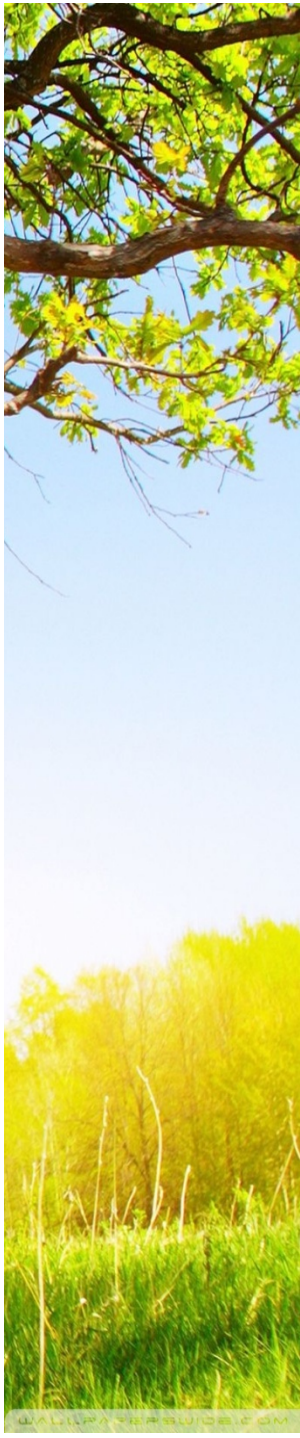
Chain

- The chain is composed of 100 or 150 pieces of galvanized mild steel wire called links, joined together with oval rings and handles at both ends. The end of each link are bent into a loop and connected together by means of three oval rings. The ends of the chain are provided with brass handles for easy handling. The length of chain is measured from one handle to other handle.



Tapes

- Tapes are used for more accurate measurements. The tapes are classified based on the materials of which they are made of such as:
- Cloth or linen tape
- Fiber tape
- Metallic tape
- Steel tape
- Invar tape



Length other than standard

Tape manufacturers do not guarantee 100 ft steel tapes to be exactly 100.00 ft. An error due to the incorrect length occurs every time the tape is used.

Example:

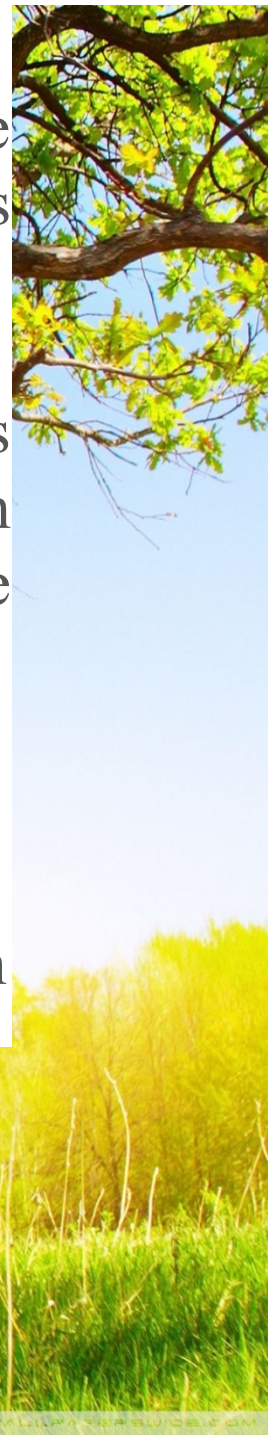
The length of survey line measured with a 30 m chain was found to be 630.50 m. When this chain was compared with standard chain, it was found to be 0.01m long. Find the true length of the survey line.

Solution:

True length of line = (L1/L)x measured length of the line

here L1 = 30.10m and L = 30.0m, Measured length = 630.5m

Therefore ture length of line=(30.10/30.0)x633.50= 633.603m



Correction for Temperature:

The Length of Tape increases if its temperature is raised and decreased if the temperature is lowered. If the Temperature of tape is above normal, the correction is positive and if it is below normal, the correction is -ve.

