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Survey Lab Manual

Definition of land survey

Is the science and art of determining relative positions of points above, on, or beneath the surface of the earth, or establishing such points *by means of direct or* indirect measurements and finally representing them on a sheet of paper known as plan or map using a suitable scale.

Importance of Surveying

• It is a necessary step to be taken in every home renovation or project. Having your land properly surveyed helps establish property boundaries, an important thing all homeowners should be aware of.

• To fix the national and state boundaries.

• To chart coastlines, navigable streams and lakes.

• To establish control points.

• To execute hydrographic and oceanographic charting and mapping.

• To prepare topographic map of land surface of the earth.

• To produce up-to-date Engineering Plans of the areas in which the work will be carried out.

These plans form the basis for the design of the construction, and so the reliability of the design depends heavily on the attention to detail with which the survey is carried out.

Types of Surveying

1. **Geodetic Surveying:** Type of surveying that takes into account the true shape of the earth. These surveys are of high precision and extend over large areas.
2. **Plane Surveying:** The type of surveying in which the mean surface of the earth is considered as a plane, or in which its spheroidal shape is neglected, with regard to horizontal distances and directions.
3. **Control Survey:** Boundary Survey, Topographic Survey, Hydrographic Survey, Mining Survey, Construction Survey, Route Survey, and Photogrammetric Survey and Astronomical survey.

*The measurements

Surveying makes the possibility of measurements in horizontal or vertical planes more available.

The measurement can be divide into:

1- **Linear measurements (Distance Measuring).**
2- **Angular measurements.**

Linear measurements divided into:

* **Horizontal distance:** The distance between points anywhere or their projection on a plane.

* **Slope distances:** is the distance between any two points on the different horizontal plane

* **Vertical distance:** it's a distance between two any points or direction perpendicular to the plane of the horizon; upright; plumb.

Angular measurements

- **Vertical angle:** one of two opposite and equal angles formed by the intersection of two lines on vertical plane.
- **Horizontal angle:** The difference in direction of two survey lines measured clockwise in a horizontal plane.

Linear measurements (Distance Measuring, chain surveying)

Note:

It must be remembered that the distance, under most circumstances presumed to be ***horizontal distance****s* and not surface distances, this dictates that every field measurement taken be either measured horizontally or, if not, reduced to a horizontal distance mathematically.

Tools used to measure distance

There are many tools that were used to measure the distances, some of them are manual or automatic, the following are some of the tools and equipment are large used in order to measure the distances

Chain, tapes, distometer, level, theodolite, tacheometery, total station, GPS and pacing.

Chain it's were used for measuring *short distance.*

Is made up of connected steel segments, or links, which each measure 20 cm.

Sometimes a special joint or a tally marker is attached every 5 meters. Usually, a chain has a total length of 20 meters, including one handle at each end.

Tapes its use for measuring *short distance.*

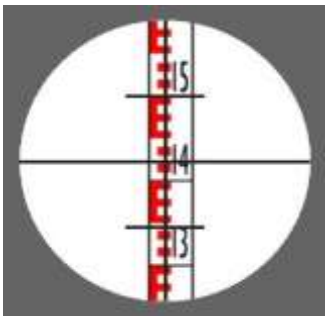
A tape measure or measuring tape is a flexible ruler. It consists of a ribbon of cloth, plastic, fiber glass, or metal strip with linear-measurement markings. It is a common measuring tool.

Distometer: hand-held laser meter for fast and easy distance measurements of length, squares and volumes with the press of a button.

Measuring Wheel: Distance Measuring Wheels are tools for measuring long distances in a hurry. Some people call distance measuring wheels "footage wheels" or "distance calculation wheels".

place the wheel at the point you want to start measuring, and roll in a straight direction to the stopping point, then read the counter, the ***distance is the counter reading * wheel perimeter***.

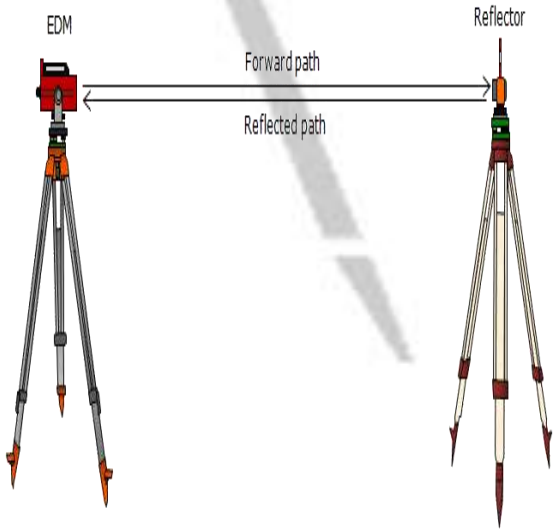
Explain: One rev =2πr
N rev = d then d = 2π r n



Level: An instrument equipped for stadia work has two horizontal stadia marks spaced an equal distance from the center crosshair of the reticle. The distance between the stadia markings usually have a stadia interval factor of 100. This is important to know when calculating the distance between the instrument and the stadia rod.
d= (upper – lower)*factor ==== d= (1.5-1.34)*100=160m

Theodolite: the way of using as level instrument.

EDM: An EDM uses electromagnetic (EM) energy to determine the length of a line. The energy originates at an instrument at one end of a line and is transmitted to a "reflector" at the other end from where it is returned to the originating instrument. The nature of the "reflector" is dependent on the type of EM. If electro-optical (infrared or laser) EM is used then the "reflector" is typically a passive medium which bounces the signal back. If the EM is



microwave, then the reflector is a second instrument which captures the incoming energy and re-transits it back to the originating instrument.

