ANNAMACHARYA UNIVERSITY
EXCELLENCE IN EDUCATION; SERVICE TO SOCIETY
ESTD, UNDER AP PRIVATE UNIVERSITIES (ESTABLISHMENT AND REGULATION) ACT, 2016)
Rajampet, Annamayya District, A.P – 516126, INDIA

CIVIL ENGINEERING

Lecture Notes
on
Surveying and Geomatics

Prepared by:
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Title of the Course:	**Surveying and Geomatics**
Category:	PCC
Semester:	III Semester
Couse Code:	24ACIV32T
Branch(s):	CE

Lecture Hours	Tutorial Hours	Practice Hours	Credits
3	-	-	3

Course Objectives:

1. To introduce the principles, classification, and tools of surveying and measurement of distances and directions using traditional instruments.
2. To develop understanding of levelling, contouring, and area/volume computations essential for engineering projects.
3. To provide knowledge and skills in the use of theodolites, traversing methods, and tacheometry for determining angles, distances, and heights.
4. To explain the geometry and setting of various curves and introduce modern surveying tools like EDM and total station.
5. To introduce photogrammetry principles, geometry of aerial photos, and mapping techniques using aerial imagery.

Course Outcomes:

At the end of the course, the student will be able to

1. Apply basic surveying principles using chains, tapes, compass, and plane table.
2. Learn the concepts and techniques of leveling and contouring, and compute areas and volumes for engineering projects involving earthworks.
3. Gain proficiency in handling theodolites, performing traversing, and applying tacheometric methods for measuring heights and distances.
4. Understand the geometry and purpose of different types of curves and explore the use of modern surveying instruments like EDM and Total Station
5. Acquire knowledge of photogrammetry techniques including aerial photography, flight planning, stereoscopy, and methods of topographic mapping.

Unit 1 Basic Concepts of surveying, Measurement of Distances and Directions 15

Basic Concepts of surveying: Introduction, concept ,purpose, Objectives, classification and principles of surveying.

Measurement of Distances and Directions,

Chain Surveying : Instruments for chaining , Ranging out survey lines, Errors in chaining ,Field book, Basic problems in chaining - Obstacles for chaining. List the errors and mistakes in Chain surveying and apply the corrections for measurement due to incorrect length of chain.

Prismatic Compass- Types of compass – Bearings - Whole Circle Bearing, Quadrantal Bearing, True meridian, Magnetic meridian, True bearing, Magnetic bearing, Convert Whole Circle Bearing in to Quadrantal Bearing and vice versa. Included angles– Declination - Dip and local attraction.

Plane table surveying: Introduction, accessories, setting up of plane table, techniques, testing, adjustments, errors, advantages and disadvantages

Unit 2 Levelling, Contouring and Computation of Areas & Volumes 12

Levelling - Basics definitions, types of levels and levelling staves, temporary adjustments, methods of levelling, booking and Determination of levels- Height of the Instrument Method-Rise and Fall method, Effect of Curvature of Earth and Refraction.

Contouring- Characteristics and uses of Contours, Direct & Indirect methods of contour surveying, interpolation and sketching of Contours.

Computation of Areas and Volumes: Areas - Determination of areas consisting of irregular boundary and regular boundary. Volumes - Determination of volume of earth work in cutting and embankments, volume of borrow pits, capacity of reservoirs.

Unit 3 Theodolite Surveying, Traversing & Tacheometric Surveying 12

Theodolite Surveying: Types of Theodolites, temporary adjustments, measurement of horizontal angle by repetition method and reiteration method, measurement of vertical Angle.

Traversing: Methods of traversing, adjustments, Introduction to Omitted measurements.

Tacheometric Surveying: Principles of Tacheometry, stadia and tangential methods of Tacheometry, Heights and distance using tachometric principles.

Unit 4 Curves & Modern Surveying Methods 10

Curves: Types of curves and their necessity, elements of simple, compound, reverse curves.

Modern Surveying Methods: Principle and types of E.D.M. Instruments, Total station- Advantages and Applications.

Unit 5 Photogrammetry Surveying 10

Introduction, Basic concepts, perspective geometry of aerial photograph, relief and tilt displacements, terrestrial photogrammetry, flight planning; Stereoscopy, ground control extension for photographic mapping- aerial triangulation, radial triangulation, methods; photographic mapping- mapping using paper prints, mapping using stereo plotting instruments, mosaics, map substitutes.

Prescribed Textbooks:

1. Manoj, K. Arora and Badjatia, Geomatics Engineering, Nem Chand & Bros, 2011.
2. Bhavikatti, S.S., Surveying and Levelling, Vol. I and II, I.K. International, 2010.

Reference Textbooks:

1. R. Subramanian, Surveying and Leveling, 1stEdition, Oxford University Press, New Delhi, 2010.
2. Arthur R. Benton and Philip J. Taety, Elements of Plane Surveying, 3rd Edition, McGraw Hill, 2010.
3. Anji Reddy, M., Remote sensing and Geographical information system, B.S.Publications, 2001.
4. Arora, K.R., Surveying, Vol-I and II, Standard Book House, 2015

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CIVIL ENGINEERING

Surveying and Geomatics

UNIT-1

Surveying & Geometics

unit ①

Surveying:-

The art of determining the relative position of points on above (or) beneath the surface of the earth by means of direct (or) indirect measurements of distance, direction and elevation is called Surveying.

Concept & purpose of Surveying:-

① To find the elevation of point with respect to a given or assumed datum

② To establish points at a given elevation (or) at a given different elevation with respect to a given (or) assumed datum

③ practically every engineering projects such as water supply and irrigation schemes. railroads and transmission lines, mines, bridges and building etc.. required Surveys

④ Before plans and estimates are prepared, boundaries should be determined and the topography of the site should be asertained.

⑤ After plans are made, structure must be staked out on the ground, as work progress, lines and grades must be given.

Purpose of Surveying:-

Information (relative positions of points on at Surface) is then used to create maps, plans and models which are essential for various Applicalion

like engineering projects

*) Mapping and planning:- To create accurate maps and plans

*) plant Development:- To determining plant elevation and Accesing the Suitabulaty of land for construction

*) Engineering projects:- It is used to guide the design and construction of various engineering proje

*) Military Operations:- To providing maps and data of planning and navigation

Objectives of Surveying:

(*) The main objectives of surveying in the civil Engineering are as Summarised below

(1) To determine the relative position of any objects or points on the earth

(2) To determine the distances and angles between the various objects

(3) To prepare a map (or) plan to respect to represent an Area on a horizontal plane

(4) To define control points of boundaries of an Area that is cadastral Survey.

Principle of Surveying:-

The fundamental principle of Surveying which are the various methods of Surveying are based on two aspects are as follows.

*) Work from whole to part
*) Location of point by measurement from two points of reference

Work from whole to part :-

Whether plane (or) geodetic is to work from whole to part. it is very essential to establish first a system of control points and to fix them with higher precision. minor control points then can be established by less precise methods and the details can then be located using this minor controlled points by running minor traverses etc. the idea of working in this way is to prevent the accumulation of errors to control and localise minor errors which otherwise would expand to greater magnitudes if the reverse process is follow, thus making the work uncontrolable at the end.

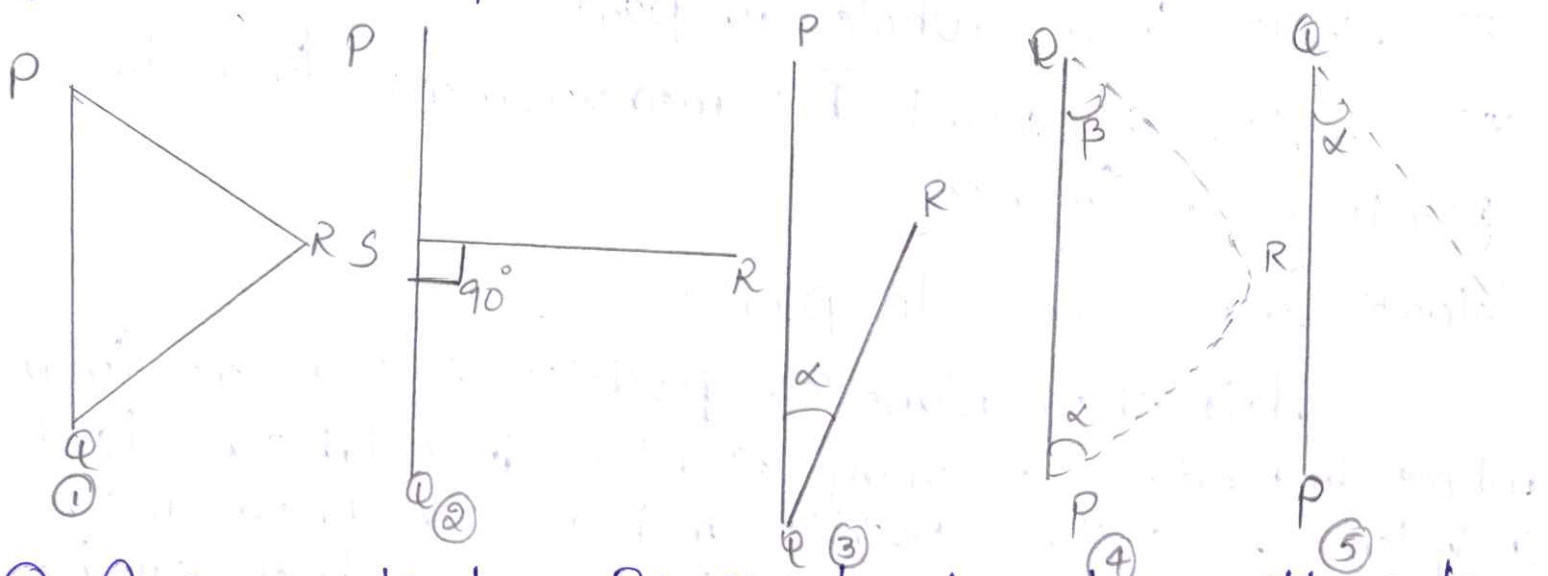
Location of a point by measurement from two points of reference.

The relative position of the points to the surveyed should be located by measurement from at least two points of reference.

*) Let P&Q are the reference points on the ground the distances PQ can be measured accurately and the relative position of P&Q, can be plotted on the sheet to some scale, any other point, such as R can be located by any one of the following direct methods

① Distance PQ & QR can be measured and point are

can be plotted by two ares to the same scale to which PQ have been plotted



② A perpendicular Rs can be droped on the reference PQ & the angles, length ps & SR are measured the point R can be plotted using set square

③ The distance QR and the angles PQR canbe measured and point R is plotted either by means of a protractor. (or) trigonometrically

④ In this method distances PR and QR are not measured but angle RPQ and RQP are measured with an angle measuring instrument, Knowing the distance PQ and point R is plotted

⑤ Angle RPQ and distance PR are measured and point are is plotted either by protracting an angle and R from Q

Classifications of Surveying:-

Surveying can be classified under headings which define the uses are purpose of the resulting maps.

Classification based upon the nature of the field Survey.

① Land Survey

*) Topographical Surveys:-

It consists of horizontal and vertical location of certain points by linear and angular measurements & is made to determine the natural features of the country like rivers, streams, lakes, woods, Hills, etc and such as artifical features like roads, railways, canals, towns and villages.

*) Catastrial Surveys:-

These are made incident to the fixing of property lines the calculation of land area & also to fix the boundaries of muncipalities.

*) City Surveys:-

They are made connection with the construction of streets, water supply systems, sewers, etc

② Marine (or) Hydrographic Survey:-

It deals with bodies of water for purpose of navigation, water supply, harbour work (or) for the determination of mean sea level.

③ Astronomical Survey:-

Astronomical surveying is a method used to determine the precise location and direction of points on the earth's surface by observing celestial objects like starts, the sun, and the moon.

Classification based on object of Survey:-

Here is a more detailed look at each type

Geological Surveying:-

Focuses on determining the composition of the earth Crust. this involves studying rock formations, soil types, and mineral deposits.

Mine Surveying:-

Used to explore mineral wealth beneath the earth's surface. this includes mapping under ground funnels, shafts, and ore bodies.

Archalogical Surveying:-

Conducted to locate and document remains of past civilizations, like rains, artifacts and ancient structures

Military Surveying:-

Employed to gather strategic information about the terrain including features that should be useful for military operations. this often involves creating maps for defense purpose.

Classification based on instruments Used:-

An alternative classification may be used based on the instruments or betters employed, the types are detailed breakdown

① Chain Surveying:-

A measuring distance using chains or tapes & is suitable for relatively flat small areas.

② Compass Surveying:-

To determine the direction of survey lines while distances are measured with chain (or) tape

③ plane Table Surveying:-

This techniques Combines field work & plotting Simultaneously, allowing for direct mapping in the field by using plane table accessories.

④ Theodeolite Surveying:-

To measure both horizontal & vertical angles a making them essential for more Complex Surveys requiring accurate angular measurement.

⑤ Tacheometric Surveying:-

A Specialized theodolite with a stadia phragm to determine distances & elevations with out direct measurement with Chain (or) tape

⑥ Areal (or) photographic Surveying:-

This method uses areal photography or other remot Sensing techniques to gather data above large Area also used for mapping & resource managements.

Scales of Surveying:-

The Area that is Surveyed is vast and, therefore, plans are made to some Scale, Scale is the fixed ratio that every distance on the plan bears with corresponding distance on the ground. scale can be represented by the following methods

① One cm on the plan represents some whole numbe of metres on the ground, such as 1cm = 10m, etc this type of Scale is called Engineer's Scale.

② One unit of length on the plan represents some no. of same units of length on the ground, Such as $\frac{1}{1000}$, etc. this ratio of map distance to the corre

sponding ground.

$$R.F = \frac{1}{50 \times 100} = \frac{1}{5000}$$

The above two types of scales are also known as numerical Scales.

③ An alternative way of (corr) representing the scale is to draw on the plan a graphical scale. A graphical scale is a line sub-divided into plan distance corresponding to conveient units of length on the ground.

Chain Surveying:-

To determine the direction of survey lines by distances one measured with a chain (or) tape is called chain Surveying.

Instruments for Chaining:-

The various instruments for determing of the length of (chain) line by chaining are as follows

① Chain:-

Chains are formed of Straight links of galvinished mild steel wire bent into rings at the ends and joint each other by three small circular wire rings. various types of chains.

*) Metric chain:-

These are generally available in lens of 5m, 10m, 20m, 30m

*) If 20m chain has 100 links then each link has = 20cm (or) 0.2m

*) If 30m chain has 100 links then each links = 30cm (or) 0.3m

*) If 30m chain has 150 links then each links
20cm (or) 0.2m

$$\text{Links} = \begin{matrix} 20\text{cm} \\ (\text{or}) \\ 0.2\text{m} \end{matrix}$$

Gunters chain (or) Surveyous Chain:-

A chain is 66 feet long and consists of 100 links each link along being 0.6 feet or 7.92 inches long. it is more convient since 10 gunter's chain is equal to 1 for lahg & gunter's chain is equal to 1mile

Engineers chain:-

Chain is 100 feet long consists of 100 links each link being 1 feet long every 10 links brass tax are fastened, the distances measure are recorded in feeds & decimals.

