

Civil Engineering

Sparks Academy
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Engineering Survey

Chain Surveying



Surveying

Survey - computation of areas - Chain Survey - Compass surveying - Plane table survey - levelling - fly levelling - L.S. and C.S. - Contour volumes - Theodolite survey - Traversing - Heights and Distances - Geodetic Observations- Tacheometry and Triangulation - Use of EDM, GPS and Remote sensing techniques.

Surveying

- **Surveying is the technique of determining the relative position of different features on, above or beneath the surface of the earth by means of direct or indirect measurements.**

- **Surveying** என்பது பூமியின் மேற்பரப்பில், மேலே அல்லது கீழே உள்ள பல்வேறு அம்சங்களின் ஒப்பீட்டு நிலையை நேரடியாக அல்லது மறைமுக அளவீடுகள் மூலம் தீர்மானிக்கும் நுட்பமாகும்.

Surveying

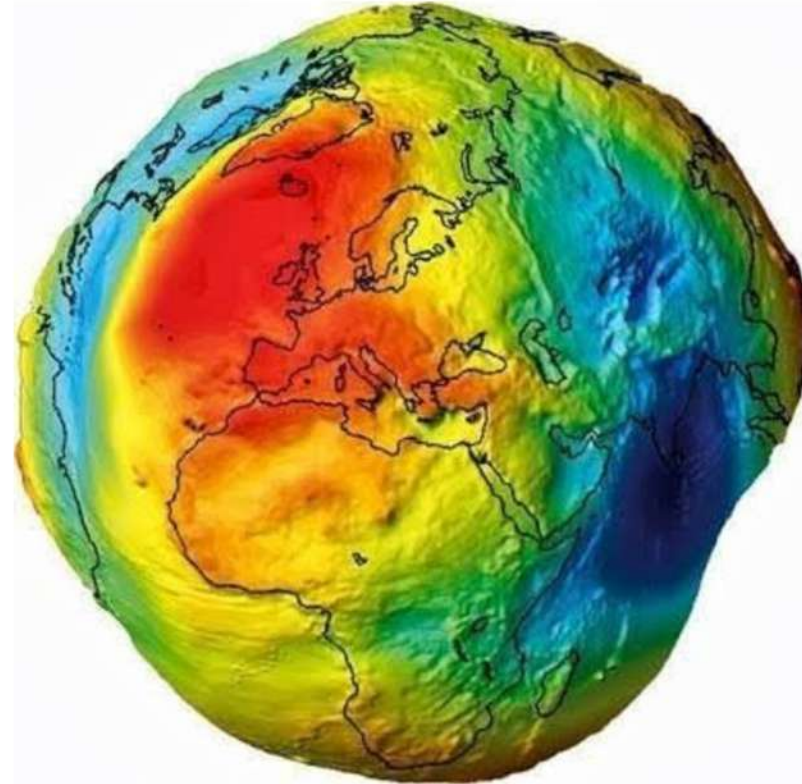
- The art of determining the relative positions of the objects on the surface of the earth by taking measurements in both horizontal and vertical plane.
- கிடைமட்ட மற்றும் செங்குத்து விமானத்தில் அளவீடுகளை எடுத்து பூமியின் மேற்பரப்பில் உள்ள பொருட்களின் ஒப்பீட்டு நிலைகளை தீர்மானிக்கும் கலை.

Object of surveying

- To obtain a map or a plan of the area to be surveyed
- கணக்கெடுக்கப்பட வேண்டிய பகுதியின் வரைபடம் அல்லது திட்டத்தைப் பெற.

Shape of earth

- **Oblate spheroid**
- **Ellipsoid**
- **Ovaloid**



The two main divisions of surveying

- 1. Plane surveying**
- 2. Geodetic surveying**

Shape of Earth

- The **shape of the earth is elliptical** in nature, but assumed to be a **spheroid**.
- The **line joining of any two points on the earth surface is in an arc** of a **great circle**.
- This is not a straight line measurement.
- பூமியின் வடிவம் நீள்வட்டமானது, ஆனால் ஒரு கோளமாக கருதப்படுகிறது.
- பூமியின் மேற்பரப்பில் ஏதேனும் இரண்டு புள்ளிகளை இணைக்கும் கோடு ஒரு பெரிய வட்டத்தின் வளைவில் உள்ளது.
- இது நேர்கோட்டு அளவீடு அல்ல.

1. Plane surveying

- The survey in which **the earth surface is assumed as plane** and the **curvature of earth is ignored** is known as plane surveying.
- பூமியின் மேற்பரப்பை விமானமாகக் கருதி, பூமியின் வளைவு புறக்கணிக்கப்படும் கணக்கெடுப்பு விமான ஆய்வு என்று அழைக்கப்படுகிறது.

1. Plane surveying

- We know that the **shape of the earth is GEOID.**
- In plane surveying, **the curvature of the earth is not taken into consideration.**
- This is because plane surveying is **carried out over a small area.**
- Plane surveying is done on an **area of less than 250 km².**
- பூமியின் வடிவம் GEOID என்பது நமக்குத் தெரியும்.
- விமான ஆய்வுகளில், பூமியின் வளைவு கணக்கில் எடுத்துக்கொள்ளப்படுவதில்லை.
- ஏனென்றால், சிறிய பரப்பளவில் விமான ஆய்வு மேற்கொள்ளப்படுகிறது.
- 250 கிமீ²க்கும் குறைவான பரப்பளவில் விமான ஆய்வு செய்யப்படுகிறது.

2. Geodetic surveying

- The survey in which the **curvature of earth is taken into account** is known as Geodetic surveying.
- This is done by **Great Trigonometrical Survey (GTS)** of India.
- பூமியின் வளைவை கணக்கில் எடுத்துக் கொள்ளும் ஆய்வு ஜியோடெடிக் சர்வேயிங் எனப்படும்.
- இது இந்தியாவின் கிரேட் டிரிகோனோமெட்ரிகல் சர்வே (ஜிடிஎஸ்) மூலம் செய்யப்படுகிறது.

2.Geodetic surveying

- It is **extended over a large area**.
- The **line joining any two points is considered as a curved line**.
- Geodetic surveying is conducted by the Survey of India department, and is carried out over an **area exceeding 250 km²**.
- இது ஒரு பெரிய பரப்பளவில் நீட்டிக்கப்பட்டுள்ளது.
- ஏதேனும் இரண்டு புள்ளிகளை இணைக்கும் கோடு வளைந்த கோடாகக் கருதப்படுகிறது.
- ஜியோடெடிக் கணக்கெடுப்பு இந்திய சர்வே துறையால் நடத்தப்படுகிறது, மேலும் 250 கிமீ²க்கும் அதிகமான பரப்பளவில் மேற்கொள்ளப்படுகிறது.

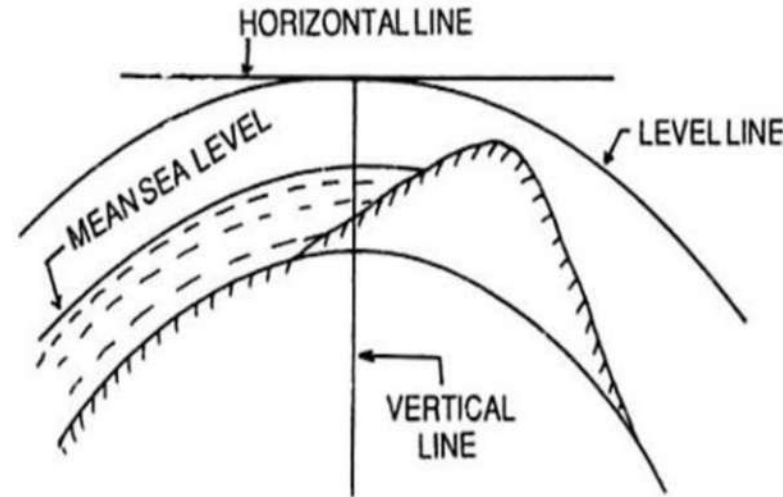
Level surface and Level line

- **Level surface** is the continuous surface parallel to the mean spheroid of the earth.
- The line representing the level surface is termed as level line.
- The level line makes right angles to the vertical line or plumb line at any point.
- நிலை மேற்பரப்பு என்பது பூமியின் சராசரி கோளத்திற்கு இணையான தொடர்ச்சியான மேற்பரப்பு ஆகும்.
- நிலை மேற்பரப்பைக் குறிக்கும் கோடு நிலைக் கோடு என்று அழைக்கப்படுகிறது.
- நிலை கோடு எந்த புள்ளியிலும் செங்குத்து கோடு அல்லது பிளம்ப் கோட்டிற்கு சரியான கோணங்களை உருவாக்குகிறது.

Horizontal plane

- Horizontal plane through **a point is a plane tangential to the level surface at that point.**

- ஒரு புள்ளி வழியாக ஒரு கிடைமட்ட விமானம் அந்த புள்ளியில் நிலை மேற்பரப்பில் ஒரு விமானம் தொடுவானது.



Technical Terms-Plan

- A plan is the **graphical representation of the features on the earth surface or below the earth surface** as projected **on a horizontal plane**.
- On a plan **horizontal distances and directions** are generally shown.
- ஒரு விமானம் என்பது ஒரு கிடைமட்ட விமானத்தில் திட்டமிடப்பட்ட பூமியின் மேற்பரப்பில் அல்லது கீழே உள்ள அம்சங்களின் வரைகலை பிரதிநிதித்துவம் ஆகும்.
- ஒரு கிடைமட்ட விமானத்தில் பொதுவாக தூரங்கள் மற்றும் திசைகள் காட்டப்படும்.

Technical Terms-Map

- The **representation of the earth surface on a small scale** is called a **map**.
- The **map must show its geographical position of the earth**.
- பூமியின் மேற்பரப்பை சிறிய அளவில் காட்டுவது வரைபடம் எனப்படும்.
- வரைபடம் பூமியின் புவியியல் நிலையைக் காட்ட வேண்டும்.

Topographical map

- The **maps drawn in a large scale** to **identify the individual features and positions of various objects on the earth surface is called Topographical map.**
- பூமியின் மேற்பரப்பில் உள்ள பல்வேறு பொருட்களின் தனிப்பட்ட அம்சங்களையும் நிலைகளையும் அடையாளம் காண பெரிய அளவில் வரையப்பட்ட வரைபடங்கள் Topographical map எனப்படும்.

