Welcome

Linear Measurement

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Linear Measurement

- **Methods of Linear Measurement**

  There are various methods of making linear measurements and their relative merit depends upon the degree of precision required.

  They can be mainly divided into three heads:

  - **Direct Measurements**: Distances are actually measured on the ground with help of a chain or a tape or any other instrument.

  - **Measurements by Optical Means**: Observations are taken through a telescope and calculations are done for the distances, such as in tacheometry or triangulation.

  - **Electronic Methods**: Distances are measured with instruments that rely on propagation, reflection and subsequent reception of either radio or light waves.
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The various instruments that are used under the electronic methods are:

a) Geodimeter
b) Tellurometer
c) The Decca Navigator and
d) The Lambda Position Fixing System

The method of measurement in the case of Geodimeter is assessed on the propagation of modulated light waves. The other three Instruments use radio waves for distance measurements.

Direct Measurements: The various methods of measuring the distances directly are as follows:

a) Pacing
b) Measurement with Passometer
c) Measurement with Pedometer
d) Measurement by Odometer and Speedometer
e) Chaining
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a) **Pacing or Stepping:** For rough and speed work, distances are measured by pacing, i.e. by counting the number of walking steps of a man. The walking step of a man is considered as 2.5 ft or 80 cm. This method is generally in the reconnaissance survey of any project. It may also be used to roughly check the distances measured by other means.

b) **Measurement with Passometer:** Passometer is an instrument shaped like a stop watch and is carried in pocket or attached to one leg. The mechanism of the instrument is operated by motion of the body and it automatically registers the number of paces, thus avoiding the boredom and strain of counting the paces, by the surveyor. The number of paces registered by the passometer can then be multiplied by the average length of the pace to get the distance.
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c) Measurement with Pedometer: Pedometer is a device similar to the Passometer except that, adjusted to the length of the pace of the person carrying it, it registers the total distance covered by any number of paces.

d) Measurement by Odometer and Speedometer: Odometer is a wheel fitted with a fork and handle. The wheel is graduated and shows a distance per revolution. There is a dial which records the number of revolutions. Thus the distance can be ascertained. The speedometer is used in automobiles for recording distances, if the route is smooth.
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e) Chaining: Chaining is a term which is used to denote measuring distance either with the help of a chain or a tape and is the most accurate method of making direct measurements. For work of ordinary precision, a chain can be used, but for higher precision a tape or special bar can be used. The distances determined by chaining form the basis of all surveying. No matter how accurately angles may be measured, the survey can be no more precise than the chaining.

 pena Instruments for Chaining: The various instruments used for the determination of the length of line by chaining are as follows:

i. Chain or tape
ii. Arrows
iii. Pegs
iv. Ranging rods
v. Offset rods
vi. Plumb bob

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Chain: Chains are formed of straight links of galvanized mild steel wire bent into rings at the ends and joined each other by three small circular or oval wire rings. These rings offer flexibility to the chain. The ends of the chain are provided with brass handle at each end with revolve joint, so that the chain can be turned without twisting. Tallies are provided at every 10 or 25 links for facility of counting. The length of a link is the distance between the centers of two consecutive middle rings, while the length of the chain is measured from the outside of one handle to the outside of the other handle.
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Various Types of Chain

**Metric Chains:** Metric chains are generally available in lengths of 5, 10, 20 and 30 metres. To enable the reading of fractions of a chain without much difficulty, tallies are fixed at every metre length for chains of 5 m and 10 m lengths and at every five-metre length for chains of 20 m and 30 m lengths. In the case of 20 m and 30 m chains, small brass rings are provided at every metre length, except where tallies are attached.

Fig: Metric Chain
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Various Types of Chain

Gunter’s Chain or Surveyor Chain: Gunter’s Chain or 66 ft. Chain: Divided into 100 links, each link is of 0.66 ft. or 7.92 inches.

Also called Surveyor’s chain.

Engineer’s chain and Gunter’s chain are commonly used in our country.

It was previously used for measuring distance in miles and furlongs (10 Gunter’s chain = 1 furlong 80 Gunter’s chain = 1 mile).
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Various Types of Chain

**Engineer's Chain:** The engineer's chain is 100 ft. long and consists of 100 links, each link being 1 ft. long. Tallies are provided at every 10 links, then central tally being round.

**Revenue Chain:** The revenue chain is 33 ft long and consists of 16 links each link being $2\frac{1}{16}$ ft long. It is mainly used in cadastral survey.

**Steel Band or Band Chain:** The steel band consists of a long narrow strip of blue steel, of uniform width of 12 to 16 mm and thickness of 0.3 to 0.6 mm. Metric steel band are available in lengths of 20 or 30 metres. It is graduated in meters, decimeters and centimeters on one side and has 0.2 m links on the other. It is used in projects where more accuracy is required.
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Tapes: Tapes are available in a variety of materials, lengths and weights. The different types of tape in general use are discussed below:

- **Cloth or Linen Tape**: These are closely woven linen or synthetic material and are varnished to resist the moisture. These are available in 10 to 30 m in length and 12 to 15 mm in width.