Revenue chain:-

The chain is 33 feets long and consist of 16 links, each link being $2\frac{1}{16}$ feet

Steel chain:-

It consists of a long narrow string of blue steel of uniform width of 12 to 16mm and thickness of 0.3 to 0.6mm this are available in the length of 20m & 30m.

Tapes:-

This are used for more accurate measurements and are classified according to the material of which they are made as follows

① Cloth (or) line tape:-

This are light & feaible & may be used for taking

Comparatevely rough & Subsidary measurements, Commonly available in 10m, 20m, 25m, 30m & in 33feets 50 feets; 66 feets & 100 feets.

② Metallic Tape:-

It is made of varnished strip of water proof, with small brass, copper (or) wires and doesn't Strech as easily as a cloth tape. this are commonly available in 2, 5, 10, 20, 30

③ Steel tape:-

This tape vary in quality and accuracy of graduation, but even a poor (quality) steel tape is generally superior to be cloth(or) metallic tape. this are available in 1, 2, 10, 30, 20 & 50m.

④ Invor tape:-

This are used mainly per linear measurement of a very high degree of brijisian Such as measured as base tines. these are normally 6mm wide & length of 20, 30, 100m

Arrows:-

These are made of steel, wire, ten arrows are Supplied with a chain, tempered steel wire four mm dia. (4mm dia), length of arrow a vary from 25-50cm.

Pegs:-

These are used to mark the position of the Stations of a survey line, Generally 2.5 cm (or) 3cm square. and 15cm long. tappered at the end. are made of timber

Ranging Rods:-

A length of either 2m(or) 3m, bottom is a heavy

iron point and painted in alternative bands ⑥ of either black and white or black and each bond is 20cm, these ~~ends~~ nods are almost invisible at a distance of above 200 meter.

Offset Rods :-

It is similar to a ranging rods and the length of 3m, rounded wooden rods with pointed iron shoe at one end and provide with a notch (or) a hook at the other end.

plasteres Laths :-

In open level ground intermediate points a line may also be lined out with straight laths, 1/2 to 1m long made of soft wood and light both in colour & weight

Whit's :-

These are pieces of sharpened thin strikes cut from a nearest edge, sharpend at one end and split with the knife at the top and pieces of white paper are inserted in the clefts in order to make them more visible

plumb bob :-

Wight chaining along slopping ground a plumb to is required from to transfer the point to the ground also used for make ranging rods, vertical it is used as centric, in thedolities, compass, plane table and other survey instruments

Obstacles in chaining :-

The 3 main obstacles in chaining of a line are of following types

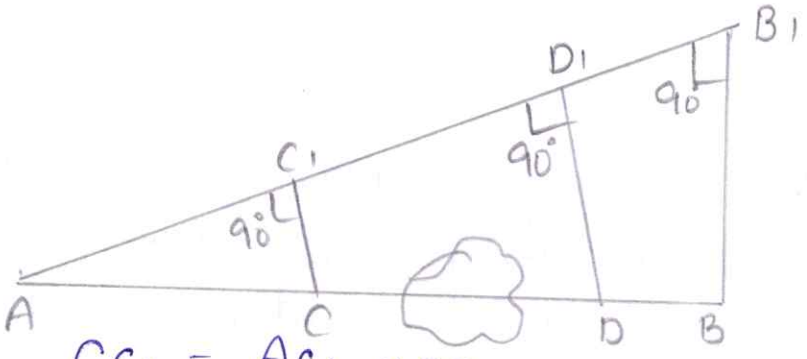
① Chaining free, vision obstructed
② Chaining obstructed, vision free
③ Chaining & vision both obstructed

It sometimes happens that a survey line passes through some object such as pond a building. a river a hedge etc which prevents the direct measurement of that part of the line which the object intersects the interfering object in such a case is called an obstacle

Type ①:- Chaining free, vision Obstructed

Case ①:- Both ends of the line may be visible & form intermediate points on the line - method of reciprocal ranging may be used.

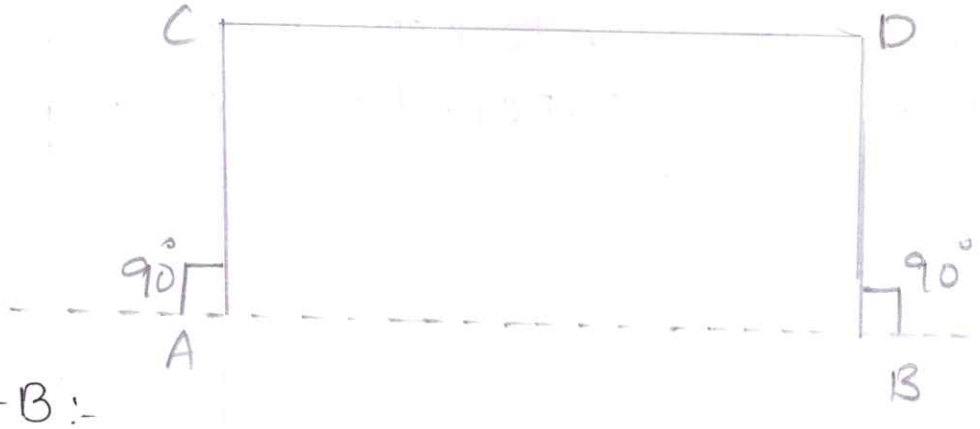
Case ②:- Both ends of the line may not be visible from intermediate points on the line. let AB be the line in which A&B are not visible from intermediate point on it. Draw a random line AB₁ in any convient direction. B₁ is visible from B. & BB₁ is ⊥ᵍ to the random line.



$$CC_1 = \frac{AC_1}{AB_1} \times BB_1$$

$$DD_1 = \frac{AD_1}{AB_1} \times BB_1$$ join C and D.

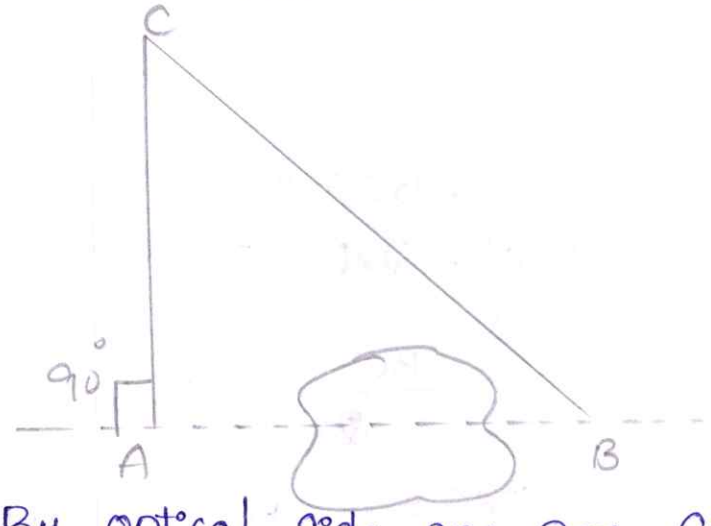
Type ②:- Chaining obstructed, vision free



Method-B :-

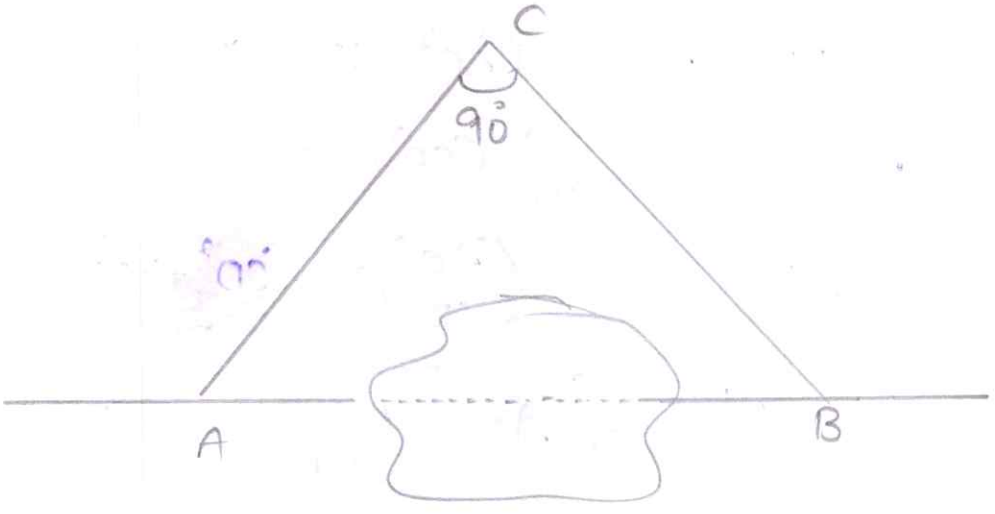
Set Out AC ⊥ᵍʳ to the chain line measure AC & BC then length AB^2 is equal to $CB^2 + AC^2$

$$AB = \sqrt{CB^2 - AC^2}$$



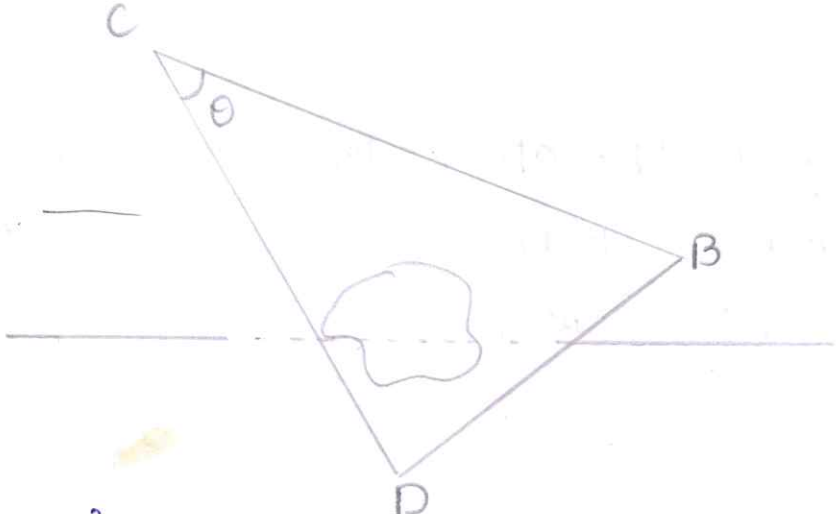
Method-C :- By optical side one are Cross top find point C with Subtends 90° with A & B. Measure AC & BC then length AB

$$AB = \sqrt{AC^2 + BC^2}$$



Method-D

Select two point C & D to both sides of A & in the same line. measure AC & AD, DC and BD, let angle BCD is θ



$\Delta BCD \Rightarrow BD^2 = BC^2 + CD^2 - 2BC \times CD\cos\theta$

$\Delta BCA \Rightarrow AB^2 = BC^2 + AC^2 - 2 \times BC \times BC\cos\theta$

from $BCD \Rightarrow \cos\theta = \dfrac{BC^2 + CD^2 - BD^2}{2 \times BC \times CD} \rightarrow (1)$

from $\Delta BCA \Rightarrow \cos\theta = \dfrac{BC^2 + AC^2 - AB^2}{2 \times BC + AC} \rightarrow (2)$

eq (1) & (2)

$$\frac{BC^2 + CD^2 - BD^2}{2 \times BC \times CD} = \frac{BC^2 + AC^2 - AB^2}{2 \times BC \times AC}$$

$$\Rightarrow (CD^2 - BD^2)\,AC = (AC^2 - AB^2)\,CD$$

$$AC^2 - AB^2 = \frac{AC}{CD}(CD^2 - BD^2)$$

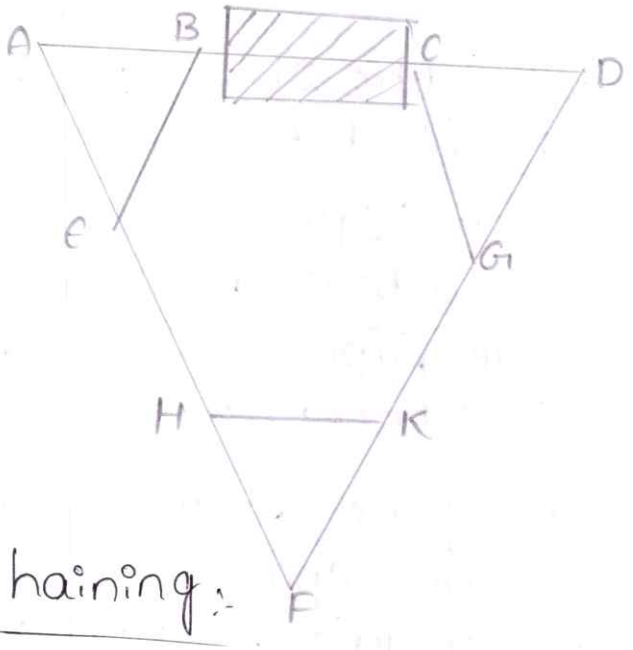
$$AB^2 = AC^2 - \left(\frac{AC}{CD}\right) \times (CD^2 - BD^2)$$

$$AB = \sqrt{AC^2 - \frac{AC}{CD}(CD^2 - BD^2)}$$

Method - E :-

(a) Mark a point C so that CA & CB clear the obstacle as shown below range E in line with AC so that CE = AC then range D in the line with BC so that CD = BC. the triangles CAB & CED are congrent. therefore DE = AB

(b) Choose two points A & B on the chain line with AB as base, construct an equilateral triangle ABC by swinging equal are with a tape. produce AC to D & the take a point E on DA. again Contract on equilateral triangle DEF with DE



Errors in chaining :-

Error due to incorrect chain Survey :-

If the chain is too long, the measured distance will be less than the actual distance, resulting in a negative error & requiring a position correction.

Understanding the Error :-

Chain Too long :-

When the chain is longer than the standard length it will cause the measured distance to be shorter than the actual distance this results in a negative error in the measurement.

Chain Too Short:-

When the chain is shorter than the standard length, it will cause the measure distance to be longer than the actual distance this results in a positive error in the measurement

Applying Correction:-

True length = Measured length * (True length of chain / in correct length of chain)

Field Book:-

The book in which the chain (or) Tape measurements are entered is called as field book. it is an Oplan book of size about 20cm x 12 cm & Opens length wise. the main requirements of the field book are that it should contain good quality. Stout Opaque paper, it should be well bound & of a size convient for the pocket.

The chain line may be represented either by a single line (or) by two lines spaced about 1.5 to 2 cm a part, ruled down the middle of each page. the double line field book is most Commonly used for Ordinary work the distance along the chain being entered between the two lines of the page. Single line field book is used for comperatevely large scale & most detailed dimension work.

Types of Compass:-

In Surveying, the two main types of compasses are the prismatic Compass & Surveyor's Compass. these are both magnetic Compasses, but they differ in their Construction & how they are used.

Prismatic Compass :-

features :-

A prismatic Compass has prism that allows for simultaneous sighting & reading of the bearing. it is generally a smaller handled instrument

Uses

Primarly used for reconnaissence surveys, filling in details, & in areas, where chaining is difficult. it is also used for military Surveys & Sketches along roads & rivers

Graduations :-

Graduations are marked in a clockwise direction from 0 to zero degree with the north directions being zero degrees.