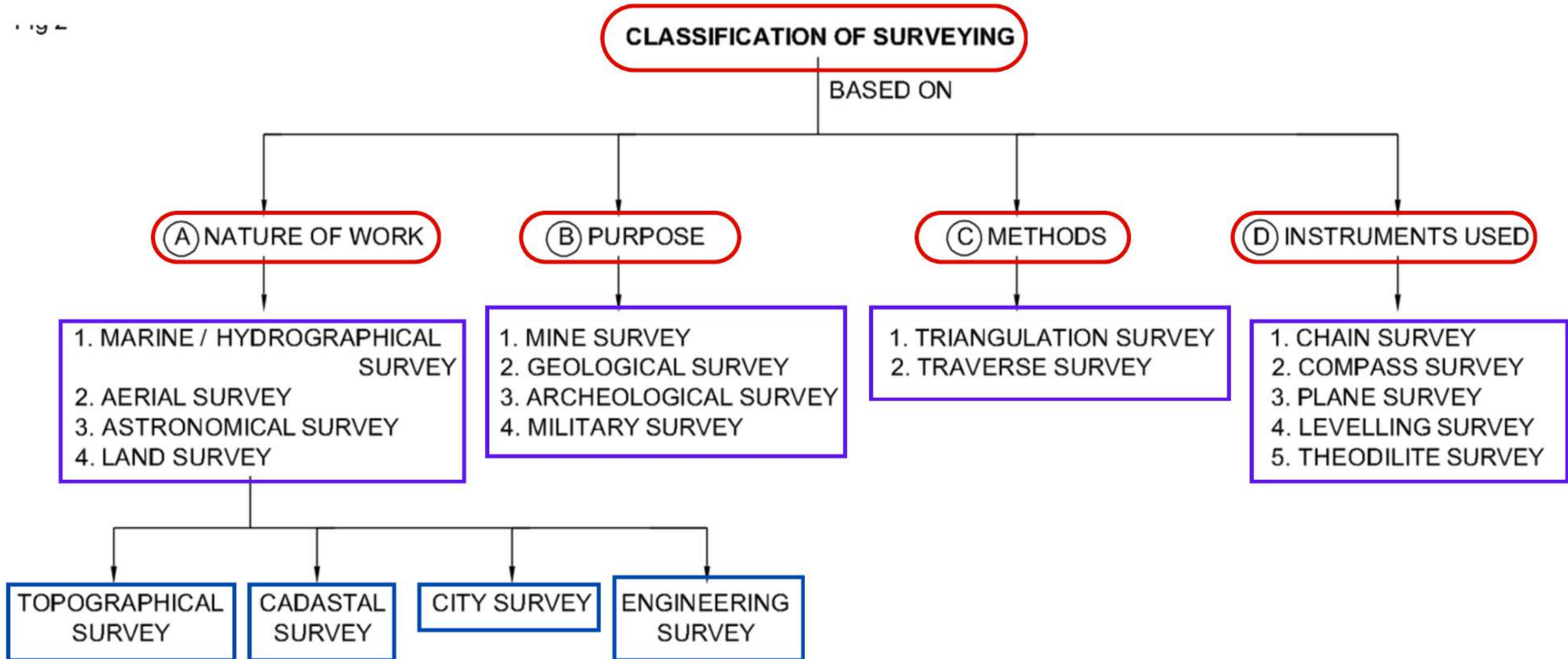
Triangulation

- The area to be surveyed is divided into a network of triangles and the length of its sides measured in the field and no angular measurements are required is known as **Triangulation.**

- கணக்கெடுக்கப்பட வேண்டிய பகுதி முக்கோணங்களின் வலையமைப்பாகப் பிரிக்கப்பட்டு அதன் பக்கங்களின் நீளம் புலத்தில் அளவிடப்படுகிறது மற்றும் கோண அளவீடுகள் தேவையில்லை என்பது முக்கோணம் என அழைக்கப்படுகிறது.

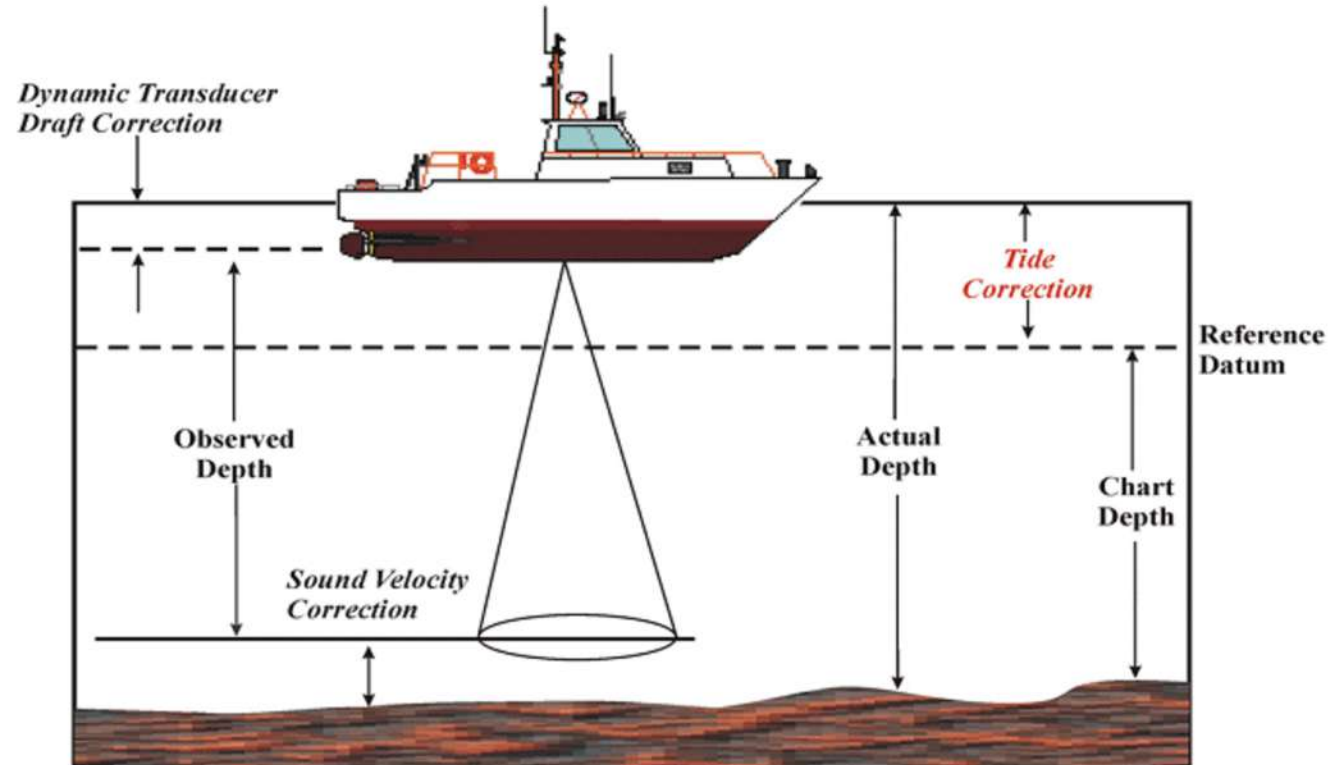
Classification of surveying

Fig 1



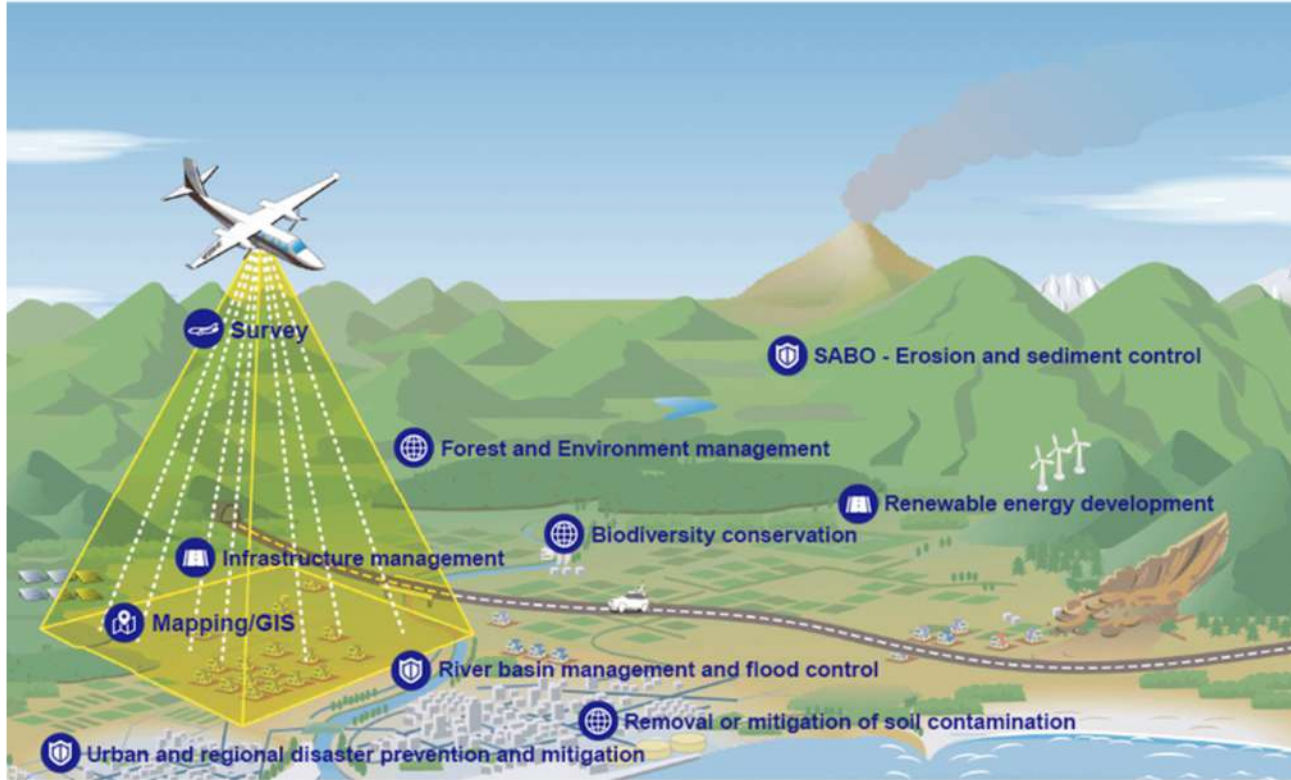
Marine/Hydrographical survey

- It is the survey, **which deals the objects under the water.**
- இது தண்ணீருக்கு அடியில் உள்ள பொருட்களைக் கையாளும் ஆய்வு ஆகும்.