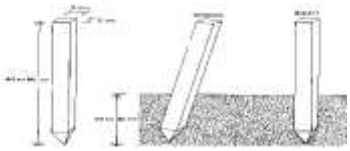
Total station: its use for measuring *long distance.*

Tape accessories

Range pole

Pins

Pegs



Nails

Compass

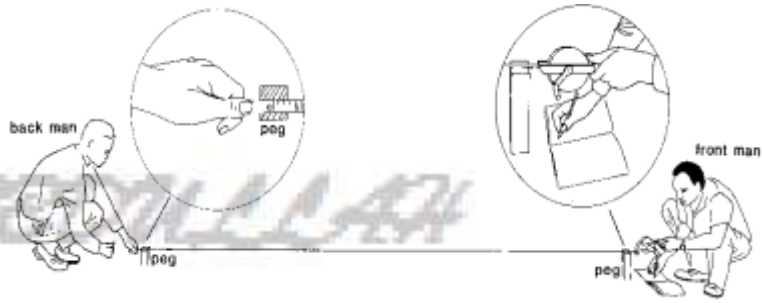
Plumb bob

***linear measurements (Distance Measuring, chain surveying)**

the distance measurement based on several factors including how long distance and the nature of the earth and the degree of steep and the degree of regularity in the gradient or tropical ground to be measured, so the measuring distance can be divided into some method depend on the steep of terrain.

1- direct distance measurement

When we want to measure a distance less than the tape length and no need to do straight line.



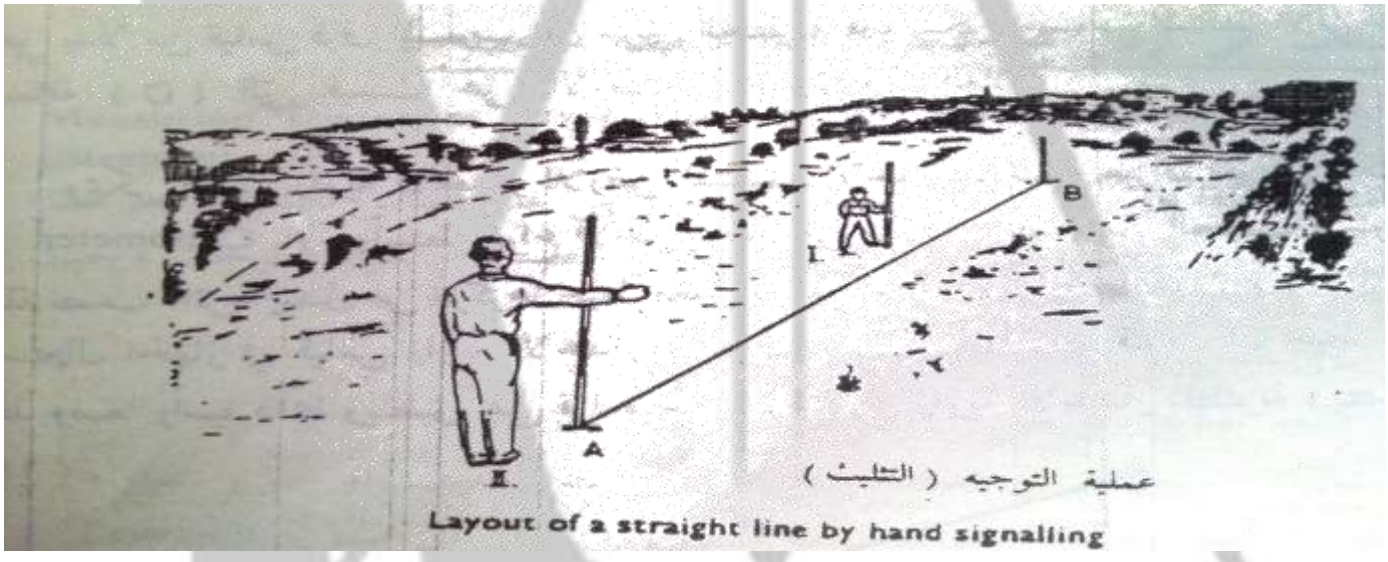
2- indirect distance measurement

Indirect distance measurement, when we want measure a distance long or more than the length of tape.

There are three kind for measuring indirect distances.

a. Measuring distance on level ground.
b. Measuring distance over uniform sloping ground.
c. Measuring distance over uneven and not uniform sloping ground.

In those types of measuring distance we have to measuring the distance by dividing it into parts and the parts may not be at equal distances, but it should be at the straight line, and we can make it as a straight line using three ranging rod and some of chain survey accessories.