Advantages :-

portable, allows for quick readings & can be used in various terrains

Disadvantages :-

Can be affected by local magnetic distrubances, so care must be taken to avoid these.

Surveyor's Compass :-

features :-

A Surveyor's Compass typically has a larger more accurate instrument, often used on a stand (or) tripod it has a magnetic needle, a graduated circle, & line of sight, but no prism

Uses:-

Used for measuring horizontal angles in a transverse and is generally used with a tripod

Graduations:-

The graduated circle is divided with four gradrants, with graduations from 0 to 90 degrees in each.

Advantages:-

More accurate than a prismatic compass for certain types of measurements.

Disadvantages:-

Requires more setup time & is not as portable as a prismatic Compass.

Bearings:-

In Compass Surveying, bearing refers to the horizontal angle blw a survey line & a reference direction, typically north to south it indicates the direction of a survey line & is crucial for plotting & transversing Surveys.

Types of Bearings:-

Whole Circle Bearing (WCB):-

The angle measured clockwise from the north or south point of reference meridian to the survey line, ranging from 0° to 360°

Reduced Bearing (RB) to Quadrantal Bearings:-

The angle measured clockwise (or) anticlock wise

from the north (or) south point of the reference meridian towards the east (or) west, ranging from 0° to 90°

Magnetic Declination :-

If the north end of the magnetic needle points towards the east side of the true meridian the declination is termed as declination east (+ve)

If the north end of the magnetic needle points towards the west side of the true meridian the declination that is declination west (-ve)

Plane Table Surveying :-

Three distinct types of tables (board & tripod) having devices for levelling the plane table & controlling its orientation are in common use

1. The traverse table
2. The Johnson table and
3. The Coast Survey table.

The traverse table :-

The traverse table consists of a small drawing board mounted on a light tripod in such away that the board can be rotated about the vertical axis & can be clamped in any position.

Johnson Table :- This consists of a drawing board usually 45x60cm (or) 60x45cm. The head consists of a ball & socket joint & a vertical spindle with two thump screws on the under side

The Coast Survey Table :-

This table is superior to the above, two types & is generally used for work of high precision, the levelling of the done way accurately with the help of the foot screws

② Alidade :-

A plane table alidade is a straight edge with some from of sighting device. Two types are used
① plain Alidade ② Telescopic alidade

plain Alidade :-

fig 11.3 shows the sample form & used for ordinary work.

Telescopic Alidade :-

The telescopic alidade is used when it is required to take inclined Slights

③ plumbing fork :-

The plumbing fork used in large scale work, is meant for centering the plane table when the plotted position of that point is already known on the sheet. Also in the beginning of the work.

④ Spirit Level :-

A small spirit level may be used for asertaining if the table is properly used.

⑤ Compass :-

The Compass is used for orienting the plane table to magnetic north. the Compass used with a plane table is a through Compass in which the longer sides of the through are parallel & flat so that either side can be used as a ruler or laid down to coincide with a straight line drawn on the paper

(6) Drawing paper :-

The drawing paper used for plane tabling must be of superior quality so that it may have minimum effect of changes in the identify of the atmosphere

Working Operations :-

Three Operations are needed

(1) fixing :- fixing the table to the tripod

(2) Setting :- (1) Levelling the table
(2) Centering
(3) Orientation

(3) Sighting the points.

Setting

Levelling :- for small-scale work levelling is done by estimation for work of accuracy. An ordinary spirit level may be used. the table is levelled by placing the level on the board in two positions of right angles & getting the bubble central in both directions

Centring :- The table should be so placed over the station on the ground that the point plotted on the sheet corresponding to the station occupied should be exactly over the station on the ground.

Orientation :- Orientation is the process of putting the plane table into some fixed direction so that line representing a certain direction on the plan is parallel to that direction on the ground this is parallel essential condition to be ful filled when than one instrument station is to used.

There are two main methods of Orienting plane table

① Orientation by means of through Compass
② Orientation by means of back-sighting

*) Orientation by through Compass :-

The Compass, through less accurate, often proves a valuable adjacent in enabling the rapid approximate to be made prior to the final adjustment.

ⓐ When speed is more important that accuracy.
ⓑ When there is no second point available for Orientation
ⓒ When the transverse is so long that accumulate errors in carrying the azimuth forward might be greater than orientation by compass
ⓓ for approximate Orientation prior to final adjustment
ⓔ In certain resection problems.

*) Orientation by back Sighting :- Orientation can be done precisely by sighting the points already plotted on the sheet two cases may arise

ⓐ When it is possible to set the plane table on the point already plotted on the sheet by way of observation from previous station.

ⓑ When it is not possible to set the plane table on the point

Problems :-

The magnetic bearing of a line 48°24m. Calculate the true bearing if the magnetic declination is 5°38' east

True bearing = Magnetic bearing + declination

$\Rightarrow 48^\circ 24' + 5^\circ 38'$

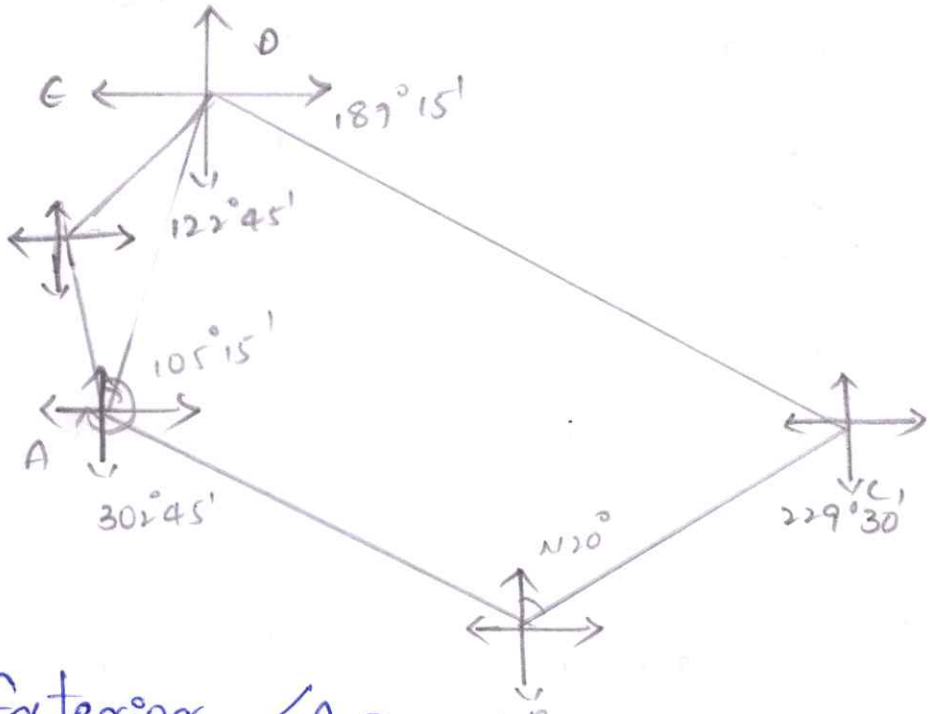
$\Rightarrow 54^\circ 2'$

The bearings of the sides of a closed transverse ABCDE are as follows.

Side	fore bearing	Back bearing
AB	105°15'	285°15'
BC	20°0'	200°0'
CD	229°30'	49°30'
DE	187°15'	7°15'
EA	122°45'	302°45'

Compute the interior Angles of the transverse

Side	fore bearing	Back bearing	difference
AB	105°15'	285°15'	180°
BC	20°0'	200°0'	180°
CD	229°30'	49°30'	180°
DE	187°15'	7°15'	180°
EA	122°45'	302°45'	180°



Exterior $\angle A$ =

$= 302°45' - 105°15'$

$= 197°30'$

Interior Angle $\angle A = 360° - \angle A$ (Exterior)

$= 360° - 197°30'$

$= 162°30'$

Exterior Angle $\angle B = 285°15' - 20° = 265°15'$

Interior Angle $\angle B = 360° - 265°15' = 94°45'$

Interior Angle $\angle C = 229°30' - 220'$

$= 29°30'$

Interior Angle $\angle D = 187°15' - 49°30'$

$= 137°45'$

Interior Angle $\angle E = 122°45' - 7°15'$

$= 115°30'$

Check :- Sum of interior Angles $= (2n-4)+90$

$= (2\times5-4)+90$

$= 540^\circ$

$162^\circ30' + 94^\circ45' + 29^\circ30' + 137^\circ45' + 115^\circ30'$

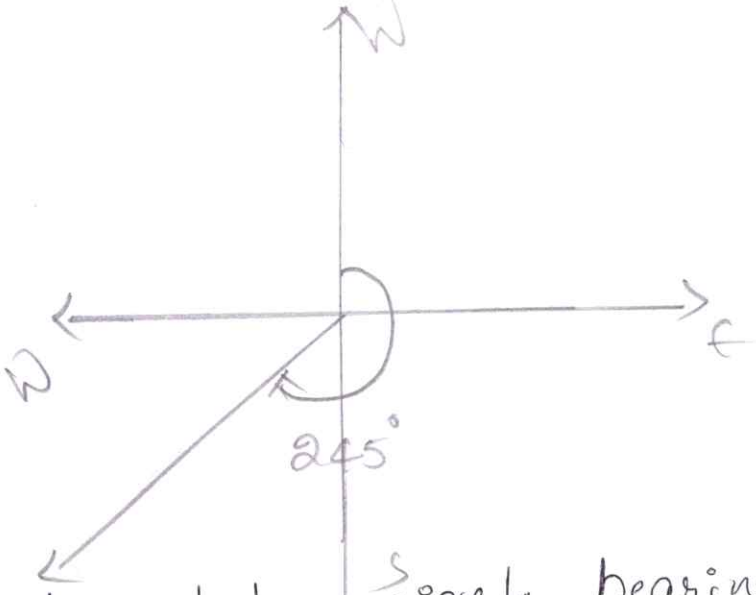
$= 540^\circ$

Convert whole circle bearing to reduced bearing

(i) 245°

(A) $RB = 245^\circ - 180^\circ$

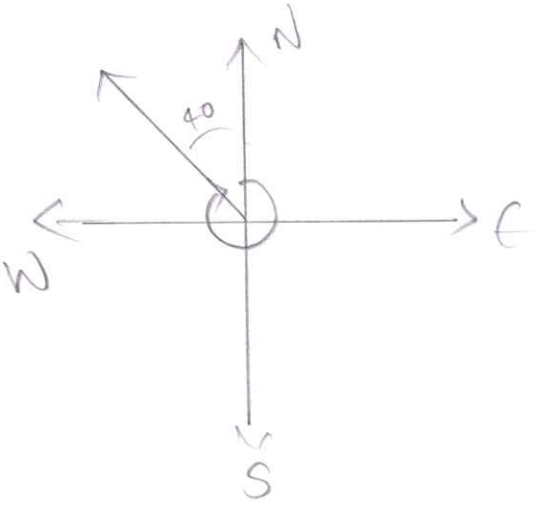
$= S65^\circ W$



Convert Reduced bearings to whole circle bearings

(i) $WCB = 360^\circ - 40^\circ$

$= 320^\circ$



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CIVIL ENGINEERING

Surveying and Geomatics

UNIT-2

Unit - ②

Levelling :-

It is a branch of surveying, the object of which is

① To find the elevation of given points with respect to a given datum

② To establish points at a given elevation (or) at different elevations with respect to a given datum

Types of Levels :-

The purpose of a level is to provide a horizontal line of sight essentially a level consists of the following four parts.

⇒ A telescope to provide a line of sight
⇒ A level tube to make the line of sight horizontal
⇒ A levelling head to bring the bubble in its centre of run
⇒ A tripod to support the instrument

There are the following chief types of levels:-

① Dumpy Level :-

The dumpy level originally designed by gravit consists of a telescope tube firmly secure in two collars fixed by adjusting screws to the stage carried by the vertical spindle

The modern form of a dumpy level as the telesope tube and the vertical spindle cast in one piece and along bubble. Tube is attached to the top of the telescope. This is the form is Knoion as "Solid dumpy"

② Y-level (or) wye-level:-

The essential difference between dumpy and wye-level is that in the formar case the telescope is carried in the two vertical Y-supports. the Y-support consists of curved clips if the clips are rised, the tele scope can be rotated in the wice (or) removed and turned end for end when the clips are fastened the telescope is held from turning about its axis by a one of the clips. the bubble tube may be attached either to the the clips. the stage carrying by the wise. the bubble tube must be half B of reversible type in the case of former

The main advantage of Y-level over the dumpy level in the fact that the adjustment can be tested with greater rapidly & easy. However the adjustments donot have longer life are distributed more frequently due to large no. of movables.

③ Reversible level:- A reversible level combines the features the both the dumpy level and the wye level the telescope is supported by two rigid sockets into which the telesope can be introduced from either & then fixed in position by a screw. the sockets are rigidly connected to the spindle through a stage. once the telescope is pushed into the sockets and the screw is hightened. the level acts as a dumpy level. for testing & making the adjustments. the screw is slackened and the telescope can be tanken out and reversed end for end. the telescope can also be turned with in the socket about the longitudnal axis

(4) Tilting Level:-

In the case of a dumpy level and a wy-level. the line of sight is 1^{r} to the vertical axis. Once the instrument is levelled the line of sight becomes horizontal and the vertic axis becomes truly vertical provided the instrument is in adjustment. In the case of tilting level, however, the line of sight can be tilted slightly without tilting the vertical axis. Thus, the line of sight and the vertical axis need not be exactly 1^{r} to each other. This feature, therefore, helps in quick levelling. the instrument is levelled roughly by the thres-foot screws with respect either to the bubble tube or to a small circular bubble, thus making the vertical axis approximately vertical. while taking the sight to a staff, the line of sight is made exactly horizontal by centering the bubble by means of a fine pitched tilting screw which tilts the telescope with respect to the vertical axis. it is, however, essential that the observer, should have the view of the bubble tube while sighting the staff

Adjustments of Levelling:-

Each Surveying instruments needs two types of adjustments

(1) Temporary adjustments (or) Station Adjustments:-

(a) Those which are made at every instruments Setting and preparatory to taking observation with the instrument

② permenent Adjustments :-

Its need be made only when the fundamental relations between some parts (or) lines are distributed the Temporary adjustments for level consists of the following :-

Setting up the level :- The operation of Setting up includes.

⇒ fixing the instrument on the stand

⇒ Levelling the instrument approximately by leg adjustment

To fix the level to the tripod the clamp is released, instrument is held in the right hand and is fixed on the tripod by turning round the lower part with the left hand.

Levelling up :- After having levelled the instrument approximately, accurate levelling is done with the help of foot screws and with refference to the plate levels. The purpose of levelling is to made the vertical axis truely vertical. The manner of levelling the instrument by the plate levels depends upon whether there are 3 levelling screws (or) four (4) levelling screws

⇒ Three (or) four Screw head :- Axis of the bubbl tube ⊥ᵍʳ to the vertical axis.

*) Level the instrument & centre the bubble

*) Rotate the telescope 180° and observed the bubble.

