Note Book

Sub-Engineer

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Aman

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Engineering surveying

surveying is the science & art of determining the relative position of Various points above, on or below the earth surface with the help of measuring distance, direction & elevation using different instrument

Purpose prepare plan & map

Classification of surveying

[A] primary Division of surveying

① plane surveying

- → The surveying in which the curvature of the earth surface is ignored is called plane surveying.
- → Area is less then 260 sq·km.
- → Low degree of accuracy.
- → The earth surface is assumed to be plane.
- → Done by the individual organization.

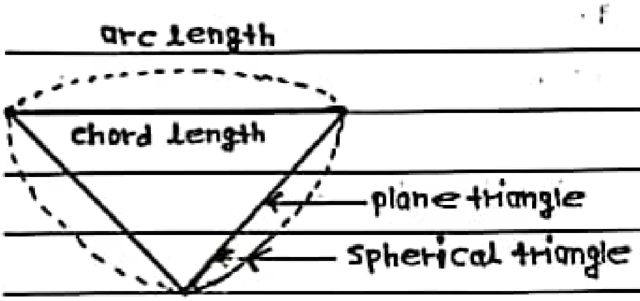
② Geodetic surveying

- → The surveying in which the curvature of the earth surface is considered is called geodetic surveying.
- → Area is grater then 260 sq·km
- → High degree of accuracy.
- → The earth surface is assumed to be spherical.
- → Done by the government department.

	① plane surveying	② Geodetic surveying
curvature of earth	ignored	considered
area	Small (< 260 Km²)	large (> 260 Km²)
assume earth surface	plane (2D)	Spherical (3D)
accuracy	low	high
measures	chord	arc
plumb bob line	parallel	not parallel
calculation	less	more
tedious	less	more
done by	individual organization	Government department
Use	all engineering survey	fix boundary of country

Note: 18.2 Kmमा, arc र subtended chord length बिचको difference = 10cm

: 195.5 Km²मा, spherical र plane triangle को angle बिचको sum को difference = 1 second.



→ **Earth** shape = oblate spheroid

→ equatorial axis = 12756.602 km

→ polar axis = 12713.168 km

→ फरक = 43.434 (0.34%)

→ average radius = 6370km.

B Secondary Division of surveying

ⓐ According to the nature of field

① Land survey

(i) **Topographical survey**: This survey is done for determining the natural features of the country. such as hills, river, forest, lake etc.

(ii) **Cadastral survey**: This survey is done for fix the property line of personal, state & country etc.

(iii) **City survey**: This survey is done for construction of streets, water supply system & sewer etc.

② **Hydrographic/marine survey** It deals with the mapping of large water bodies for the purpose of navigation, construction of harbor, prediction of tides & determination of mean sea level.

③ **Astronomical survey** It deals with the determination of absolute location & direction of heavenly bodies. like sun, moon & star etc.

Ⓑ **According to the purpose of surveying**

① **mine survey** This is used for the exploring the earth minerals. Coal, copper etc

② **military survey** This is used for preparation of maps the area of military importance.

③ **Geological survey** This is used for determining different strata in the earth crust.

④ **Archaeological survey** This is used for prepare map of ancient culture/historical object.

⑤ **Engineering survey** This is used for determining & collecting data for the design of engineering works such as road, railway, water supply etc

(i) **Reconnaissance** This is used for determining the feasibility & rough cost of scheme.

(ii) **preliminary survey** This is used for collecting more precise data to choose the best location of the works.

(iii) **Location survey** This is used for setting out the work on the ground.

Ⓒ **According to the instrument used**

① chain survey
② compass survey
③ plane table survey
④ Theodolite survey
⑤ Tacheometric survey
⑥ Total station survey
⑦ Gps survey
⑧ Aerial survey
⑨ photometric survey
⑩ Levelling

Ⓓ **According to the surveying method**

① Traversing
② Triangulation

Principle of Surveying

① Working from whole to part

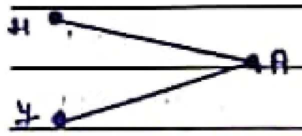
According to this principle the whole area is first enclosed by main station. the area is then divided into a number of parts by forming well-condition triangle. the main survey lines are measured with high precision. then sides of triangles are measured.

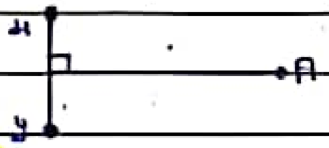
Objectives → Prevent the accumulation of error.
→ Localize minor error.

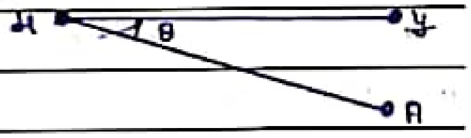
Note It is very essential to establish control points.

② Location of a point by measurement from two control points

The relative position of the points to be survey should be located by measurement from two referance point.







③ Consistency work

In a particular survey, the instrument, method, measurement, symbol, unit etc used should be same, otherwise, errors may arise.

④ Independent check

The relative position of a point to be surveyed should be located by measurements from at least two points of reference. the control points are selected in the area & the distance between them measured correctly.

Selection of Suitable Methods

	Suitable
chain survey	Small area having fairly level ground.
Compass survey	no effects of magnetic & electric field.
plane table survey	area having open ground.
Tacheometric survey	broken ground. . . . etc.

Scales, plan & Maps

Scale It is the ratio of linear dimension of object as represente in a drawing to the actual dimension.

→ Scale is defined as fixed proportion.

$$\text{Scale} = \frac{\text{Dimension in drawing}}{\text{Actual dimension}}$$

Types of scales

① **Plane scale** It is used to read or measure two dimension only.

→ such as meters & decimeters, Kilometers & hectometers.

② **Diagonal Scale** It is used to measure three dimension

→ such as (m, cm, mm) or (yard, foot, inch).

③ **Scale of Chords** It is used to measure & set of angle.

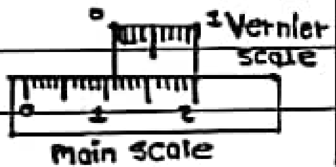
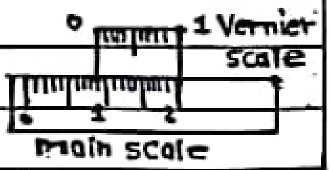
→ It is generally marked on a rectangular protractor.

④ **Vernier scale** It is used for small measurement.

Types of Vernier scale

① **Direct Vernier** Extend in the same direction of their main scale increases. → Smallest division of Vernier scales is shorter then smallest division of main scales.

② **Retrograde Vernier** Extend in the opposite direction of their mai scale increases. → Smallest division of Vernier scales is Longe then smallest division of main scales.

Types of Vernier scale	① Direct Vernier	② Retrograde Vernier
Direction of Vernier scale	Same as main scale	Opposite
Smallest division of Vernier	shorter	Longer
Division	$(n-1)MS = (n)VS$	$(n+1)ms = (n)VS$
measuring LC	for square, rectangle	for circular object
Figure	 	

Scale :

Large	1cm = 10m
Medium	1cm = 100m
Small	1cm = 1000 m

Least Count (LC)

The difference between smallest division of main scale & Vernier scale is called least count. it is obtained by;

$$LC = \frac{\text{one division of main scale (S)}}{\text{Total no. of division of Vernier scale (n)}}$$

$LC = P - V$ or $V - P$

Representative Fraction (RF)

→ Another way of scale → When a scale is expressed as fraction having numerator & denominator in same unit & keeping the numerator as unity. it is unitless. i.e. 1:100

→ for example : $\frac{1}{100}$ means 1cm = 100 cm etc.

Question : Convert the following scale into representative fraction, 1cm = 5km.

Soln $\frac{1cm}{5Km} = \frac{1\cancel{cm}}{5 \times 1000 \times 100\,\cancel{cm}} = \frac{1}{500000} = 1 : 500000$

Shrinkage Factor

→ It is also called Shrinkage ratio. → It is the ratio of shrunk length & actual length of a drawing. Used in graphical scale.

$$\text{Shrinkage ratio} = \frac{\text{Shrunk length}}{\text{Actual length}}$$

Plan	Map
→ the horizontal projection of any area in horizontal plane.	→ details are given in the form of symbol, word, line & colours.
→ Two dimension (distance, direction)	→ 3D (distance, direction, elevation)
→ Considered small area.	→ considered large area.
→ Large Scale	→ Small scale.
→ Example ; plan of house.	→ Example ; Map of nepal

Types of maps

① Guid map	The map provided for tourist.
② Geographical map	The map prepared on small scale.
③ Topographical map	Scale larger then geographical map.
④ cadastral map	scale larger then topographical map.

