FWM 304:AERIAL AND GROUND SURVEY

LECTURE NOTE

Lecturer

MR. A. O. OLADOYE

Forest Ecology and Conservation

DEPARTMENT OF FORESTRY & WILDLIFE MANAGEMENT

UNIVERSITY OF AGRICULTURE, ABEOKUTA

P. M. B. 2240,

ABEOKUTA

INTRODUCTION

Surveying deals with determination of relative location of point on in new the surface of the earth. It is concern with measurement of distance on land it an area of object too it involves measuring horizontal or vertical distribution between terrestrial object, measuring cragles between terrestrials lines, determining direction of lines an establish point by determine angular and linear measurement thus,

Surveying involve measurement a relative position of points on earth surface, such that natural and artificial treating can be represented in their current horizontal and vertical relationship such features include forest reserves, road, housing estuaries, rivers etc.

DIVISION OF SURVEY

Surveying can be divided into 2 bond type which are Aerial and Ground survey.

Aerial survey is the one carried out in the air or space with the use of aircraft.

Ground survey are the kind of survey that takes place on the surface of the earth. Ground surveying can be divided into two major sub areas

a) Geocletic plane survey: Here the size and shape of the earth crust the alienate as in with the use of retrieval and precise instrument it forms the frame work in which then Geodetic surveying deals with large area of the earth and the earth curvature must be taken into consideration, it is a highly accurate type of survey.

Plane survey: This is the type of survey in which the surface of the earth refers to is the plane with regards to distance and direction. The direction of the plumb line at any point is considered parallel to the direction and angle of polygons which are considered as plane angles.

In actual sense, the measurement taken is longer then the distance could have been if the slope and shape are considered, nevertheless, the slope of the earth is taken into consideration where

precise measurement are required in surveys covers a measurement are required on surveys covers a large surface area. Plane survey deals with the relatively small area. In the type of surveying, it is assume that the earth si that plane surveying method can be applied to an area up to 250km^2.

Plane surveying is employed in architectural, engineering, exploratory activities.

TYPES OF PLANE SURVEYING

Base on the nature of work to be done, we have the following types of the plane survey.

1) Cardastral survey: Involves measuring, delivery, recording the boundaries of precipitate, supplies map plan beyond a parcel of land described in land register. This is kind of plane surveying used in committed areas of land mostly private properties it is mainly used to establish boundary of the precipitate.
2) Engineering surveying: This embraces the survey work require before, during and after a engineering work, it is done for the construction and design of new roads and rails roads. The type of scale of engineering surveying of archtechtural work drawing are 1 – 50 or 1:50, 1:100, 1:200 for sight plane and civil engineering work, scale of 1:500, 1:1000, 1:2000, 1:2500 for town survey or highway survey, we have scale of 1:2000, 1:2500, 1:5000, 1:10000 etc.
3) Mining surveying: This is a plane surveying used in determining the position and dimension of underground passage of the mine and also the natural and artificial feature of the mine, the data include both horizontal and vertical parts, length direction and slope of the turning and geological and topographic characteristics in a particular vicinity.

We can have open cast mine survey and underground mine survey.

It generally involves establishment of mineral boundaries and fixation of reverence monuments such as locating bore hole, rail roads and constructing geological map.

4) Road surveying: It is a plane surveying carried out for the purpose of locating and constructing cones of transportation and communication such as highways, rail roads, canal pipeline etc. here primary work usually involve topographic survey.

5) Hydrographic surveying: This is the type of plane surveying carried out in relation to considerable body of water such as lakes, rivers, ponds, etc.

The survey aims at determining channel depth for the purposes of navigation, water supply or sub-aquatic construction. In the case of river hydrographic surveying is made for flood control, water storage and apply, navigation and power supply some of the process in hydrographic surveying include (i) topographic survey of shore and bank, leveling to determine underground profile

Plotting of such profile taking cross section, calculating volume of networks measuring drawings areas and laying out culvert and bridges.

Topographic surveying: This is a plane surveying used in purchasing map's and plans of natural and mammals features such as relief, elevation, unequal land surfaces. There is no clear differences between a plan and a map of this nature, it is generally accepted that open details are rail drawn to a chosen scale while in map many textile has to be represented in symbol. Topographic plan survey are used for engineering or design and administrative purpose only whereas topographic map are found useful in navigation, constructional activities.

The second characteristics of plane survey base or equipment are

1) Chain surveying or linear surveying which include the use of chain or tape to measure distances.

2) Compass surveying: Which involves the use of compass I getting bearing.
3) Theoclatide surveying: Which measure angles of elevation and depression
4) Leveling: Which make use of abnormal level, land standard pole; leveling is defined as the process of finding the differences between in height of any 2 points on the ground.

For the purpose of

a) Tracing contour line
b) Plotting vertical section
c) Establishing point at given any elevation in constructional project.

IMPORTANCE OF SURVEYING

Surveying can be carried out to achieve all or any of the following purpose.

1) For the determination of the earth size and shape
2) For setting out construction works and roads
3) For navigational purposes
4) The making plans, chart and maps
5) For collection of tracts and details
6) For location of features

BASIC PRINCIPLES OF SURVEYING

It is possible to recognize, the methods and practices may change, but the basic principles remove the same.

The fundamental principles is to work from whole to part and to use a frame work of guideline on which to fix next details.

Besides, before any survey exercise is to be carried out, the following should be bore in mind

1) You know the purpose of the surveying
2) The degree of work (precision) required
3) At the precision of the instrument required
4) The possibility of obtaining very precise instrument without additional cost
5) The likely cause of error, the controlling factors to minimize error.
6) Organization of your work (plan) for the exercise.

POINTS OF ORIGIN AND CONTROL POINT

Any type of surveying depends on the element it frame work and the framework refers to working from a whole to part.

When you want to survey an area, look for the closest because nut necessarily from the origin itself because several beacon are reference from the origin, hence that beacon becomes the control point. To survey an area, all you need to do is to look for a pillar that have XY co-ordinate.

METHOD OF SURVEYING

- Triangulation method: which involve formation of and position of DO. The basic principle of triangulation is that if the length of one side of the triangle is known and any

sides of triangle are measured, then the length of the other two sides can be calculated, the relative position of the 3 points. Formerly the triangle can thus be established.

- Transverse method: Which involve cutting of transverse line or straight along the survey tone.
- Astronomical method: Which is the observation of horizontal and vertical lines in relation to time of the day. It is use to get latitude and longitude.
- Combination of any of the above, Here the position of a point on a ground may be established if its bearing and distant from another through point are measured. It can be extended successive point.

TOPOGRAPHIC SURVEYING

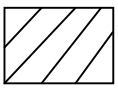
Provision of base map of an area is essential for any detailed work. this helps in accurate determination of the cross-section of an area topographic survey is achieved by why leveling.

Levelling is the method of expressing the relative height of any umber of points above or below some plawn of difference called the DATUM. In leveling we do not generally speak of length, we do speak of level e.g. the level of A = 90 implies that the length of A some fixed point is 90m.

DATUM is an arbitrary surface to which observed length of point can be referred. The DATUM in the country is F. S. D. i.e. Federal Survey Datum. It is related to the habour in Lagos. In other country, the datum is the main sea level of that country.