Aerial survey

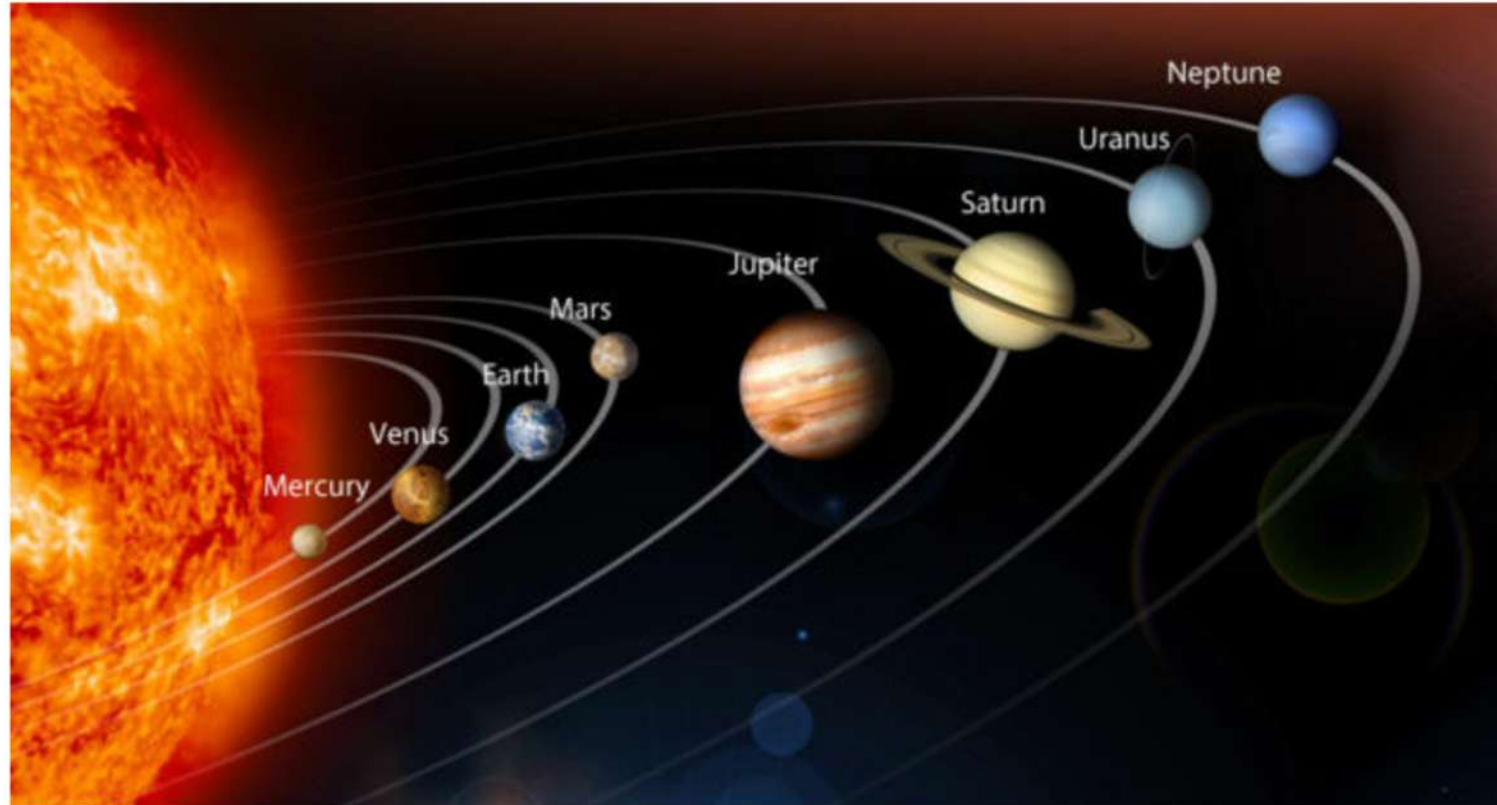
- It is the survey in which to collect the details of cyclonic affected areas, flooded areas etc. is done by aero plane in air.
- இது சூறாவளியால் பாதிக்கப்பட்ட பகுதிகள், வெள்ளம் பாதித்த பகுதிகள் போன்ற விவரங்களை சேகரிக்கும் கணக்கெடுப்பாகும். காற்றில் ஏரோ பிளேன் மூலம் செய்யப்படுகிறது.



Astronomical survey

- It is the survey, **which deals with the stars in the sky.**

- இது வானத்தில் உள்ள நட்சத்திரங்களைப் பற்றிய ஆய்வு.



Topographical survey

- It is the survey to **determine the natural and artificial features on the earth.**

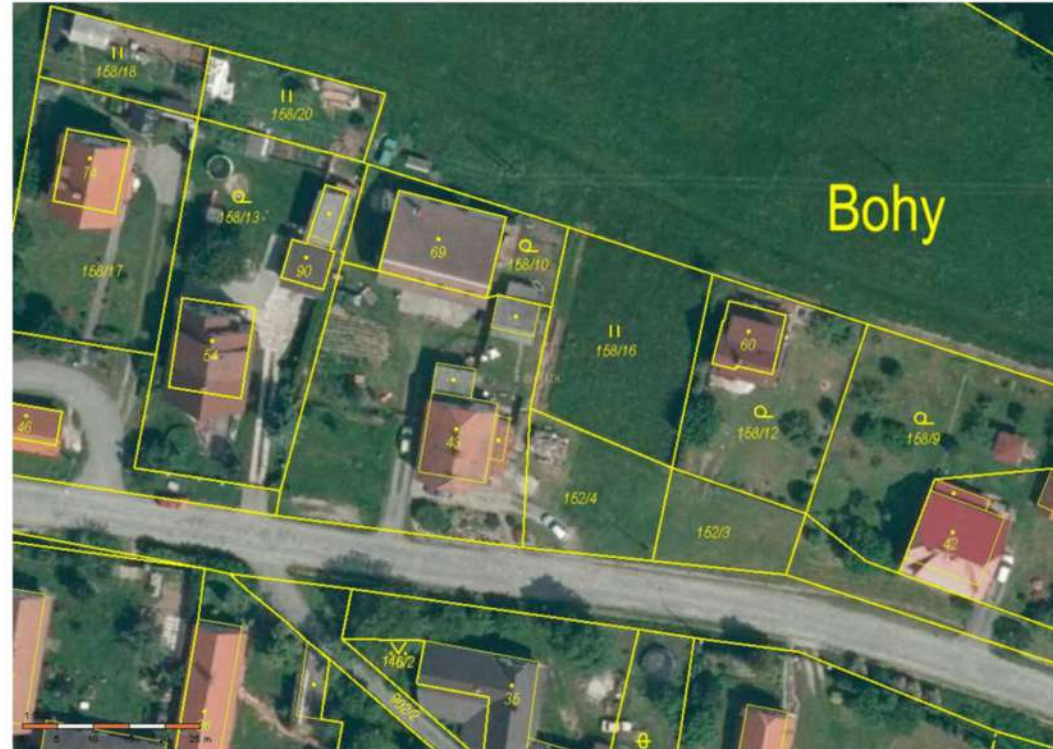
- பூமியில் உள்ள இயற்கை மற்றும் செயற்கை அம்சங்களைக் கண்டறியும் ஆய்வு இதுவாகும்.



Cadastral survey

- It is the survey **which deals the additional details of the boundaries of fields, houses etc.**

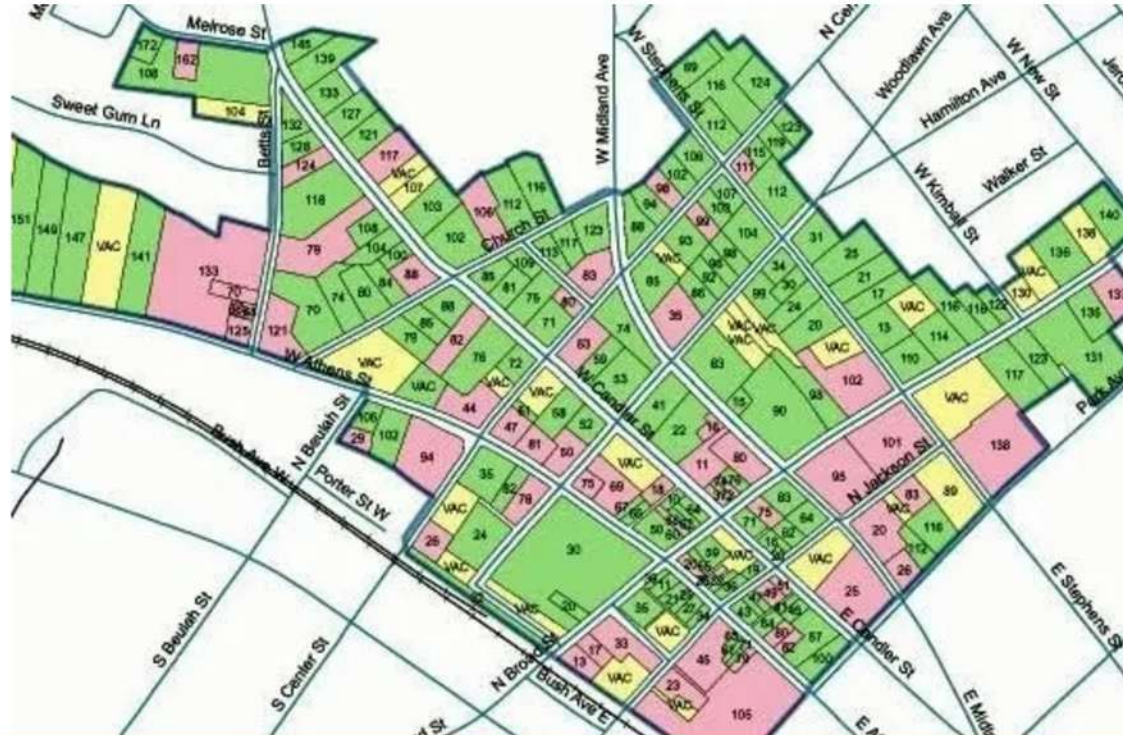
- இது வயல்வெளிகள், வீடுகள் போன்றவற்றின் எல்லைகளின் கூடுதல் விவரங்களைக் கையாளும் ஆய்வு ஆகும்.



City survey

- It is the survey **which deals the layout plots, roads, water supply and sewerage systems.**

- இது மனைகள், சாலைகள், நீர் வழங்கல் மற்றும் கழிவுநீர் அமைப்புகளின் அமைப்பைக் கையாளும் ஆய்வு ஆகும்.



Engineering survey

- It is the survey which deals with **determining the quantities and collecting the data for the design of engineering projects such as roads, dams etc. reservoirs or work in connection with water supply sewerage etc.**

- சாலைகள், அணைகள் போன்ற பொறியியல் திட்டங்களின் வடிவமைப்பிற்கான அளவை நிர்ணயிப்பது மற்றும் தரவுகளை சேகரிப்பது தொடர்பான கணக்கெடுப்பு இதுவாகும். நீர்த்தேக்கங்கள் அல்லது நீர் வழங்கல் கழிவுநீர் போன்றவற்றுடன் தொடர்புடைய வேலை.

Mine survey

- It is the survey **which deals in exploring mineral wealth such as gold, coal, copper etc.** with in the earth's crust.

- இது தங்கம், நிலக்கரி, தாமிரம் போன்ற கனிம வளங்களை ஆராய்வதற்கான ஆய்வு ஆகும். பூமியின் மேலோடு.



Geological survey

- It is to determine the different strata in the earth's crust.

- இது பூமியின் மேலோட்டத்தில் உள்ள பல்வேறு அடுக்குகளை தீர்மானிப்பதாகும்.



Archaeological survey

- It is the survey **deals in unearthing the relics of the past.**

- கடந்த காலத்தின்
நினைவுச்சின்னங்களை
வெளிக்கொணருவதற்கான ஆய்வுகள்
இதுவாகும்.



Military survey

- It is the survey for **determining points of strategic importance both offensive and defensive.**
- இது தாக்குதல் மற்றும் தற்காப்பு ஆகிய இரண்டிற்கும் மூலோபாய முக்கியத்துவம் வாய்ந்த புள்ளிகளை தீர்மானிப்பதற்கான ஆய்வு ஆகும்.



Principles of surveying

- **To work from whole to the part.**
- **To locate a point with respect to two reference points.**
- முழு பகுதியிலிருந்து ஒரு பகுதிக்கு வேலை செய்ய வேண்டும்.
- இரண்டு குறிப்பு புள்ளிகளைப் பொறுத்து ஒரு புள்ளியைக் கண்டறிதல்.