Entry into field book & Level book

In case of field book (chain survey) entry data is started from bottom page of field book to top in upward direction.

In case of level book (levelling) entry data is started from top page of level book to bottom in downward direction.

Types of field book

① Single line field book chain line represented by single line.

② Double line field book chain line represented by double line spaci about 1·5 to 2 cm.

Size of field Book 20cm x 12cm

Levelling

Levelling is the process of determining the relative elevation or altitude of a point on or beneath the earth surface.

Main objective assumed datumको respect मा point हरुको Vertical distance निकाल्नु।

Principle of Levelling

Principle of Levelling is to find the Vertical distance of the point above or below the line of sight with the help of horizontal line of sight.

The line of sight is provided with a level & levelling staff is used for measuring the height of line of sigh above the staff positions.

Technical Terms used in Levelling

① **Bench mark** elevation known भएको fixed वा permanent point हो।

② **Back sight** known elevation को point मा लिइने first staff reading हो।

→ plus sight → $\boxed{HI = RL \text{ of } BM + BS}$

③ **Fore sight** Unknown elevation को point मा लिइने, instrument shifting गर्नु अघिको last staff reading हो। → minus sight

→ $\boxed{RL = HI - FS}$

④ **Height of Instrument** Instrument को line of sight को elevation हो

⑤ **Changing/Turning point** BS र FS reading taken गरिने point हो।

⑥ **Reduce Level** Datum surface को माथि वा तलको point को Vertical distance/elevation हो → GPS survey द्वारा निकालिन्छ।

⑦ **Instrument station** observation कालागि instrument set गर्ने point हो।

⑧ **Station** levelling staff राख्ने point हो। no. of instrument station < Static

⑨ **Datum surface** Imaginary level surface हो। जसको आधारमा points को elevation मापिन्छ।

⑩ **mean sea level** समुन्द्रको tides को hourly observation बाट पत्ता लगाएको level → 19 वर्षमा।

⑪ **Level surface** earth को mean spherodial surface सँग parallel हुन्छ level surface को प्रत्येक point हरु earth को center बाट equidistant हुन्छ।

⑫ **Level line** level surface मा laying भएको line हो।

⑬ **Horizontal surface** any point मा level surface सँग tangential हुन्छ।

⑭ **Horizontal line** horizontal surface मा laying भएको line हो। यो straight line हो, जो level line सँग tangential हुन्छ।

⑮ **Vertical surface** level surface मा normal हुने surface हो।

⑯ **Vertical line** level line सँग perpendicular हुने line हो।

⑰ **Vertical angle** Vertical surface मा भएको inclined र horizontal line बिचको angle हो।

⑱ **Level book** Levelling field data लाई recored गर्ने note book हो।

⑲ **Diaphragm** eye piece को front मा cross hairs carrying गर्ने frame हो।

⑳ **Cross hair** यो silk (रेशम) threads, spider threads. वा platinum wires बाट बन्दछ। → **horizontal hair** चाहिँ levelling staff read गर्न used हुन्छ।

→ **Vertical hair** चाहिँ levelling staff vertically भको check गर्दछ।

↳ Telescope मा एकभन्दा बढी horizontal wire fitted गर्नुलाइ **stadia hair** भनिन्छ।

Levelling Instruments & Accessorie's

[A] Level

The instrument used for levelling is known as level. it consists of telescope, level tube, levelling head, tripod.

① Telescope

→ Telescope is an optical instrument used for magnifying & viewing the image of distant objects & get line of sight.

→ The lens fitted near the eye is called **eye piece** & the other fitted nearer to objects is called **objective**.

Types of Telescope

ⓐ **External Focusing Telescope** The telescope in which the focusing is done by external movement of either eye pieces or objective is known as external focusing telescope.

ⓑ **Internal Focusing Telescope** The telescope in which the focusing is done by negative lens is known as internal focusing telescope.

② Level / Bubble tube

→ A level tube is used to make line of sight is horizontal.

→ Level tube is made of glass tube encased in a brass tube & sealed with plasters of pairs.

→ The line tangential to the circular arc at its highest point, is called **axis of level tube.**

→ The level tube is filled either ether, alcohol or mixture of both.

Sensitiveness of a Bubble tube (कार्यक्षमता)

It is designated either in terms of radius of curvature of upper portion or by angle through which the axis is tilted.

$\propto$ Radius of curvature of internal surface.

$\propto$ Length/Diameter of level tube.

$\propto \frac{1}{\text{Temperature}}$

$\propto$ Decreasing the roughness of level tube.

$\propto$ Decreasing the viscosity of liquid.

⑨ Levelling Head

→ The levelling head is generally consists of two parallel plate with three or four foot screw.

→ The upper plate is known as **Tribarch**.

→ The lower plate is known as **Trivet** which can be screwed on to the tripod.

Function of levelling head

ⓐ To support the telescope.

ⓑ To make bubble in center.

ⓒ To attached the level on tripod.

④ Tripod

→ It is a three legged instrument on which level is supported during use.

→ Pivoted iron shoes is provided at lower end of legs which help in fixing.

→ Tripod head carries at its upper surface, an external screw to which the trivet of the levelling head can be screwed.

Types of Level

① **Dumpy Level** Rigidy fixed telescope.

② **Tilting Level** Telescope चाहिँ few degreeमा tilted हुन्छ।

③ **Wye Level** Telescope लाई rotated moved वा raised गरिन्छ।

④ **Automatic Level** Instrument automatically level हुन्छ।

[B] Levelling Staff

It is in the form of straight, rectangular graduated into meter/feet & smaller division upto 5mm.

→ It is made from well-seasoned wood or aluminium.

Types of Levelling staff

① self-reading staff Instrument man द्वारा reading taken गरिन्छ।

ⓐ solid staff → Length 3m ⓑ folding staff (2+2=4m) ⓒ Telescopic staff (1.25 x 2 + 1.5 = 4m)

② Target staff Staff man द्वारा reading taken गरिन्छ।

* philadelphia staff → Length 6+7=13 ft.

Fundamental line of levelling telescope

① Line of sight The line which passes through the optical center of objective & the intersection of cross hairs of eye pieces to eye.

② Line of Collimation The line which passes through the intersection of cross hair of eye pieces & optical center of objective to object

③ Axis of Telescope: It is the line joining the optical center of objective & center of eye pieces.

④ Axis of level tube The line tangential to the circular arc of the level tube at its highest point.

⑤ Vertical axis   Vertical axis ⊥ Horizontal axis

⑥ Horizontal axis

Types of Levelling

[1] Sprit / Direct Levelling Assumed datum को respect मा given points को elevation find गर्छ। जसमा level instrument लाई line of sight गरिन्छ।

Instrument Auto-level

ⓐ Simple Levelling: level को single position बाट two point visible हुदा level को single setup गरिन्छ।

⑥ Differential Levelling level को single position बाट two point visible नहुदा। level को no. of setup गरिन्छ। **Reason** two point बिचको distance large हुदा वा obstacles हुदा।

Types of Differential Levelling

Ⓘ Profile/ Longitudional Levelling कुनैपनि St. line को along मा भएका विभिन्न structure हरुको height find गरिन्छ।

ⅱ Cross-Sectional Levelling जमिनमा Earth को Vertical section पत्ता लगाउनको लागि कुनै main line को perpendicular direction मा रहेका points को height find गरिन्छ।

ⅲ Check Levelling पहिल्यै fix गरेको Bm को accuracy check गर्नकालागि level line लाई running गरिन्छ।

ⅳ Fly Levelling work station जहाँ Bm भन्दा far हुदा used हुन्छ। Bm र survey line को starting point connected गर्छ। BS र FS reading taken गरिन्छ। approximate levelling हो।

ⅴ Reciprocal Levelling जब instrument दुई visible points को बिचमा set up गर्न सकिदैन, त्यस्तो अवस्थामा two set को reciprocal observation बाट कुनै दुइ points को height difference पत्ता लगाइन्छ। eg. river, pond etc. **Eliminated** Curvature & Collimation error **Partly Eliminated** Refraction error.