The disadvantages of such a tape include: (1) It is affected by moisture and gets shrunk; (2) Its length gets altered by stretching; and (3) It is likely to twist and does not remain straight in strong winds.
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**Metallic Tape:** It is a linen tape with brass or copper wires woven into it longitudinally to reduce stretching. As it is varnished, the wires are not visible. These are available in 20-30 m length. It is an accurate measurement device and is commonly used for measuring offsets. As it is reinforced with wires, all the defects of linen tapes are overcome.
**Linear Measurement - Tapes**

**Steel Tapes:** These are 1 to 50 m in length and are 6-10 mm wide. At the end of the tape a brass ring is attached, the outer end of which is zero point of the tape.

**Invar Tape:** This is made of an alloy of nickel (36%) and steel, having very low coefficient of thermal expansion (0.122 x 10^{-6} / °C). These are available in lengths of 30, 50 and 100 m and in a width of 6 mm.
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**Pegs:** Wooden pegs are used to mark the positions of the stations or terminal points of a survey line. They are made of stout timber, generally 2.5 cm or 3 cm square and 15 to 60 cm long, tapered at the end. They are driven in the ground with the help of a wooden hammer and kept about 4 cm projecting above the surface.
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**Arrows (Chain pin):** Arrows are made of stout steel wire. An arrow is inserted into the ground after every chain length measured on the ground. Arrows are made of good quality hardened and tempered steel wire 4 mm in diameter and are black enameled. The length of arrow may vary from 25 cm to 50 cm (generally 40 cm). One end of the arrow is made sharp and other end is bent into a loop or circle for facility of carrying.
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Ranging Rods: Ranging rods have a length of either 2 m or 3 m, the 2 metre length being more common. They are combined at the bottom with a heavy iron point, and are painted in alternative bands of either black and white or red and white or black, red and white in succession, each band being 20 cm depth so that on occasion the rod can be used for rough measurement of short lengths. Ranging rods are used to range some intermediate points in the survey line. They are circular or octagonal in cross-section of 3 cm nominal diameter, made of well-seasoned, straight grained timber. The rods are almost invisible at a distance of about 200 metres; hence when used on long lines each rod should have a red, white or yellow flag, about 30 to 50 cm square, tied on near its top.
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- Flag
- Hook

- Black or Red bands
- White bands

- Ranging rod
- Offset rod

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**Offset Rod:** An offset rod is similar to a ranging rod and has a length of 3 m. They are round wooden rods, shod with pointed iron shoe at one end, and provided with a notch or a hook at the other. The hook facilitates pulling and pushing the chain through hedges and other obstructions. The rod is mainly used for measuring rough offsets nearby. It has also two narrow slots passing through the centre of the section, and set at right angles to one another, at the eye level, for aligning the offset line.

**Plumbing Bob:** While chaining along sloping ground, a plumb-bob is required to transfer the points to the ground. It is also used to make ranging poles vertical and to transfer points from a line ranger to the ground. In addition, it is used as centering aid in theodolites, compass, plane table and a variety of other surveying instruments.
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Method of Chaining on Sloping Ground:

Direct Method:

This method is applied when the slope of the ground is very steep. In this method, the sloping ground is divided into a number of horizontal and vertical strips, like steps. So, this method is known as the stepping method. The length of horizontal portions are measured and added to get the total horizontal distance between the points.

Figure: Stepping Method

The total horizontal length, \( AB = AP_1 + P_2P_3 + P_4P_5 \)
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Indirect Method:

When the slope of the ground surface is long and gentle, the stepping method is not suitable. In such a case, the horizontal distance may be measured by the following process:

i. By Measuring The Slope With The Clinometer:

ii. By Applying Hypotenusal Allowance:
In this method, the slope of the ground is first found by clinometer. Hypotenusal allowance is then made for each tape length.

Let, $\theta = \text{angle of slope}$

$AB = AB_1 = 20\text{m} = 100 \text{ links}$

$AC = AB \sec\theta = 100 \sec\theta$

$B_1C = AC - AB_1$

$= 100 \sec\theta - 100$

$= 100 (\sec\theta - 1)$

The amount 100 $(\sec\theta - 1)$ is said to be the “hypotenusal allowance”. While chaining along the slope, one chain would be actually located at $B_1$. But the arrow should be placed at $C$ after making hypotenusal allowance. The next chain length will be start from $C$. The same principle is followed until the end of the line is reached.
iii. By Knowing The Difference Of Level:
Another method of measuring horizontal distance consists in measuring the slope distance $\lambda$ (PQ) and the difference in elevation $h$ between the two points by a level. Required horizontal distance is,

$$PQ = \sqrt{\lambda^2 - h^2}$$
Reconnaissance Survey?

Before the commencement of any work, the area to be surveyed is thoroughly examined by the surveyor, who then thinks about the possible arrangement of the framework of survey. This primary investigation of the area is termed as reconnaissance survey.

During reconnaissance survey, the surveyor should walk over the area and note the various obstacles and whether or not the selected stations are invisible. The main stations should be so selected that they enclose the whole area. The surveyor should also take that the triangles formed are well-conditioned. It is important to give a north line on the rough sketch and though the sketch is not prepared according to the scale, it should represent the approximate positions of the different things in the plot and hence to be a good guidance for further work.
Why Reconnaissance Survey?

Reconnaissance survey is the first step of any kind survey work. Here some important considerations are:

- Different possible and suitable sites for base lines.
- Selection of various station and substation point.
- Investigation of the country to be surveyed.
- Information regarding communication, supplies of food staffs, water, construction materials and other things.
- Probable sites and height of towers and signals.

Mainly reconnaissance survey give a clear concept of the total work and makes it easier. As a results surveyors get much benefit from this.
Thank You!