To work from whole to the part

- To survey an area, it is **to establish the main control points with great precision.**
- The main idea is to
- **prevent the accumulation of errors**
- control and localize minor errors.
- ஒரு பகுதியை ஆய்வு செய்ய, முக்கிய கட்டுப்பாட்டு புள்ளிகளை மிகத் துல்லியமாக நிறுவ வேண்டும்.
- முக்கிய யோசனை
- பிழைகள் குவிவதைத் தடுக்கும்
- சிறிய பிழைகளைக் கட்டுப்படுத்துதல் மற்றும் உள்ளூர்மயமாக்குதல்.

To locate a point with respect to two reference points

- To fix the position of new stations, at least two independent positions are required.
- The new stations are fixed from points already fixed by
 - linear measurements
 - angular measurements
 - both linear and angular measurements
- புதிய நிலையங்களின் நிலையை சரிசெய்ய, குறைந்தது இரண்டு சுயாதீன நிலைகள் தேவை.
- புதிய நிலையங்கள் ஏற்கனவே நிர்ணயிக்கப்பட்ட புள்ளிகளிலிருந்து சரி செய்யப்பட்டுள்ளன
- நேரியல் அளவீடுகள்
- கோண அளவீடுகள்
- நேரியல் மற்றும் கோண அளவீடுகள்

Steel Tape

- It is **used for accurate work.**
- It is **lighter weight and easier to handle than the chain.**
- It is **20m or 30m long.**
- It is **made from ribbon of steel 16mm wide.**
- The **brass handles are provided at the ends of the chain with swivel joint.**
- இது துல்லியமான வேலைக்கு பயன்படுத்தப்படுகிறது.
- இது சங்கிலியை விட இலகுவான எடை மற்றும் கையாள எளிதானது.
- இது 20 மீ அல்லது 30 மீ நீளம் கொண்டது.
- இது 16 மிமீ அகலமுள்ள எஃகு ரிப்பனில் இருந்து தயாரிக்கப்படுகிறது.
- பித்தளை கைப்பிடிகள் சங்கிலியின் முனைகளில் சுழல் கூட்டுடன் வழங்கப்படுகின்றன.

Steel Tape



Chain surveying

- Measurement of distance:
- There are two main methods of determining distance.
- 1. Direct method
- 2. Computative
- Direct method:
- The distances are **actually measured on the ground by means of a chain, tape or other instruments.**
- தூரத்தை அளவிடுதல்:
- தூரத்தை தீர்மானிக்க இரண்டு முக்கிய முறைகள் உள்ளன.
- 1. நேரடி முறை
- 2. கணக்கீட்டு
- நேரடி முறை:
- தொலைவுகள் உண்மையில் ஒரு சங்கிலி, டேப் அல்லது பிற கருவிகள் மூலம் தரையில் அளவிடப்படுகின்றன.

Chain surveying

- **Computative:**
- The distances are obtained by calculation as in **tacheometry** or **triangulation**.
- கணக்கீடு:
- டேக்கியோமெட்ரி அல்லது முக்கோணத்தில் கணக்கிடுவதன் மூலம் தூரங்கள் பெறப்படுகின்றன.

Pacing

- For rough and speedy work, **distances are measured by pacing (i.e) by counting the number of walking steps of a man.**
 - The walking step of a man is considered as **80cm** (average).
- கடினமான மற்றும் வேகமான வேலைக்காக, ஒரு மனிதனின் நடைப் படிகளின் எண்ணிக்கையைக் கணக்கிடுவதன் மூலம் வேகம் (அதாவது) மூலம் தூரம் அளவிடப்படுகிறது.
 - ஒரு மனிதனின் நடைப் படியானது 80cm (சராசரி) ஆகக் கருதப்படுகிறது.

Measured distance: Length of pace x Number of paces

Passometer

- It is a **small pocket instrument** resembling a watch in size and appearance used for counting the number of steps automatically by some mechanical device.

- இது ஒரு சிறிய பாக்கெட் கருவியாகும், இது ஒரு கடிகாரத்தின் அளவு மற்றும் தோற்றத்தில் சில இயந்திர சாதனங்கள் மூலம் படிகளின் எண்ணிக்கையை தானாகவே கணக்கிட பயன்படுகிறது.



Pedometer

- It is also a **similar instrument and is used for the same purpose**, but it registers the distance traversed by the person carrying it.

- இது ஒரு ஒத்த கருவி மற்றும் அதே நோக்கத்திற்காக பயன்படுத்தப்படுகிறது, ஆனால் அது அதை சுமந்து செல்லும் நபர் கடந்து செல்லும் தூரத்தை பதிவு செய்கிறது.



Speedometer

- It is an automobiles instrument which is also used to measure the distances approximately.

- இது ஒரு ஆட்டோமொபைல் கருவியாகும், இது தோராயமாக தூரத்தை அளவிட பயன்படுகிறது.



Chain Surveying

- **Definition:**
- The operation of **measuring a distance between two points with the help of a chain, or chain with tape is called chaining.**
- For **ordinary works chain is used for measuring the distances** but where **great accuracy is required, a steel tape is invariably used**
- **வரையறை:**
- இரண்டு புள்ளிகளுக்கிடையேயான தூரத்தை ஒரு சங்கிலி அல்லது டேப்பைக் கொண்டு சங்கிலியின் உதவியுடன் அளவிடும் செயல்பாடு சங்கிலி என்று அழைக்கப்படுகிறது.
- சாதாரண வேலைகளுக்கு, தூரத்தை அளக்க சங்கிலி பயன்படுத்தப்படுகிறது, ஆனால் அதிக துல்லியம் தேவைப்படும் இடங்களில், எஃகு டேப் பயன்படுத்தப்படுகிறது.

Identification and construction of metric chain

- **100 links in 20m chain**
- **150 links in 30m chain**
- Each link having **20cm in length**
- Length of link is **the distance between the centers of two consecutive middle rings**
- **Brass handles** are provided at the ends of the chain with **swivel joints**.
- 20மீ சங்கிலியில் 100 இணைப்புகள்
- 30மீ சங்கிலியில் 150 இணைப்புகள்
- ஒவ்வொரு இணைப்பும் 20 செமீ நீளம் கொண்டது
- இணைப்பின் நீளம் என்பது இரண்டு தொடர்ச்சியான நடுத்தர வளையங்களின் மையங்களுக்கு இடையிலான தூரம்
- பித்தளை கைப்பிழிகள் சங்கிலியின் முனைகளில் சுழல் மூட்டுகளுடன் வழங்கப்படுகின்றன.

Identification and construction of metric chain

- The length of the chain is the distance from outside of one handle to the outside of the other handle
- Chain has **brass rings** at every one meter length
- **Brass tallies** are provided at every 5m length
- சங்கிலியின் நீளம் என்பது ஒரு கைப்பிடியின் வெளிப்புறத்திலிருந்து மற்ற கைப்பிடியின் வெளிப்புறத்திற்கு உள்ள தூரம்
- சங்கிலியில் ஒவ்வொரு ஒரு மீட்டர் நீளத்திலும் பித்தளை வளையங்கள் உள்ளன
- ஒவ்வொரு 5 மீ நீளத்திற்கும் பித்தளை உயரங்கள் வழங்கப்படுகின்றன

Identification and construction of metric chain

Fig 1

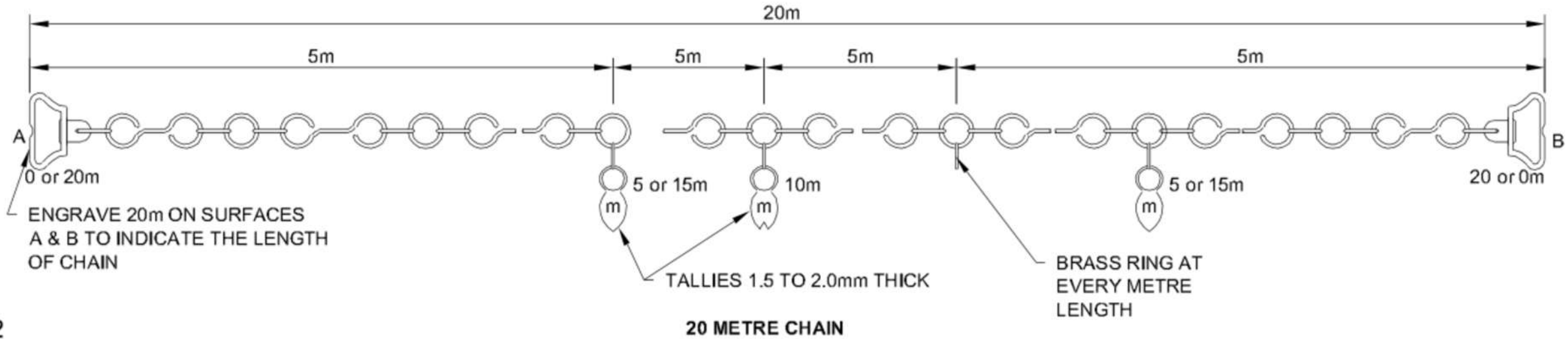
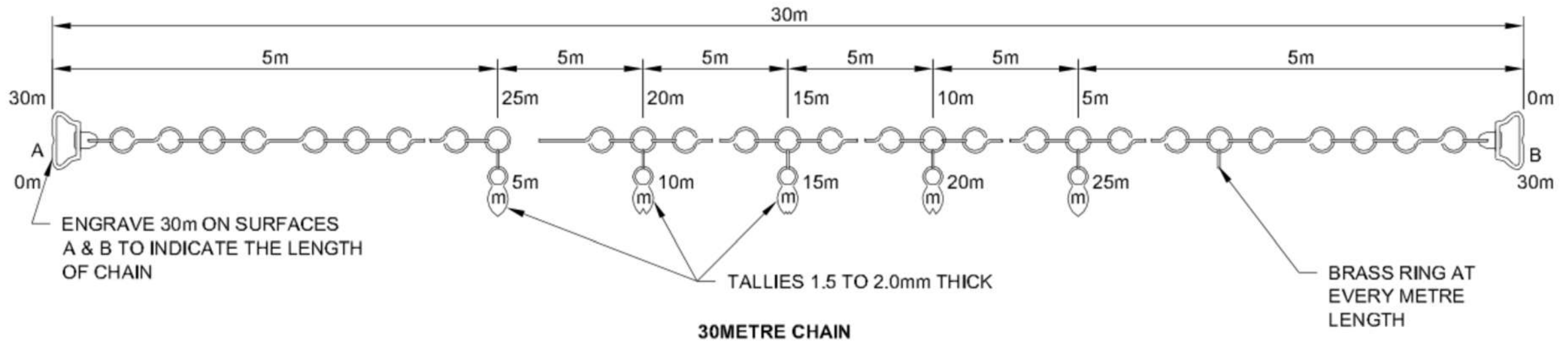