ⅵ Precise Levelling त्रुटि हटाउनकालागि बढी precise instruments हरुको प्रयोगद्वारा Levelling गरिन्छ।

Types	Used	Allowable error
① Primary Levelling	Wide distributed Bm	$\pm 4\sqrt{K}$
② Secondary "	Principal Bm	$\pm 8\sqrt{K}$
③ Tertiary "	minor Bm	$\pm 12\sqrt{K}$
④ Ordinary "	Location & Construction	$\pm 24\sqrt{K}$
⑤ Rough "	Recci & preliminary survey	$\pm 100\sqrt{K}$

Where K = Total distance of level line in km

2 Trigonometric Levelling, यसमा points हरुको उचाइको फरक vertical angle र horizontal distance का आधारमा पत्ता लगाइन्छ। horizontal distance directly नापेर वा calculation द्वारा find गरिन्छ। यो Indirect method हो। Instrument Theodolite, tape

3 Barometric Levelling, यसमा air pressure को help मा approximate altitude को measurement गरिन्छ। यो Indirect method हो। Instrument Barometer

4 Hypsometric Levelling यो Indirect method हो। Very tough method हो। rarely used हुन्छ।

Methods of Levelling

① Height of Instrument method / Ht. of collimation method

- → It is quick & simple method of levelling.
- → This method is suitable for no. of reading are more required.
- → Used in profile levelling & in setting out level for construction worl
- → There is no check on the reduction of the intermediate RL.
- → Two arithmetical check. $\Sigma BS - \Sigma FS = \text{Last RL} - \text{First RL}$
- → Format

SN	BS	IS	FS	HI	RL	Remarks

Time कम लाग्छ।
Accuracy less

② Rise & Fall method

- → It is slow & labourious method of levelling.
- → This method is suitable for no. of reading are less required.
- → Used in differential levelling & in precise levelling.
- → There is check on the reduction of the intermediate RL.
- → Three arithmetical check. $\Sigma BS - \Sigma FS = \Sigma \text{Rise} - \Sigma \text{Fall} = \text{Last RL} - \text{first}$
- → Format

SN	BS	IS	FS	Rise	Fall	RL	Remarks

Time बढी लाग्छ।
Accuracy more

Temporary & permanent adjustment of level

Temporary adjustment ① Centering ② Levelling ③ Elimination of Parallax.

Permanent adjustment

① Line of Collimation ⊥ Horizontal axis.

② Horizontal axis ⊥ Vertical axis

③ Vertical axis ⊥ axis of level tube.

Correction for curvature & Refraction

* **Curvature** ले, object जस्ता छन त्यो भन्दा सानो देखाउछ।

$C_c = \frac{d^2}{2R}$ (−ve)   Where, d = distance in km

R = Radius of earth = 6370 km.

$= \frac{d^2}{2 \times 6370} = 7.85 \times 10^{-5} d^2 \text{ km}$ $\therefore$ $\boxed{C_c = 0.0785 d^2 \text{ m}}$

* **Refraction** ले, object जस्ता छन त्यो भन्दा ठूलो देखाउछ।

$C_r = \frac{1}{7}^{th} C_c$ (+ve) $= \frac{1}{7} \times 0.0785 d^2$ $\therefore$ $\boxed{C_r = 0.0112 d^2 \text{ m}}$

* **Combined correction** $= C_c + C_r = -0.0785 d^2 - 0.0112 d^2$ m

$= -0.0673 d^2 \text{ m}$

Plane Table surveying

The methods of surveying in which the field work & plotting are done simultaneously, is called plane tabling.

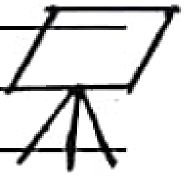
Principle of plane tabling

The main principle of plane tabling is based on the fact that the line joining the points on the plane table are made to lie **parallel** to their corresponding line joining the ground points while working at each stations.

Suitability	Unsuitability
→ open area	→ Congested ([illegible]) area.
→ Less accuracy required.	→ more accuracy required.
→ fair weather	→ bad weather

Advantage of plane Tabling	Disadvantage of plane Tabling
→ Rapid method.	→ Can not be used rainy season.
→ suitable for small scale map.	→ It never produce accurate result
→ field book is not necessary.	→ Instruments are heavy.
→ Use on magnetic area.	→ Difficult to re-plotted.
→ Less costly then most of surveying	→ Required no. of accessories.

Instrument used in plane tabling



① plane Table

→ Size of plane table is 750mm x 600mm or 400mm x 300mm.

→ The thickness of plane table board is about 20 mm.

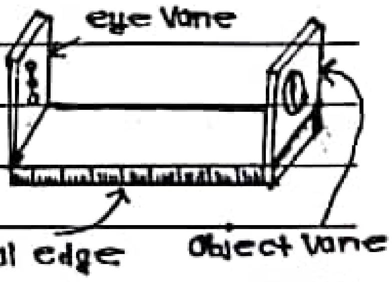
→ made with well-seasoned soft wood. like teak, pine etc.

② Alidade or sight Vane

→ It is straight edge ruler having some form of sighting device.

→ The working edge of alidade is called fiducial edge.

Types of alidade



① plane alidade The plane alidade used for sighting. material metal or wood

→ Vanes are hinged & fold.

② Telescopic alidade

The telescopic alidade used for measure vertical angle, horizonta & vertical distance. take inclined sight.

③ sprit Level

→ It consists of a small metal tube which contains small bubble

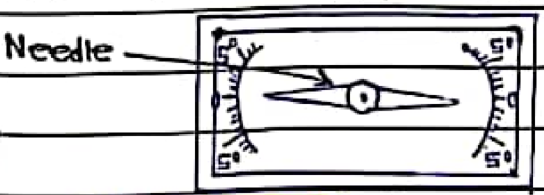
→ It is used for the levelling of plane table.

④ magnetic compass

→ It is also called trough compass.

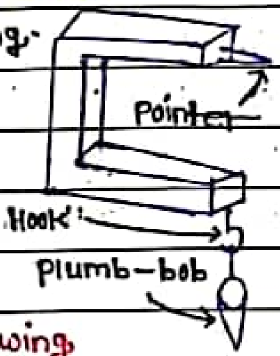
→ Size 80 – 150 mm long & 30mm wide box carrying a freely suspended needle.

Used for orientation (N).



⑤ plumbing fork & plumb-bob

→ It consists of a hair pin shaped brass frame having two equal arm. → It is used for the centering of plane table as well as transforming location of instrument station.



⑥ Tripod

→ used support the plane table.

⑦ Drawing paper & Accessories for drawing

→ Drawing paper must be superior quality.

→ Accessories : Pencil, cutter, eraser etc.

Method of plane Tabling

① Radiation

→ A plane table is set up any station then detail points are plotted on their radiating line drawn from the instrument station after reducing their respect ground distance to desired scale. → for detailing

→ It is used for small area having all points are visible from singal station. → Very accurate then other method.

→ plane table set up at one station only.

② Intersection or Graphic Triangulation

→ In this methods, the point is fixed on plan by the intersection of rays drawn from the two instrument station.

→ It is suitable for large area & case of Inaccessibility.

Example ; mountain, undulating ground etc.

→ for locating the instrument station

— less accurate then radiation method.

③ Traversing

→ It is similar to compass & theodolite traverse.

→ plane table is set up at each instrument stations. → for detailing.

→ It is suitable for small & congested area. like, town, forest etc

→ It is the combination of radiation & intersection.

④ Resection / Fixing method.

→ This method is used for established the instrument station only.

→ After fixing the station, the details are located either by radiation or intersection. → practically, Rection is not method of plane table.

Method of Resection

① Back ray methods
② compass methods
③ Two-point problem methods
④ Three point problem methods

Note The result of two point problem is less accurate & more tediou then three point problem.

method of three point problem
→ ① mechanical or tracing paper method
→ ② Graphical methods
→ ③ Lehman's or trial & error methods

Temporary Adjustment of plane Table

① Fixing the plane table on tripod.

② Setting up the plane table → levelling & centering simultaneously.

③ Sighting the ground & intersection points.

Theodolite & Traversing surveying

Theodolite The theodolite is the most precise instrument designed for the measurement of horizontal & Vertical angle.

Application of Theodolite laying of horizontal angle, locating points on lines, Prolonging (विस्तार) of survey line, determine difference in elevation, setting out curve etc.

Function of Theodolite

→ measurement of horizontal/vertical angle, bearing of lines, direct angle, deflection angle etc.

Classification of Theodolite

① Transit Theodolite → Telescope transited हुन्छ।
② Non-Transit Theodolite → Telescope transited हुँदैन।

Types of Non-Transit Theodolite

① Vernier theodolite horizontal र Vertical reading लिन Verniers राखिन्छ।
② Glass arc theodolite " " " " " micrometers " ।
Micrometer

Theodolite are also classified

① Analog Theodolite horizontal र Vertical reading लिन graduation राखिन्छ।
② Vernier Theodolite " " " " " Verniers " ।
③ Digital Theodolite " " " " directly digital display box मा देखाइन्छ।

Temporary Adjustments of Theodolite

① setting up the theodolite over the station.
② Approximate levelling.
③ centering.
④ Levelling → Theodolite को Vertical axis लाइ truely Vertical बनाउने

method of Levelling ① Three screw head.
② four screw head.