BENCH MARK

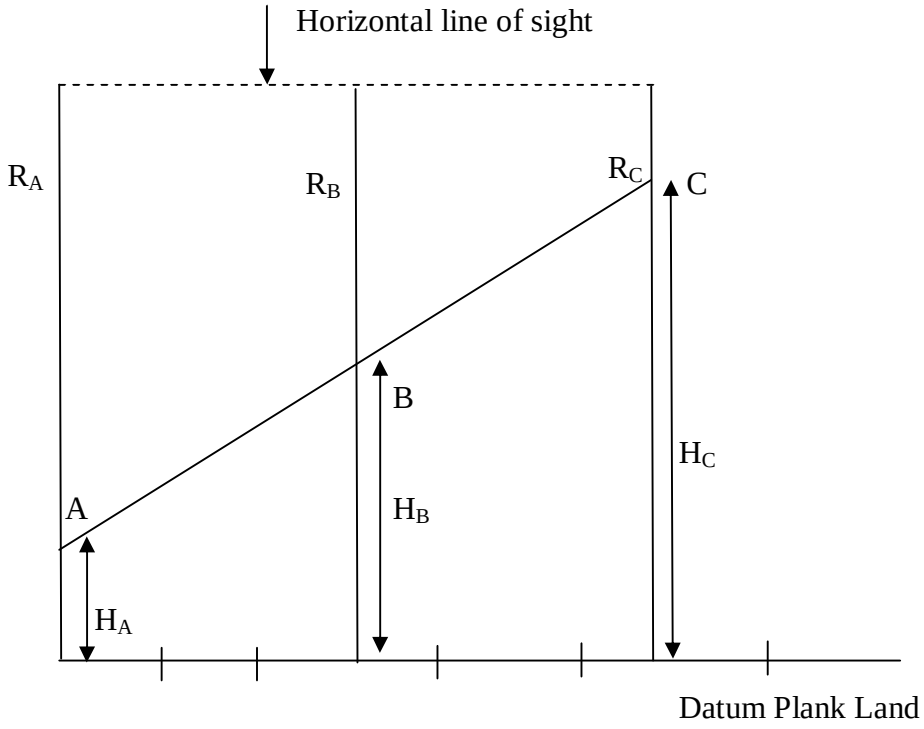
It is the permanent or semi permanent point of height which has been determined by the level.



It is usually in the form of concrete pillar A temporary bench mark may be a peg.

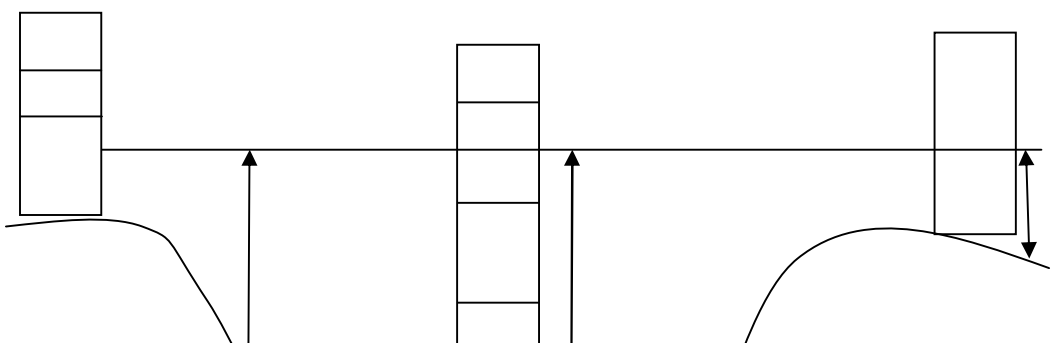
RISE AND FALL

In relation to 2 points in topographic survey, we talk of rise and fall. A positive difference is a rise and the negative difference is a fall.



The difference in length between A and B = $R_A - R_B$

The difference in length between B and C = $R_D - R_C$



When two or more points are not on the same elevation, there is difference of level. Suppose this point level is held at an eye level of 1.5m, the horizontal plane at spirit level extended in imagination over the table, the plane will cut a rule held vertically on a rule hold at 0.75m at Mr. A, similarly if rule is held on chair at point C the reading at the interception of horizontal plane will be at 1.05m while the reading of rule held on the floor at Mr B will be 1.5m.

In practical leveling, the simple rule is replaced by the leveling start, while the spirit level is replaced by instrument called a level. If the table of the chair are replaced by 2 points the earth surface, the figure A is replaced by figure B. it is obvious on H.

Figure B that height of Mr. A datum or sea level is about 1.5m – 0.75m = 0.75m, while the length C above datum him point R is 1.50 – 1.05 = 0.45m.

The datum in this case is on imaginary horizontal plane through the top of peg or point B.

I other words, to determine the difference of level of 2 points start is placed in between or simultaneously on the 2 points where difference in height is to be determined.

The position of the instrument is not important, but in order to cancel out the effect of instrumental error. The instrument should be placed mid-way as much as possible. The instrument set firmly on a ground is then leveled using the foot screw. The eye piece is focused. The telescope is directed towards the vertically level staff and the reading is noted or recorded…….. that the instrument babble is central while reading is taken fro the second stall position.

The difference between the 2 readings is the height difference for the 2 points. If we cant find the height of a known point the height if a narrow point at the end point.

We have to end where we started depending in the work at hand, then if there is no known length for our starting point, we then assume an arbitrary starting point. This is why the ratio of the main sea level to the next of observation = Natural datum

MSL = ND

NOB

LEVELLING INSTRUEMNT

Level is an instrument used in establishing horizontal line. it uses spirit babble tube with the construction of telescope, you can sight or object aid also focus, line of sight is called line of collaboration. Basically there are 3 main types of level or leveling instrument.

Each instrument have a few basic parts the working of which will be firmly under store. Hide are dumping level, tilting level, automatic level. Each is used in sighting different ways.

DUMPING LEVEL

This is the most common form of survey level and it consist of able tube attach to the telescope. The telescope is rightly fixed to the stage which has 3 or 4 foot screw.

The foot screw used to bring the babble to the centre of its run and also to make axis of the babble horizontal. If the line at collimation is parallel to the able axis then the line of collonation is horizontal. The advantage was in the fact that when it is leveled, you can sight all the direct – this instrument is getting out of the …….

TILTING LEVEL

Is an improvement of the dumping level, instead of being tilted. When using this instrument it is only necessary to set it roughly leveled. As babble is finally leveled for each reading by means of adjusting screws ad thus greater accuracy is obtained. Since the babbles axis is always mark to be right angle with the axis however the adjustment is done before every reading.

AUTOMATIC LEVEL

Just as the name implies, it is an automatic instrument. the instrument may be out of adjustment if the recticle is mis-position after carrying out the task as described for titling level.

In automatic level, the horizontal hair is brought to the correct readings by MV of recticle.

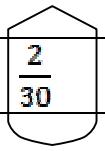
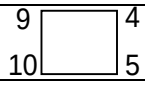
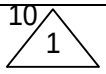
The instrument has circular spirit babble you don't have to set the babbles every time. It also gives direct image instead of inverted images.

Along with any of the above 3 types of level we can also use level staff, staff plate or cross-foot especially when we are on soft ground.

FIELD BOOK

The field book is use for recording all the various measurement taken in the field with chain, compass and tapes.

A typical field book has 5 columns. Column one is used for recording both forward and backward bearing which must always be reading as ordinary figure e.g. 60^0 = 60 columns 2 and 4 are use for recording distances of objects and in sighting object to which offset has been taken.