Fig 2



Identification and construction of metric chain

Fig 3

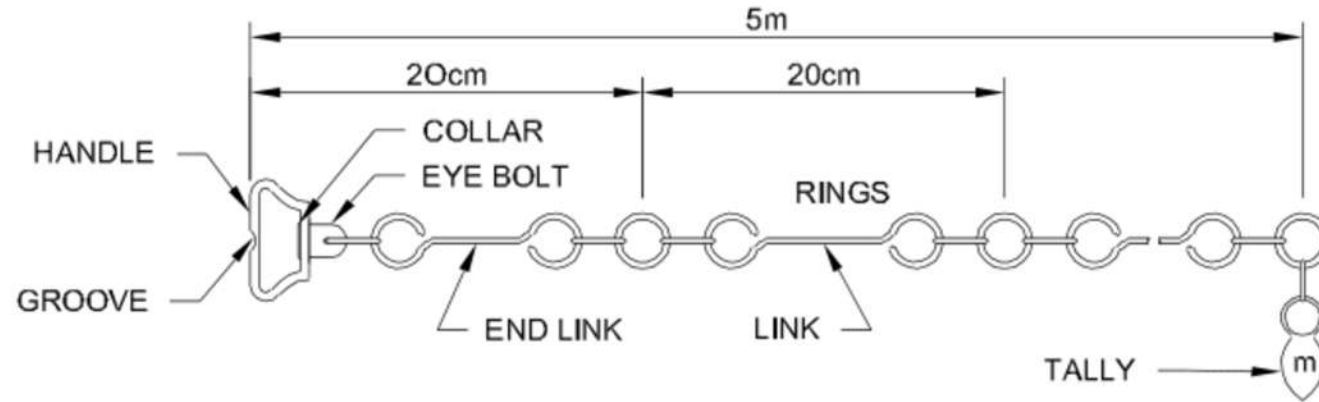


Fig 4

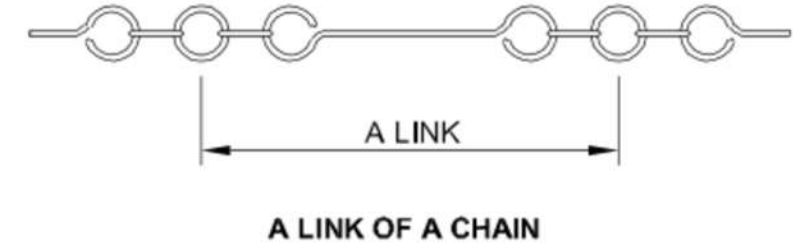
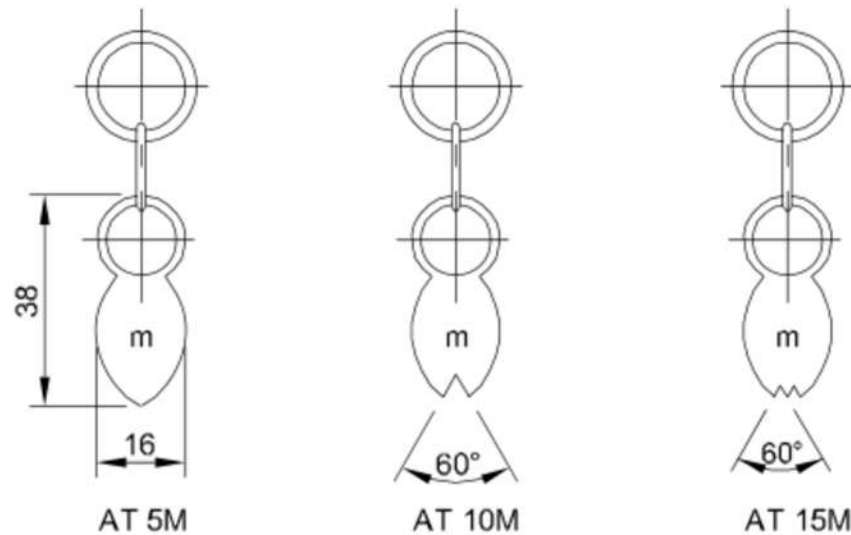


Fig 5

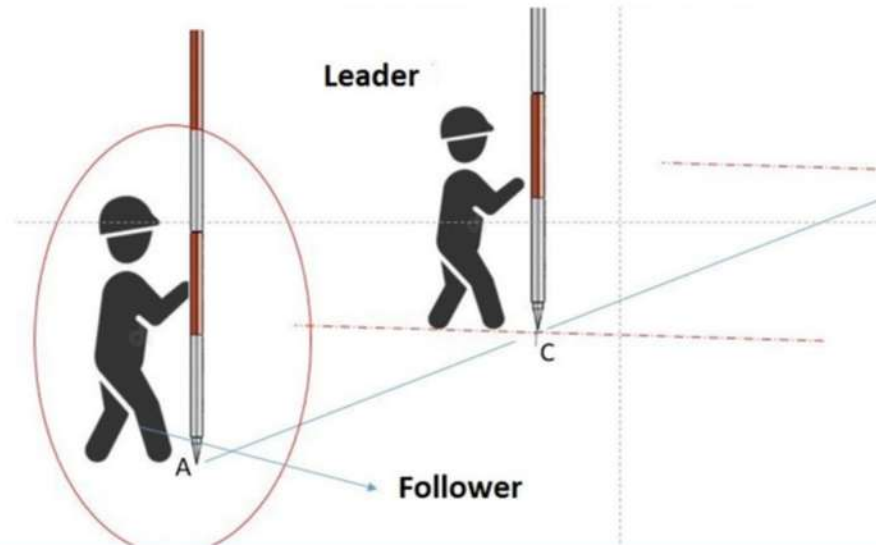
DETAILS OF A METRIC CHAIN



SHAPE OF TALLIES IN 30m METRIC CHAIN

Chaining a line

- For a chaining operation two chain men are required.
- The **chain man at the forward end of the chain is called leader** and **other chain man at the rear end is called a follower**.
- ஒரு சங்கிலி அறுவை சிகிச்சைக்கு இரண்டு சங்கிலி ஆண்கள் தேவை.
- சங்கிலியின் முன் முனையில் உள்ள சங்கிலி மனிதன் தலைவர் என்றும், பின் முனையிலுள்ள மற்ற சங்கிலி மனிதன் பின்தொடர்பவர் என்றும் அழைக்கப்படுவர்.



Error in length due to incorrect chain

$$\text{Correct or True distance} = \text{measured distance} \times \frac{\text{Incorrect length of chain or tape}}{\text{Correct length of chain or tape}}$$

$$\text{True distance} = \text{Measured distance} \times \frac{L'}{L}$$

Where L = True length of chain or tape

L' = Incorrect length of chain or tape

Error in area due to incorrect chain

$$\text{True area} = \text{Measured area} \times \left(\frac{L'}{L}\right)^2$$

Error in volume due to incorrect chain

$$\text{True volume} = \text{Measured volume} \times \left(\frac{L'}{L}\right)^3$$

Problem

1. The distance between two points measured by 20m chain was recorded as 720m. It was afterwards found that the chain used was 4cm too long. What was the true distance between the points?

$$\text{True distance} = \text{Measured distance} \times \left(\frac{L'}{L} \right)$$

$$\text{Measured distance} = 720\text{m}$$

$$\text{Chain} = 20\text{m}$$

$$\text{Error} = (+) 4\text{cm}$$

$$\therefore L' = 20 + \frac{4}{100} = 20.04\text{m}, L = 20\text{m}$$

$$\text{True distance} = 720 \times \frac{20.04}{20} = 721.44\text{m}$$

SCALE

$$\text{Scale} = \frac{\text{length of a line on Plan or Map}}{\text{length of same line on the ground}}$$

1. Numerical Scale

- a) Representative Factor (RF) 1 cm = 10km = 1: 1000000
- b) Engineer Scale 1 cm = 10km

SCALE

Graphical Scale

- Graphical scale has advantage over Numerical scale such that distance on the Plan (or) map can be determined by actual Scaling, Even though plane (or) Map is shrunk.
- In case of shrinkage of Map, Graphical scale also changes with the Map and therefore ratio is unaffected.

$$\text{S.F} = \text{Shrunk length} / \text{Original length}$$

SCALE

- **Vernier** is a device which is used for measuring the readings which are fractional part of smallest division on main scale.
- வெர்னியர் என்பது முக்கிய அளவில் சிறிய பிரிவின் பகுதியளவு பகுதியான அளவீடுகளை அளவிட பயன்படும் ஒரு சாதனம் ஆகும்.

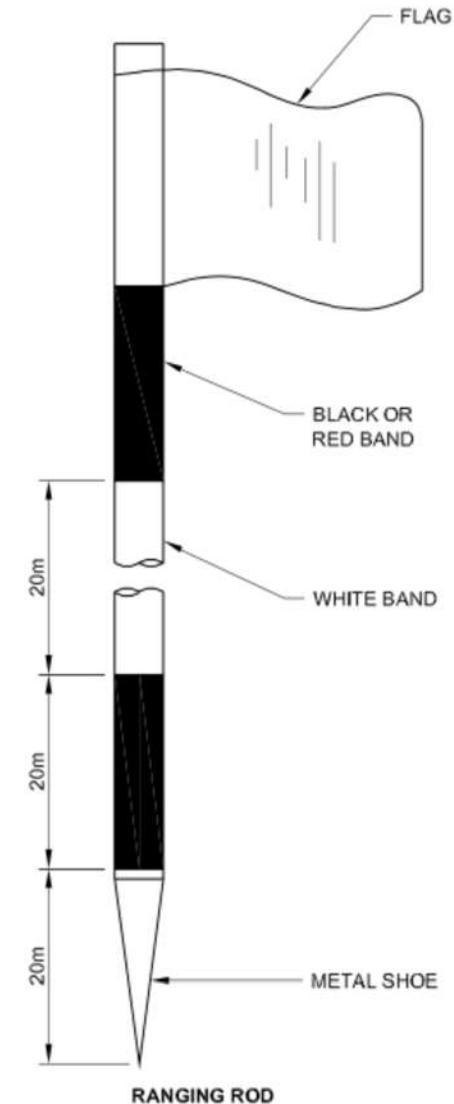


Instruments for chaining

- Ranging Rod
- Offset Rod
- Arrows
- Wooden peg
- Plumb bob
- Measuring Tapes
- ரேங்கிங் ராட்
- ஆஃப்செட் ராட்
- அம்புகள்
- மர ஆப்பு
- பிளம்ப் பாப்
- அளவிடும் நாடாக்கள்