⑤ Elimination of parallax → Observer को आँखाको position change हु object को Position मा change आउनुलाई parallax भनिन्छ। Telescope मा जब cross-hair को plane मा objective ले बनाएको image परेन भने parallax आउँछ।

Method of Elimination of parallax
- ① focusing eye piece
- ② focusing Objective

Permanent Adjustments of Theodolite

① Horizontal axis ⊥ Vertical axis

② Horizontal plate level axis of plate level ⊥ Vertical axis.

③ Telescope adjustment of horizontal & Vertical hair.

④ Telescope level adjustment of level tube on telescope.

⑤ Vertical circle index adjustment of altitude level & Vertical index frame.

Fundamental Lines of Theodolite

① Horizontal axis ⊥ Vertical axis ② Vertical axis.

③ Line of Collimation ⊥ Horizontal axis.

④ Axis of plate level ⊥ Vertical axis.

⑤ Axis of telescope // Line of collimation.

Note : Horizontal axis, Vertical axis र line of Collimation, meet हुने point लाई Instrument center भनिन्छ।

Parts of Theodolite

① Levelling Head दुई भाग मिलेर बन्छ।

ⓐ Upper Tribarch तिनओटा arm भएको Triangular plate हो। प्रत्येक arm मा levelling foot screw हुन्छन्। यसलाई Tribarch पनि भनिन्छ।

ⓑ Lower Tribarch/Trivet/Base plate Arm 3 Circular hole 1 Shape triangular plate → Circular hole मा thread हुन्छ, जसमा tripo fixing गरिन्छ। Levelling Head = Tribarch + foot screws + Trivet

Function of Levelling Head ① Theodolite लाई levelling गर्छ। ② Theodolite लाई Tripod मा attach गर्छ। ③ Instrument को main part support गर्छ।

② **Lower plate / scale plate** यो outer spindle संग जोडिएको हुन्छ। यसमा horizontal graduated circle हुन्छ (0–360°). → Lower clamp screw ले fixed गर्छ। → Lower tangent screw ले slow rotated गर्छ। → Lower plate को diameter को according मा theodolite को size designed हुन्छ।

③ **Upper plate / Vernier scale** यो inner spindle axis संग जोडिएको हुन्छ। यसमा दुइटा Vernier scale हुन्छन। motion Controlled by upper clamp screw & upper tangent screw. Support → standard लाई।

④ **Standard or A-Frame** upper plate को माथि दुइटा 'A' shaped को frame हुन्छ। support telescope, Verticle circle & Vernier scale

⑤ **Index bar or T-Frame** → [illegible]

[illegible]

⑥ **Plate level / Bubble tube** upper plate मा attached गरिएको हुन्छ। जसलाई foot screw द्वारा level गरिन्छ।

⑦ **Telescope** → optical instrument → Used: Magnifying & Viewing the image of distant objects & gets line of sight.

⑧ **Verticle circle** Telescope को trunnion axis मा attached हुन्छ। यसमा Vertical graduated circle हुन्छ। divided four quadrants (0°–90° each quadrants) motion controlled by clamp screw & tangent screw. Used read true elevated & depression angle.

⑨ **Spindles** ① outer spindles → hollow ② Inner spindles → solid

⑩ **Tripod** तिनओटा solid leg यसमा हुन्छ। used theodolite लाई support गर्छ। → leg को प्रत्येक lower end मा pointed iron/steel shoes हुन्छ।

⑪ **plumb bob** main Verticle axis संग fitted hook मा यसलाई suspended गरिन्छ। → यसले station को ठिक माथि instrument लाई centering गर्दछ।

Technical Term used in Theodolite

① **Horizontal / Trunnion / Transverse axis** जो axis को about मा telescope rotated हुन्छ in Verticle plane मा।

② **Vertical / zenith axis** जो axis को about मा theodolite rotated हुन्छ in horizontal plane मा।

③ **Line of collimation / Line of sight** Imaginary line हो। जो eye-pie को cross-hair को intersection र objective को optical center हुँदै passing हुन्छ।

④ **Centering** ground station mark को ठिक माथि theodolite set up.

⑤ **Transiting / reversing / plunging** Telescope लाई vertical plane through 180° turning गर्ने process हो।

⑥ **Swing** Telescope लाई horizontal plane मा Vertical axis को about revolving गर्ने process हो। **Right swing** → clockwise rotatio
Left swing Anti-clockwise rotation।

⑦ **Face Right** Theodolite को Verticle circle-चाहिँ observer को Righ hand side मा हुन्छ। र त्यो बेला गरिने observation, **face right observation**

⑧ **Face Left** Theodolite को Verticle circle-चाहिँ observer को Left hand side मा हुन्छ। र त्यो बेला गरिने observation, **face left observatio**

⑨ **Changing Face** Theodolite को face changing गर्ने process हो। Left to right & vice-versa.

⑩ **Telescope Normal** **Verticle circle** left मा। **Bubble of telescope** up
⑪ **Telescope Inverted** → right मा। → down मा

Principle of Theodolite

Theodolite ले optical plummets (plumb bob), bubble level र graduated circle को combination बाट horizontal र vertical angle find गरिन्छ।

Traversing

A series of connecting straight line, each joining two points on the ground is called Traverse.

Traverse station: end point **Traverse legs:** प्रत्येक st. line.

Traverse angle: दुई consecutive traverse बिचको angle.

Types of Traverse

① Closed Traverse A traverse which starting from station & closed on the same station or run between two known station is called closed traverse.

→ Accuracy of linear & angular measurement may be chec

Sum of internal angle	Sum of external angle	Algebraic sum of deflection angle
$(2n-4)\times 90$	$(2n+4)\times 90$	360°

② Open Traverse A traverse which neither returns to its starting station nor ends on another known station is called open traverse.

→ Accuracy of linear & angular measurement may not be check

Better Degree of accuracy का आवश्यकता → Closed traverse

Based on Instrument

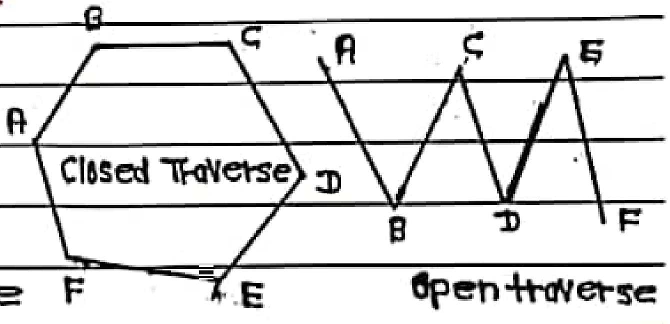
① Chain traverse

② Compass traverse

③ Plane table traverse

④ Theodolite traverse
most accurate

⑤ Tacheometric traverse



Method of Traverse plotting

① By parallel meridian

② By deflection angle

③ By magnetic bearing

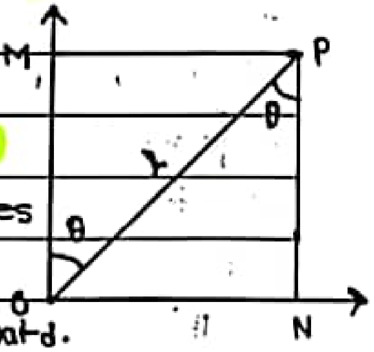
④ By Coordinate method

Consecutive / Dependent coordinates :

Latitude & departure of any stations with respect to the Precedin station is known as consecutive coordinates.

Ⓐ Latitude It is the projection of survey line. The latitude of a survey line is defined as its co-ordinate length measured paralle to assume meridian. Sometime latitude are also called meridian.

Northing → latitude ⊕ & measured northward / upward. Southing → latitude ⊖ & measured southward / downward. ∴ $\boxed{\text{Latitude}(L) = l\cos\theta}$

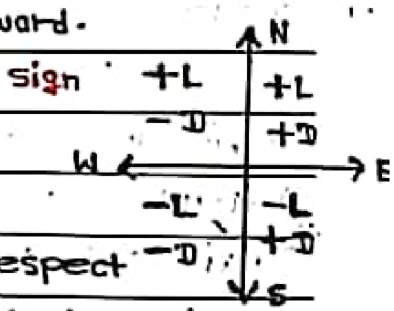


Ⓑ Departure It is the projection of survey line. The departure of a survey line is defined as its co-ordinate length measured perpendicular to assume meridian. Sometimes departure are also called perpendicular.

Easting → Departure ⊕ & measured eastward.

Westing → Departure ⊖ & measured westward.

$\boxed{\text{Departure}(D) = l\sin\theta}$



Total / Independent coordinates

Latitude & departure of any station with respect to the common origin is known as independent coordinates.