1	2	3	4	5
				
		20		
60				

Column 3 represent the chain line and it is use for recording the station, the distances which offset are taken and the total distance of each chain line or survey line. Column 5 is use for recording the angle of slope.

Angle of slope can be measure by the use of Abney level or chynometer.

SURVEY TEAM

A common survey team comprises the following:

1) The surveyor: (Team Leader) – He is the sole-leader of the team and is directly in charge of all aspect survey operation, his duty include the following – compass reading, booking offset measurement, organization and supervision of all operation of survey work. for e.g. he sees to it that the chair is correctly aligned and fully drawn fight, he walks along the chair to check the toys, rings, joint and loops, he reads and records the drawing at every offset and at the end of every station.
2) Chain men: This consists of front back chain men, the chain men are usually forward and experienced labourer, the back chain man should be relatively intelligent then the front chair man, the back chair man allows the front chair man in the direction of the pole. The back chairman check the arrows in his hand and give the report of the total change to the surveyor. The front chair man is responsible for inserting the arrow and for pulley the chair at every chair length.
3) 2 Pole men: These set of workers consist of the front and the back pole men. The front pole man should be more intelligent than the back pole man. His choice of suitable stations reduces the number of useless stations and survey lines with or able front pole men, the longest possible survey line can be obtained, this will reduce the surveyor work in the office.
4) Offset man – He holds the tape and help the surveyor whenever his service is needed.

A team of people is adequate for a normal survey work, however a team of 8 or more may required where this is need to cut the survey line.

BOOKING

Survey exercise is preceded by preamble of foot note which include the following:

1) Little of the survey i.e. the name of the area to survey
2) Description of the starting point
3) Instrument used
4) Total compass error
5) Weather distance are reduced to horizontal or not
6) Methods of measuring the offset by tape why pacing
7) Name of surveyor
8) Date the survey commences

Preamble may go thus: The survey of the main road path of UNAAB permanent site starting at the junction of the main gate and the Alabata road, using prismatic compass of total compass error of 6^0W, 30m chain, 10 arrows, 6 ranging poles and 20m tape. Distances are measured in meters and net reduces to horizontal surveyed by 1998/99 Erm 304 student UNAAB. 02/12/99.

The booking should always be neat, correct and presentable below the survey may not necessary be the only person to plot the survey. Moreover the field book may be preserved for an indefinite time, if the 1^{st} map plotted from it is destroy or lost, new map may need to be produced again from the same records. The following rule should be observed when booking.

Each survey line must be booked separately, and a single cone should be drawn cross the field bark to mark the end of the survey line.

Each station number should be recorded in triangle or enclosure and the total distance of each survey line should record in a circular enclosure.

The end of a complete survey should be marked with double lines or single line for open and close survey respectively.

The surveyor should write his name and sign the end of the survey.

PLOTTING

DRAWING MATERIALS AND INSTRUMENT

Drawing board, T-square, straight edge, papers (cartridge paper and square paper), racing paper or tracing cloth, pencils (H or 2H), eraser, set square (45^0 and 60^0 protractor (circular), divider compass).

SCALES

Scales is the ratio of the distance between 2 points on the map to the horizontal distance between the same points in the ground i.e. 1: 50 or distance between Ibadan to Abeokuta is 60km and it is represented by 5cm on the map then we have

$\frac{5\square\square}{60\square\square} \times \frac{1}{100\times1000}$

= 1, 200

$\Rightarrow$ 1:1,200,000

METHOD OF REPRESENTING SCALE

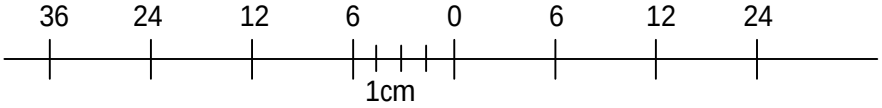
Scales are commonly express in 3 different methods:

a) Representative fraction
b) Direct comparison
c) Linear scale

Representative fraction: This may be written as 1:1,200,000 or $\frac{1}{1,200,000}$. In either case, it means that the distance between the 2 points on the ground is 1,200,000 x the distance between the same distance on the map. An important feature of representative fraction si that it is not tied to any particular unit, thus $\frac{1}{1,200,000}$ can be interpreted and 1 inch to 1,200,000 inches or 1m = 1,200,000m the most important thing is representative fraction is that the scales are experienced in its same unit.

Direct comparism: A scale is sometimes expressed by comparing the length of one unit on the map with a different unit of length in the ground e.g. 5cm represent 60km i.e. 1cm = 12km thus the unit are thus the same.

Linear scale: The expressed the scale of the map by drawing a line and marking it in unit which represent directly the unit of distance length or the ground.



Any map with a linear scale can be interpreted by measuring the distance between the 2 points on the map with a ruler on string and making it off on the scale.

LARGE AND SMALL SCALE

A large scale denotes a small of land represented by a large map e.g. a scale of 1cm to 10km.

A small scale on the other hand climate a comparative likely large area of land represented by a small map e.g. 1cm represent 200km.

CHOICE OF SCALE

The choice of scale for any particular survey work is determined by:

1) The size of the paper
2) The purpose of the survey
3) Amount of detail required
4) The nature of the survey

CONSTRUCTION OF SCALE

1) To calculate the scale from a given size of paper

Assuming that the size A of the paper is 20cm and total length or distance = 4, 000km

The formula = $\frac{\square\square}{\square\square}$ =PS (paper size)

Scale (SC) = $\frac{\square\square}{\square.\square} = \frac{4,000}{20\square\square} \Rightarrow$ 1cm = 200km

Or $\frac{4,000}{20\square\square}$ x 100 x 1000 (covalent to cm)

$\Rightarrow$ 20,000000 $\Rightarrow$ 1cm $\Rightarrow$ 20, 000000km

$\Rightarrow$ 1:200km

2) To calculate the size of paper from a given scale

$= \frac{\square\square\square\square\square\ \square\square\square\square\square\square\square\square}{\square} = 3$

e.g. T. D. = 1, 425km

= $\frac{1,425}{3} = 47.5$□□

Assuming the scale is 1: 500,000

P. S. = $\frac{475}{5,000,000}$ □ 100 □ 1000

= 9.5cm

Then add 10cm to it ⇒ 9.5110cm = 19.5cm

DETERMINATION OF LENGTH OF SCALE

Assuming that the length is 20,000km and the scale is 1:2000km – This means that 10cm will represent 20, 000km on the map.

STEPS IN PLOTTING A SURVEY

1) Draw a rough diagram of the sinking on another sheet of paper put in the distances and bearing as accurate ways possible.
2) Having calculated the scale, construct the scale at the bottom right had corner of the paper.
3) Draw a vertical line at the top left hand corner of the sheet and mark it the true north ⇒ N ↑
4) Either (a) calculate the true bearing from each of the compass bearing this from your rough sketch, find the approximate position on the map of the starting point and draw a line parallel to the true north though the points with a protractor lay off your true bearing

to the next station from this point, and then with a poor of divider measure off the correct distance along the bearing very your constructed scale.