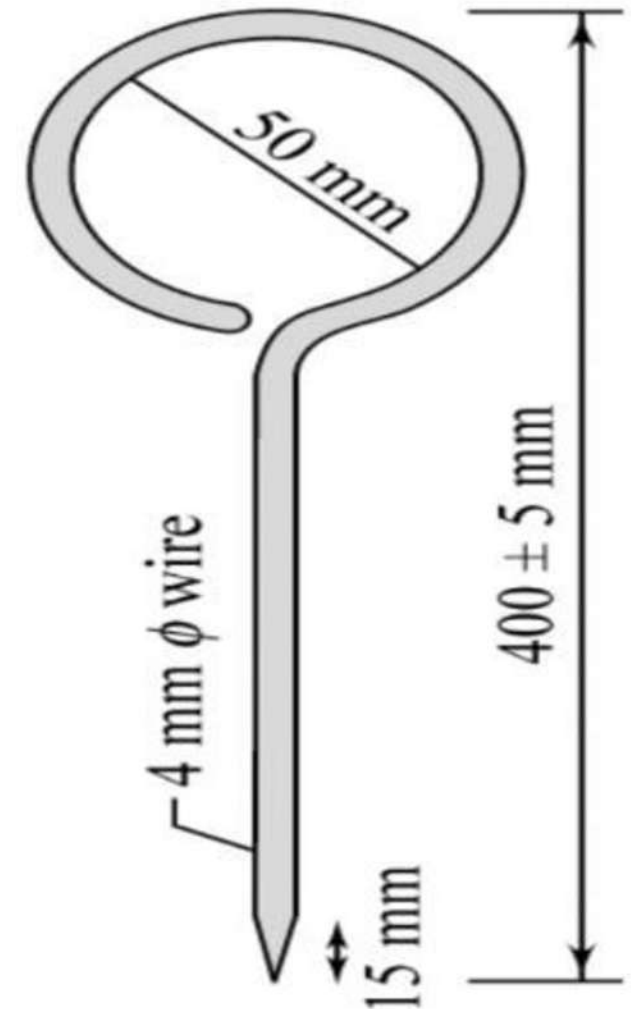
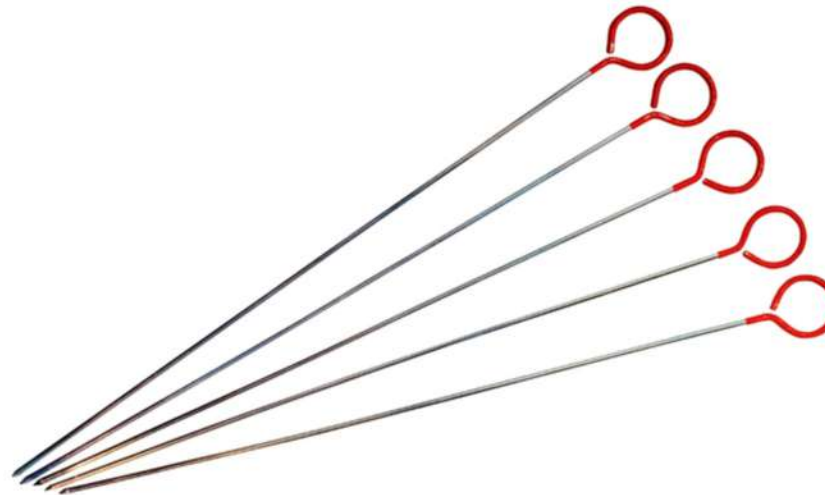
Ranging Rod

- It is **used for marking the position of station** in chaining.
- It is also **used for fixing intermediate points in ranging**.
- It is a **wooden/steel pipe of 2m or 3m in length** with **3cm in diameter** for steel and for wooden is 4 cm ϕ .
- It is **painted in red and white or black and white in 20cm band width**.
- **Bottom of rod is fixed with a sharp metal shoe** for fixing on ground.
- **Flag is fixed on the top for visibility when it is more than 200m in distance.**



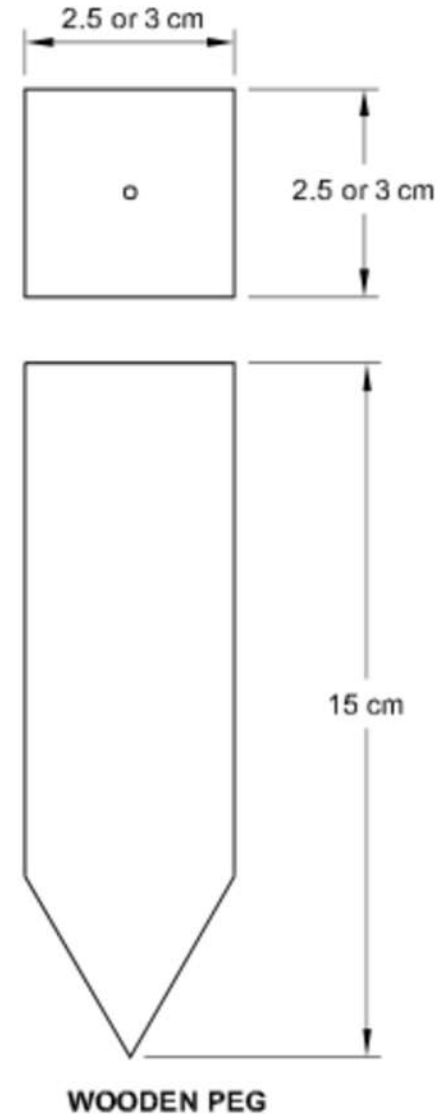
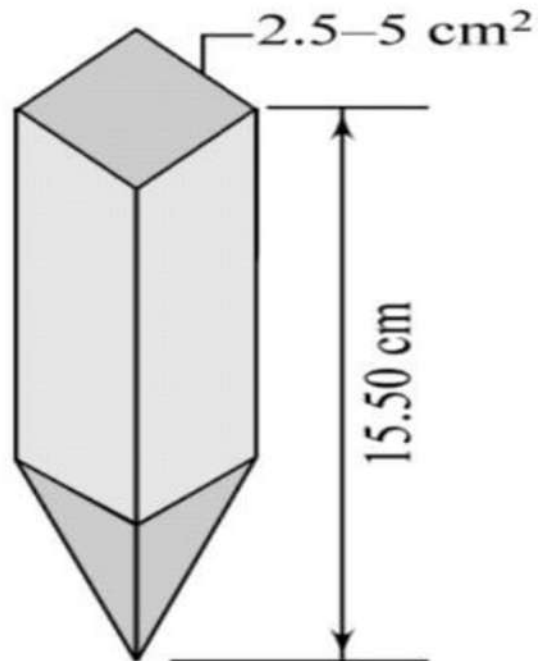
Arrows

- It is made up of **4mm steel wire** and **40cm long**.
- It is **pointed at one end** for inserting into the ground.
Another end bent into a ring for easy handling.
- Each **metric chain** shall accompanied with **10 arrows**.
- It is **used to mark the ends** of each chain during the process of chaining



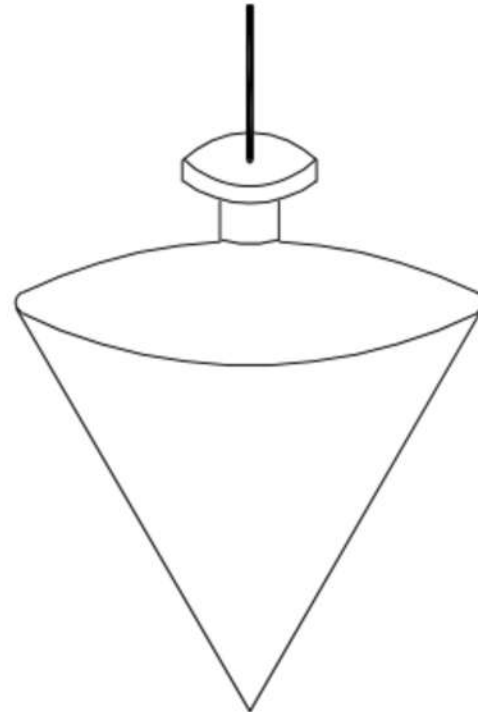
Wooden peg

- These are **15cm in length and tapered at one end.**
- It is **used to drive on the ground to mark the position of stations.**



Plumb bob

- While chaining along a sloping ground, it is used to transfer the points on the ground.
- It is also used as a centering aid in Theodolite, compass and plane table.



PLUMB BOB



Measuring tape

- **This is the instrument used for measuring distances**
- **Cloth or linen tape** : It is 12 to 15mm wide and is made of linen cloth. It is available in lengths of 10m, 20m and 30m. At the end of this tape is provided with brass handle which is included in the total lengths of the tape.
- **Metallic tape**
- **Steel tape**
- **Invar tape**
- **Fibre or plastic tape**

Measuring tape

Equipments used in Chain Surveying

1. Surveying chain:-

A. Revenue chain = **33 feet, 16 link**

B. Gunter's chain = **66 feet, 100 link**

C. Engineer's chain = **100 feet, 100 link**

D. Metric chain

- **20m - 100 link**
- **30m - 150 link**

Revenue chain

- The Revenue chain is 33 ft long and consists of 16 links.
- This chain is mainly used for measuring fields in cadastral survey.



Survey chain

Gunter's chain or Surveyors chain

- A Gunter's chain or surveyor's chain consists of **100 links of 66ft long**.
- Each **link being 0.66 ft. or 7.92 inches** long. It is used for land measurement.

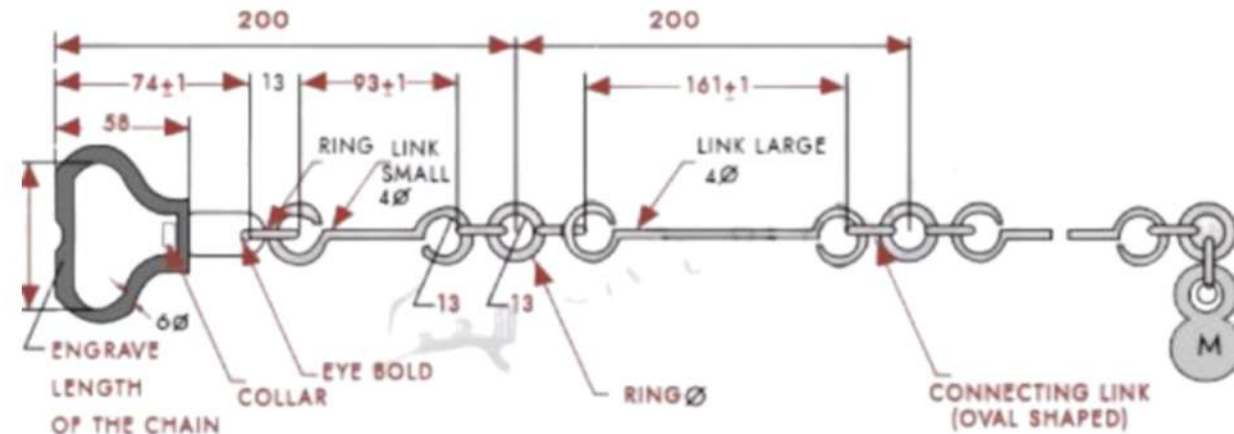


Linear Measurements

Chain Survey

Engineer's chain

- **Engineer's chain is 100 ft long and consists of 100 links. Each link is being 1 ft long.**



Metric chain

- Metric chains are commonly used in now a days.
- Metric chains are generally available in lengths of 5, 10, 20 and 30 m. tallies are fixed at every meter length for chains of 5 and 10 m length.
- Tallies are provided at every 5 m length, for the chain of 20 and 30 m length. Small brass rings are provided at every meter length.