Formula, $\text{Temp Corr } \alpha = (T_m - T_o) \times L$

where L = Measured Length of Line

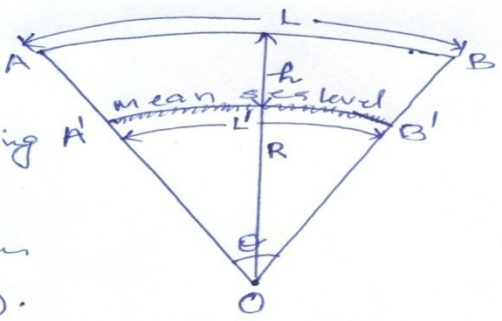
T_m = Mean Temperature during Measurement

T_o = Normal Temp at standardisation

α = Co-eff of Thermal Expansion of the Tape Material.

Mean Sea Level

The measured length of a line at an altitude h Meter above Sea Level will be more as compared with the corresponding Line on the MSL.



Formula for M.S.L. correction

$$= L \times \frac{h}{R} \text{ (approx)}.$$

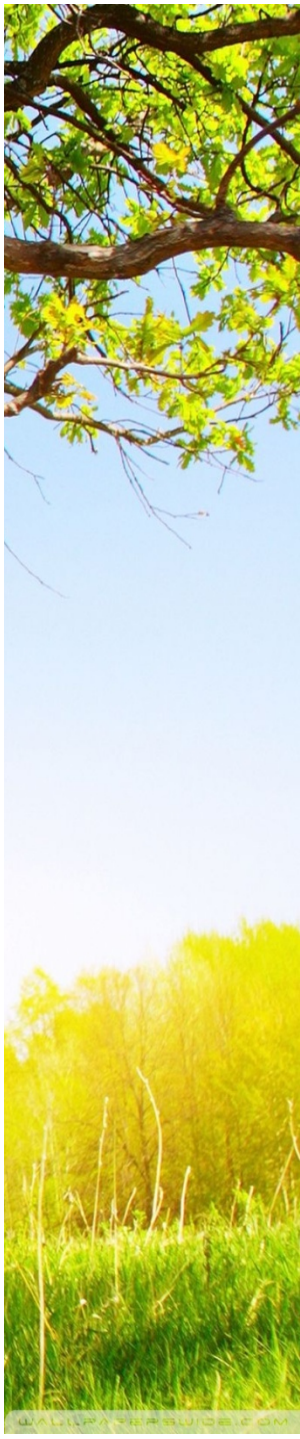
Where L = Distance AB Measured at an altitude h meters above M.S.L.

R = Radius of Earth (6371 km)

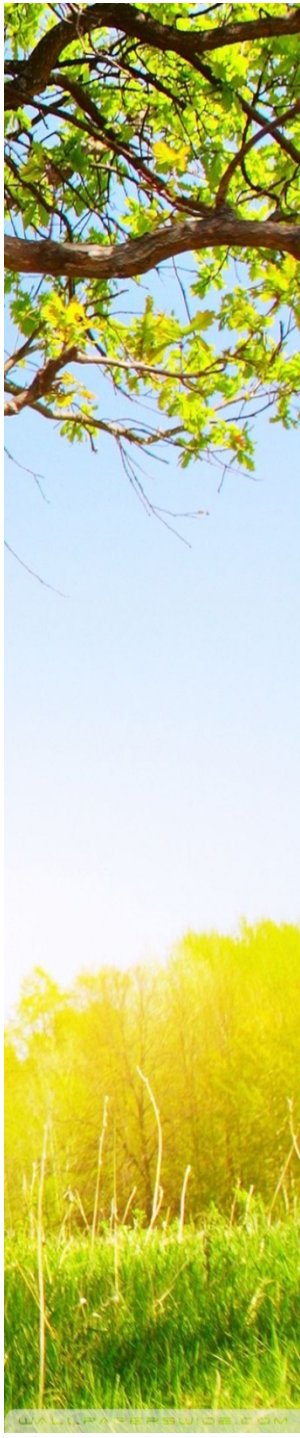
h = Altitude observed.