PRINCIPLE OF SURVEY

Reconnaissance Survey: This is not a detail survey but a predominance inspection of a purpose resource. It is carried out by walking round the purpose resource or estate and observing natural features of the area, the rough sketch map of the purpose area showing natural boundaries and artificial boundaries and the position of survey stations are draw. The preliminary repoint should contain the following – the name and the situation (location of the description, the climate of the area, topography (shape), geology (soil colour, texture, structure, and vegetation), compile the name of dominant plant spp. Also, human population, type of settlement (low, high or dense) forming activities noted, presence of wildth, past and present animal type, the ownership of the estate (private, community or govt).

The objective of the exercise such as forest reservation.

TRANSVERSE SURVEY

This consist of measurement of

Actual internal angle of paper – Actual distances between the distances of points.

SURVEY EQUIPMENTS

- Chain (steel band chain – tape

- Compass dry and oil compass – offset staff

OFFSET

This is a measurement taking at right angle to a small line if an object which is not more than 1 chain or 30 away from the chain line. such an offset can be a building, tree, fence, hedge which run most or less in the direction of the survey cone. Offset can be measured with

- Linear tape, offset staff with graduated rod of 10ft or 3m long.
- Ranging rod or ranging pole
- Pacing the distance from the chain line to the object (this should have never not be use when or accurate survey is required)
- By estimation of the distance from the chain line (the also is not advisable when length of an offset, the chair is aligned along the survey line with the chain still straight on the line a right angle between the edge of the object and the survey line is set and the distance along the chain line is known. The distance between the point in which the object is at right angle is the measured.

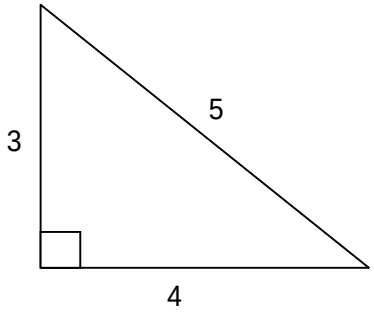
SETTING RIGHT TRIANGLE TO THE CHAIN LINE

Right angles can be set from the chain line to the object by the following method:

Estimation involves the use of optical square or cross-staff. Optical square consist of a small cylindrical staff about 2 inches or 5cm in which it is fitted a prism at right angle to the plane of the instrument.

The observer must always stand on the chain line tracing the survey station, he then moves forward and backward while looking into the instrument until the object is at right angle to the eye.

Pythagoras theorem: This is the use of the ratio of chain of a right angle. A right angle triangle is a ratio 3:4:5



This fact can be used in setting out a right angle triangle with a chain, the length of the triangles of the multipliers of 3; 4:5.

ERRORS IN CHAINING

The following errors are likely to occur while changing.

- Incorrect length of changing: This is corrected by checking a chain a field standard. A field standard is a standard chain length, if the length of the chain is too longer or short, it should be corrected by adjustment or by mathematical calculation. If the chain is too long,

(TL) True length = measured length x (1 + error)
Chain length

If the length is too short

$$TL = ML \times \frac{(1 + error)}{\text{Chain length}}$$

Thus in order to correct chair length which is too short we and subtract.

e.g. – The measured length is 1500m and the chain is 0.5m to long. What is the true length, chain length = 30m

TL = 1,500 x (1 + 0.5)

= 1,500 x 1.5

= 2, 250m

$$1{,}500 \times \frac{1.5}{30}$$

It is clear is too short by 0.5m

$$= 1,500 \times \left(1 - \frac{1.5}{30}\right)$$

= 1, 500 x (1 – 0.0167)

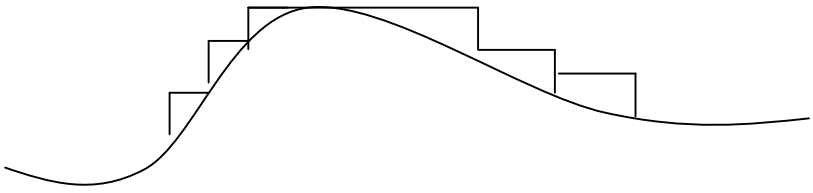
= 1, 500 x 0.9633

= 1.475

- Chain not properly align – The front chain man and the back chain man should be properly align before arrow is inserted to marked the end of chain.

The back chain man should be more experience so that he can keep accurate record of the total thing.

- Chain not fully tight – The chain should be pull tightly to avoid sagging. When pull the chain it should be very close to the ground. In chaining across a slope a valley, chain should not sag into the slope but should be pull straight.
- Expansion or contraction of the chain due to difference in temperature. This error is negligible.
- Stretching the chain or elongation due to tensile strength. The front chain man should pull the chain more carefully and should not run with it. It is the chain is held by an obstacle, the front chain the man should go back to tree the chain and not to swing as this damages the chain. The back chain mass should insert the front chain man to stop when the back end of the man renches the arrow.
- Arrow not properly inserted – Arrow should be properly inserted on the ground, where the soil is very hand or on a concrete surface, an “X” marked should be made with the arrow to mark the end of the chain end.
- Incorrect reading of the chain – Care should be taken to avoid mis-reading the chain, particularly attention is needed for reading the chain length.
- Adequate allowance not being made for slope allowance should be made for slope.

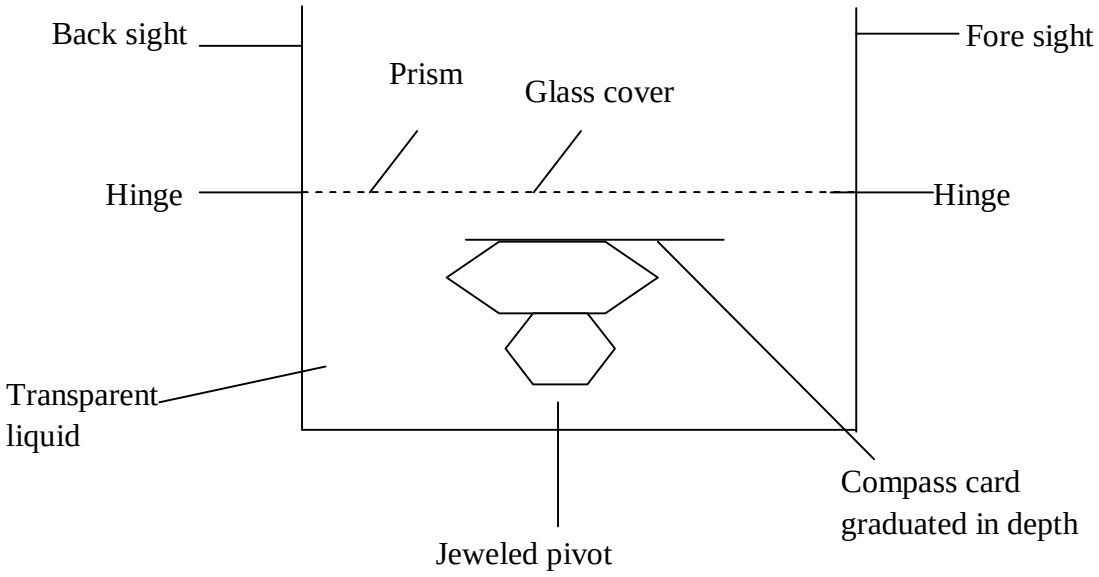


- Incorrect booking of result – Greatest care should be taken to avoid incorrect booking, the tendency under a hot sun or towards the end of the day's work is to book wrong figure such as instead of 12^0 = 120 instead of 30 = 300.