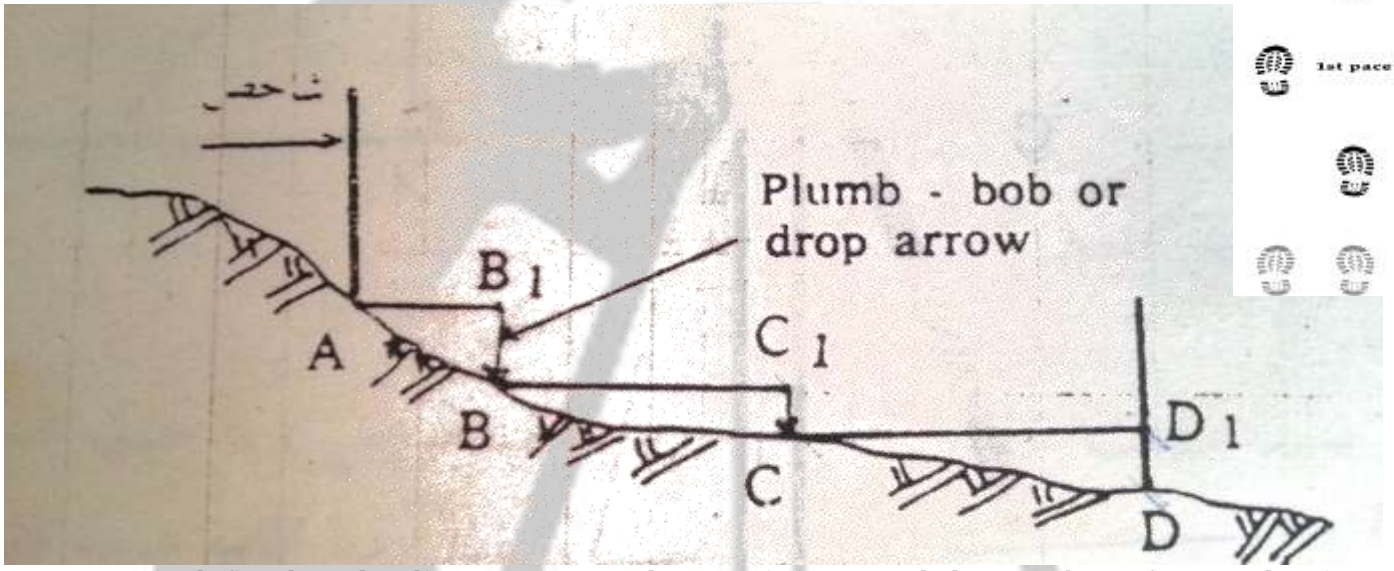


Layout of a straight line by hand signalling

Homework # 1

Pacing: is a reasonably easy and quick method of measuring distance in the field without any tools.

Pacing Calibrating: To estimate one's own pace, a measure of known distance, such as 10m, should be marked in a straight line on level ground.



One pace is defined as the distance is paced several times and the number of paces that it takes to walk the distance each time is recorded.

To determine the average distance of one pace, the total distance walked is divided by the number of paces that it takes to pace that distance.

Lastly the pace is how much the real distance divided on average of pacing.

Report # 1

Layout of properties using tape

Objective:

To make layout is to be familiar how the surveyor works and how much time does the project approximately takes and to be familiar with geometrical concept.

Geometrical concept

Is the way it's been taken all measurements and the dimensions of the building in site and the tools that were used, and below some of geometrical concept for making layout.

. ***Distance intersection***: This process is done by linking each point of the construction point of two points from the points of Traverse by taking a distance.

. ***Angle intersection***: This process is done by linking each point of the construction point of two points from the points of Traverse by taking an angles

. ***Offset method***: In this way we must work projections for of point of the points in the building on the traverse line and measure the projection line, and how far the projection point for the point of traverse is?

. ***Polar method***: each point of the building points should be tying by distance and angle from one point of the traverse points.

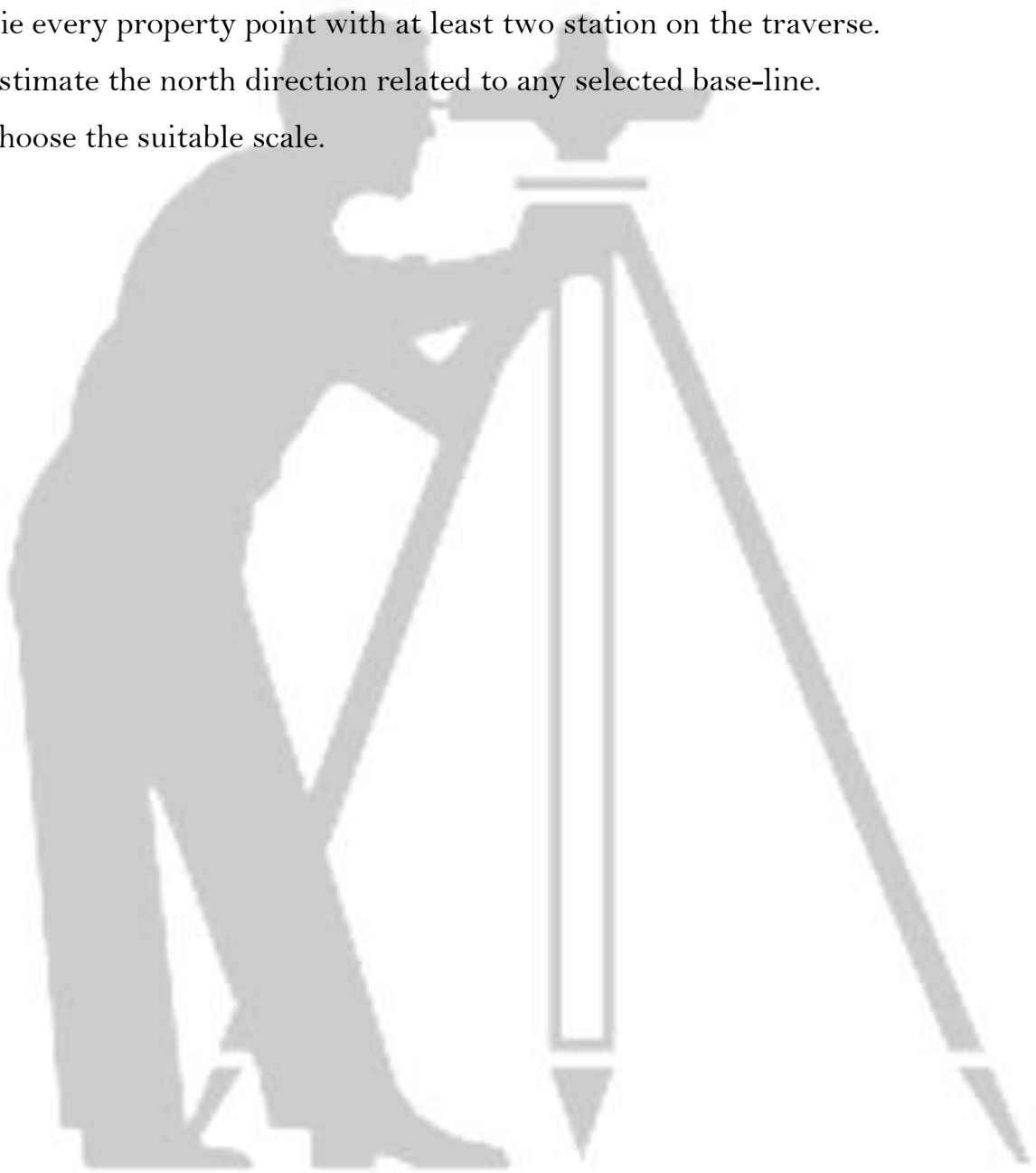
. ***Graphical method (combination method)***: each point of the building points should be tying by distance and angle from two points of the traverse points.