*) If the bubble is not centered, adjust the screw of the bubble tube and the untill it is

⇒ Repeat this process until the bubble remains Centered bubble when the telescope is rotated

Elemination of parallax :- A condition rising when the image formed by the objective is not in the plane of the cross hairs unless the parallax is eliminated, accurate sighting is impossible parallax is can be eliminated in two steps :-

⇒ By focusing the eye-piece for distrinct vision of cross-hairs

⇒ By focusing the objective to bring the image of the object in the plane of cross-hairs

Methods of Levelling :-

Several Methods are used to achieve this, broadly Categorized into direct and indirect Methods. direct methods involve using a level instrument And a grauted Staff, while indirect method, rely on othes measurement like angles or a atmospheric pressure to calculate elevations

① Direct Levelling Methods :-

① Simple levelling :-

A single step of the level instrument is used to determine the elevation of a point

② Differential Levelling :-

this method is used when points are far apart (long distance), requiring multiple instruments set up.

③ fly Levelling :- A quick and less precise method for recognnaisanse or checking approximate levels.

④ Profils Levelling :- Determination of elevation of points along a line or canal centre line at specified intervals

⑤ precise Levelling :- A highly accurate form at differential levelling often used for critical projects.

⑥ Cross-Sectional Levelling :-

Used in conjection with profile levelling to determine the elevations at right angles to the profile line

⑦ Reciprocal Levelling :- used when a direct line of sight is obstructed line across a river, involving simultaneous observations from both ends.

* Indirect Levelling Methods :-

① Trignometric Levelling :- Calculate elevations using vertical angles and horizontal distance between points

② Barometric Levelling :- Estimate elevations based on differences in atmospheric pressure

③ Stadia Levelling :- Uses a tacheometer to measure distances at vertical angles, providing an indirect measures of levelling

*) Other Levelling Techniques:-

① Check Levelling:- This method used to verify the accuracy of levelling work by repeating measurements.

② Contour Levelling:-

Creating Contour lines on a map to represent point joints on equal elevations.

Height of Instrument Method:-

⇒ It is simple, less tedious And quicker
⇒ There is no ~~&~~ check on the ~~ris~~ reduced levels of intermediate stations
⇒ Errors in any of the intermediate sights are not detected
⇒ There are two Arithematical checks i.e,

$\Sigma B.S - \Sigma F.S$ = last R.L - first R.L

⇒ It is more suitable for the reduction of levels are cross-Sectional (or) longitudnal levelling.

Rise and fall Method:-

⇒ It is labonious, since the staff reading of each station is compared to find rise and fall.
⇒ There is a Complete check on the reduced levels of intermediate station also
⇒ Errors in the intermediate sights are detected, as there are used for finding its rise and falls

⇒ There are three arithematical checks i.e,
$\Sigma B.S - \Sigma f.S = Last\ R.L - first\ R.L = \Sigma Rise - \Sigma fall$
⇒ It is more Suitable to determine the difference in levels of two points where Accuracy is needed.

Contour Surveying :-

Contouring in Surveying is the determination of elevation of various points on the ground. and fix these points of same horizontal position in the contour map

*) A contour is a group of imaginary lines. based on the instruments one can classified the contouring in different types

Methods :- These are two methods of contour Surveying

(1) Direct Method :-

It consists finding vertical and horizontal Controls of the points which live on the Selected Contour lines explain as follows

⇒ for vertical control levelling instrument is Commonly used. A vertical is set on a commonding position in the area after taking fly levels from the by bench mark. The plane of collimation (or) Height of instrument is found and the required staff reading for a contour Line is a calculated

⇒ The instrument man asks staff man to move up & down in the area till the required

is found. A surveyor establishes the horizontal control of that point using his instrument

⇒ After that instrument man directs the staff man to other point where the same staff reading can be found. it is followed by establishing horizontal control

⇒ Several points are established on a contour line on one or two contour lines and suitable noted down plane table survey is ideally suited for this work

⇒ After required points are establised from the instrument set in instrument is shifted to another point to cover more area the level and survey instrument need not to be shifted at the same time. it is better if both are near to communicate easily

⇒ for getting spead in levelling some times hand level abney levels are also elsed. this method is slow tedious but accurate. It is suitable for small areas

(2) Indirect Method:-

In this method levels are taken at some selected points and they levels are reduced thus in this method horizontal control is established first and then the levels of these points found after locating the points on the plane, R.L.s are marked.

for selecting points any of the following

methods can be used

① Method of Squares

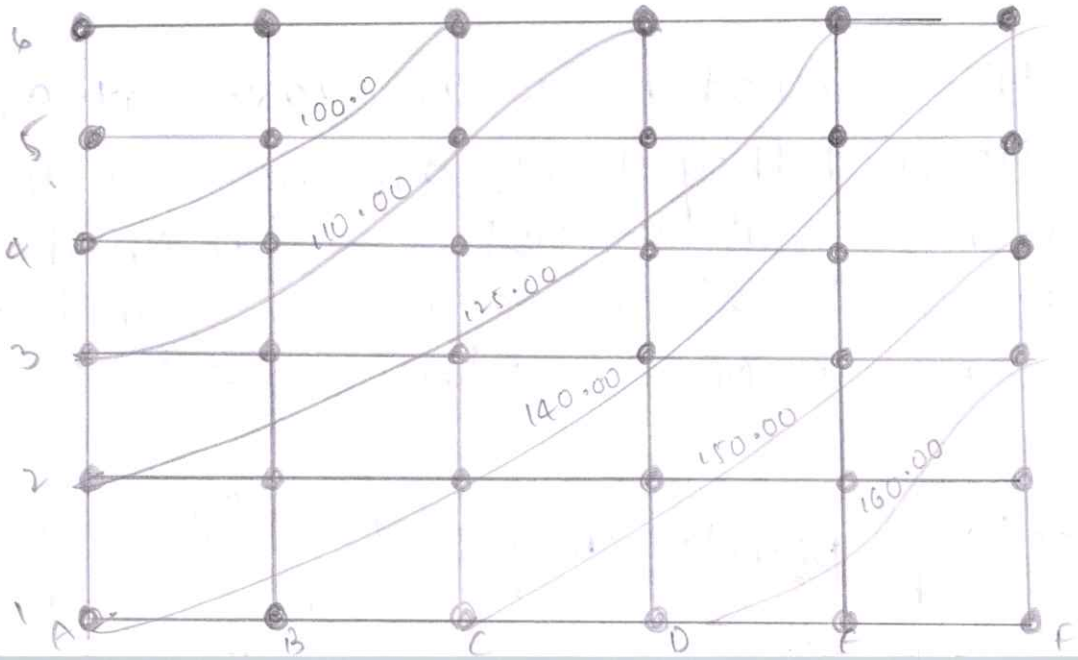
② Method of Cross-Section

③ Radial line method

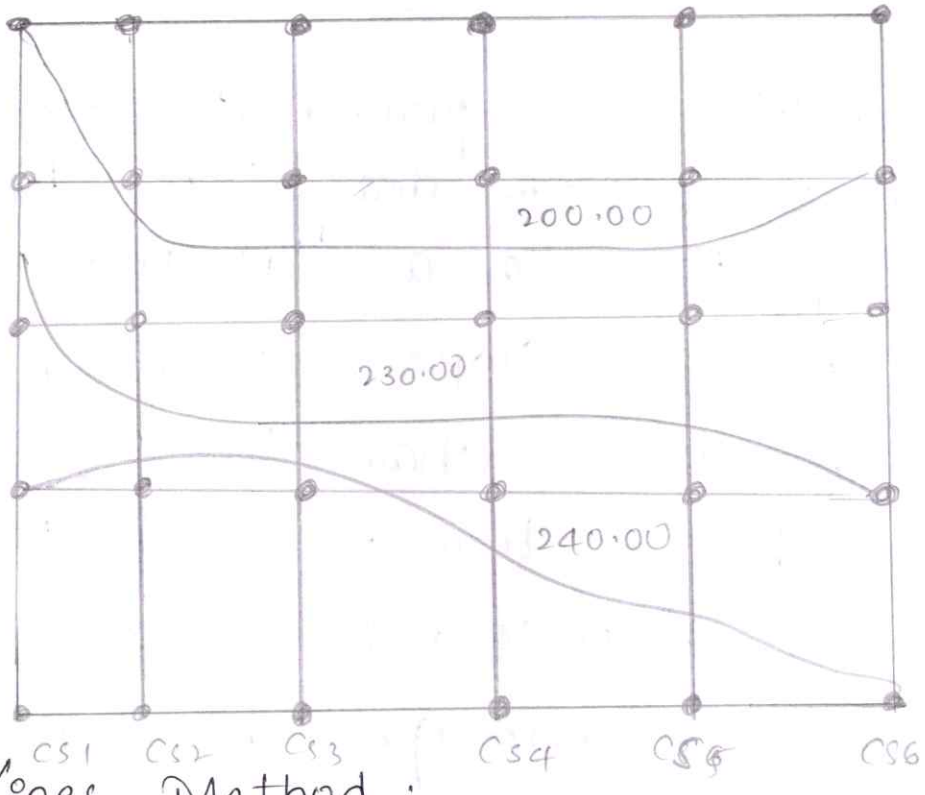
① Method of Squares (Grid Method):-

This is also called Coordinate method of locating Contours. This method is used when the area to be Contoured is not very large and where the ground is not much undulating.

In this method, the entire area is divided into Squares or rectangles forming a grid. the grid points are marked at the intersection of the grid lines points are identifed by the number and letter of the intersecting lines. the size of square depends upon the nature of the ground and the accuracy required. It generally varies from 5m to 20m. the elevations of the corners are then determined by spirit levelling. The levels are then interpolated.



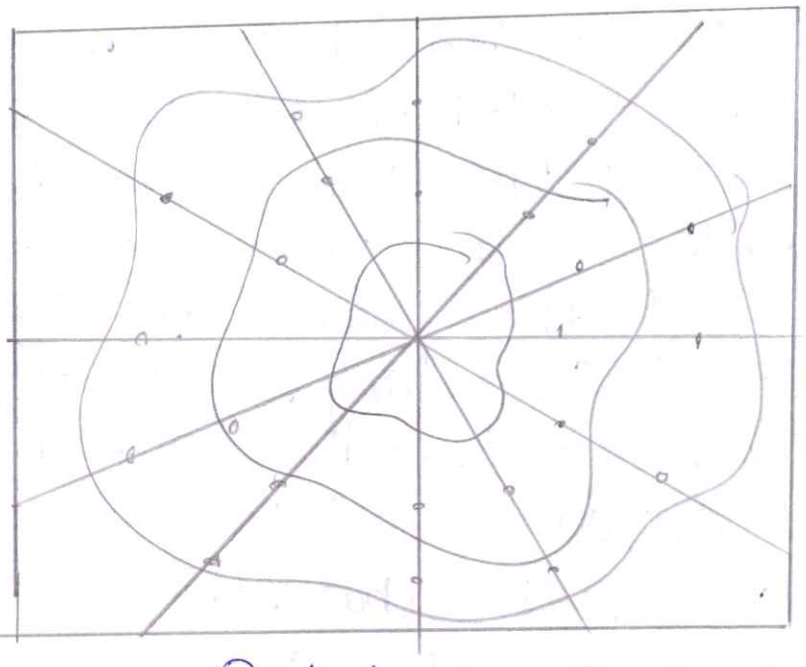
② Cross-Section Method :- The cross-section method generally used for the determination of contour along a fixed route, such as a road, canal, railway, line etc.. Cross-sections are located on the ground at right angles to the fixed line (or centre line) of the route. the spacing of the cross-sections depends upon the nature of the ground. the contour interval and the purpose of contouring. After this, points are marked along the fixed line and the cross-section. After calculation of RL's of all the plotted to a suitable scale. After that, the required contour line is drawn by interpolation.



③ Radial Lines Method :-

for measuring contouring small hilly areas, radial lines are run from the peak to cover the area. the guide points are taken on the radial lines and their elevations are determined with a level. After plotting radial lines, guide points, the

required Contour lines are obtained by interpolation



Radial line Method

Uses of Contours :-

① Representation of ground surface

=> Contours give a clear idea of the topography (hills, valleys, slopes) on a flat map

② Determination of slope & Gradient

③ Determination of characteristics of terrain

④ Distance between two inaccessible points

⑤ Estimation of reservoir capacity

=> The slope of the ground can be studies.

=> Closed contours -> Steep slope

=> Wide contours -> Gentle slope

⑥ Selection of sites

*) Helps in choosing suitable sites for dams, canals, railways, buildings etc

(4) Alignment of Engineering projects

*) Best alignment of roads, railways, canals, pipelines.

General Methods of Competation of Areas:

The following are the general Methods of Calculating areas

(1) By competations based on directly on field measurements

(*) By dividing the area into no.of triangles

(*) By offsets to base line

(*) By latitude and depatures

=> DMD [double maridian distances]

=> DPD [Double parallel distances]

(*) By coordinates

(2) By competation based on measurements scale from a map

(3) By mechanical method (usually by means of a planimeter

*) By dividing the area into no.of triangles

Thus if two sides and one included of a triangle is measured, the area of triangle is given by

$$\text{Area} = 1/2 \times ab \sin c$$

When the lengths of the three sides of a triangle are measured its Area is Computed by Equation

$$\text{Area} = \sqrt{S(S-a)(S-b)(S-c)}$$

S = Half perimeter = $1/2\,(a+b+c)$

*) Area from offsets to a base line (offsets at regular intervals)

This method is suitable for long narrow strips of land. The offsets are measured from the boundary to a base line (or) a survey line at regular intervals. The Area may be calculated by the following rules.