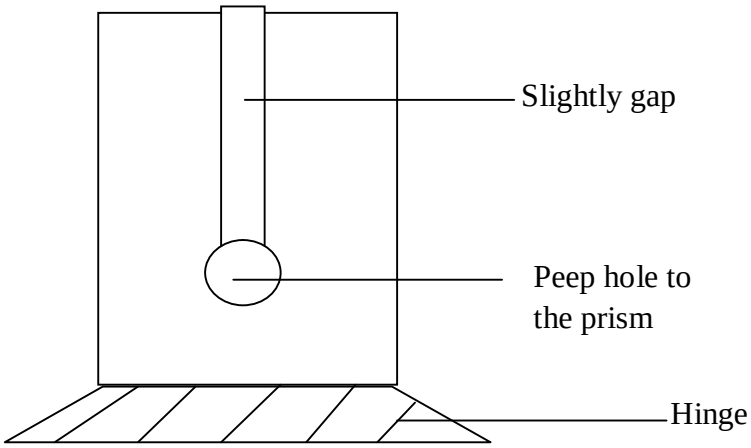
In conclusion, if the above mentioned errors are taken care off, accuracy of survey work will be guaranteed, moreover the permissible error in plotting after surveying is 1:300 or 1:400. The ratio is the sum of the distance of perimeter of the transverse divided by the length of the closing error or gap.

PRISMATIC COMPASS

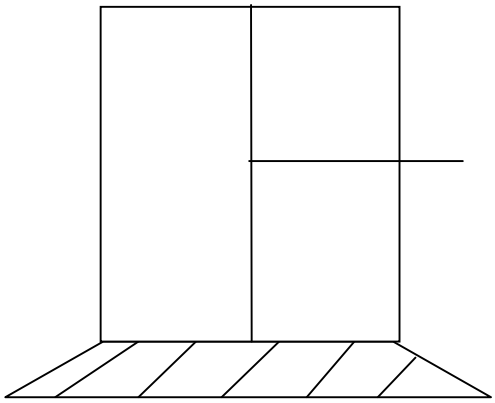
This is an instrument used for measuring the bearing of a point or an object on earth surface. Most survey operators are carried out with chain and compass.

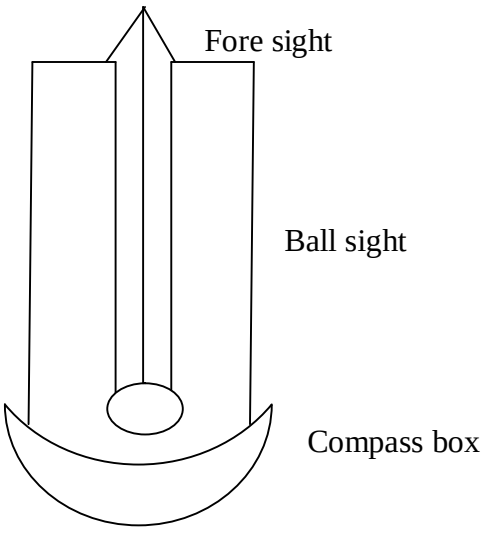


BACK SIGHT



FORE SIGHT





The prismatic compass consist of a floating magnetic needle which is balanced on a jeweled pivot, on top of this magnetic needle is the compass cord usually made up of aluminum, the cord is graduated in degrees starting on a whole cord from 0^0 - 360^0 the 0^0 is not shown on the cord as it canard with the 360^0. The component is enclosed in a compass but usually made up of metal which is the covered with a glass cover because it is filled with transparent oil which helps to clamped control the MV of the compass needle and the compass. On one side of the compass is the back sight longer on a glass cover or compass but the back sight consist of a sighting gap and prism which magnified the graduation on the compass cord for easy reading. On the other end of the compass is the fore sight also loge on the glass cover, the fore sight consist of sighting line/vane which is either made up of thin wire or hair or else a line extend on the glass. In reading the compass, a sight is taken through the fore sight to the raying pole making the survey station and at the same time you look down to the compass through the prism, the bearing is the recorded in degree.

TYPES OF PRISMATIC COMPASS

Dry compass and oil immersed compass

The dry compass takes a long time to settle down to the magnetic meridian and it is not suitable for hard (usually the dry compass is bigger).

Liquid or oil immersed or the other hand has the compass but filled with clear or transparent liquid which help to damp and sharks the swings of the needle on the magnetic meridian on in a very short time for quicker rending, it is normally a hand compass.

STEPS IN USING A COMPASS

1) Check the compass between 3 survey beacons with known bearing, this will give a total compass error
2) When using compass with tripod, screw the compass firmly to the tripod
3) Either erect tripod over a starting point having removed the ranging pole or stand firmly with your back bone against the ranging pole.
4) Remove the compass lid and erect the fore sight and the back sight
5) Raise the compass to the eye and line up late the station
6) Having aligned the compass it should be held in a horizontal position and rending taken in same position
7) The bearing is the rend to ½º always read from right to the left and never from left to the right
8) Rotate the compass through 360º and retake the bearing if it agree with the 1st reading, write down the result, if it does not rotate and take the bearing again, write down the reading of the 3 which agree, if all the three readings are differed, then the compass is sticking and should be examined
9) Move to the next station and sight back to the previous station take the reading (back reading) following step (3 – 8)
10) Having taken the back bearing, the different between the two reading should be ±180º, if you do not get the difference of 180º, it means that either the previous with current reading or both are wrong and this should be checked. If after checking, the readings do not yet agree, it means there are some magnetic objects interfering with the compass at one or both station and care must be taken to avoid them.

11) Sight the next station and repeat step 3 – 10

ERRORS IN USING THE COMPASS

1) The compass not checked before each survey exercise
2) The compass not very correct or very detective and such defect include:
   (a) Damage to the fore or back sight.
   (b) Damage to the prism
   (c) Loose screws not been tightened
   (d) Cord not rotating properly
   (e) Presence of large air bubbles
3) The compass been held horizontal when taking the reading
4) The compass not been steadying when readings are taken
5) Reading taking from left to right instead of from right to left
6) Readings not being checked by rotating the compass
7) Reading not being check by taking both forward and backward bearing
8) Presence of local magnetical fraction such as
   (a) Stone or rock
   (b) Rail
   (c) Vehicle
   (d) Metal
   (e) Rolled up chain

(f) matchet, parched Kofi, key, wrist watches e.t.c.

MAGNETISM

A magnetic is a suitable with low power to attract other magnetic substance such as iron, steel, Nickel. This power of attraction is called magnetism in any magnet, magnetisary is more concentrated or both end which are called north and south poles respectively. If two magnets are brought together, the north pole of one will repels north of another on the other hand, the north pole of one will attract of south. Pole of the magnetic needle whose south pole point to the earth's north pole or vice-versa. All compasses are called magnetic compasses.

This phenomenon is summarized thus: like poles repel unlike pole attract. This attraction repulsion related its compare of the earth.

Earth magnetism: The end behaves as a huge magnet due to various numerals and electric charge which are present on it. The earth magnetic north pole is near the earth geographical south pole. All other magnet set themselves along the line of force of the earth magnetic field that is bear of magnet will set itself along the earth meridian which its south pole pointing to the north polest the earth magnet north pole. A compass the convert of a bear magnet or base on the principle they operate, in surveying, two north are commonly used these are true north or geographical north and magnetic north.