. ***Coordinate method***: each point of the building points should have (X, Y and Z).

Any survey project has two kinds of work, field work and office work.

Field work:

1- Doing sketch drawing with all details scene must be drawn.
2- Traverse: marking of station and measuring the distance of base-line.
3- Measure all dimension of the property.
4- Tie every property point with at least two station on the traverse.
5- Estimate the north direction related to any selected base-line.
6- Choose the suitable scale.



Homework #2

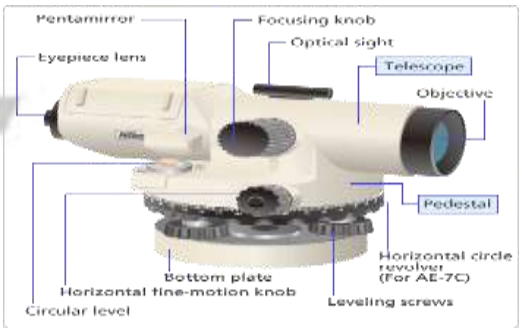
Levelling

Levelling **:** is a general term applied to any of the various processes by which elevations of points or differences in elevation are determined.

Levelling is a branch of surveying, the object of which is:

i) To find the elevations of given points with respect to a given or assumed datum.

ii) To establish points at a given or assumed datum.



The first operation is required to enable the works to be designed while the second operation is required in the setting out of all kinds of engineering works. Levelling deals with measurements in a vertical plane.

Types of levelling

Trigonometric Leveling: is the branch of Surveying in which we find out the vertical distance between two points by taking the vertical angular observations and the known distances.

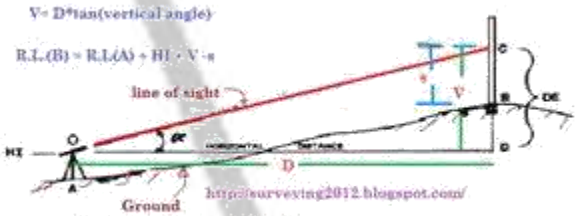
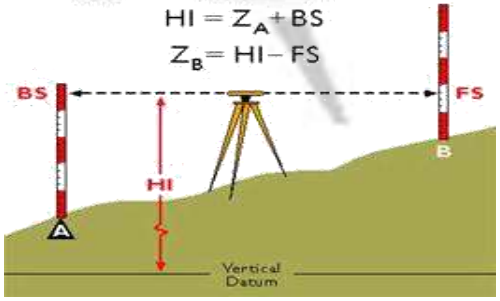


Figure. Trigonometric leveling

Barometric leveling: A type of indirect leveling in which differences of elevation are determined from differences of atmospheric pressure observed with altimeters or barometers.

Differential levelling: is the term applied to any method of measuring directly with a graduated staff the difference in elevation between two or more points.



Some definition of levelling terms

Datum surface: *a* reference plane with respect to which RL of the other survey points is determined. The datum surface may be real or imaginary location with a nominated elevation of zero. The commonly used datum is mean sea level

Benchmark (BM): fixed reference point of known elevation with respect to which RL of other points is determined. Benchmarks can be arbitrary or permanent.

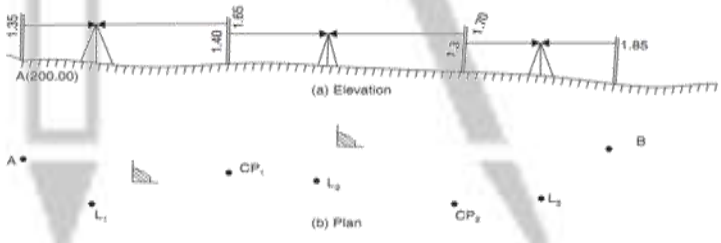
Back sight (BS): the first staff reading taken by the surveyor after the levelling instrument is set up and levelled. B.S is generally taken on the point of known reduced level as on the benchmark or a change point.

Fore sight (FS): the last staff reading taken before changing the instrument to the other position. It is the staff reading taken on point whose RL is determined. This sight is considered as negative and deduced from Height of Instrument to determine RL of the point.

Intermediate sights (I.S): all readings taken between back sight and fore sight. These are the points whose RL is determined by the method already mentioned above in FS. Also called inter-sight readings.

Turning Point (TP): An intervening point between BMs or TBMs upon which a backsight and a foresight are taken.

Differential Levelling procedure:



Set up the instrument approximately within 100 meters of a point of known or assumed elevation. A rod or staff is held vertical on that point and the instrument is used manually or automatically to read the rod scale. This gives the height of the instrument above the starting (back sight) point and allows the height of the instrument (H.I) above the datum to be computed.

The rod is then held on an unknown point and a reading is taken in the same manner, allowing the elevation of the new (foresight) point to be computed. The procedure is repeated until the destination point is reached.