The Area may be calculated by the rule

1. Mid-Ordinate Rule
2. Average-ordinate Rule
3. Trapezoidal Rule
4. Simpson's Rule

Mid-Ordinate Rule :-

$$\text{Area} = (O_1 + O_2 + \dots + O_n)\,d$$

O_1, O_2 = The ordinates at the mid points of each division

n = number of divisions

L = length of base line $= nd$

d = Distance of each division

② Average Ordinate Rule :-

The offsets are measured to each of the points of the divisions of the base line

$$\text{Area} = \left[(O_1 + O_2 \dots O_n)/n+1\right] \times L$$

$O_1, O_2 \dots$ = Ordinates at the of each division

③ Trapezoidal Rule :-

This rule is more accurate than the previous two rules (mid ordinate rule, Average Ordinate rule) which are approximate versions of the trapezoidal rule

The Area of the first trapezoidal is

$$\Delta_1 = \left(\frac{O_0 + O_1}{2}\right) d$$

$$\Delta_n = \left(\frac{O_{n-1} + O_n}{2}\right) d$$

Total Area

$$\Delta = \Delta_1 + \Delta_2 \dots \Delta_n$$

$$= \frac{O_0+O_1}{2} + \frac{O_1+O_2}{2} + \cdots\cdots + \frac{O_{n-1}+O_n}{2} d$$

$$= \left[\frac{O_0+O_n}{2} + (O_1+O_2+ \cdots\cdots +O_{n-1})\right] d$$

$$= \frac{d}{2}\left[O_1+O_n+2(O_2+O_3+ \cdots O_{n-1})\right]$$

$$A = \frac{d}{2}\left[\begin{matrix}\text{1st}\\\text{Ordinate}\end{matrix} + \begin{matrix}\text{Last}\\\text{Ordinate}\end{matrix} + 2\left(\begin{matrix}\text{remaining}\\\text{Ordinate}\end{matrix}\right)\right]$$

(4) Simpson's Rule:

It is a method used to calculate the area of irregular boundaries when offsets are taken at equal intervals along a survey line

*) The boundary b/w every two offsets is assumed to be a simpson's rule

$$A = \frac{d}{3}\left[\begin{matrix}\text{first}\\\text{Ordinate}\end{matrix} + \begin{matrix}\text{Last}\\\text{Ordinate}\end{matrix} + 4(\text{Sum of even ordinates}) + 2(\text{Sum of odd ordinates})\right]$$

O_1, O_2, O_3, O_4, O_5

$$A = \frac{d}{3}\left[O_1+O_6+4(O_2+O_4)+2(O_3+O_5)\right]$$

The following staff readings were observed sucessefully with level the instrument have been moved forward after second, fourth, eight readings - 0.875, 1.235, 2.310, 1.385, 2.930, 3.125, 4.125, 0.120, 1.875, 2.030, 3.765 the first reading was taken with the staff held upon a bench mark of elevation 139.135 apply usual check calculate elevations (or) reduced level

Height of instrument Method :-

B.S	I.S	f.s	H.I	R.L	Remarks
0.875		1.235	133.01	132.135	BM
2.310		1.385	134.085	131.775	1st 2nd
2.930			135.63	132.7	
	3.125			132.505	
	4.125			131.505	
		0.120		135.51	3rd shift
1.875			137.385	135.355	
	2.030			133.62	Last
		3.765			

$\Sigma B.C - \Sigma F.S$ = Last R.L - first R.L

$7.99 - 6.505 = 133.62 - 132.135$

$1.485 = 1.48K$

OK //

The following Conjugate readings were taken with a level & 3m levelling staff and Continuosly sloping ground at a Common interval of 20m, 0.602, 1.234, 1.860, 2.574, 0.238, 0.914, 1.936, 2.872, 0.568, 1.824, 2.722. The R.L of the first point was 192.122. Rule out a page of a level field book & entes the above readings. Calculate the reduced level of the points by readings. Rise & fall method & apply checks

B.S	I.S	F.S	Rise	fall	R.L	Remarks
0.602					192.122	B.M
				0.632	191.49	
	1.234					
				0.626	190.864	
	1.860					
				0.714	190.15	1st shifted
		2.574				
				0.676	189.474	
0.238						
				1.022	188.452	
	0.914					
				0.936	187.516	2nd shift
	01.936					
				1.256	186.26	
		2.872				
0.568						
				0.898	185.362	
	1.824					Last point
		2.722				

Check :-

$\Sigma B.S - \Sigma F.S = \Sigma Rise - \Sigma fall = Last\ R.L - first\ R.L$

$1.408 - 8.168 = 0 - 6.76 = 185.362 - 192.122$

$-6.76 = -6.76 = -6.76$

Hence OK //

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CIVIL ENGINEERING

Surveying and Geomatics

UNIT-3

Theodolite :-

Theodolite is a precise instrument used for accurate measurement of horizontal & vertical angles. it is widely used for various purposes And Hence it is called as an Universal instrument.

Theodolites Are primarily classified as ① Transit And ② Non-transit

① Transit

Transit theodolite is one in which the telescope can be revolved through a complete revolution about its horizontal axis in a vertical plane

② Non-transit

Non-transit theodolite is one in which the telescope can be rotated only by a limited amount in the vertical plane transit theodolite is now in use mostly.

Temperory Adjustments of theodolite :-

Temperory adjustments Are required to be made at every set-up of the instrument.

Following steps are to be followed for temperory adjustments of a theodolite

① Setting over the station :-

The tripod stand is placed approximately

over the station such that centre of tripod is just in line with the centre of the station, then the theodolite is bodily lifted from the box and fixed on the top of the tripod stand.

② Levelling by Tripod Stand:-

The legs of the tripod stand are spread well apart & to be fixed firmly on the ground. Approximate levelling is done by the stand itself. In order to do this, two legs are kept firmly fixed and the third one is moved such that the bubble remains at the centre of its run.

③ Centering:-

It is the process by which the instrument is set exactly over a station point at the time of levelling by leg adjustment itself the correct centering should be done by suspending the plumbob. the centering is then done accurately with the help of the shifting head and it should be ensured that the plum bob is exactly over the nail head of the station peg.

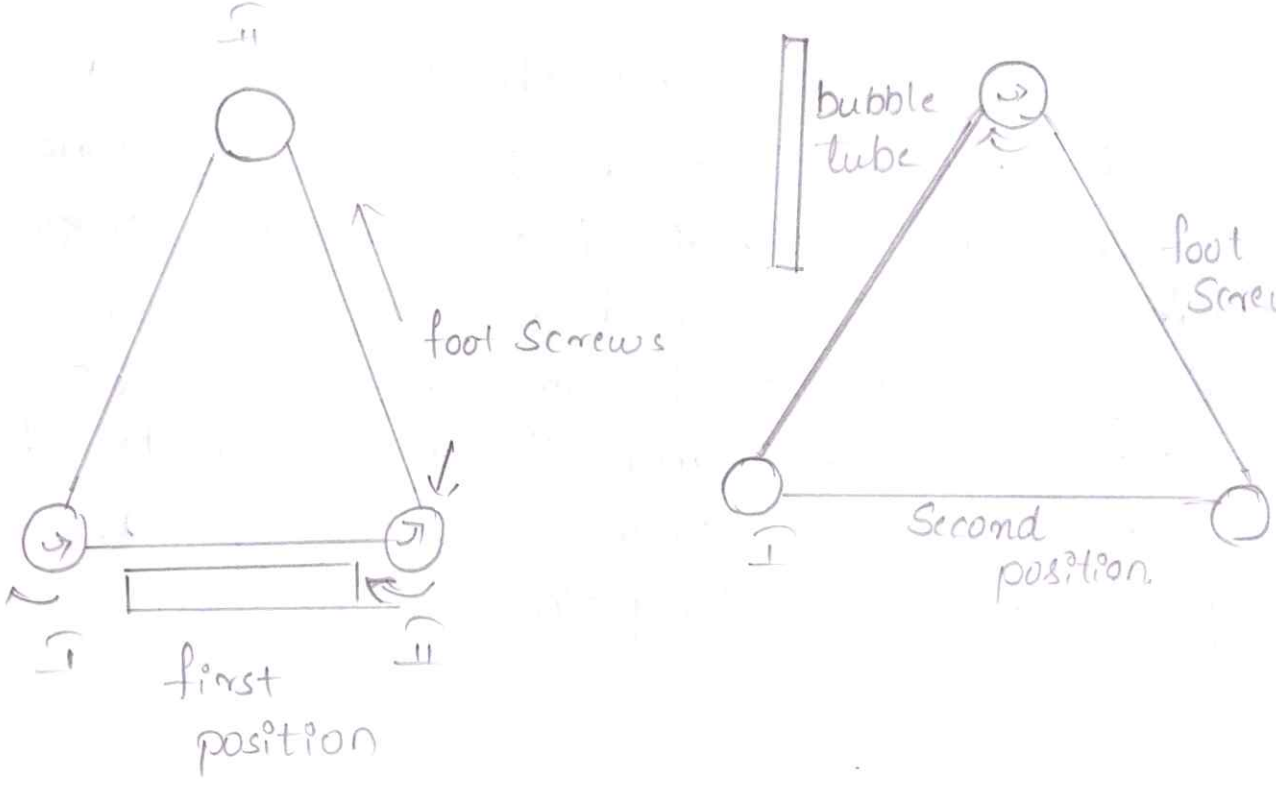
④ Levelling:-

Before starting the levelling it should be ensured that the foot screws are brought to the center of their run

Then in the first position the plate bubble is placed parallel to any pair of foot screws. the bubble is brought to the centre of its run by these two foot screws equally inwards or outwards

Now in the second position the plate bubble is turned through 90° such that is the perpendicular to the line joining two foot screws. the bubble is brought to centre of its run turning the third foot screw either clockwise (or) anti clock wise

The procedure is repeated such that bubble remains in the centre of its run in both the positions. Then the plate bubble is rotated 360° should about the vertical axis, then also the bubble should be at the centre of its run



⑤ focussing the eye-piece:-

focussing is done by adjusting the eye-piece for to get a clear view of the cross-hairs. this is done by directing the telescope to the sky or a piece of white paper is held in front of the object glass and they eye-piece moved in(or) out such that the cross-hairs appear clean & sharp

⑥ Elimination of parallax:-

This is done to get a sharp image of the object or tangent on the plane cross-hairs & to eliminate parallax. The telescope is directed towards the object and focussing is done untill the image appears clean and sharp. then by moving the eye-up and down, it is checked for any relative movement of the image. if there is no movement ensures no error due to parallax

⑦ Setting the vernier:-

Before Starting of the work, the vernier a should be set at 0° & B at 180°. this is done by fixing the lower clamp & looseing the upper clamp. the upper plate is moved untill the vernier approximately coincides with zero & the vernier B at 180°, Appear upper clamp is tightened by turning the upper tangent screws the arrows are exactly brought over 0° and 180° points

Methods of Measurement of Horizontal Angles:

1. Ordinary Method
2. Repetition Method
3. Reitration Method

(1) Repetition Method:-

This method is used for very accurate work, in this method, the same angle is added several times machinally & the correct value of the angle is obtained by dividing the accumulated reading by the no.of repetitions the no.of repetitions made usually in this method is six three with the face left & three with the face right in this way angles can be measured to a finger degree of acuracy than that obtainable with the least count of the vernier to measure horizontal angle by repetitions

(1) → Set up the theodolite at Starting point O & level it accurately

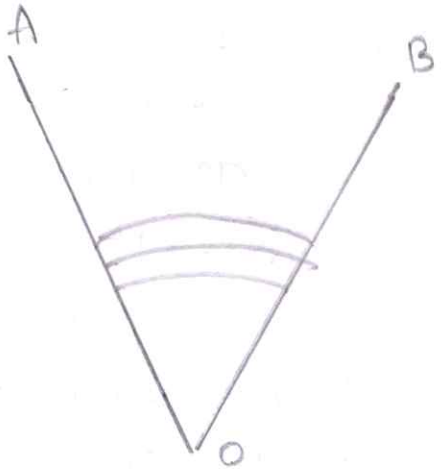
(2) → Measure the horizontal angle AOB

(3) → Loosen the lower clamp and turn the telescope clock wise unit the object (A) is sightened again bisect B, Accurately by using the upper tangent screw the vernier will now read the twice the value of the angle now

(4) → Repeat the process untill the angle is repeated the required no.of times casually 3) read again

both verniers to final reading after n repetations should be approximately nx (angle) divide the sum by the no.of repetations & the result thus obtained gives the correct value of the angle AOB.

⑤ ⇒ Change the face of the instrument repeat exactly in the same manner & find another value of the angle AOB. The average of two readings gives the required precise value of the angle AOB.



② Raiteration Method :-

This method is another precise and comparatevely less tedious method of measuring the horizontal angles

It is generally preferred when several angles one to be measured at a particular station

procedure :-

Suppose it is required to measure the angle AOB, BOC and COD, then to measure these angles by repetation method.

(1) => Set up the instrument over station point O and level it accurately

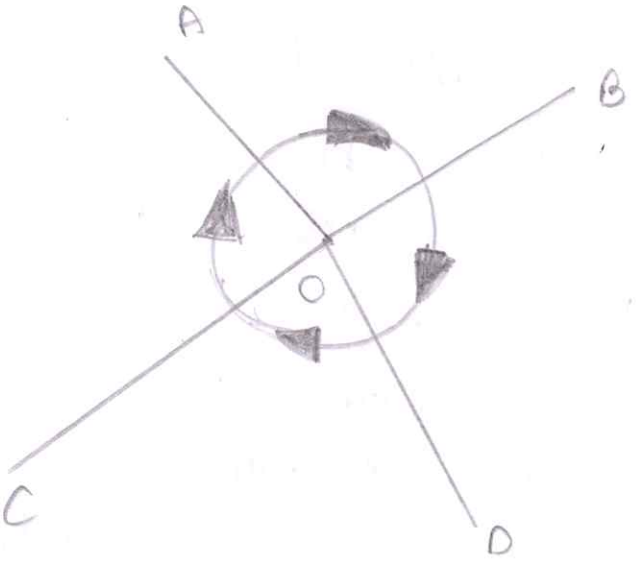
(2) => Direct the telescope towards point A which is known as referring object bisect it accurately & check the reading of vernier as 0 (or) 360° loosen the lower clamp and turn the telescope clockwise to sight point B. exactly read the verniers again and the mean reading will give the value of angle AOB.

(3) => Similarly, bisect C&D successively read both verniers at procedure each bisection, find the value of the angle BOC & COD.

(4) => finally, close the horizon by sighting towards the referring object (point A)

(5) => The vernier a should now read 360°. if not note down the error this error occurs due to slip etc

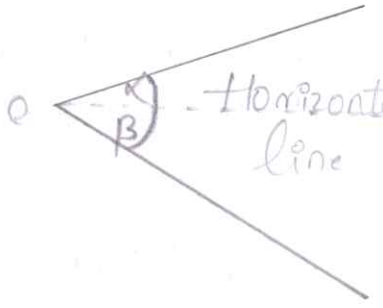
(6) => If the error is small it is equally distributed among the several angles. if large the reading should be discarded & a new set of readings be taken

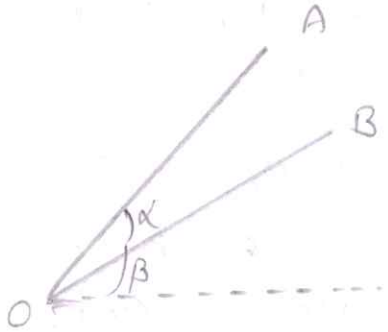


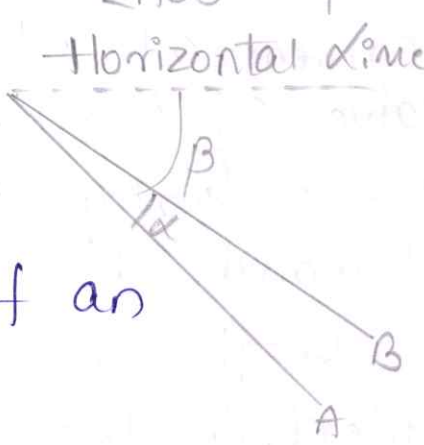
Methods of Measurements of vertical Angles:

Vertical Angle:-

A vertical angle is an angle between the inclined line of sight & the horizontal. It may be an angle of elevation (or) depression. According as the object is above (or) below the horizontal plane.







To measure the vertical angle of an object A at a station O

① ⇒ Set up the theodolite at station point O and level it accurately with ~~in~~ reference to the attitude bubble

② ⇒ Set the zero of vertical vernier exactly to the zero of the vertical circle clamp and tangent screw

③ ⇒ Bring the bubble of the attitude level in the antral position by using clip screw the line of sight is thus made Horizonatal and vernier still roads zero

④ ⇒ Loosen the vertical circle clamp screw and direct the telescope towards the object A & Sight it exactly by using the vertical scale

⑤ → Read both verniers on the vertical circle, the mean of the two vernier readings gives the value of the required angle

⑥ → Change the face of the instrument & repeat the process the mean of the instrument mean of two vernier readings gives the second value of required angle

⑦ → The Average of the two values of the Angles thus Obtained is the required value of the angle free from instrumental errors

→ For measuring vertical angle between two points A&B.