True north on the global man of the earth, all lower longitude converse at two points. The point at which this we converge at the extreme north is called the true north of the earth, it is also called the geographical north. The true north is the farthest pont north of the equator and is

permanently fixed. True north is therefore direction of the true north or geographical north pole at any particular point with surface of the earth.

Magnetic north is the direction at which the magnetic needle point, the magnetic needle is not fixed but changes from place to place and from time to time. A core or the place between the true north and the true south is called the True or geographical meridian and that between the magnetic pole are called the magnetic meridian.

Magnetic variation and inclination is the angle between the magnetic north and true north or the angle between the geographical meridian and magnetic meridian.

Magnetic variation is not constant but vary every year and place to place. Magnetic variation con be determine by the following methods

1) From survey department: magnetic variation can be obtained from the department for any particular place.
2) Stem and beacon: magnetic variation can be determine from standard beacon whose true bearing is known total compass errors is a friction of magnetic variation and index error (MV + index error)
3) Isogamic map/chart: is a map of the world or a country with line draw on it giving places. An equal magnetic variation. The variation decreases west ward at the rate of 5½ minutes per annum

e.g Assuming that the magnetic variation in Abeokuta in 1980 = 9º, what will be the magnetic variation in year 2000

2 – 1980 = 20 years $\Rightarrow 5\frac{1}{2} = \frac{11}{2}$

$\Rightarrow \frac{11}{2}$ x 30 x $\frac{1}{60} = \frac{11}{6}$ = 1.83º or $\frac{110}{60}$ degree = P.50^1

$\Rightarrow$ Magnetic variation = 9º - 1º50º = 7º.10^1

Index error: is the error interest in a particular compass which is true to the fault of the manufacturer, each compass has its own index error which is usually determine and known by the manufacturer.

Total compass error: this equal to the magnetic variation ± index error (W – S+).

Thus, TCE should always be determined for a compass and should be checked atleast once annually where an index error of a compass is unknown the total compass error can be determined by the method of standard beacon. Index error can if necessary be determined by subtracting the MV from the TCE. The TCE should be started in the field book with the direction and date e.g. 6º 55^1 W(1999). All bearing should be converted to true bearing before the survey is plotted and all survey bearing should be plotted to true north. True bearing is determined by subtracting the TCE from the magnetic bearing TB = MB – TCE. If the magnetic variation is in the west, true bearing is obtained by subtracting MV from MB, if the variation is in the east true bearing is obtained by adding MV to MB

SETTING UP OF THE LEVEL

This is refers to as temporary adjustment and the following steps are taken

1) Open the tripod legs out to about 60º and press firmly to the ground

2) Open the box containing the surveying instrument is parked, neglecting this aspect may cause considerable difficulty when replacing the instrument and if not done correctly, it may cause damages to the surveying instrument
3) Lift the instrument from the box (note with the telescope tube) and screw it firmly into the tripod
4) Rough leveled the instrument by adjusting the tripod and complete the process by income of the tool screw continue this until bubble is centralized. It is important
    - Avoid parallax which may result in the inaccurate
    - Rending of the staff
5) Do your focusing first by putting the telescope out of focusing using the eye piece by sighting the staff hold by staff man and focus the telescope until the fore man steps and the staff he is holding are in coinerdence or all in proper adjustment with the cross hair.

TERMS IN SURVEYING THAT CAN BE USED IN BOOKING

1. Back sight: This is the first sight that is seen further after the level has been set up. It is a sight to a point whose height is known or can be calculated, it is always designated as (B.S)
2. Fore sight (F.S): This is the last sight taken for a particular set up leveling is a sight taken to a point of required height on a line of leveling.
3. Intermediate sight: Is any other sight taken in a set up leveling (I.S)
4. Reduced level: Is the calculated level of a point above or below a datum (R. L)

Height of instrument (H.I): is the length of the ions of collonation above the datum.

Change point: the point at which both foresight and back sight are taken.

Sources of error in surveying

In correct settings up if equipment: this include

(a) Bubble off-center (i.e. not centrally positioned when taken readings) this may be corrected by always checking the bubbles before taken the readings.

(b) Movement of shaft: during a change over of level may cause error.

(c) Parallax: reading out of focus could parallax when there is alignment before taken the readings.

(d) Movement of instruments during the reading of B.S and F.S.

2 Instrument error: this include

(a) collination error –it can be corrected by frequently checking and equalizing length of F.S and B.S.

(b) error due to staff graduation: this can be corrected by the staff used during the surveying work is correctly graduated.

(c) Error due to loose tripod end; this can be corrected by carrying out repairs or in adjustment.

(d) error due to telescope bubble and centralizing it.

3 error due to natural causes such as

-poor reading due to climatic condition such as heat, harmattan, haze.

-bad light may result in serious error: this can be corrected simply by reading the light of sight, note that the maximum permissible length of sight with ordinary instrument under a suitable condition is 100m but the shorter the length the better.

4 error due to incorrect readings or booking this is an error generated during data gathering in survey field, this may be as a result of use of wrong unit, mix units, or wrong column,

interchanging of figures e.g. 0.685 instead of 0.865, it may even be as a result of complete omission of reading, note that there is permissible error in survey work e.g in building sight, permissible error is ± 0.006 on the choosing bench mark (B.M) when leveling long distance, the permissible error in (m) is the product of the constant and the square root of the distance leveled in km. constant × √ distance, and on rough ground its 0.03.

methods of booking leveling note

there are two methods of booking level note: H.I or collination method and rise and fall method.

H.I-method: the first reading taking on each occasion, when the level instrument is set up should be enter into back sight column, the reading taken each time before the instrument is removed is enter into foresight column, the collination column gives the level of the sight line, this being the number obtain by adding the number in the reduced column to the B.S column e.g. in the table below 37.25 + 2.31 = 39.56, the numbers on the same line in B.S and F.S refer to the reading on the staff taking in one position, to find the numbers in the reduced (R.L) column which is generally object of leveling operation, each number in the F.S column is subtracted from the previous collination and the result is entered into R.L column. The numbers in the next two columns are taken in the field, those in the next two columns are obtained by including these figure except in the first number in the R.L column which is B.M level and this is always given to enable other numbers being induced, all numbers in the R.L column are obtained by declining F.S number from their previous collination.

Order of reduction

Add the given number in R.L column to B.S (2.31) to get

(1) 39.56 and enter it into collination period

(2) deduct F.S (0.27) from collination 39.56 to get 39.29 and enter it into R.L column

(3) add R.L (39.29) to B.S (8.34) to give 47.72 and enter it into collination column

(4) subtract F.S (0.21) from collination (47.72) to give 47.51 and enter it into R.L column.

(5) Add B.S (12.73) to R.L(47.51) to get collintion (60.24)

(6) Reduce F.S or (1.86) from collination (60.24) to get R.L (58.38) the levels arenow reduced.

A check on the accuracy of the arithmetic is produced by adding the number in B.S and F.S columns and the deduct the smaller from the larger, this should agree with the result obtained by subtracting the first R.L value from the last R.L value.