Example for levelling and two methods of calculation

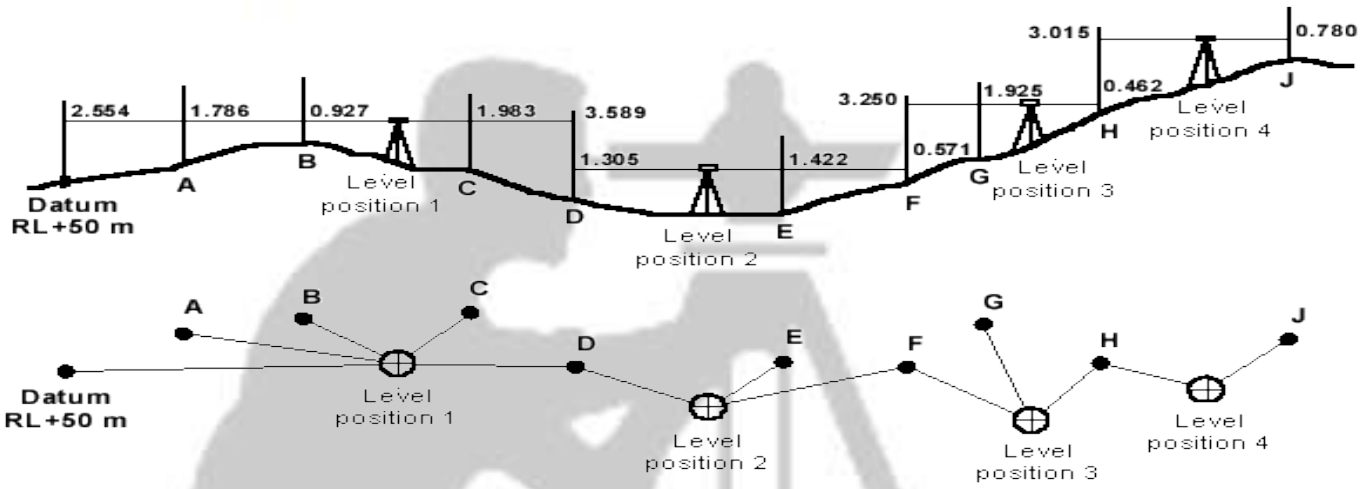


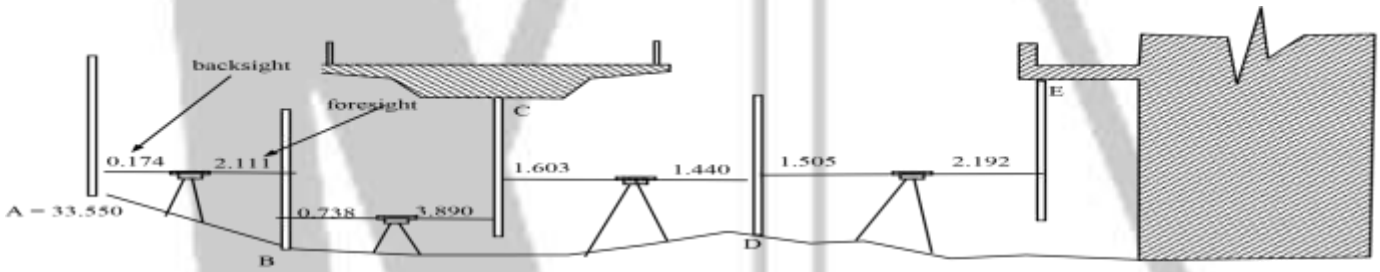
Table 1 Rise & Fall Method

Back-sight	Inter-mediate	Fore-sight	Rise	Fall	Reduced level	Remarks
2.554					50.00	**Datum** RL+50 m
	1.783		0.771		50.771	**A**
	0.926		0.857		51.628	**B**
	1.963			1.037	50591	**C**
1.305		3.587		1.624	48.967	**D** / change point **1**
	1.432			0.127	48.840	**E**
3.250		0.573	0.859		49.699	**F** / change point **2**
	1.925		1.325		51.024	**G**
3.015		0.496	1.429		52.453	**H** / change point **3**
		0.780	2.235		54.688	**J**
10.124		**5.436**	**7.476**	**2.788**	**54.688**	Sum of B-sight & F-sight, Sum of Rise & Fall
-5.436			-2.788		-50.000	Take smaller from greater
4.688			**4.688**		**4.688**	Difference should be equal

Table 2 Height of collimation method (height of instrument)

B.S	I.S	F.S	Height of collimation	Reduced level	Remarks
2.554			52.554	50.00	**Datum** RL+50 m
	1.783			50.771	**A**
	0.926			51.628	**B**
	1.963			50591	**C**
1.305		3.587	50.272	48.967	**D** / change point **1**
	1.432			48.840	**E**
3.250		0.573	52.949	49.699	**F** / change point **2**
	1.925			51.024	**G**
3.015		0.496	55.468	52.453	**H** / change point **3**
		0.780		54.688	**J**
10.124		**5.436**		**54.688**	Sum of B-sight & F-sight, Difference between RL's
-5.436				-50.000	Take smaller from greater
4.688				**4.688**	Difference should be equal

And now the following example will demonstrate the booking and reduction of inverted staff readings. Note the way that inverted staff readings are emphasized in the booking, surround them by a square bracket and use a negative sign. Write "inverted staff" in the remarks column. Do not forget when doing summation of back and fore-sights in the arithmetic check that negative quantities are involved.