① Sight A as before and take the mean of the two vernier readings at the vertical circle let it be α

② Similarly sight B and take the mean of the two vernier readings at the vernier vertical angle circle. let it be B.

③ The Sum or difference of the dings will give the value of the vertical angle between A & B. According as one of the points is above and the other below the horizontal plane (or) both points are on the same side of the horizontal plane fig b&c

Traversing:-

Traversing is the type of Survey in which a no.of connected Survey line form the frame work and the directions & lengths of survey lines are measured with the help of an angle (or) directions measured instrument And a tape (or) chain respectively. when the lines form a circuit which ends at the starting point. it is Known as closed travels. if the circuit ends else it is said to be as open travels

Methods of Traversing:-

There are Several Methods of traversing. depending on instruments used in determining the relative directions of the traverse line

the following are the principle methods

*) Chain traversing

*) Chain And Compass traversing

*) Transit tape traversing

⟹ By fast needle method

⟹ By measurement of angle blw the lines

*) plane table traversing

Lattitude & depature:-

In Surveying, the position of a line is described with respect to a reference meridian (North-South line) & perpendicular to it (east-west line)

Latitude (L) :-

*) It is the projection of a survey line of the north-South axis (Meridian)

*) Represents the northing or Southing of the lines

Formula :- L = length of line x cosθ

*) positive if the line extends north word, negative if South word.

Depature (D) :-

*) It is the projection of a survey line of the east-west axis

*) Represents the easting (or) westing of the

formula :-

(D) = length of line x sinθ

Open & Closed traverse :-

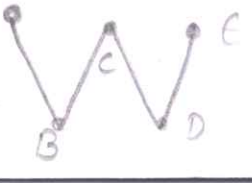
Open traverse :-

*) A series of connected survey lines that doesn't return to the starting point

*) Also called unclosed traverse

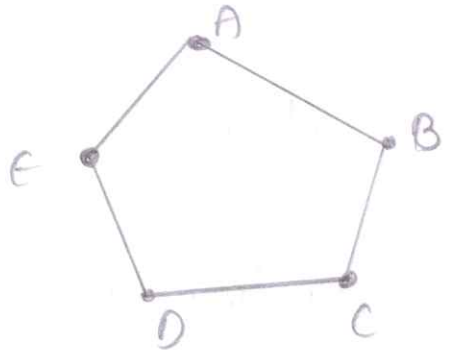
*) Commonly used in roads, canals, pipelines, railways, transmission, lines etc

*) It used for long narrow projects



Closed traverse:-

* A frame work which start and finish at point of known coordinate and its normally form in polygon
* A series of connected survey lines that form a closed polygon. i.e, the traverse returns to the starting point (or) close on a known station
* Used in property, surveys, boundaries, of lakes field, forests, etc



Calculation of closing Error:

When plotting a traverse (open (or) closed) the last point may not exactly meet the starting point due to errors in measurement of length (or) bearing. This gap is called the closing error.

① Compute lattitudes & depatures for each line

$$L = \text{length} \times \cos\theta \quad , \quad D = \text{length} \times \sin\theta$$

② find algebraic sum of all lattitudes and depatures

ΣL = Sum of north things - Sum of South things

ΣD = Sum of East things - Sum of West things

(3) Closing Error (e) = $e = \sqrt{(\varepsilon L)^2 + (\varepsilon D)^2}$

(4) Direction of closing error (εe) = $\varepsilon e = \tan^{-1}\left(\frac{\varepsilon D}{\varepsilon L}\right)$

(5) Relative precision of closure

$$\text{precision} = \frac{\text{Total length of traverse}}{e}$$

Note:-

→ If the traverse in perfectly closed, then

$\varepsilon L = 0, \varepsilon D = 0$

→ Small errors are adjusted using methods like Bowditch's rule (or) transit rule.

Bowditch's Rule (Compass rule):-

* Assumes errors linear measurements ∝ lengths of lines and errors in angular measurements ∝ length of lines
* Corrections to latitude (ΔL) & departure (ΔD) of each line are distributed in proportion to line length

formula:-

Correction in latitude of a line

$$= \frac{\text{length of line}}{\text{perimeter of traverse}} \times \varepsilon L$$

Correction in departure of line

$$\frac{\text{Length of line}}{\text{perimeter of traverse}} \times \Sigma D$$

Transit Rule:-

When angular measurements are more precise than linear

formula:-

Correction in latitude of a line

$$\frac{\text{Latitude of line}}{\Sigma|\text{Latitude}|} \times \Sigma L$$

Correction in departure of a line

$$\frac{\text{departure of line}}{\Sigma|\text{departure}|} \times \Sigma D$$

Graphical / Empirical Method:-

for approximate (or) small surveys

Empirical Method => used in rough survey Surveys where high accuracy is not essential

Omitted Measurements:-

*) In chain Surveying, while taking offset & chainages, some times certain readings are missed (or) omitted by mistake

*) These are called Omitted Measurements.

Cases of Omitted Measurements :-

(1) One offset omitted
(2) Two offsets Omitted
(3) Chainage Omitted
(4) Both chainage & offset method

* Tacheometry Surveying :-

Tacheometric is a branch of Surveying in which horizontal and vertical distances are determined by taking angular Observation with a instrument known as a tacheometer

Tacheometeric is adopted in rough & diffault terrain where direct levelling & chaining are either not possible or very tadious the accuracy attained in such that under favorable conditions the error will not exceed 1/100. And if the purpose of a survey doesn't require accuracy, the method is uncelled. tacheometric survey also can be used for railways, roadways, and reservoirs, etc. though not very accurate. tacheometric Surveying is very rapid, and a reasonable Contour map can be prepared for investigation work with in a short time on the basis of such Survey.

Uses of Tacheometry :-

(*) preparation of topo graphic map where both horizontal And vertical Distances are required to be measured

(*) Survey work in difficult terrain where direct methods of measurements are in Convi-ent

(*) Reconnaissance Survey for highways and railways, etc

Principle of Stadia method in tachomelry

The Stadia method is based on the principles that the ratio of perpendicular to the base is Constant in similar isoscels triangle.

$$\frac{Oc_2}{A_2B_2} = \frac{Oc_1}{A_1B_1} = \frac{Oc}{AB}$$

Constant $K = \frac{1}{2} \cot \frac{\beta}{2}$

This Constank K, entirely depends upon the magnitude of the angle β. it is made equal to 34'22' by the Constant

$$K = \frac{1}{2} \cot 14'11'.32 = 00$$

In this case, the distance b/w the Staff & the point O will be too times the start intercept In actual practice, Observations may be made with either horizontal line of sight or with inclined line of sight, in the latter case, the Staff may be Kept either vertically (or) normal to the line of sight

Let A, C & B = The point cut by the three lines of sight Corresponding to the three wires. b, c & a. Top Axial and bottom hairs of the

diaphragm

ab = i = Interval between the stadia hairs (stadia interval)

AB = s = Staff intercept

f = focal length of the objective

f_1 = Horizontal distance of the staff from the optical centre of the objectives

f_2 = Horizontal distance of the cross-wires from O

d = distance of the vertical axis of the instrument from O.

D = Horizontal distance of the staff from the vertical axis of the instrument

M = Centre of the instrument, Corresponding by the vertical axis

Since the ray Bob & Aoa pass through the optical centre, they are straight so that, Δs AOB & aob are similar, Hence,

$$\frac{f_i}{f_2} = \frac{s}{i}$$

Again, Since f_i & f_2 are Conjugate focal distances we have from lens formula,

$$\frac{1}{f} = \frac{1}{f_2} + \frac{1}{f_1}$$

Multiplying throught by f_1 we get $f_1 = \frac{f_1}{f_2} + f + f$

Substituting the values of $\frac{f_1}{f_2} = \frac{s}{i}$ in the above, we get $f_1 = \frac{s}{i} + f + f$

The Horizontal distance between axis the staff is $D = f_1 + d$

$$D = \frac{f}{i} s + (f + d) = Ks + C$$

The Constant $K = f/i$ is Known as the multiplying Constant (or) Stadia interval factor & the therefore the staff intercept is to be found by Substracting the staff reading Corresponding to top & bottom Stadia hairs.

The table below given a the lengths & bearing of a line, then calculate length & bearing of line JK (10)

Line	Length	Azimuth from South
JK	Un Known	un Known
KL	381.92	270° 00'
LM	203.94	29° 15'
MJ	135.30	90° 00'

Line	L	θ	LCosθ	LSinθ
JK	L	θ	LCosθ	LSinθ
KL	381.92	270°	0	-381.92
LM	203.94	29°15'	177.936	99.64
MJ	135.30	90	0	135.30

$$\Sigma L = L\cos\theta + 177.936$$
$$\Sigma D = L\sin\theta - 146.98$$

$\Sigma L = 0$

$\Rightarrow L\cos\theta + 177.936 = 0$

$L\cos\theta = -177.936 \rightarrow (1)$

$\Sigma D = 0$

$\Rightarrow L\sin\theta - 146.98 = 0$

$$L\sin\theta = 146.98 \rightarrow ①$$

$$\frac{L\sin\theta}{L\cos\theta} = \frac{146.98}{-177.936}$$

$$\tan\theta = -0.826$$

$$\theta = \tan^{-1}(0.826)$$

$$= -39.55$$

Method ①:-

$$(L\cos\theta)^2 + (L\sin\theta)^2 = (-177.936)^2 + (146.98)^2$$

$$L^2 = (-177.936)^2 + (146.98)^2$$

$$L = \sqrt{(-177.936)^2 + (146.98)^2}$$

$$L = 230.79m$$

Method ②:-

$$L\cos(-39.55) = -177.936$$

$$L = \frac{-177.936}{39.55}$$

$$L = -230.76$$

$$\Rightarrow 230.76$$

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CIVIL ENGINEERING

Surveying and Geomatics

UNIT-4

Unit ④

Curves

Curves in Surveying:-

Curves in Surveying are classified into two main types. they are as follows.

Types of Curves in Surveying:-

① Horizontal Curves

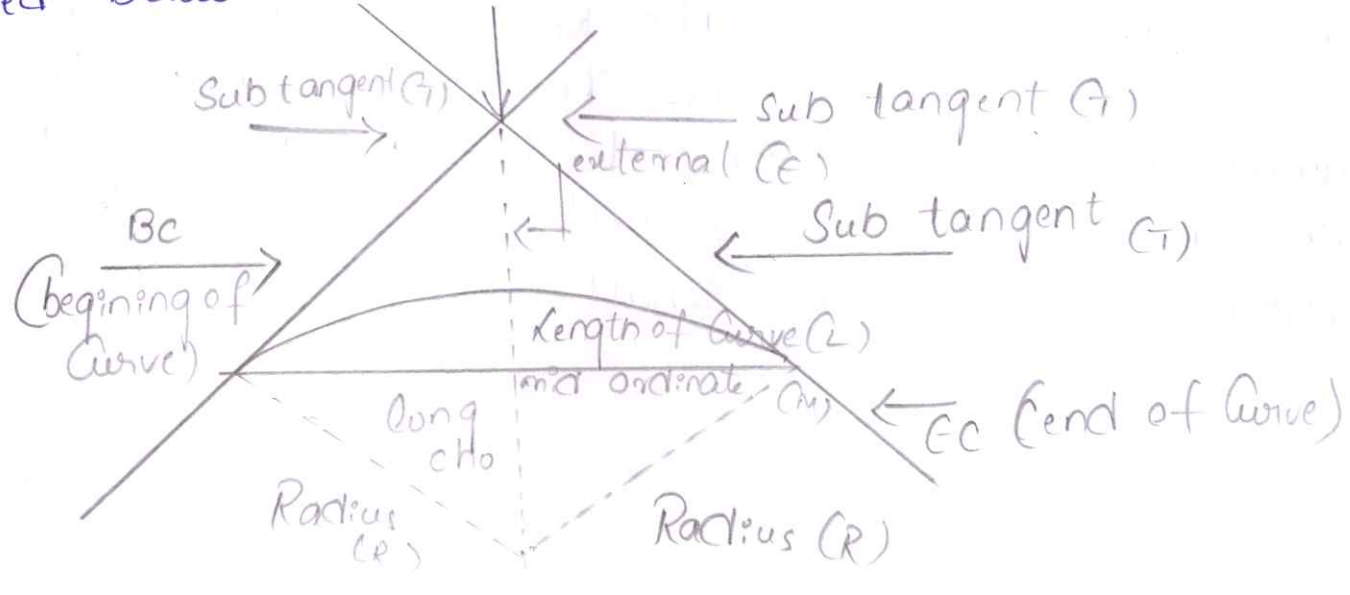
② Vertical Curves.

① Horizontal Curves:-

A horizontal Curve is provided where two Straight line intersect with each other in a horizontal plane. when a curve is given in a horizontal plane, it is known as a horizontal Curve, the horizontal Curve are further divided as follows.