1. **Instrumental:** Surveying error may arise due to imperfection or faulty adjustment of the instrument with which measurement is being taken. For example, a tape may be too long or an angle measuring instrument may be out of adjustment. Such errors are known as instrumental errors.

2. Personal: Error may also arise due to want of perfection of human sight in observing and of touch in manipulating instruments. For example, an error may be there in taking the level reading or reading and angle on the circle of a theodolite. Such errors are known as personal errors.



Natural: Error in surveying may also be due to variations in natural phenomena such as temperature, humidity, gravity, wind, refraction and magnetic declination. If they are not properly observed while taking measurements, the results will be incorrect. For example, a tape may be 20 meters at 20^0C but its length will change if the field temperature is different.



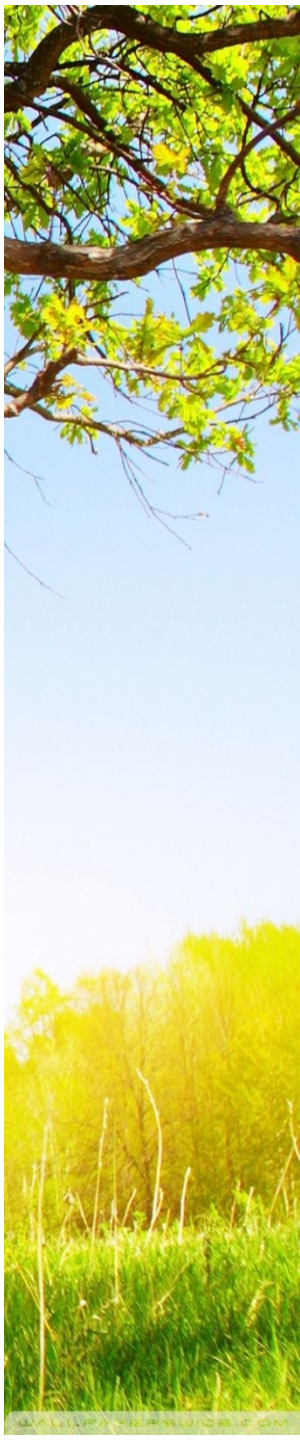
Mistakes: Mistakes are errors which arise from inattention, inexperience, carelessness and poor judgment or confusion in the mind of the observer. They cannot be measured. However, they can be detected by repeating the whole operation. Hence, every value to be recorded in the field must be checked by some independent field observation. The following are the **examples of mistakes:**

Erroneous recording, e.g. writing 69 in place of 96

Counting 8 for 3

Forgetting once chain length

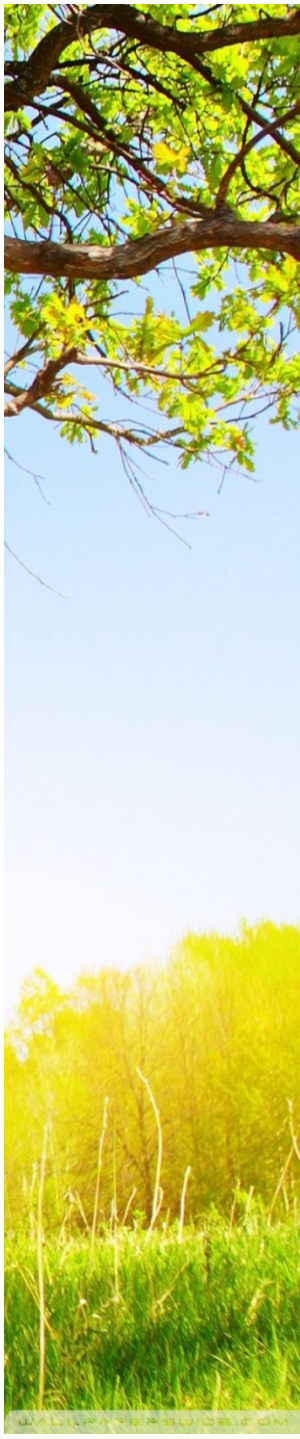
Making mistakes in using a calculator



Systematic or Cumulative Errors

The systematic errors may arise due to (i) variations of temperature, humidity, pressure, current velocity, curvature, refraction, etc. and (ii) faulty setting or improper leveling of any instrument and personal vision of an individual. The following are the examples:

- Faulty alignment of a line
- An instrument is not leveled properly
- An instrument is not adjusted properly



Common instrumental errors in linear measurement

Due to usage of a chain over rough ground its oval shape rings get elongated and thus the length of the chain gets increased. The general rule says

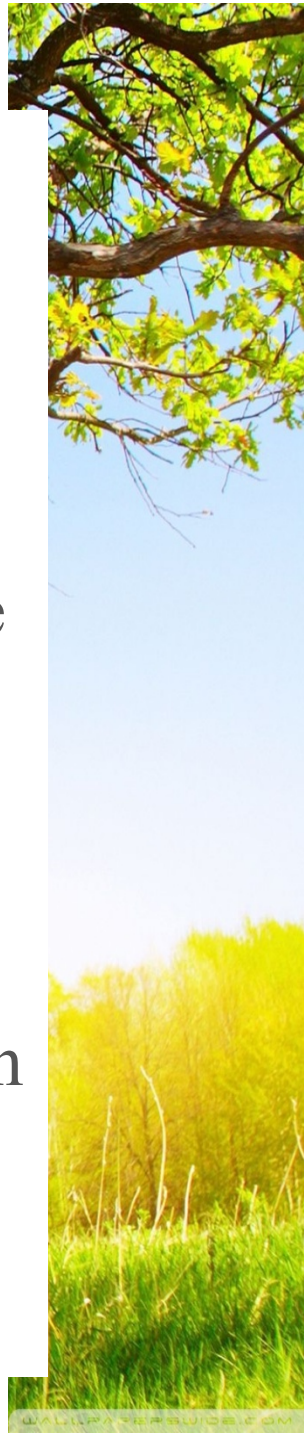
“ if the chain is too long the measured distance will be less and’ if the chain is too short, the measured distance will be more”

Let ‘L’ be the true length of the chain

L1 be the faulty length of the chain

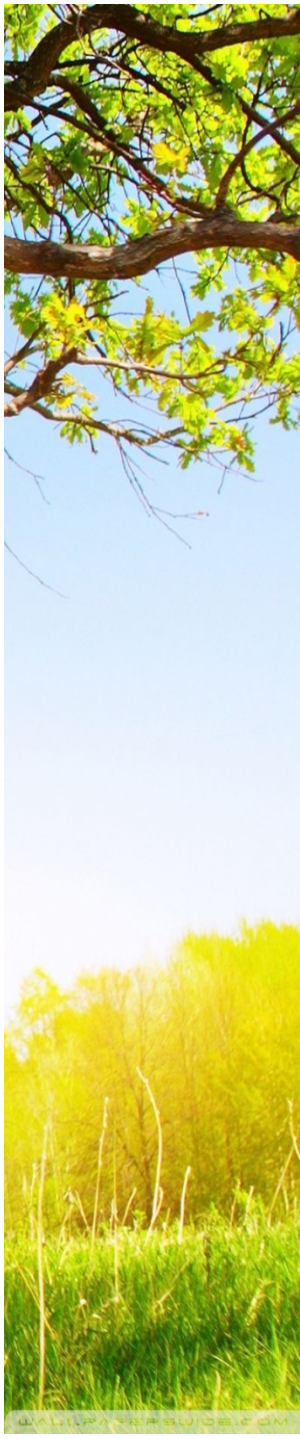
then True length of the line =(L1/L)x measured length of line.