BACK SIGHT	INTER-MEDIATE	FORE SIGHT	H.P.C.	REDUCED LEVEL	COMMENTS
0.174			*33.724*	*33.550*	*OBM (=33.550) point A*
0.738		*2.111*	*32.351*	*31.613*	*Point B - c.p.*
-[1.603]		***-[3.890]***	*34.638*	***36.241***	*Point C - Bridge Soffit – **Inverted staff** - c.p.*
1.505		*1.440*	*34.703*	*33.198*	*Point D - c.p.*
		-[2.192]		***36.895***	*Point E - Balcony – **Inverted staff***
ΣBS		ΣFS		Last - First	
0.814	BS - FS	-2.531		3.345 ←	Check sums: arithmetic OK
	3.345 →				

Levelling Practice – Checks

All levelling operations must be checked on completion of the circuit. The checks in levelling are of three types: -

a) Arithmetic checks

b) Check on accuracy

Arithmetic checks

The check on correct arithmetic usage in levelling is simple: -

∑Backsights - ∑foresights = Last reduced level — First reduced level

∑Backsights - ∑Foresights = ∑Rises - ∑Falls = Last reduced level – First reduced level

Check on accuracy

There are several ways of determining the acceptable closing error and this often depends on the accuracy specified for a particular levelling operation.

One method depends on the number of instrument set-ups: -

Maximum permissible error = 0.0015m x $\sqrt{\text{number of instrument set ups}}$

In the example given above, the permissible closing error would be: -

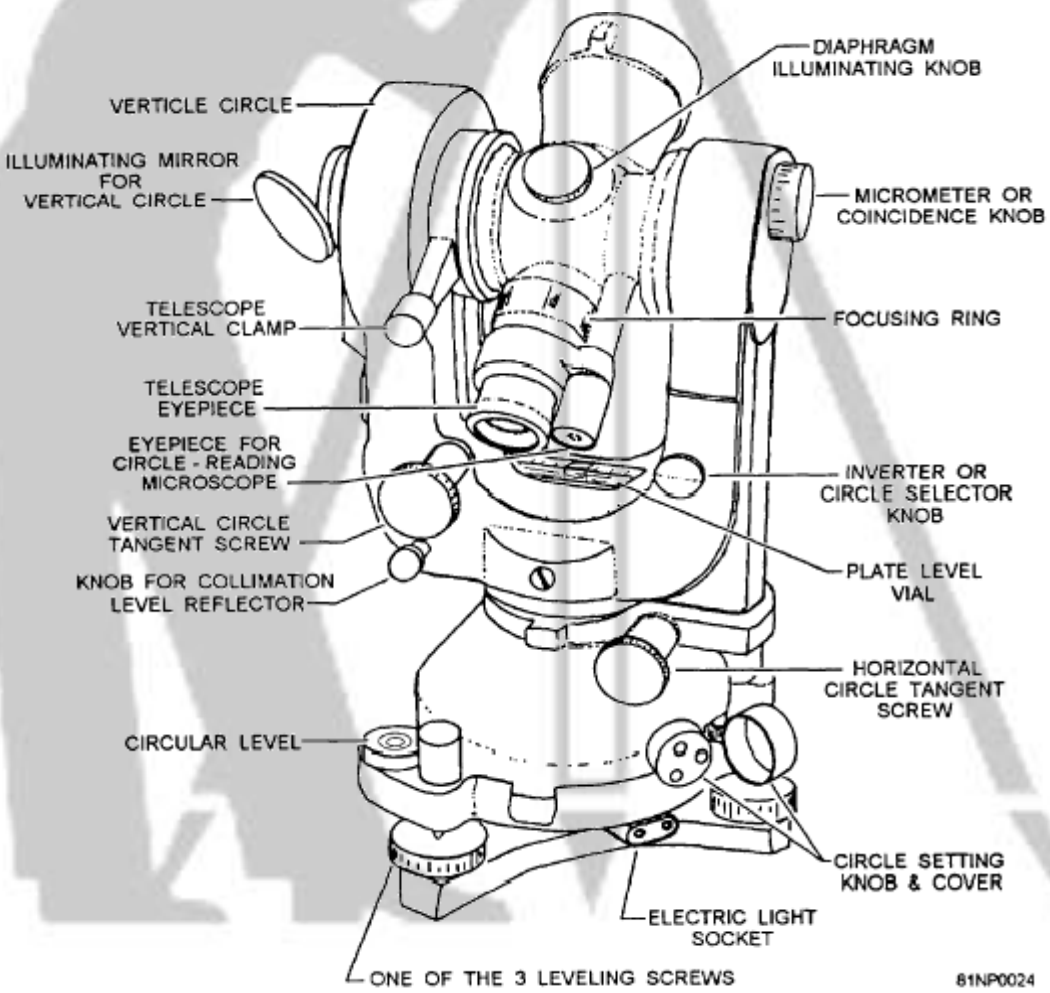
0.0015 x $\sqrt{3}$ = 0.003m, of course the magnitude of the closing error cannot be calculated unless the final level is known beforehand.

Theodolite

A theodolite is a measuring instrument that gives a precise angle between two points. Theodolites are small telescopes mounted on tripods so that they can swivel both horizontally and vertically. The lens of a theodolite has crosshairs and angle scales that the viewer uses to determine angles.

Theodolites are commonly used for surveying and triangulation in road building, tunnel alignment and other civil engineering projects. They come in several varieties suited to different types of projects. A transit theodolite is built so that it can completely reverse directions.