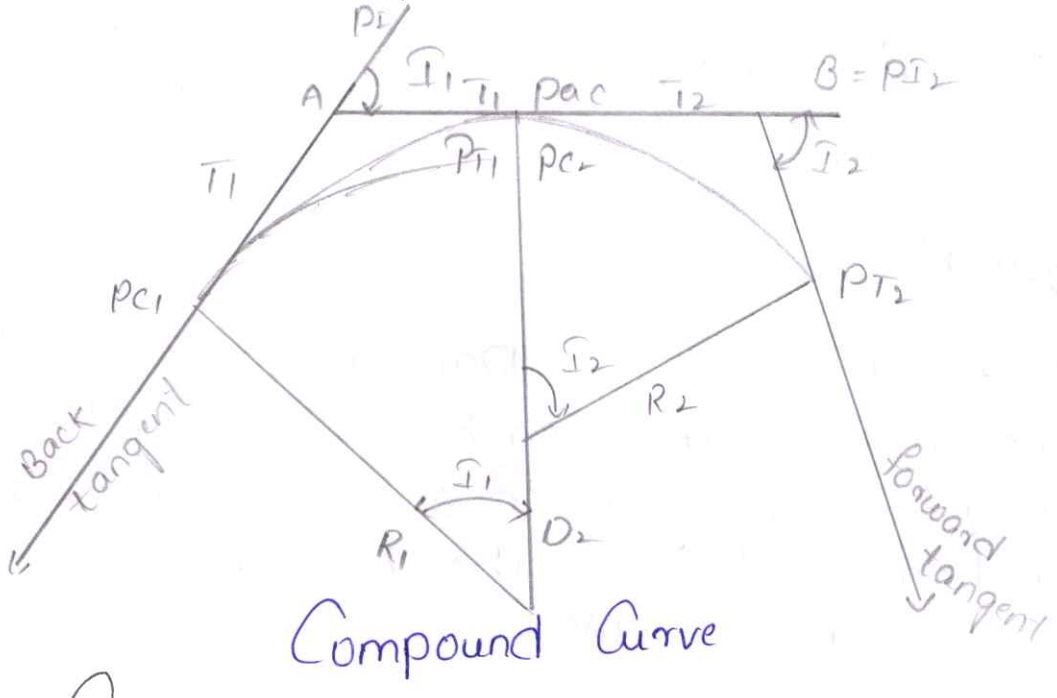
⊛ Simple Curve:-

A simple Curve is a single arc of a circle, which is tangential to both the straight lines of a route. there are a few elements of a simple Circular Curve discussed below



Compound Curve:-

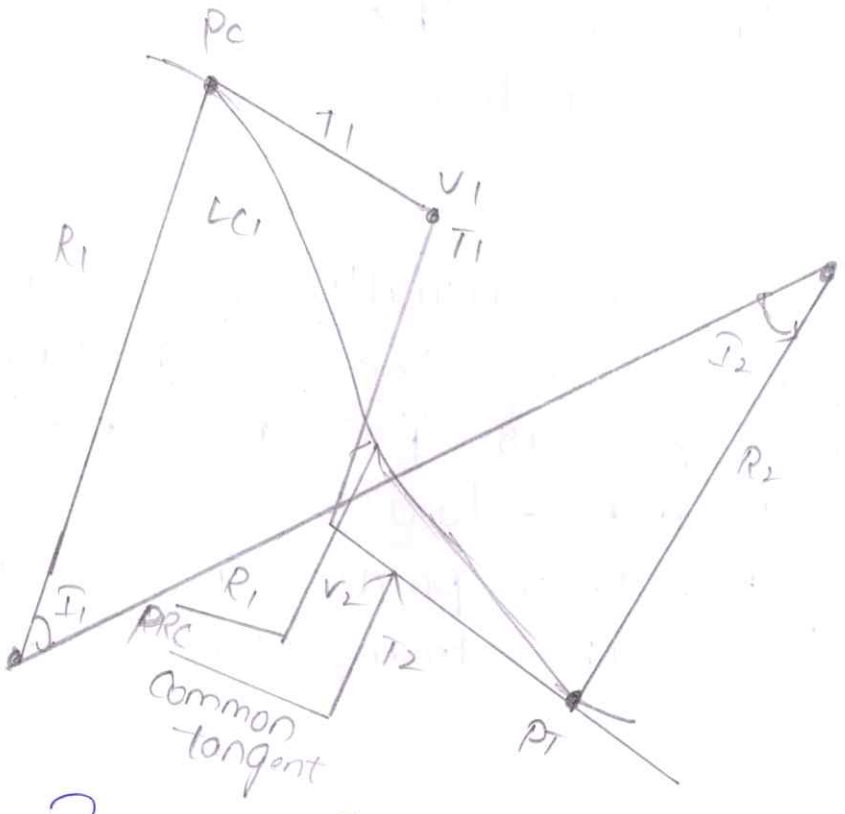
A Compound Curve Comprises two (or) more circular Arcs of different radii with their Centers of Curvature on the same side of the Common tangent. it is where the cutting and filling of soil is to be avoided. Compound Curves Are necessary whenever the Space restrictions rule out a signal circular Curve and when there are property boundaries



Compound Curve

Reverse Aure:-

A Curve consisting of two circular arcs of similar (or) different sizes radii having their Centeres of opposite sides of the Common tangent at the point of reverse Curvature is Known as a reverse Aurves reverse curve is also Known as a Serpentine Are used Curves (or) S-Curve due to its Shape reverse Curves are used to Connect two parallel roads (or) railway lines. it is generally used when two lines intersect at a very small angle



Reverse Curve

Transition Curve:-

It is a curve of varying radius. the value of the radius of this type of curve varies from infinity to a certain fixed value. it provide a gradual change from the straight line of the circular curve and again from the circular curve to a straight line. it is usually provided on both ends of a circular curve. the transition curves are provided on roads & railways to lessen the discomfort at the sudden change in curvature at the junction of a straight line and curves.

Combined Curve:-

The combination of a simple circular curve & a transition curves, is known as a combined curve Combined curves are mostly preferred in highways & railways

When transition Curves are provided at both ends of a circular Curve, the Curve formed as Known as Combined or a complete Curves.

Vertical Curves:-

Vertical Curves are usually provided when a highway (or) a railway crosses a ridge (or) a valley vertical Curves are provided when there is difference of level blw two points. So to make the movement easy blw these points, a vertical Curve is provided it makes the transition of the vehicle Smooth and Comfortable.

Summit Curve:-

A vertical Curve having its convexity in the upwards direction is Known as a summit Curve

Sag Curve (or) Valley Curve:-

A vertical Curve having its Convexity in the down wards direction (or) when it is Concave upwards is Known as a valley Curve. it is also Known as Sag Curve.

Simple Curve:-

Terminologies in Simple Curve:-

*) PC = point of Curvature. it is the beginning of Curve

*) PT = point of tangency. it is the end of Curve

*) PI = point of intersection of the tangents also called vertex

*) T = length of tangent from pc to pI and form pI to pT. it is Known as Sub Tangent

*) R = radius of simple Curve (or) simply radius

*) $\mathcal{L}$ = length of chord form pc to pT point Q as shown below is the mid point of C

*) Lc = length of Curve from pc to pT. Point M in the figure is the mid point of Lc

*) E = external distance, the nearest distance from PI to Curve

*) m = middle ordinate the distance from mid point to Curve to mid point of chord

*) I = deflection Angle (also called angle of intersection And Central Angle) it is angle of intersection of the tangents. the angle Subtended by pc and pT at O is also equal to I, where O is the center of the circular Curve from the above figure.

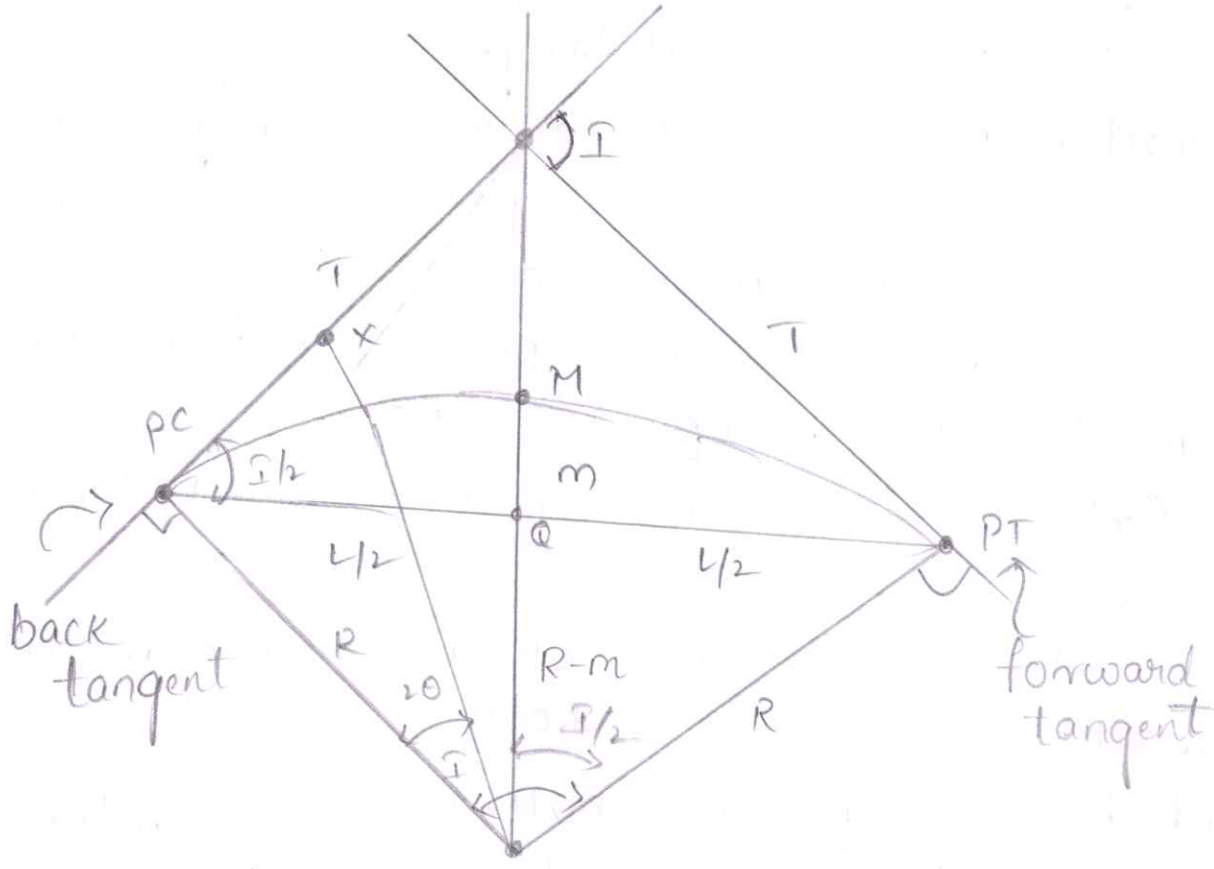
*) X = offset distance from tangent to the Curve

Note = X is $\perp^{r}$ to I

*) θ = offset Angle Subtended at pc blw pI & any point in the Curve

*) D = degree of Curve. it is the central Angle Subtended by a length of Curve equal to one station in english system, one station is equal to 100 ft & in SI, one station is equal to 20m

*) Sub chord = Chord distance blw two adjacent full stations



Length of tangent, T :-

Length of tangent (also referred to as Sub tangent) is the distance from pc to pI. it is the distance from pc to pI. it is the same distance from pI to pT. from the right triangle pI - pT = 0

$$\tan \frac{I}{2} = \frac{T}{R}$$

$$\boxed{T = R \tan \frac{I}{2}}$$

External distance, E :-

External distance is the distance from pI to the mid point of the curve from the same right triangle pI - pT = 0

$$\cos \frac{I}{2} = \frac{R}{R+E}$$

$$R + E = \frac{R}{\cos I}$$

$$\boxed{E = R \sec \frac{I}{2} - R}$$

Middle Ordinate, m :-

Middle ordinate, is the distance from the mid-point of the curve to the mid point of the chord. from right triangle O-Q-PT,

$$\cos \frac{I}{2} = \frac{R-m}{R}$$

$$R \cos \frac{I}{2} = R - m$$

$$\boxed{m = R - R\cos \frac{I}{2}}$$

Length of long chord, L :-

Length of long chord, (or) simply length of chord is the distance from pc to pI. Again, from right triangle, O-Q-PT

$$\sin \frac{I}{2} = \frac{L/2}{R}$$

$$R \sin \frac{I}{R} = L/2$$

$$\boxed{L = 2R \sin \frac{I}{2}}$$

Length of Curve, Lc :-

Length of Curve from pc to pT, is the road distances blw ends of the simple Curve, by ratio

And proportion

$$\frac{LC}{I} = \frac{2\pi R}{360}$$

$$\boxed{LC = \frac{\pi R I}{180}}$$

An alternate formula for the length of curve is by ratio and proportion with its degree of curve

$$\frac{LC}{I} = \frac{1 \text{ Station}}{D}$$

$$LC = \frac{1 \text{ Station} \times I}{D}$$

SI units :-

1 Station = 20m

$$LC = \frac{20 I}{D}$$

English system = 1 Station = 100 ft

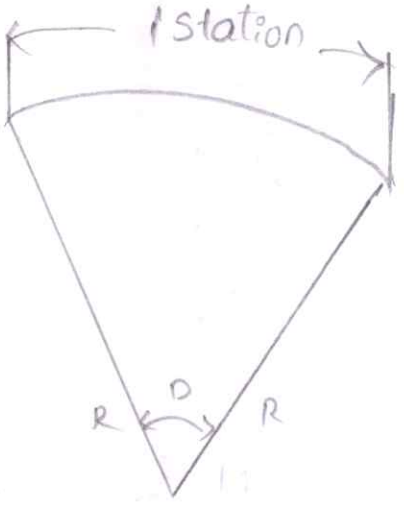
$$LC = \frac{100 I}{D}$$

If given the Stationing of PC & PT

LC = Stationing of PT - Stationing

Arc Basis :-

In arc defination, the d degree of curves is the central angle subtened by one station of circular arc. this defination is used in highway using ratio and proportion



$$\frac{1 \text{ Station}}{D} = \frac{2\pi R}{360}$$

SI units :- (1 station = 20m)

$$\frac{2R}{D} = \frac{2\pi R}{360^\circ}$$

English System (1 station = 100 ft)

$$\frac{100}{D} = \frac{2\pi R}{360^\circ}$$

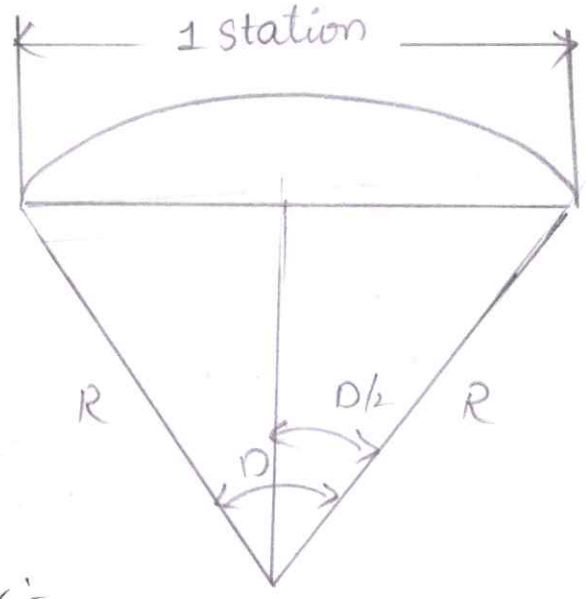
Chord Basis :-

Chord defination is used in railway design. the degree of Curve is the central angle subtended by one station length of chord. from the dotted right triangle below

$$\sin\frac{D}{2} = \frac{\text{half station}}{R}$$

SI units :- (half station (50 ft))

$$\sin\frac{D}{2} = \frac{5D}{R}$$



Impact factor:-

$$if = \varphi \frac{v^2}{gR}$$

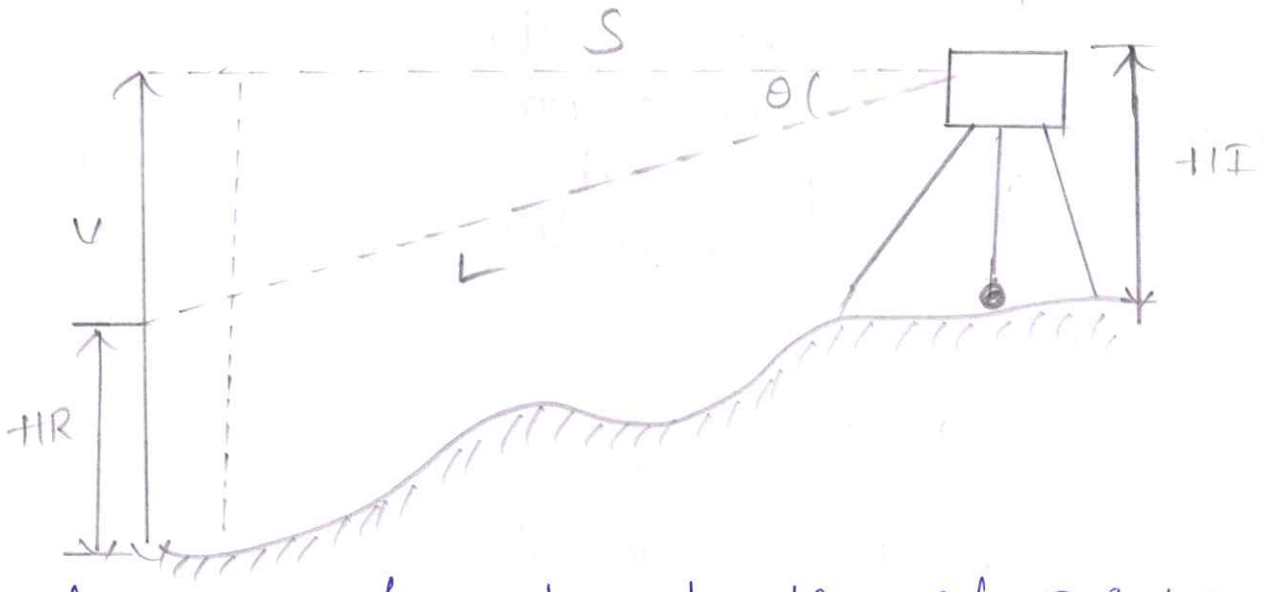
Electronic Distance Measurements (E.D.M):-

It is a Surveying method used to measure the distance blw two points using electronic instruments that rely on electro magnetic waves.