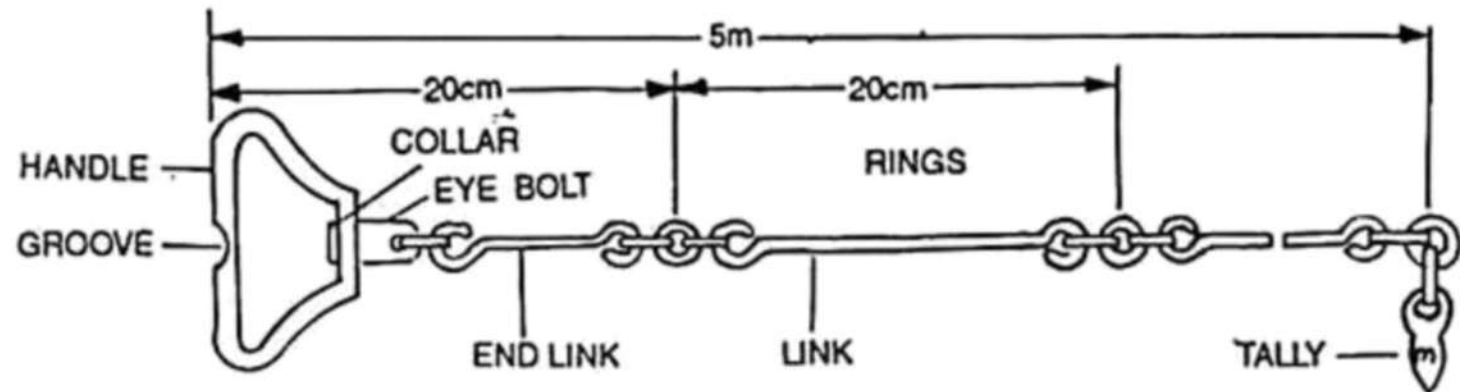
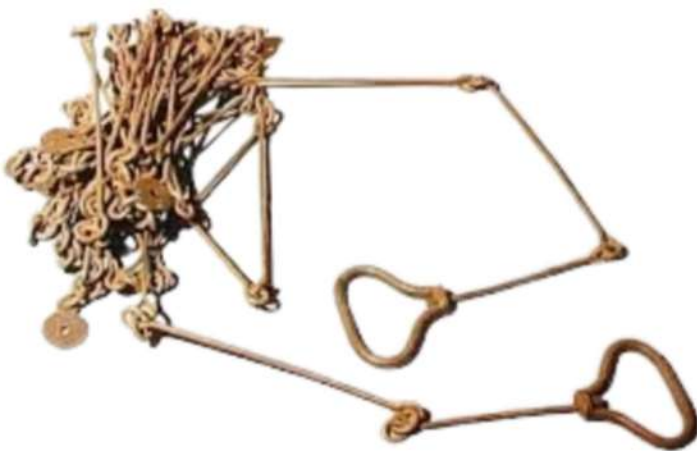


Fig. 2.3 Details of a Metric Chain

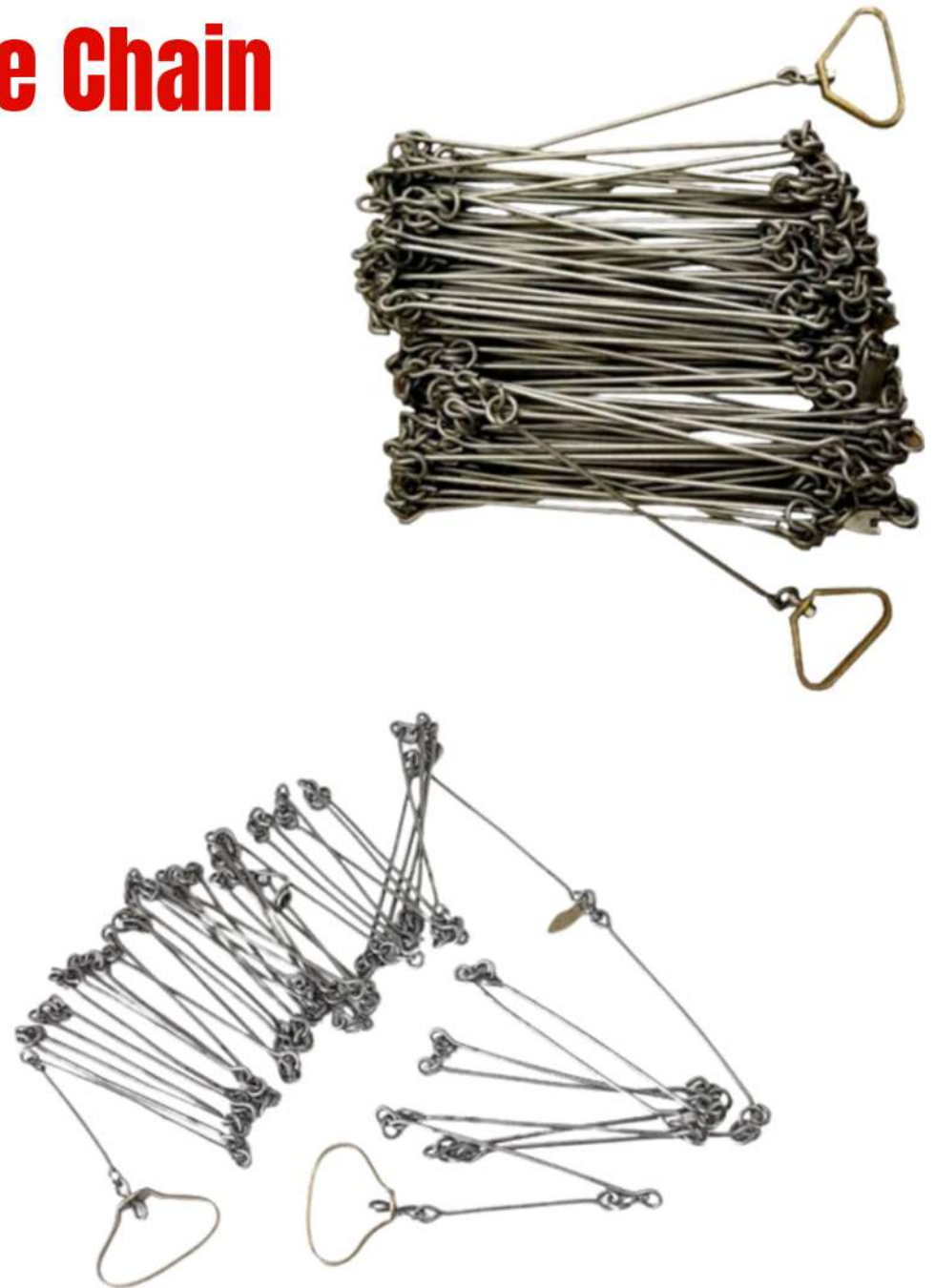
Folding and unfolding of chain

- Two chain men are required for measuring the length of a line, which is greater than a chain length.
- The more experienced chainman remains at the zero ends or the rear end of the chain who is called as the follower.
- The other chainman holding the forward handle is known as the leader.



Unfolding the Chain

- To unfold a chain, the chainman keeps both the handles in the left hand and throws the rest of the chain in forward direction with his right hand.
- The other chainman assists in removing the knots, if any for making it straight.



Tapes

- Tapes are used for more accurate measurements.
- They are classified according to the material of which they are made.
- Cloth tape or Linen tape.
- Metallic tape.
- Steel tape.
- Invar tape.



Cloth Tape or Linen tape

- Cloth tapes are made up of closely woven linen, 12 to 15 mm wide, varnished to resist moisture.
- They are light and flexible, and may be used for taking comparatively rough and subsidiary measurement such as off sets.
- Cloth tapes are available in length 10, 20, 25 and 30 m (30, 50, 66, 100 ft).
- The end of the tape is provided with small brass ring whose length is also included in the total length of the tape.



Metallic tape

- A metallic tape is made up of varnished strip of water proof linen inter-woven with small brass, copper or bronze wires and does not stretch as easily as a cloth tape.
- Due to this reason **it is used for some accuracy of work.**
- Metallic tapes are made **in length of 2, 5, 10, 20, 25, 30 and 50 m.**



Steel tape



- Steel tapes vary in quality and accuracy of graduation, but even a poor steel tape is generally superior to a cloth or metallic tape for most of the linear measurements that are made in surveying.
- A steel tape consists of a light strip of width 6 to 10 mm and is more accurately graduated. Steel tapes are available in lengths of 1, 2, 10, 20, 30 and 50 m.

Invar tape



- Invar tapes are used mainly for linear measurements of a **very high degree of precision**, such as measurement of base lines.
- The invar tape is **made of alloy of nickel and steel (36% of nickel and 64% of steel)**, and has very low co-efficient of thermal expansion.
- Invar tapes and bands are more expensive. Invar tapes are normally 6 mm wide and **are available in lengths of 20, 30 and 100 m.**

Testing and Adjustment of Chain

- As the chain is a metal made, it may undergo many changes due to temperature effect or human error and etc.
- So for all lengths of chain a tolerance is given,
 - 5m chain = + or - 3mm
 - 10m chain = + or - 3mm
 - 20m chain = + or - 5mm
 - 30m chain = + or - 8mm

Errors in chain Surveying

- Personal errors
- Compensating errors, and
- Cumulating errors.

Personal Errors

- Wrong reading, wrong recording, reading from wrong end of chain etc., are personal errors.
- Care should be taken to avoid such errors.

Compensating Errors

- These errors may be sometimes positive and sometimes negative.
- Hence They are likely to get compensated when large number of readings are taken.
- The magnitude of such errors can be estimated by theory of probability.
- Incorrect marking of the end of a chain.
- In the method of stepping while measuring sloping ground, plumbing may be crude.

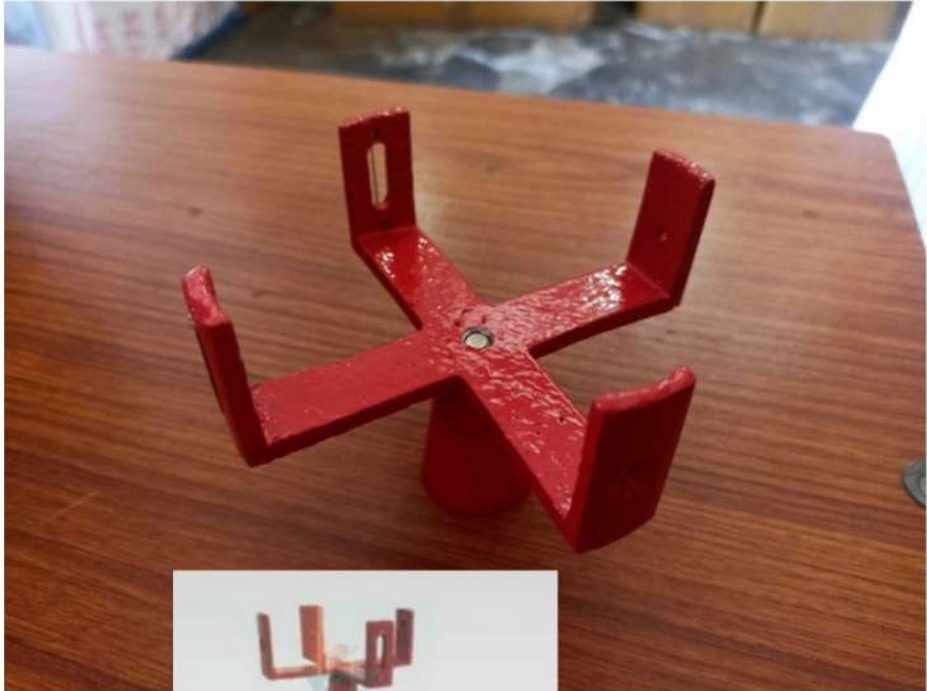
Cumulative Errors

- The errors that occur always in the same direction are called cumulative errors.
- In each reading the error may be small, but when large number of measurements are made they may be considerable, since the error is always on one side.