Balancing of Consecutive Co-ordinate

for closed traverse $\Sigma\text{Latitude} = 0$ & $\Sigma\text{Departure} = 0$

$\text{Length of line}(l) = \sqrt{\text{Latitude}^2 + \text{Departure}^2}$

$\text{Reduced bearing}(\theta) = \tan^{-1}\left(\frac{\text{Departure}}{\text{Latitude}}\right)$

Checks in Closed Traverse

Field measurements बाट closed traverse plotted गर्दा, travers को end station चाहिँ starting station सँग coincide हुँदैन, जुन

discrepancy भनेको linear वा angular errors का कारण हुन्छ। जुन error लाई closing error भनिन्छ। corrected → graphical or computation method बाट।

Correction for Closed Traverse

① Bowditch's Rules

→ It is also known as compass rule.

→ This rule is used to balance the traverse when the angular & linear measurement are equal precise.

→ It is most commonly used in traverse adjustment.

→ $$\boxed{\text{correction to lat.} = \text{total error in lat} \times \frac{\text{length of any side}}{\text{perimeter of traverse}}}$$

→ Similary, Correction for departure.

② Transit Rules

→ This rule is used to balance the traverse when the angular measurement more precise then linear measurement

→ $$\boxed{\text{Correction to lat.} = \text{total error in lat.} \times \frac{\text{latitude of any side}}{\text{algebric sum of all latitud}}}$$

→ Similary, correction for departure.

③ Graphical method

④ Axis Method

Tacheometry

Tacheomety is the branch of surveying in which both horizontal & vertical distance are determined from instrument observation.

→ It is best for steep & broken ground, deep ravines & large water body. Removed → Tape/chain

accuracy low in plane compared to direct chaining.

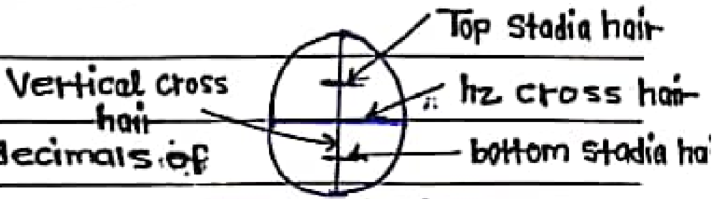
more in broken ground.

Instrument used in Tacheometry

① **Tacheometer** Theodolite + stadia hair & anallatic lens

Stadia hair – 2 & **cross hair** – 2

② **Stadia rod/ Vertical stave**



Length 5 – 10m → graduated in decimals of meter.

fig ; Stadia diaphragm

System of Tacheometric measurement

① Stadia hair system → stadia hair provided होता। → **common metho**

ⓐ **Fixed hair method** **Constant** stadia hair **Variable** staff intercept

ⓑ **Movable hair method** **Constant** staff intercept **Variable** stadia hair

② Tangential system → stadia hair provided होता। **Reading taken by** single horizontal cross hair. → generally used होता क्योंकि it needs two pointings of telescope.

③ Subtense bar system **Instrument** है। **used** measuring horizontal distance. **Reason** undulations या obstructions से chaining difficult हो

Horizontal Distance = $\frac{S}{\theta} \times 206265$

Where ; S = Distance between center of disc of subtense bar.
θ = Horizontal angle subtended by theodolite in seconds.

Distance Formula.

Horizontal distance

Case I: Line of sight is horizontal & staff is Vertical. $D = ks + c$

Case II: Line of sight is inclined & staff is Vertical. $D = ks\cos^2\theta + C\sin$

Case III: Line of sight is inclined & staff is normal. $D = (ks + c)\cos\theta + h\sin\theta$

Vertical distance

Case I: Line of sight is inclined & staff is vertical. $V = \frac{1}{2}ks\sin 2\theta + c\sin\theta$

Case-II: Line of sight is inclined & staff is normal. $V = (ks + c)\sin\theta$

Analltic Lens

It is a special convex lens fitted in Between the objective & eye pieces. → The main purpose to fitted anallotic lens in surveying telescope to eliminate the additive constant, from the tacheometer distance equation. $c=0$

Increasing → absorption of light. Reduction brilliancy of image.

Tacheometer distance equations

Horizontal Distance $= ks\cos^2\theta$

Vertical Distance $= \frac{1}{2} ks \sin 2\theta$

Contouring

Contour A contour is an imaginary line on the ground joining the points of equal elevation above the datum surface.

The process of tracing contour line on the surface of earth is called Contouring.

Characteristics of Contour Line

→ The contours of different elevation do not cross each other except in the case of an overhanging cliff or cave.

→ All points in a contour line have the same elevation.

→ A set of closed contour with higher value inside indicate a hill & outside indicate a pond or a depression.

→ Contour drawn closed together indicate steep slope & far apart indicate gentle slope.

→ contour equally spaced represents a uniform slope.

→ Contour are parallel, equidistance & straight represents an inclined plane surface.

→ Contours do not have sharp turning.

→ Contours do not pass through permanent structure.

→

Methods of Contouring

① Direct Method	② Indirect Method
→ Contour traced on field.	→ field + office
→ Very accurate method.	→ less accurate method.
→ slow, tedious & expensive.	→ Quicker, less tedious & cost
→ used for small area with low undulation.	→ used for hilly area & steep slope.

Types of Indirect Method

① square/grid Method → for low undulation area.

② Cross section Method → for road, canal, railway etc.

③ Tacheometric/Radial method → for high undulation area.

Technical Terms used in Contouring

① **Contour Interval** The Verticle distance between two consecuti contour is called Contour interval. It is kept constant for each map Depends SANEPA (scale of map, Availability of time & fund, Nature of ground, Extend of survey, purpose of map, Amount of permissibl error.

$$\text{Contour Interval} = \frac{20}{\text{no. of cm per km}}\ \text{m (SI system)}$$

$$= \frac{50}{\text{no. of inches per mile}}\ \text{ft (FPS system)}$$

② **Horizontal Equivalent** The horizontal distance between two consecutive contour is called horizontal equivalent. → not constant. Depends steepness of ground. → Less, steeper ground ज्या।

③ **Index Contour** Topograply map may have many contour lines. it is not possible to level the elevation of each contour line. to make the map easy to read every fifth contour line vertically is an index contour. → Thick line → इसका elevation marked जातिका।

④ **Contour Gradient**

Method of Interpolation

The process of drawing contours between the plotted ground point is known as Interpolation of Contour.

① Estimation or Eye judgment Method

→ Imperfect method → rough → small scale → accuracy low

② Arithe

→ accurate method. → large scale → time consuming.

③ Graphical Method

→ higher accurate method. → rapid & convenient.

Uses of Contours

→ Drawing of section → Determination of intervisibility.

→ measurement of catchment's area.

→ Selection of canal alignment.

→ Calculation of storage capacity of reservoir.

→ Tracing of contour gradient.

→ Selection & location of route.

Setting out

Setting out of small Building

It is the marking of out lines of excavation on the ground for the guidance of the contractor & the labour. To minimize the digging foundation trenches, it is very necessary.

The main reason for setting out is to minimize the cost as well as providing the accurate location of the structure.

Method of setting out

① Setting out by circumscribing rectangles.

② Setting out by rectangles formed by the center line.

→ Boning rod is used for setting out of sewer.

Curve

A curve is the regular bend path. the curve may be either Circular, Parabolic or spherical.

Types of Curves

Horizontal curve
Vertical curve

Vertical curve → Summit curve, Valley curve

Circular curve	Transition curve
→ simple circular curve	→ Cubic Parabola
→ compound curve	→ Cubic spiral
→ Reverse curve	→ Cemniscate Curve.

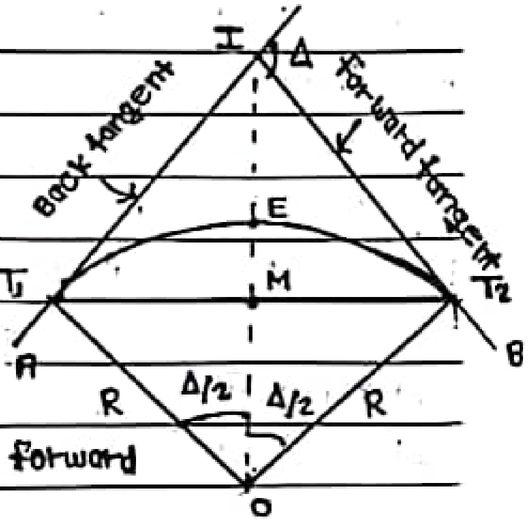
Circular Curve

① **Simple Circular Curve** The curve which consists of a single circul arc is known as simple circular curve. It is tangential to the both straight portion.

② **Compound Curve** The curve Consists of two or more arc of differe Circle with different radii have in different center laying on the sam side of the common tangent & which bend in the same direction is known as compound curve.