B.S	F.S	H.I	R.L
2.31	-	39.56	37.25
8.43	0.27	47.72	39.29
12.73	0.21	60.24	47.51
-	1.88	-	58.38
23.47	2.34	-	58.38
2.34	-	-	37.25
21.31	-	-	21.13

in numbering the line of level, it is never sufficient to take the level on the ground one way since there is no check on accuracy of the reading taking with the instrument so when you are at the last instrument station after checking the reading start leveling back to the standing point, this is called check bock.

Rise and fall method

8.22 is a positive value, hence it is recorded under rise-column line with 0.21, to compare 3rd with 4th station. Use the readings taking at the 3rd instrument station which is B.S (12.73) and F.S (1.86). the difference in level equal to 10.87 (i.e. 12.78 – 18.86), 10.87 is a positive value hence it is recorded under rise column.

NOTE – To work out the rise and fall, each F. S. reading is deducted from each B. S. reading from the previous one. If the B. S. is larger than F. S., the result is a rise, but if it is smaller, the result is a fall,

To complete these operation then obtain all the values of R. L. using common sense operation e.g. if the R. L. of a staff stahica = 37.25 and the rise from that station to the next station = 2.04, then if R. L. of the next station = 37.25 + 2.04 = 39.29.

Also, since the rise to the next station = 8.22, R. L of the new station = 39.29 + 8.22 = 47.51. The operation of the reducing level is now complete.

CHECK THE ARITHMETIC

1) Sum up the B. S. and F. S., find the difference between the . S. and F. S when = 21.13
2) Find the difference between the left value and 1st value of reduced level which is = 21.13.

In addition, find the sum of rise and fall, also find the difference between sum of rise and fall, this must equal the difference in the sum of B. S. and F. S or the difference between the last value and 1st value of R. L. as obtained above.

B. S.	F. S	Rise	Fall	R. L.
2.31	-	-	-	37.25
8.43	0.27	2.04	-	34.29
12.73	0.21	8.22	-	47.51
	1.86	10.87	-	58.38
	2.34	4.132	-	58.38
23.47				37.23
2.34		21.13		21.13
21.13				

COMPARISON OF RISE AND FALL METHOD WITH THE COLLINATION METHOD OF LEVEL REDUCTION

The rise and fall, method (system) of level reduction provide a complete check on total working with ease whereas, the collination system takes longer time to work but take wider tone than does rise and fall system.

The rise and fall system should be used where the leveling involves a great number of intermediate sight

Without any doubt, the collination system is best for setting out leveling and since a great deal of setting that has to be done or varying side, hence the reads for this method being popular among the building engineers.

AERIAL AND GROUND SURVEY

A simple and the near accurate means by which the landscape feature are analyzed and interpreted is by photographic image.

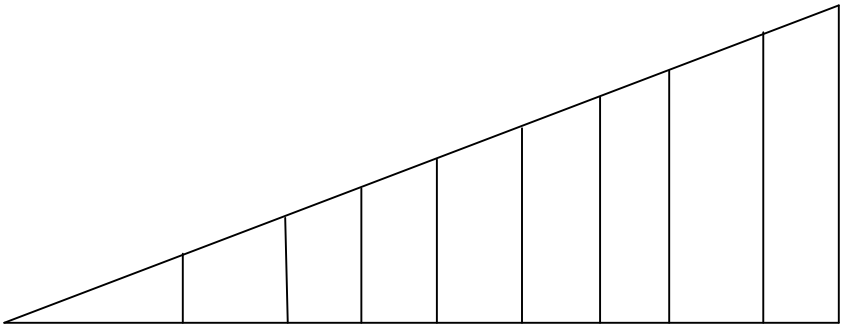
Photographic image in turn is result of complete interaction that interplays with the sun's energy. Object on the earth surface and the camera (Aerial camera), in order words, for better understanding of the precipitate of the photographic image and how this provides clues to the analysis and interpretation of early phenomenon, it will be necessary to discuss a nutshell two fundamental concept and principles of aerial photography.

ENERGY FOR AERIAL PHOTOGRAPHY

The basic form of energy requires for aerial photography is electromagnetic radiation. The most prominent source of this energy is the sun. the electromagnetic energy is made up of bot electric and magnetic forces.

Electron that are combine to each other on their line of propagation. It has a broad spectrum that is released to:

Electromagnetic spectrum: A spectrum covers from gamma-rays (γ - rays to radio frequency VHF/IF (very high frequency/Intermediate frequency). Furthermore, it has wavelength that varies inversely with its frequency thus the γ-ray has th shortest wavelength with highest frequency while the opposite will for radio frequency. However, the region of the spectrum that is not conceal to photographer (aerial photographer is the visible region (light). So the visible is refer to as light electromagnetic energy (EE) is propagated high space in discrete units called quanta of photons.



Using you constructed scale organ, draw a vertical line parallel to the north through the new point and repeat the operation until all the bearing a distance has been thoroughly plotted.

Using a protractor, mark off the compass error from the true north at the top of the map and proceed as for

Except that the line are drawn parallel to the magnetic north and actual compass bearing are used.

If the survey does not close, check your record book fro the mistake, if it is plotted correctly and still does not closed, then the closing error can be corrected using the following graphical methods. Add up the length of the sides to find the perimeter of the figure

Draw a line at bottom of the map to represent the length of the perimeter to the new scale.

Mark the position of the station from the line again from the new scale

Measure the closing error, the from the end of the newly drawing line, draw a line upward at right angle equal to the closing error.

Complete the triangle so formed and drawn a line at right angle to the base line to pass through each of the station joining them to the hypotenuse of the drawing.

On your map, draw a line parallel to the closing error through each of the station.

With a pair of divider, measure the length of upright at each station on the constructed triangle, then this length will be distance each station will have to move in order to close the error.

Mark up this distances measure to the marked scale along the lines drawn a parallel to the closing error through each of the stations in such a direction as to move the finishing point.

Join up this point to produce your chain survey

Using set of square and dividers put in your offset.

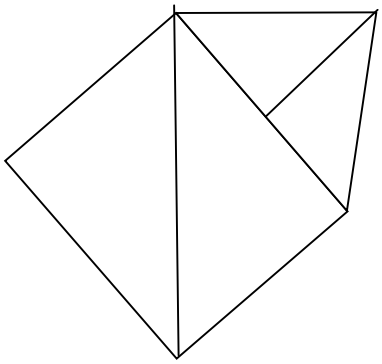
Put any unwanted line, calculate the area of the figure of the map.

Write the title at the top of the map. Link in the map title north point, scale and your name and the scale at the bottom and indicate the day it is been plotted.