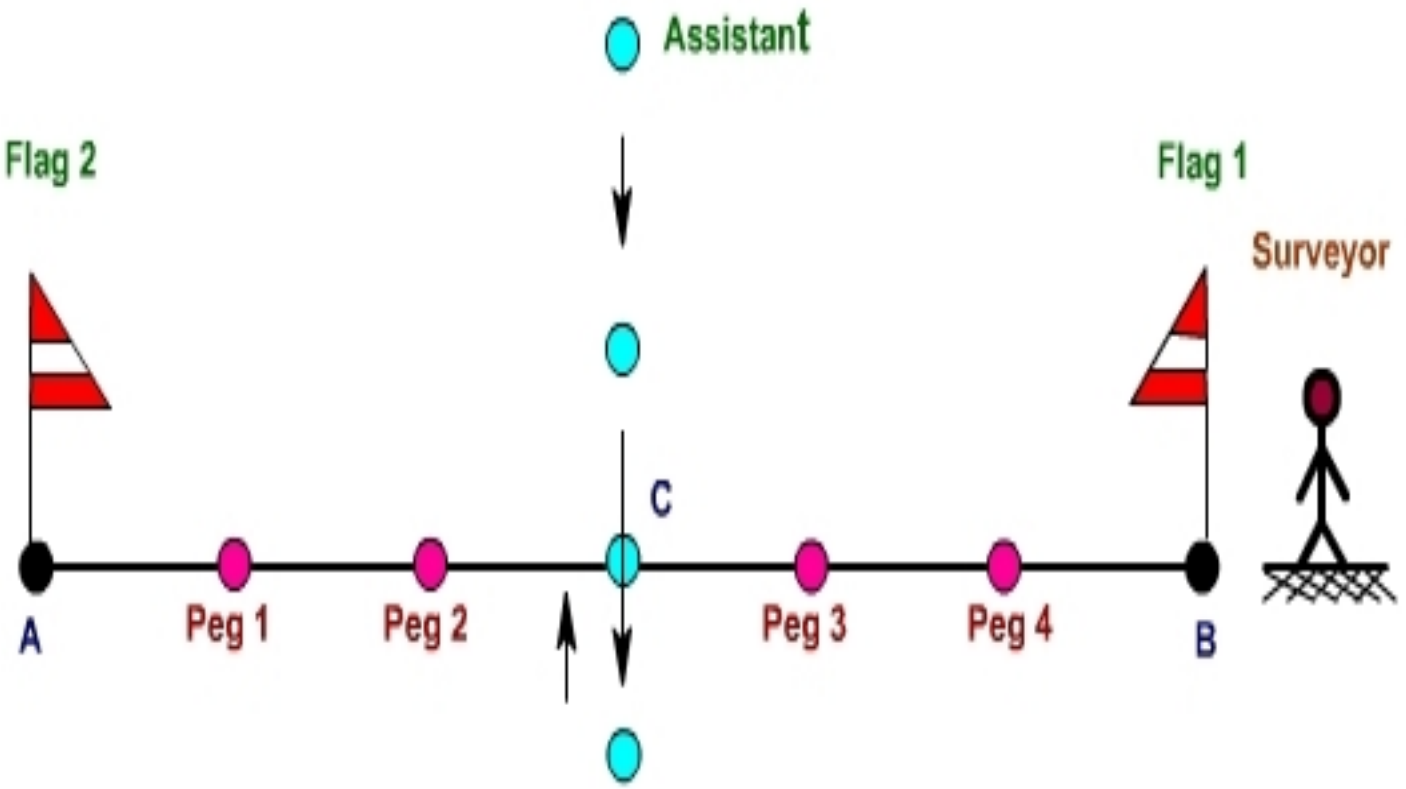
True area of the plot of land = (L1/L)x (L1/L)x Measured plot area.



Linear Measurement

- **Direct Ranging** When the end stations are inter visible, ranging is being carried out directly. The intermediate points are placed at distances having interval less than one tape length. The intermediate points are found by moving a ranging pole in transverse direction and thus, points are selected in such a way that the end points and the intermediate points lie in a straight line. In this method, two flags, one ranging pole and a bunch of pegs are required in a team of at least one surveyor and one assistant




Assistant
Flag 2
Flag 1
Surveyor
C
A
Peg 1
Peg 2
Peg 3
Peg 4
B