③ **Reverse curve** The curve which consists of two arc of different circle of same or different radii but the center of arc on opposite side is known as reverse curve.

Elements of Curve :



① Back Tangent IT_1
② Forward Tangent IT_2
③ Point of commencement T_1 (curve start)
④ point of Tangency T_2 (curve end)
⑤ point of intersection I, back tangent & forward tangent का Intersection point है।

⑥ **Angle of Deflection (Δ)** forward tangent deflects भए पछिको angle.

⑦ **Angle of Intersection**: Back tangent र forward tangent बिचको angle.

⑧ **Tangent distance** $(T) = R \tan\left(\frac{\Delta}{2}\right)$

⑨ **Length of curve** T_1 देखि T_2 सम्मको curve length हो $L = \frac{\pi R \Delta}{180°}$

⑩ **Long chord** T_1 र T_2 लाई जोड्ने st. line हो। length of long chord $= 2R\sin\left(\frac{\Delta}{2}\right)$

⑪ **Mid ordinate** curve र long chord को mid point बिचको distance हो।

mid-ordinate $= R\left(1 - \cos\frac{\Delta}{2}\right)$

⑫ **Apex distance** point of intersection र curve को mid point बिचको distance हो। apex distance $= R\left(\sec\frac{\Delta}{2} - 1\right)$

⑬ **Normal chord** curve मा भएको successive (क्रमिक) regular peg बिचको curve हो।

⑭ **Sub-chord** यो normal chord भन्दा short हुन्छ। generally, यो sub-chord, curve को beginning र end मा occurs हुन्छ।

Degree of Curve

① if arc is 30m, $D° = \frac{1718.9}{R}$

② if arc is 20m, $D° = \frac{1146}{R}$

गण्डकी प्रदेश गण्डकी प्रदेश गण्डकी प्रदेश

Total station surveying

A total station is an electronic/optical instrument used in modern surveying & building construction. it is a combination of an electronic theodolite & an electronic distance meter (EDM). It is also integrated with micro-processor, electronic data collector & storage system.

Components of Total Station

$$\left.\begin{array}{l} \text{① Base plate} \\ \text{② Foot screw} \end{array}\right\} \longrightarrow \text{Levelling Head}$$

③ Display
④ keys
⑤ optical plummet
⑥ Horizontal Clamp screw
⑦ Horizontal tangent screw
⑧ Vertical clamp screw
⑨ Vertical tangent screw
⑩ plate level
⑪ Telescope
⑫ Eye piece
⑬ objective lens
⑭ Battery
⑮ Focusing knob
⑯ Vertical circle
⑰ Sighting
⑱ Handle
⑲ center
⑳ USB port etc.

Function of Total station

↳ measurement of horizontal distance, horizontal/Vertical angle, bearing of lines, levelling etc.

Advantages of Total station

→ quick setup of the instrument on the tripod by the utilizing the laser plummets.

→ Calculations of Coordinates is very fast & accurate.

→ It supports local languages.

→ NO recording & writing errors.

→ All in one & multitasking instrument.

→ Faster work, saves time.

→ Data can be saved & transferred to a pc.

→ It has integrated database.

Disadvantages of Total station

→ The Instrument costly then other instruments.

→ It might difficult for surveyor to investigate & check the work

→ Working with total is not so easy, more skilled surveyors require

→ To perform the work completely its needed to go back to the office & perform drawing with particular software.

Features of Total Station

① Distance Measurements major part of total station. is EDM. Range 2.8 KM – 4.2 KM Accuracy 5mm – 10mm per km.

② Angle Measurements Electronic theodolite is part of total station. used measuring horizontal & vertical angle. accuracy 2 – 6 seconds

③ co-ordinate calculation

④ Data processing

⑤ Display

⑥ Electronic Book Use data stored Capacity 2000 – 4000 points

⑦ power supply. Rechargeable nickel – Cadmium batteries (2–10h

⑧ Reflector or prism constructed glass cubes

Application of Total Station

- → Topographical survey
- → Cadastral survey
- → Engineering survey
- → mine survey
- → Detail survey
- → Co-ordinate calculations
- → control survey
- → Height measurement
- → Area calculations.
- → Resection
- → Remote distance measureme
- → Road / Rail / Canal survey.

गण्डकी प्रदेश

Global positioning system (GPS)

Gps is a Satellite based navigation system that can be used to locate positions anywhere on earth. → Gps designed & operated by the U.S. Department of Defense (DOD).

Components of GPS

① Gps Antenna Antenna come in many shapes & size & it's basic function is to receive the Gps Signal.

② Gps Receivers Receiver is used for collection of geographical data of specific area.

③ Gps Display & Storage Records & reports are displayed & stored by Gps display & Storage components.

④ Interface Standardized protocol allows data exchange between many devices or interfacing with other devices.

⑤ DGPS is essential a system to provide positional Correction to GPS signals.

⑥ Gps Ground Control stations/control segment measurements collected by the monitor station to predict the behavior of each Satellites orbit & atomic clocks. prediction data is linked up to the Satellite for transmission to users.

⑦ Gps satellites/space segment

Functions of GPS

- → position & Coordinates.
- → The distance & direction between any two waypoints.
- → Travel progress reports.
- → Accurate time measurement.

Advantages of Gps

→ It helps to survey with many times greater precision.

→ It helps to complete a survey with lesser time.

→ It reduces the difficulty.

→ Gps works in all weather.

→ Very less chance of error.

→ Easy to navigate, tells the direction & reach to destination.

→ low instrument cost.

Disadvantage of Gps

→ Required special hardware & software.

→ Higher capital cost.

→ Need for good care & handling.

→ privacy concerns.

→ Weak on many place, eg: mountain, building etc.

Linear Measurements

Earth surface को दुई point बिचको distance determine गर्ने·

two method छन्।

① Direct Method	② Indirect Method
→ Distance measure directly	→ By calculation.
→ Pacing, tape, chain	→ EDM, Distomat, tellurometer.
→ Low accuracy.	→ High accuracy

Pacing it consists in walking over a distance & counting number of paces. Average length of pace = 80cm or 2.5ft. Distance = No. of pace X pace factor Use Reconnaissance survey

Instrument for Measurement

① Passometer Instrument shape like watch Carried in pocket. Work Automatically record the number of paces.

② Pedometer similar to passometer Work record the distance.

③ Odometer गाडीको तत्कालीन distance नाप्ने device हो। in km मा।

④ speedometer गाडीको तत्कालीन speed नाप्ने digital instrument हो।

Tape

Tape	Length	width	Material	Accuracy	Use
① Cloth/linen	10,20,30m	12-15mm	closely woven linen.	low	offset measure
② Metalic	20,30m (c)	16mm	linen tape reinforced (brass & copper wire)	higher then ①	offset measure
③ Steel	10,20,30,50m	6-10mm	steel	higher then ②	construction work
④ Invar	30,50,100m	6mm	steel 64%, Nickel 36%.	accurate	Base measurement

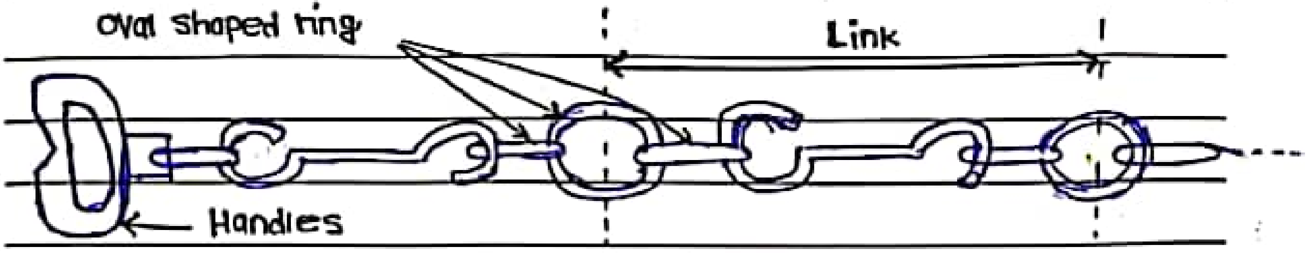
Note linen tape light, flexible हुन्छ। र Vernish गरिन्छ, moisture resist गर्न। र high sag र pull error हुन्छ। metallic tape wire ले stretching वा twisting रोक्छ। wire, naked आँखाले देखिँदैन। high temperature error हुन्छ।

Glass fiber (synthetic) material glass fiber with pvc coating

Use any weather Note Temp र moisture change हुदा stretch र shrink हुँदैन।

Chain

chain	Engineering	Gunter's	Metric	Steel band	Revenue
Length	100ft	66 ft	20m, 30m	20m, 30m	33ft
Link	100	100	100, 150	150	[illegible] 16
Each link	1ft	0·66ft	20cm	20cm	2·0625ft
Use	engineering survey			high accuracy	cadastral survey



fig; metric chain

Metric chain material Links → galvanized mild steel. Diameter 4mm

Handles → brass (include in whole length) → with swivel joint for flexibilit

Tallies → brass (every 5m, 10m etc मा हुन्छ) brass ring → brass (every 10mमा

Instrument for Making stations

① Peg Side 2·5cm Length 15cm Use survey station को mark गर्न।

Material wooden र harder ground कालागि Iron peg.