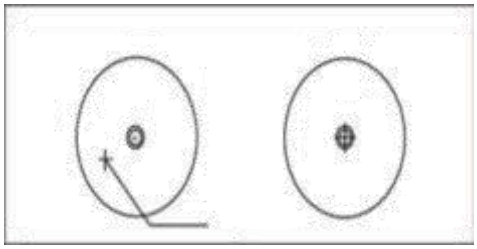
Theodolite parts



Setting up of theodolite:

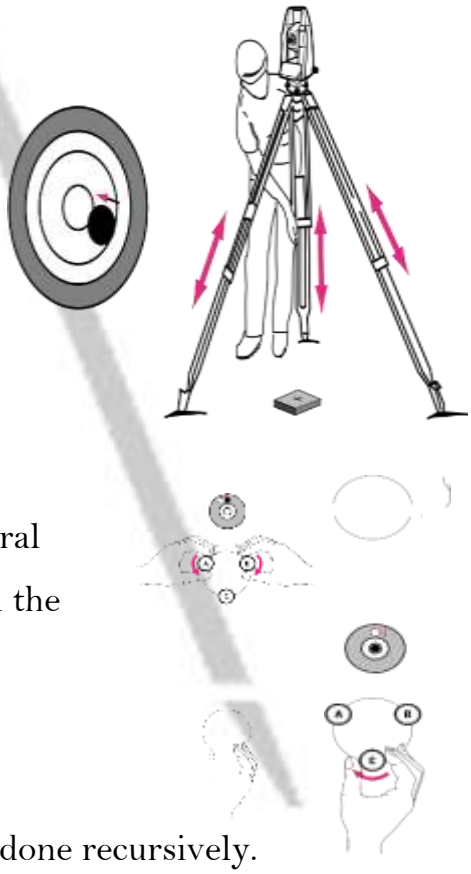
The setting operation consists of fixing the theodolite with the tripod stand along with approximate leveling and centering over the station. For setting up the instrument, the tripod is placed over the station with its legs widely spread so that the centre of the tripod head lies above the station point and its head approximately level (by eye estimation).

The instrument is then fixed with the tripod by screwing through trivet. The height of the instrument should be such that observer can see through telescope conveniently.



Centring

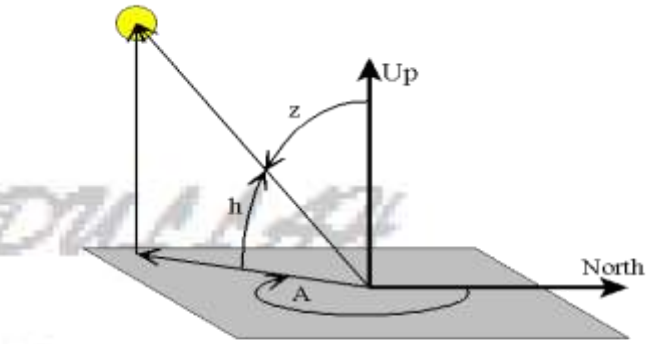
1. Push the tripod legs firmly into the ground and use the central fixing screw to secure the instrument on the tripod.
2. look through the optical plummet and turn the footscrews so that the optical plummet is centred on the ground point (illustration, top right).
3. Centre the bull's-eye bubble by adjusting the lengths of the tripod legs.
4. After accurately levelling up the instrument, release the central fixing screw so that you can displace it on the tripod plate until the laser dot is centred precisely over the ground point.
5. Tighten the central fixing screw again.



Must be noted that the centering and leveling of instrument is done recursively.

Type of angles

- Vertical angle (elevated angle or depress
- Horizontal angle (azimuth angle).
- Zenith angle.



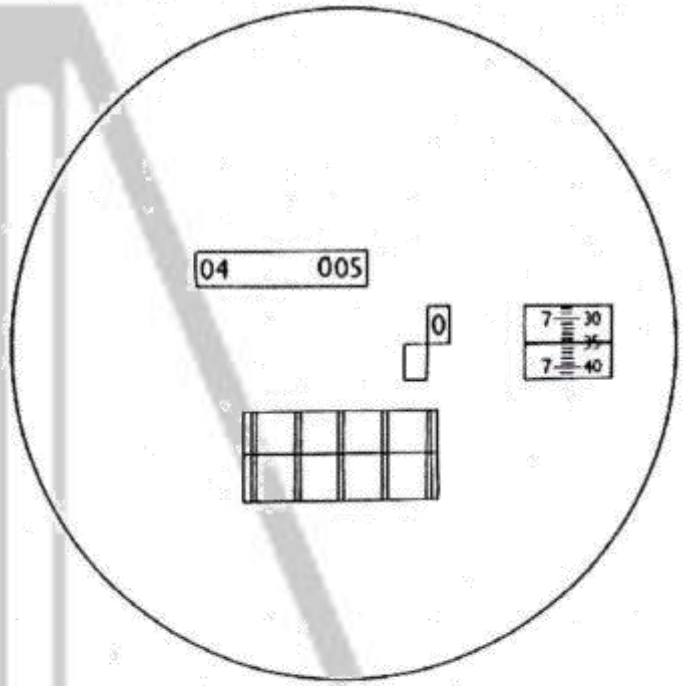
h = elevation angle, measured up from horizon

z = zenith angle, measured from vertical

A = Azimuth angle, measured clockwise from North

How to read angles

At the upper box we read the three digits and it will angle's degree, for this figure the three digits is 005^0 , then take the tens of minutes from one of the two boxes that at the bottom of degree box, for this figure it is 00', now we will take the individual figures from the left side of the right box which is 07' as the figure shown, finally the seconds will be 35" from the right side of the same box.



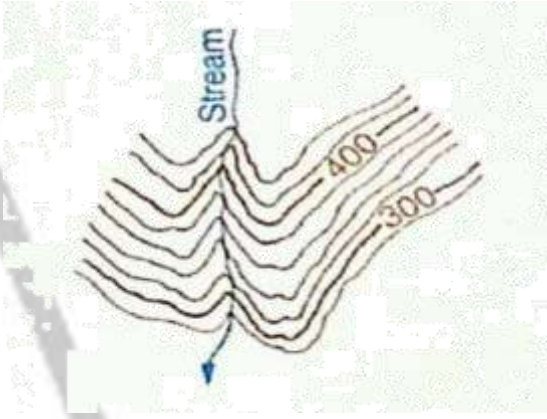
Hz = 5° 07′ 35″

Topographic Map Contour Lines

A topographic map is a detailed and accurate illustration of man-made and natural features on the ground such as roads, railways, power transmission lines, contours, elevations, rivers, lakes and geographical names.