DETERMINATION OF AREA OF PLOTTED MAP

Triangulation

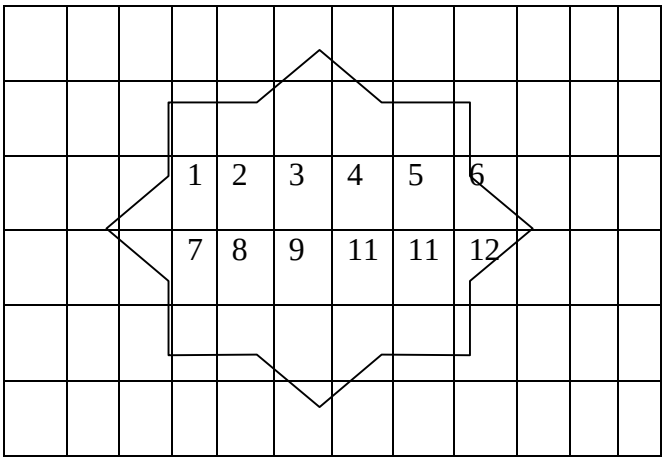
The map is doubled into triangles, having mark all the triangles, with a pair of divider, construct perpendicular line to the base of the triangles. Using the formula area = ½ b x h



Area = ½ AC x BF

Square

The area of the map can also be calculated by counting the number of area of triangle enclose they the figure …….. either plotting your map on a square paper and tracing your map on the square using tracing papers after counting the fall square, the small squares are also counted and added up



e.g. if we have to complete square and we have 2,500 small square = 25

= 21 + 25 = 46 5% up to square

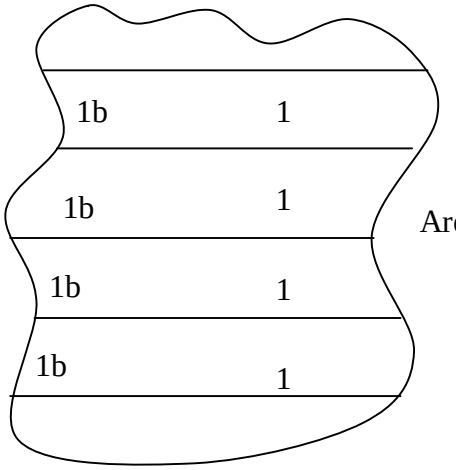
1:2,00 $\Rightarrow$ 1cm $\Rightarrow$ 2, 000 $\Rightarrow$ 1cm $\Rightarrow$ 20m

If 1cm = 20m

$46cm^2 = 20 \times 46 \Rightarrow 920m^2$

PARALLEL LINE

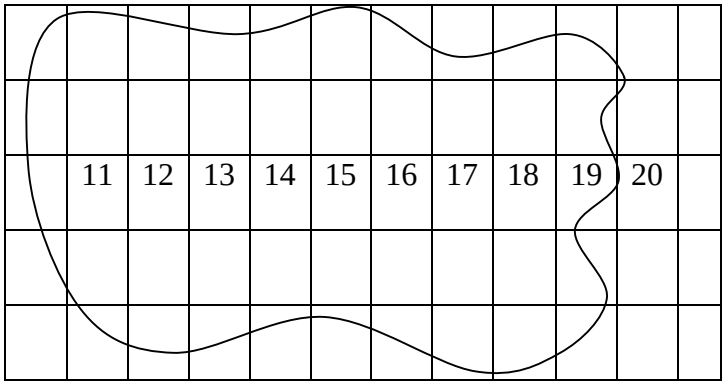
The area of the map is divided into rectangle or square equally spaced apart i.e. the breadth on sides of the rectangle is constant.



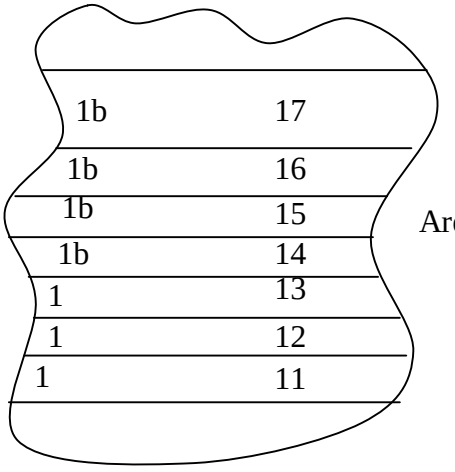
Area = El x b

SIMPSON RULE

In this method, the figure is divided into odd number or parallel line equally spaced.



1b



Area = El x b

Add the lengths of L –bone i.e. $L_1 + L_{11}$ or $L_1 + L_{11} = (x_1)$

Add the length of odd number line together and multiplying by 2 i.e. $L_3 + L_5 = (x_2)$

Add the length of area and multiply by 4

$= (L_2 + L_4 + L_{16}) \times 4 \qquad (x_3)$

$= a + b + c \qquad (x_4)$

Multiply the $= \frac{d \times b}{2}$ parochial value

$\Rightarrow \frac{x_4 \times b}{2} = (x_5)$

= distance between the parallel line the area of the map is x_5

CONSTRUCTION IN CHAINING

In chaining there are 2 important values which must be ensuring at all tone to ensure accurate damage. The are:

a. The chain line should be straight
b. Measurement should be continued from one station to another

This obstacles occurs in 3 ways:

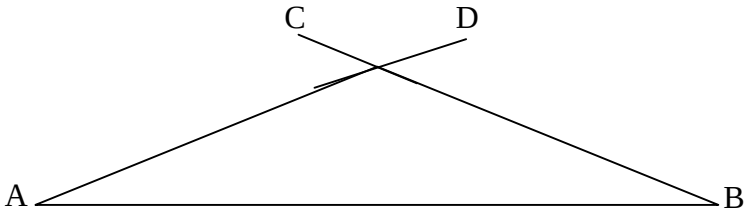
Chaining is free but vision is obstructed e.g. a hill a building

Chaining is obstructed but vision is free e.g. river or part of water

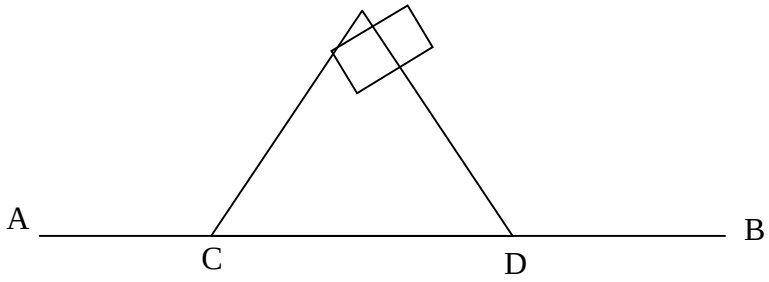
Chaining obstructed vision babbling

The obstacle can be overcome in the following

To correct chaining free vision or parallel method



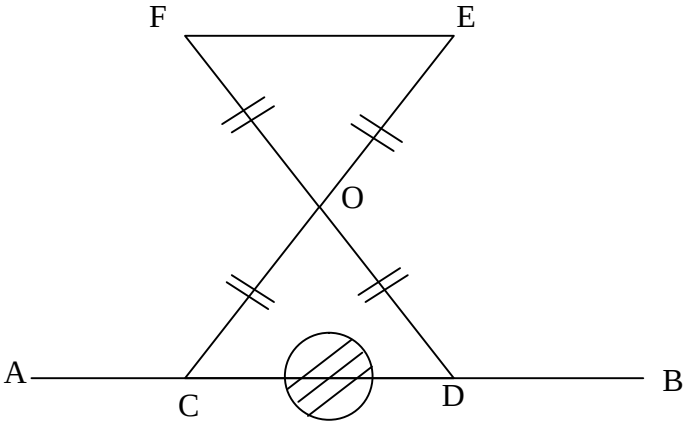
Chaining obstructed vision free, use Pythagoras method



$< CDE = 90^0$

$CE^2 = CD^2 + DE^2$ $= CE = \sqrt{CD^2 + DE^2}$

Or use similar triangle method



Fix a pole at C, O and E so that COE is a straight line and CO = OE. Also fix another set of pole D and F such that DOF is a straight line and Do = OF

Triangle COD and EOF are similar

$\therefore$ CD = FE

Vision obstructed chaining obstructed