② Ranging Rod Length 2–3m diameter 3cm Use station mark, st line ranging.

Material Light, thin & straight bambo, well seasoned hard wood.

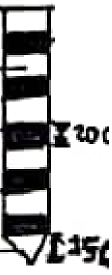
अतोल metallic materials बाट बन्छ। painted black-white or red-white

Reason long distance र bad weather मा राम्ररी देख्न। Length of one paint 20cm

Visible up to 200m

③ Ranging poles Length 4–8m Diameter 6–10cm Use undulating ground

Very long lines ranging गर्न। Material hard wood or steel

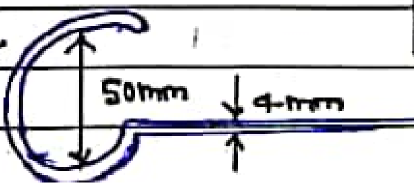


④ Offset Rod Similar to ranging rod Length 3m Diameter 3cm

Use small offset measuring गर्न।

⑤ Arrow Another name marking or chaining.

Pin Length 40cm (25–50cm) Diameter 4mm



Use During chaining process मा chain को end mark गर्ने।

Material good quality hardened & tempered steel wire.

no. of arrow in one chain 10

⑥ **Plumb Bob** **Length** 5 cm **Weight** 2–5 N (0·2–0·5 kg)

Material iron **Use** centering गर्ने।

⑦ **Line Ranger** small reflecting instrument हो।

Use chain line मा intermidate point fix गर्ने।

⑧ **plasterer's laths** line ranging गर्ने। **Material** soft wooden

Length 0·5–1m → long intermediate point setting गर्नकालागि।

Colour white or light

⑨ **Whites** **Length** 0·5–1m **Shape** circular **Use** lathe जस्तै।

→ यो sharpened thin sticks का pieces हो।

⑩ **Bench Marks** यो elevation known भएको permanent र fixed point.

Ranging

Ranging is the process of **fixing intermediate points** on the chain lines.

Types of Ranging

Types of Ranging	Suitability	Required ranging rod
① Direct Ranging	End station intervisible	3
② Indirect Ranging	End station not visible/hill rock	4
③ Random Ranging	Dense forest	>4 रड

Note Indirect ranging लाई reciprocal ranging पनि भनिन्छ।

Abney Level object वा hill को inclination नाप्ने optical instrument हो। → Rapid work, easy **Suitable** Hilly area **Error** High

Use → measuring vertical angle & slope → Tracing grade contours. → Taking cross section in hilly ground → used as **hand level** by setting it's vernier index to zero., levelling

Clinometers Elevation & vertical angle measuring instrument.

Source of Errors

① **Personal error** मान्छेको आँखा, confusion र careless आदिबाट हुन्छ।

② **Instrumental error** Instrument को गलत adjustment र बिग्रेका कारण।

③ **Natural error** Temp, wind, humidity र refraction आदिबाट हुन्छ।

Errors in chaining

→ **Systematic error**

① **Cumulative Errors** same direction मा add गर्दा longer वा shorter प्रकार error हुन्छ। 'Types' → $\propto$ Length of line

① **Positive cumulative error** measured length actual value भन्दा बढी हुन्छ।

Reason link bending, ignored sag & slope correction, incorrect alignment, working in windly weather. **Correction** −ve

② **Negative cumulative error** measured length actual value भन्दा कम हुन्

Reason link open, standard length भन्दा chain long हुदा। **Correction** +ve

② **Compensating Errors** जो both direction मा occur हुन्छ।

Reason Incorrect holding of chain/tape. **Correction** Not → $\propto \sqrt{L}$

③ **Accidental Errors** surveyor को careless बाट error हुन्छ। Mistak

Reason displacement of arrows, wrong read & entries in field book.

→ **Random error** → $\propto \sqrt{N}$ where N = no. of observation taken.

Correction for Linear Measurements

		Sign
① Correction for standard/absolute length	$C_a = \frac{CL}{L}$	±
② Correction for alignment =	$l_1(1-\cos\theta_1)+l_2(1-\cos\theta_2)$	−
③ Correction for slope or vertical alignment ⇒	$\frac{h^2}{2L} = C_s$	−
④ Correction for pull or tension	$C_p = \frac{(P-P_0)L}{AE}$	± Pull ज्यादा + कम −
⑤ Correction for temperature	$C_t = (t_m - t_0)L\alpha$	±
⑥ Correction for sag	$C_g = \frac{L}{24}\left(\frac{W}{P}\right)^2$	−
⑦ Correction for M.S.L	$C_{msl} = \frac{hL}{R}$	−

⑧ Normal tension → $P = \frac{0.204W\sqrt{AE}}{}$

Discrepancy → Difference between two measured value of same quantity

Residual Error = Measured quantity − Most Probable Value = Variation (Error)

Theory of Probability is applied to Accidental errors.

Note: True length = Measured length × $\frac{\text{incorrect length of chain}}{\text{correct length of chain}}$

True area = Measured area × $\left(\frac{\text{incorrect length of chain}}{\text{correct length of chain}}\right)^2$

True Volume = Measured Volume × $\left(\frac{\text{incorrect length of chain}}{\text{correct length of chain}}\right)^3$

Discrepancy = Forward distance − Backward distance | same quantity का।

Chain Surveying

→ In chain surveying only linear measurement are taken.

Suitability	Unsuitability
① fairly level ground	① undulating ground
② Small area	② large area
③ open area	③ Crowded area
④ large scale plan are required.	④ wooden countries

Principle of Chain surveying

The main principle of chain surveying is triangulation.

→ The best triangle for chain survey is equilateral/ideal triangle.

→ The triangles should not have any angles smaller then 30° & greater then 120° is called well-Conditional triangle & vice versa is called ill-Conditional triangle.

Important point in chain surveying

① main survey station The points where two sides of main triangle meet. Represent small triangle with capital letter.

② Main survey line The line joining the main survey station.

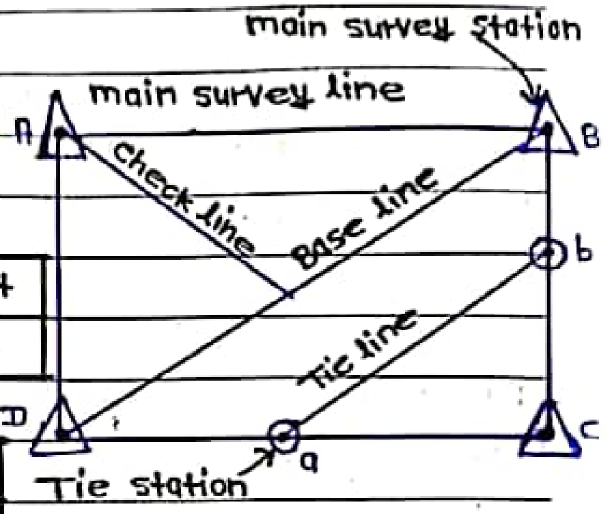
③ Tie/sub-sidiary/sub-station The station selected on the main survey line. Represent small circle with small letter.

④ Tie/sub-sidiary/auxiliary lines. The line joining the two tie station on main chain line. → long offset avoid करते

⑤ Base line. The longest line in whole survey area of main survey line. Various survey station are plotted with reference to

⑥ **Check/proof line** The line which run in the field to check accuracy of field work. प्रत्येक triangle कालागि एउटा check line हुनैपर्छ।

⑦ **Offset** lateral measurement for locating the positions of details.



Types of offset

[A] Based on measurements

① perpendicular offset	② oblique offset
right angle to survey line	not right angle

[B] Based on Length

① Long offset	② short offset
L > 15m	L < 15m

→ small measurement ~~from~~ chain line.

Obstacles in chaining

Condition	Example
① obstacles in ranging but not in chaining	Hill rocks
② obstacles in chaining but not in ranging	Rivers & Ponds
③ obstacles in both ranging & chaining	Tall building

Note if chain too long → less measured distance.
if chain too short → More measured distance

→ sign of correction चाहिलेपनि error को opposite हुन्छ।

Right angle Instrument

① **Cross staff** used cadastral map

① open cross staff	② french cross staff	③ Adjustable cross staff
measuring 90°	measuring 45° & 90°	measuring any angle

② **Optical square** → most accurate & convenient then cross staff.
→ Based on double reflection. → Generally used measuring long offset.