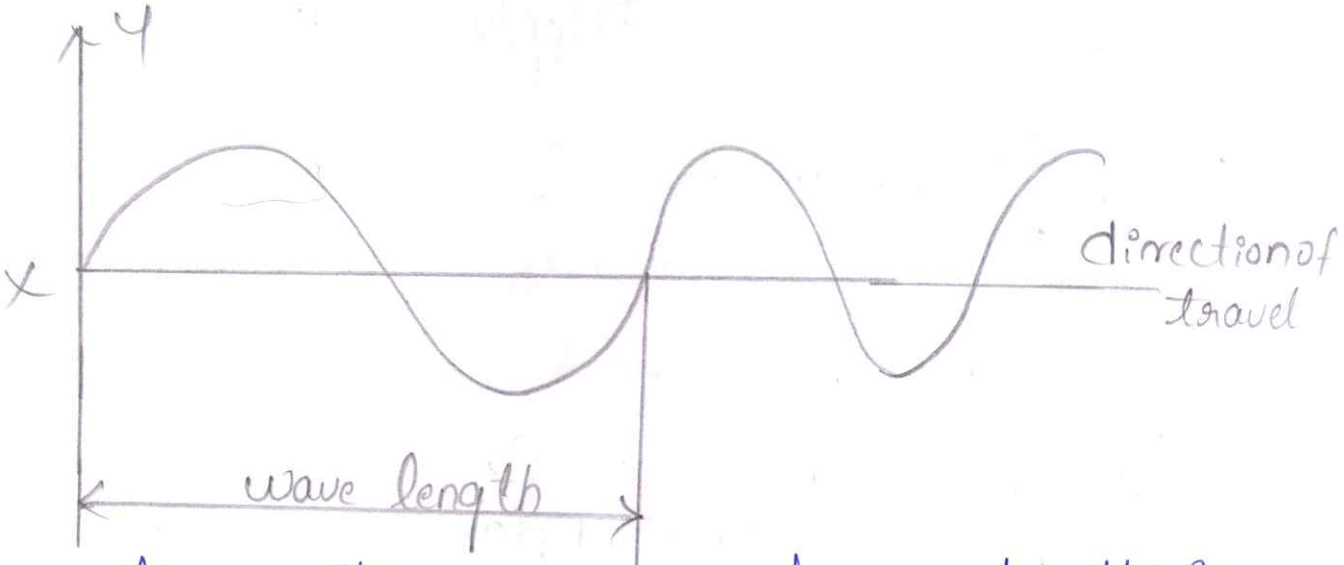
Principle of EDM instrument:-

The principle of measurement device in EDM is Correctly used in a total station or electronic / optic theodolites, that is calculates the distance by measuring the phase shift during take the rediated by being reflected through reflector, which is positioned at a measuring point

In figure, 'L' is the slop distance and θ is Slope angle are measured by EDM., if the elevation of point 'A' is the reference point, where the instrument is kept, we can find the elevation of point B, by the following formula, elevation of point B.



By the following formula. elevation of point B.-
= Elevation on of point A' + HI ± l sinθ - HR



The above figure shows a wave of wave length is the wave is travelling along the x-axis with a velocity of light the frequency of the wave is the time taken for the complete wave length

where,

$\lambda = c/f$

λ = wave length in meters

C = velocity in Km/sec

f = frequency in hertz (one cycle per sec)

The double distance is taken as 2L which is equal to the total whole no. of wave length n1 & the partical wave length w therefore the distance blw the EDM instrument and the reflection is calculated as follows

$$L = \frac{n1 + w}{2} \text{ (m)}$$

Types of EDM instruments :-

① Infrered wave instrument :

⇒ Use Infrarred light as a Carrier wave
⇒ Require prisms (reflectors) to reflect the signal
⇒ Range : up to 3Km
⇒ Example : ① Distomats

② Light wave instrument :

⇒ Use microwaves as Carries waves
⇒ Suitable for long distance measurement
⇒ Range : 25-100Km
⇒ Example :- Tellurometer

Total Station :-

A total station is a combination of an electronic theodolite, An electronic distance measuring device (EDM) and a micro processor with memory unit

Types of Total Station:-

*) Manual total station
*) Semi automatic total station
*) Automatic total station

Advantages of Total Station:-

*) Quick setting of the instrument on the tripod by using laser plument
*) Area Automatic calculation programme Computer & displays the area of the field by simple observations
*) On screen, graphical view of plots, and land Can be made for quick visualization
*) plotting and area Computation of any user required scale can be done
*) Integration data base is possible
*) Using robotic total station Angle Survey (or) Can perform surveying work
*) Automatic of old maps & fall GIS creation is possible.

Disadvantages:-

⇒ Their use doesn't provide hard copies of field notes
⇒ for an overall check of the survey it is necessary
⇒ The instrument is costly and skilled persons are required to operate it

Problems :-

(1) Two tangents intersect at a chainage of 1250.50m, having deflection angle of 60°, if the radius of the curve to be laid out is 375m. Calculate the curve to be length of curve, tangent distance, length of the cord (long), apex distance, mid ordinate ; degree of curve & chainage pe&pt

R = 375m

Length of the curve = $\Delta = 60$, chainage of I
=> 1250.50

$l = (\pi R)\Delta / 180^\circ$, where Δ is a degreess.

$= \pi \times 375 \times 60^\circ / 180^\circ$

=> 392.69m

Tangent length, $T = R \tan \Delta/2$

=> $375 \tan 60^\circ/2$

=> 216.50m

Length of the long chord => $L \Rightarrow 2R \sin \Delta/2$

=> $2 \times 375 \times \sin 60^\circ/2$

=> 375.00m

Apex distance => $E = R(\sec \Delta/2 - 1)$

=> $375(\sec 60/2 - 1)$

=> 58.01m

Mid ordinate $M \Rightarrow R(1 - \cos(\frac{\Delta}{2}))$

=> $375\left(1 - \cos \frac{60}{2}\right)$

-> 50.24m

Degree of Arc $D^{\circ} = 1718.9/R$

$\Rightarrow 1718.9/375$

$\Rightarrow 4.58$

Chainage of pc $\Rightarrow$ Chainage of I-T

$\Rightarrow 1250.50 - 216.50$

$\Rightarrow 1034\,m$

Chainage of pt $\Rightarrow$ Chainage of I+t

$\Rightarrow 1250.50 + 392.69$

$\Rightarrow 1643.19\,m$

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CIVIL ENGINEERING

Surveying and Geomatics

UNIT-5

Unit-⑤ :-

Persepective geometry of Areal photo graphy:-

The geometry of Areal photo graphy is based on central projection, where all light race from ground points pass, through the camera lens and form and image on the photo plain

Essential Terms:-

① persepective Center (O):-

The optical centre of the camera lens from which light races diverge

② principal point (p):-

The point on the photo graph where the ⊥ᵍʳ from the perspective Center needs the photo plain.

③ Natir point (n):-

The point on the ground vertically peneath the Camera lens

④ Iso center (I):-

The mid point between the principle And nadir point on the photo graph

⑤ photo plane (xy)

The plane on which the image is recoreded

⑥ Ground plane (xy')

the corresponding area on the ground

Photogrammetry Survey

Applications :-

1. preparation of photographic maps and digital elevation model
2. High way, Canel, pipe line allignments
3. volume calculations for earth work (or) operations
4. Urban planning & infra Structure monitoring
5. Diseaster mapping and land use Studies

Advantages:-

1. Rapid & Economical data collection
2. Covers large And in accessiable Areas
3. provides permenent visual records
4. Anables 3D modeling through Stero plains

problems:-

A camera having focal length of 20cm is used to take a vertical photograph to a terrain having An average elevation of 1500m. what is the height above sea level of which an air-craft must fly in Order to get the Scale of 1:8000?

$f = 20cm. \Rightarrow \frac{20}{100} = 0.2m$

$h = 1500m$

$Rf = \frac{1}{8000}$

$$Rf = \frac{f}{H-h}$$

$$\frac{1}{8000} = \frac{0.2}{H-1500}$$

$$H-1500 = 0.2 \times 8000$$

$$H-1500 = 1600$$

$$H = 1600 + 1500$$

$$H = 3100m$$

above MSL

The distance from the principle point to an image on a photograph is 6.44cm, and the elevation of the object above the datum (sea level) is 250mmm. what is the relief displacement of the point if the datum scale is 1/10,000 and the focal length of the camera is 20cm?

$$r = 6.44cm$$

$$h = 250m$$

$$Sd = \frac{1}{10,000}$$

$$Sd = \frac{f}{H}$$

$$\frac{1}{10,000} = \frac{201.00}{H} \quad H \Rightarrow 2000m$$

$$d = \frac{rh}{H} = \frac{cm \times m}{m}$$

$$= \frac{6.44 \times 250}{2000}$$

$$\Rightarrow 0.805m$$

Axial Triangulation:-

Defination:-

Axial triangulation is the process of extenting horizontal & vertical ground control from a few known points to all other photo graph in a block by using the geometry of over lapping aerial photographs

Purpose:-

To minimize field survey work by transferring control points through overlapping photos.

Principle:-

When two (or) more photographs overlap, each point appears on more than one photo by measuring the image coordinates of the same points (tie points) in over lapping photos, we can determine their 3D ground coordinates using triangulation geometry

Steps Involved:-

(1) Selection of ground points (Geps) Known points on the ground are identified on photo graphs

(2) Identification of the points: Common points appearing in adjacent photographs are selected

(3) Measurement of image coordinates: image co-ordinates of ground and the points measured.

(4) Relative Orentation:- The entire model is fixed to ground coordinates using Geps

⑤ Absolute Orientation :- thes Spactical relationships blw over lapping photographs is established

⑥ Computation :- Coordinates of unKnown points are calculated through triangulas equations

⑦ Adjustment :- Errors are adjusted using least Squares (or) block adjustment methods

Advantages :-

*) Reduce ground control work

*) provides accurate planimetric and height Control

*) Suitable for large area mapping

*) Essential for digital photogrammetric mapping & Ortho photo Creation

Radial Trigulation

Defination :-

Radial triangulation is a graphical method of extending control by using radial lines drawn from the principal point of each aerial photograph

Principle :-

In a truly vertical photograph, all image points lie on straight lines radiating from the principal point of each aerial photograph by drawing radial lines from the principal point through Known Control points & intersecting then from overlapping photographs the positions of unKnown points can be determined

Procedure:-

*) Identify principal points & ground control points on overlapping photos
*) Draw radial lines from each principle point through image points
*) The intersection of corresponding radial lines from two photos gives the location of the ground point
*) Scale & Orientation are fixed using known control points
*) New control points are extended forther to othes photographs.

Advantages:-

① Simple and quick
② Requires fewer computations
③ Suitable when limited control points are available
④ Ideal for small-scale mapping

Limitations:-

*) Less accurate than analytical triangulation
*) Errors increase with terrain relief
*) Not suitable for large-scale detailed mapping

Photographic Mapping:-

Photographic mapping refers to preparing maps directly from aerial photographs using various plotting methods

*) Mapping Using paper points:-

Description:-

This is a manual where overlapping photographic prints are aligned and traced to form a map

procedure:-

① Obtain overlapping paper prints
② Mark principal & Control points
③ Match features between overlapping photos
④ paste & align them to maintain Scale
⑤ Trace map details like roads, rivers, & boundaries

Advantages:-

① Simple and low-cost
② Requires minimum equipment
③ Suitable for small-scale, reconnaissance mapping

Disadvantages:-

① Low Accuracy
② Errors due to manual Matching
③ Not Suitable for large-scale works

*) Mapping using Stero plotting instruments

principle:-

When two overlapping photos are viewed through a stero scope (or) stero plotter a 3-D model of the terrain appears

This enables precise tracing of features three dimensions

Instrument Used:-

1. Mirror Stereoscope
2. Stereo plotter
3. Analytical (or) digital plotters

Advantages:-

1. provides high accuracy and 3D details
2. Contours can be plotted directly
3. Saves time and field work.

Apptications:-

1. Topographic mapping
2. Engineering Surveys (Roads, Canals, reservoirs)
3. Geological and forest Surveys

Mosaic:-

Defination:-

A mosaic is a continuous phographic maps made by joining together several over lapping aerial photographs to form one large image of the area

Types of Mosaics:-

1. Uncontrolled Mosaic:-
   1. photos are joined by matching features visually
   2. No geometric connections are applied
   3. used for reconnaissance and priliminary studies

② Controlled Mosaic:-

① Photos are rectified corrected for tilt & relief displacement

② Joined using ground control points for accuracy

③ Used for precise mapping and planning.

Steps in mosaic preparations:-

① Select suitable photographs with correct overlaps

② Match and trim edges carefully

③ Align photos using control points

④ paste (or) digitally merge the images

⑤ Apply scale and coordinate grid.

Advantages:-

① provides a continuous view of large area

② Easy to interpret visually

③ useful in planning & resource mapping

Uses:-

① City and regional planning

② Land use analysis

③ forest and agricultural surveys

④ Military reconnaissance

Map Substitutes:-

Definition:- Map substitutes are photographic representations that serve the same purpose as maps but are derived directly from aerial photographs

① photo maps:-

Description:-

A photo map is an aerial photograph printed with marginal information like scale, grid lines and places. It represents ground details as seen in reality.

Advantages:-

① Quick and in expensive
② True visual representation
③ useful for planning & reconnaissance

Disadvantages:-

*) Contains distortions due to camera tilt (or) relief
*) Not suitable for precise measurements

② Artho photos:-

Definition:-

An ortho photo is an aerial photograph geometrically correct (ortho rectified) to have a uniform scale and free form distances

Advantages:-

① Accurate representation of terrain
② Can be used for measuring distance and Areas

Applications :-

1. Urban and regional planning
2. Highway and irrigation projects
3. Land records and cadastral mapping