The topographic map is a two-dimensional representation of the Earth's three-dimensional landscape.

Contour Map Characteristics

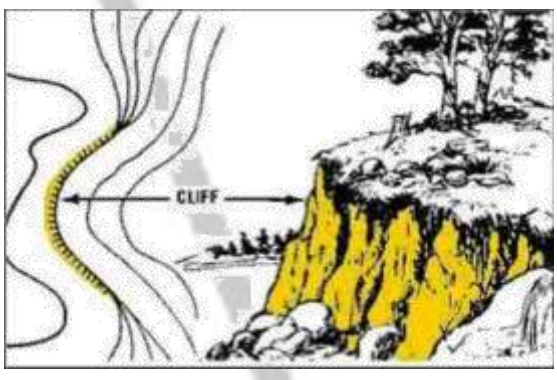


Valleys: Lines form a "V" pattern along valleys

•"Vs" point upstream; indicating the direction of the stream flow.

•Streams always flow downhill

•Contours can and do cross streams



•Concurrency: Contour lines never cross or divide.

•Cliffs: May appear to merge on vertical cliffs, but are stacked.

•Caves: May appear to cross in caves, but go under one another.

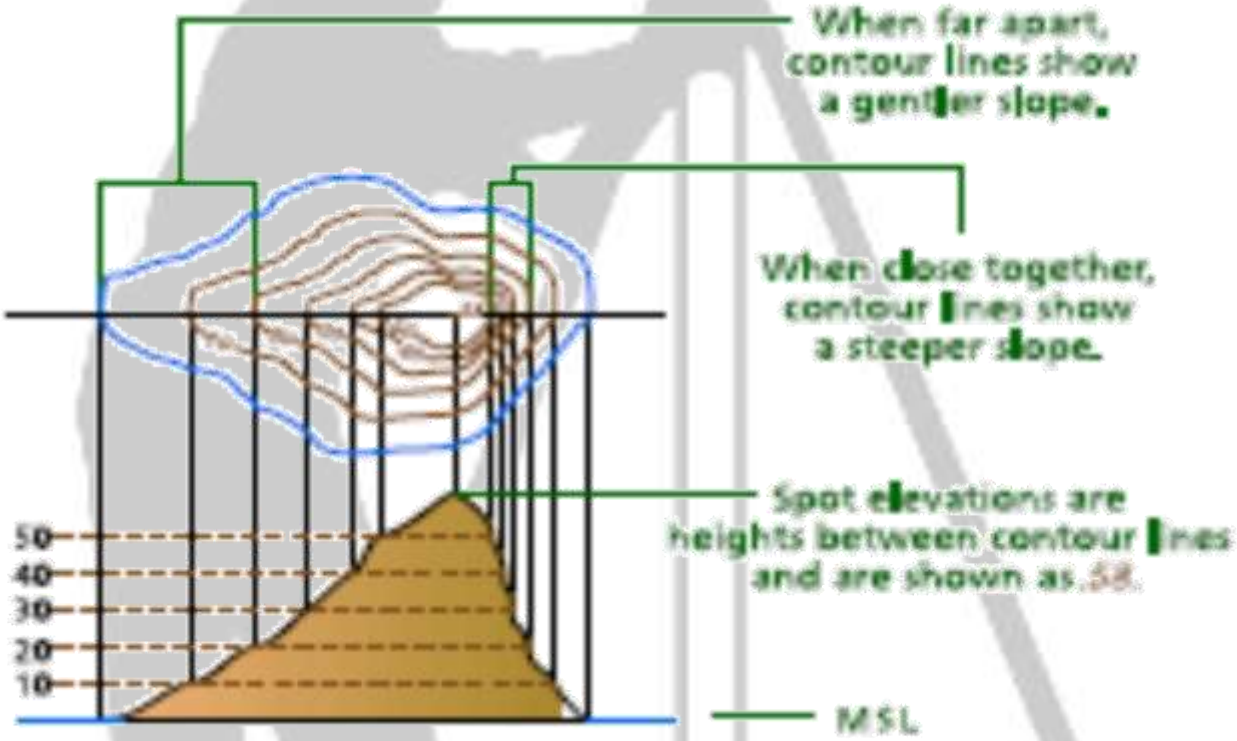
In the field, points and their elevations are measured using automatic levels, total stations, or GPS devices

Geotechnical engineers use these points to generate topographic maps

What are contour lines and contour interval?

Contour lines connect a series of points of equal elevation and are used to illustrate relief on a map. They show the height of ground above mean sea level (MSL) either in metres or feet, and can be drawn at any desired interval. For example, numerous contour lines that are close to one another indicate hilly or mountainous terrain; when further apart they indicate a gentler slope; and when far apart they indicate flat terrain.

Contour interval of a contour map is the difference in elevation between successive contour lines.



What is scale?

Maps are made to scale. In each case, the scale represents the ratio of a distance on the map to the actual distance on the ground.

$$\frac{\text{MAP DISTANCE}}{\text{GROUND DISTANCE}} = \frac{2\text{ cm}}{1\text{ km}} = \frac{2\text{ cm}}{100\,000\text{ cm}} = \frac{1}{50\,000}$$

SCALE ⇨ 1:50 000

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What is a grid?

A grid is a regular pattern of parallel lines intersecting at right angles and forming squares; it is used to identify precise positions. To help you locate your position accurately on the surface of the Earth (or map sheet).

Topographic Profiles

•Generating profiles:

•Draw a line between the two points bounding the desired profile area.

•Place a folded sheet of paper along the line.

•Mark each contour line intersecting the paper.

•From each mark, indicate the vertical height with a dot on a scale.

•Connect the height dots with a smooth line.