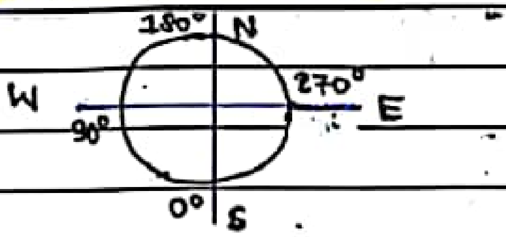
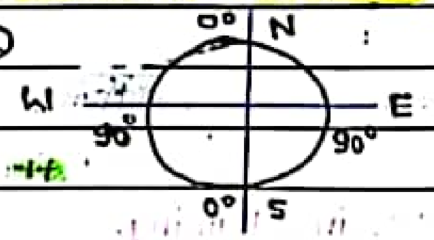
③ **Prism square** more modern & precise then optical square.

Compass surveying

Measured direction of survey lines by means of compass & distance are measured by tape or chain directly on the surface of earth.

→ Suitable for those place where the magnetic effects is least or none.

Types of Compass

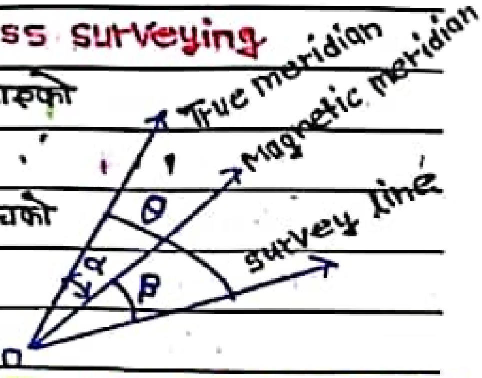
① Prismatic compass	② Surveyor compass
① 	① 
② Whole circle bearing system	② Reduced/Quadrantal bearing
③ Tripod is not essential.	③ Tripod is very essential.
④ Inverted (0° at South & run CW)	④ Erect (0° at north & South)
⑤ Scale are attached to needle.	⑤ Scale are attached to box.
⑥ Board magnetic needle.	⑥ Edge bar magnetic needle.
⑦ Generally used in survey work.	⑦ Sometimes used in survey work.
⑧ Reading taken by help of prism.	⑧ Reading taken directly from glass.

Important point used in compass surveying

θ = true meridian सँग survey line ले बनाएको सानो horizontal angle लाई Azimuth भनिन्छ।

β = Magnetic meridian र survey line बिचको सानो horizontal angle लाई Bearing भनिन्छ।

α = True meridian र magnetic meridian बिचको, सानो horizontal angle लाई, Declination वा Magnetic declination भनिन्छ।



Meridian पृथ्वीको सतहमा कुनै एउटा fixed direction, जसको आधारमा survey lines हरूको bearing measure गरिन्छ।

Types of Meridian

① **True Meridian** earth को north र south बाट passing हुने imaginar line हो। अर्को नाम : **Astronomical Meridian.**

② **Magnetic Meridian** एउटा standard reference line हो, जोकी freely balanced magnetic needle द्वारा देखा पर्छ। जुन बेला local attraction को असर हुनुहुँदैन।

③ **Grid Meridian** कुनैपनि area को central portion देखि pass हुने true meridian हो।

④ **Arbitrary Meridian** आफ्नो इच्छा अनुसार मानिएको उपयुक्त direction हो।

Bearing कुनैपनि reference meridian र survey line बिचको horizont angle हो। जो clockwise direction मा measured गरिन्छ।

Types of Bearing

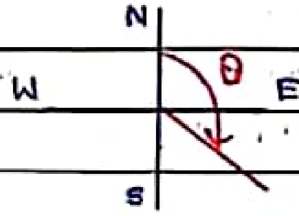
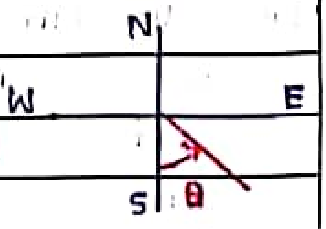
① **True Bearing** True meridian र survey line बिचको horizontal angle ह

② **Magnetic Bearing** magnetic meridian र survey line बिचको horizontal angle

③ **Grid Bearing** Grid meridian र survey line बिचको horizontal angle हो।

④ **Arbitrary Bearing** Arbitrary meridian र survey line बिचको horizontal angle

System of Bearing

① Whole circle Bearing (WCB)	② Quadrantal/Reduced Bearing
→ North बाट Bearing measured गरिन्छ।	→ North र south बाट।
→ Clockwise direction मा।	→ clockwise वा Anticlockwise
→ Bearing को Value 0°– 360° हुन्छ।	→ Bearing को Value 0°–90° हुन्छ।
→ Example,  $\therefore WCB = \theta$	→ Example,  $\therefore QB/RB = S\theta E$

Conversion of WCB to QB

case	W.C.B	Role of QB	Q.B
1.	0°–90°	WCB	NθE
2.	90°–180°	180 – WCB	SθE
3.	180°–270°	WCB – 180	SθW
4.	270°–360°	360° – WCB	NθW
5.	0°	N	
6.	90°	E90°	
7.	180°	S	
8.	270°	W90°	

Fore Bearing	Back Bearing
→ survey गइरहेको direction को bearing	→ opposite direction को bearing
Note Back Bearing = Fore Bearing ± 180°	FB र BB को difference = 180°
if FB < 180° → ⊕ if FB > 180° → ⊖	यदि station local attraction free.

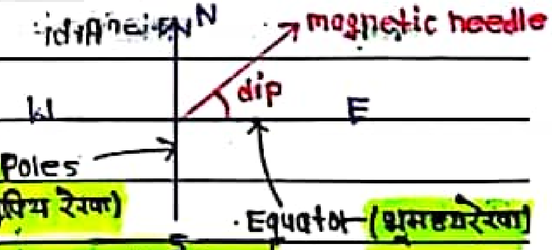
Dip It is the inclination between the longitudional axis of magnetic needle & the horizontal plane through its pivot.

→ Dip at Equator — 0°

→ Dip at poles — 90°

→ Vertical angle हो।

ठाउँअनुसार Dip फरक हुन्छ।



Magnetic Declination

True Bearing = magnetic Bearing ± Declination

Types → यदि declination east मा भए ⊕ मा Eastern Declination

→ यदि declination West मा भए ⊖ मा Western Declination

Lines used in compass survey

① Agonic line zero declination को point, joining गर्ने line हो।

② Isogonic line equal declination को point, joining गर्ने line हो।

③ Isoclinic line equal dip को point, joining गर्ने line हो।

→ magnetic declination constant हुँदैन, time अनुसार Varies हुन्छ।

→ magnetic Variations is more near poles & less at equator.

Types of Variation in magnetic Declination

① Diurnal Variation in 24hr (3'–12') → Day मा बढी र night मा कम।

② Annual Variation in year (1'–2') → summer मा बढी र winter मा कम

③ Secular Variation in 250 years (0·02'–12') → large Variation..

④ Irregular Variation Due to earthquake, Volcanic, Storm (आँधी) etc (1°–2°)

Temporary Adjustments of compass

① centering ground station को ठिक Vertically माथि pivots पार्ने process

② Levelling graduated ring लाई ठिक horizontal, holding गर्ने process हो

③ focusing of prism clear figures र graduations, achieve गर्न pris
लाई up वा down moving गर्ने process हो। २०७४

Local Attraction Disturbing force हो। जसले चुम्बकको needle लाई आफ्नो वास्तविक position बाट deflected बनाउँछ। कारण: needle को नजिक magnetic र electric वस्तु हुदा। कसरी पत्ता लाग्छ ? यदि FB र BB बिचको difference 180° नहुदा। हटाउने तरिका Affected station हरुमा रेखाहरुबिचको angle calculate गरेर। र प्रत्येक station मा local attraction को मान पत्ता लगाएर, (Unaffected Bearing) बाट सुरु गर्ने।

Different types of measuring instrument used in Surveying

① Horizontal Distance Tape, chain, EDM, Tacheometer etc.

② Vertical Distance Levelling, Tachometer, Altimeter etc.

③ Horizontal Angle Magnetic Compass, Theodolite, Sextant etc

④ Vertical Angle Theodolite, Total Station, Clinometer, Sextant, Slant rule etc.

⑤ Area planimeter etc.

⑥ speed Odometer (total distance), speedometer