Examples of such errors are:

- Bad ranging
- Bad straightening
- Erroneous length of chain

Open cross staff



- It is the simplest instrument used for setting out right angle.
- It consists of either a frame or box with two pairs of vertical slits and is mounted on a pole shod for fixing in the ground.
- The two pairs of vertical slits give two lines of sights at right angles to each other.
- Type of cross-staff which is also used to set out 90° .

French Cross-staff

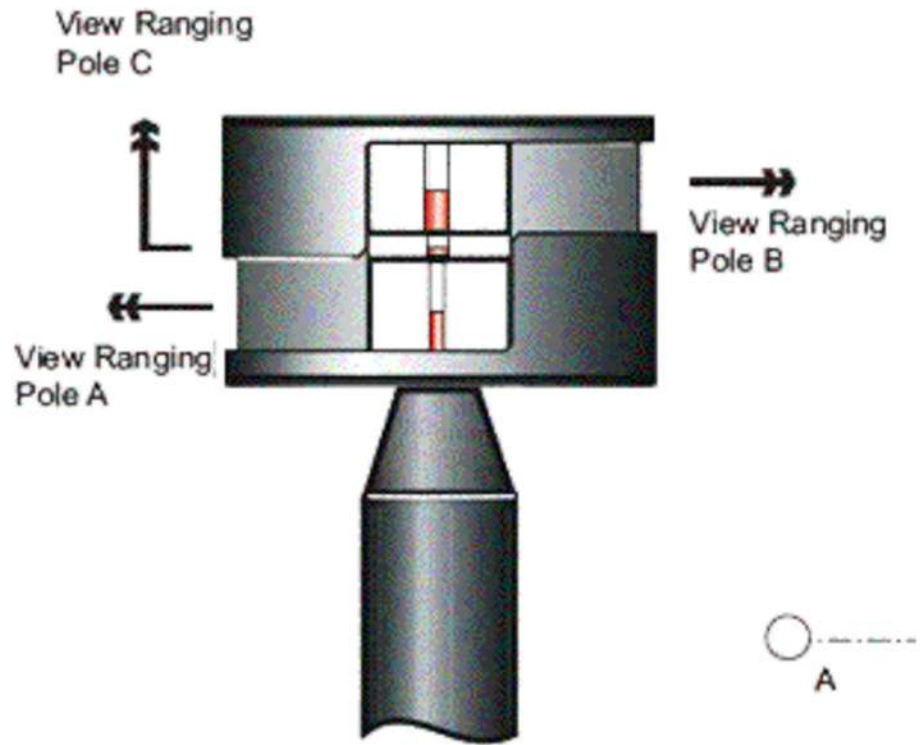
- The accuracy of French cross staff is less than that of an open cross staff.
- However the French cross - staff has the advantage that the lines can also be set out at angles of 45 degree and 135 degree.
- In that respect, a French staff is superior to an open cross staff.
- The French Cross Staff has Eight Faces on it. Each Face is connected to the other with a 45 Degree Angle.

French Cross Staff



45° and 90°

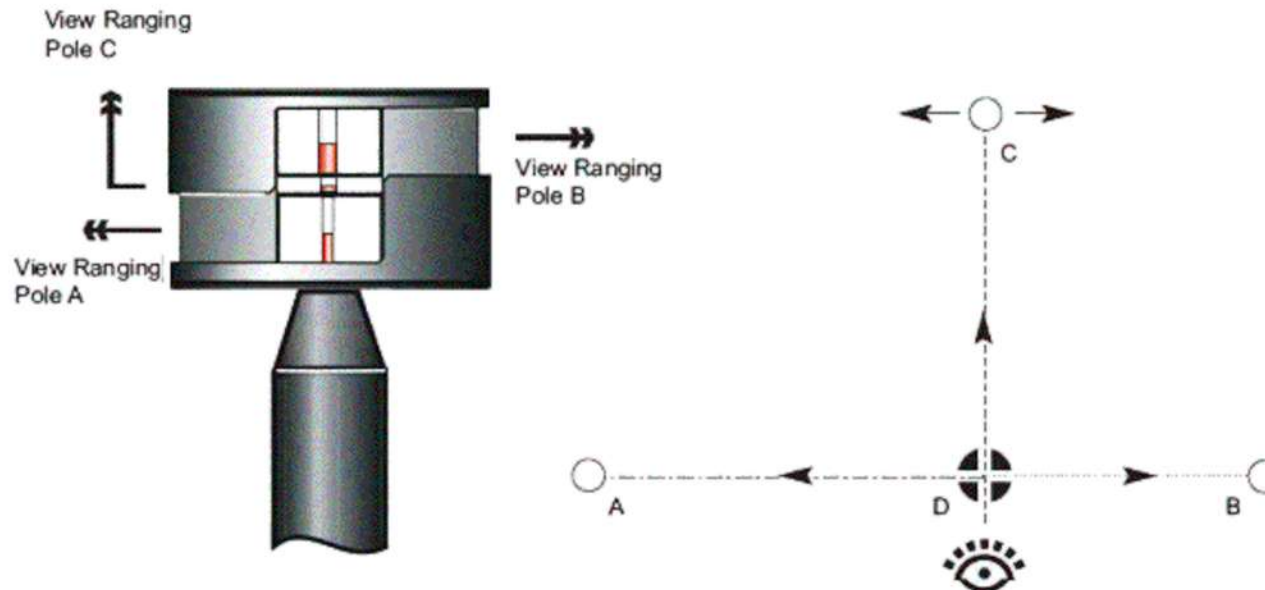
Optical Square



- It is more convenient and accurate than cross-staff for setting out right angles.
- Consists of two mirrors making a 45° with each other, one mirror totally silvered another top bottom un-silvered.
- An optical square is also used for setting out right angles.
- It consist of a small circular metal box of diameter 5 cm and depth 1.25 cm. It has a metal cover which slides round the box to cover the slits.

Optical Square

- A horizon glass H is fixed at the bottom of the metal box. The lower half of the glass is unsilvered and the upper half is silvered.
- A index glass I is also fixed at the bottom of the box which is completely silvered.
- The angle between the index glass and horizon glass is maintained at 45 degree



Prism Square

- It works on the same principle as that of the optical square.
- It is more modern and precise instruments and has the merit that no adjustment is required since the angle between the reflection surface (i.e. 45°) cannot vary.



Simple Clinometer

- It is used to measure slope of the ground and vertical angles.

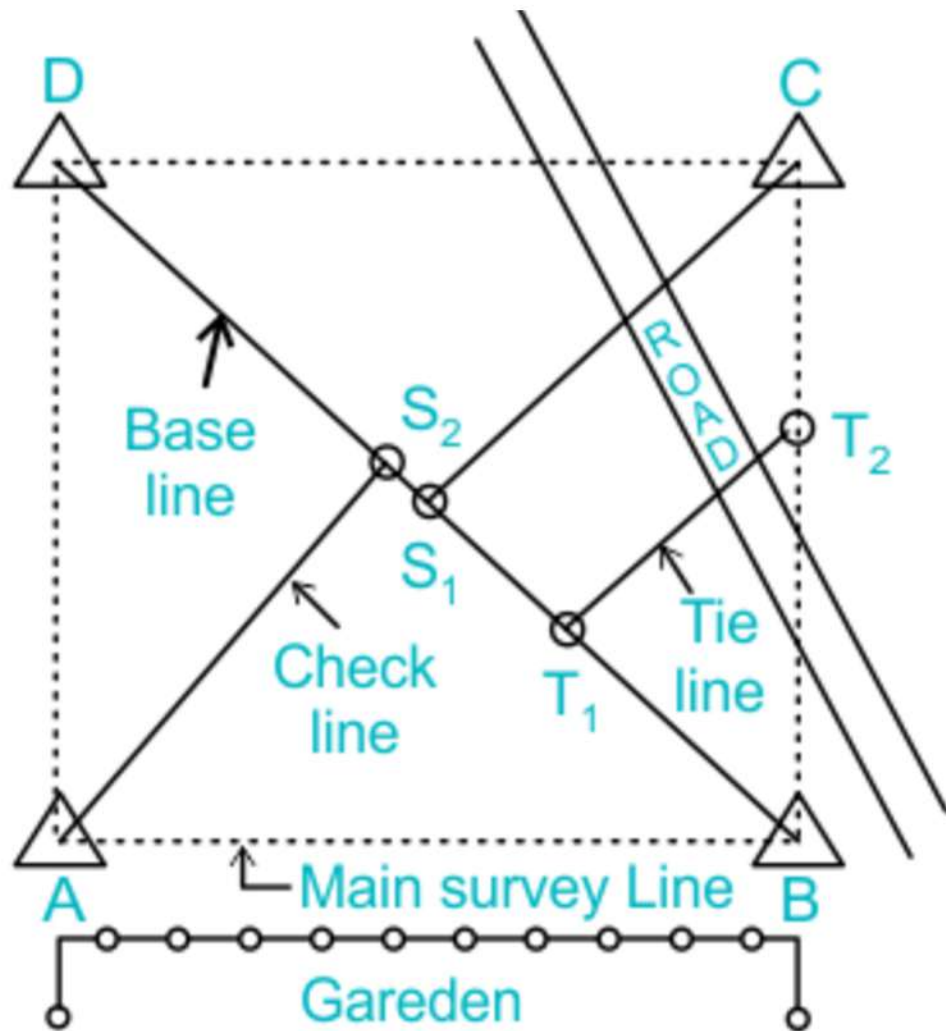
Clinometers in Surveying



Clinometer



Offset



- The lateral measurement taken from an object to the chain line is known as 'offset'.
- Offsets are taken to locate objects with reference to the chain line.
- They may be of two kinds - perpendicular and oblique.

Offset

1. Perpendicular offsets

- When the lateral measurements are taken perpendicular to the chain line, they are known as perpendicular offsets

2. Oblique offsets

- Any offset not perpendicular to the chain line is said to be oblique. Oblique offsets are taken when the objects are at a long distance from the chain line or when it is not possible to set up a right angle due to some difficulties.

Limiting length of offset

- The maximum length of the offset should not be more than the length of the tape used in the survey.
- Generally, the maximum length of offset is limited to 15m.

1. The desired accuracy of the map

2. The scale of the map

3. The maximum allowable deflection of the offset from its true direction and

4. The nature of the ground

Limiting length of offset

CORRECTION FOR STANDARDIZATION

- it is also called as correction for absolute length.
- If actual length of the tape/Chain is not equal to nominal length of the tape, then correction for standardization is required

Correction

- We know that slope distance will always be greater than corresponding horizontal distance, therefore **correction for slope** will always be negative.
- **Correction for pull** is applied to the tape when pull applied during measurement is more than the standard pull at which the tape was standardized

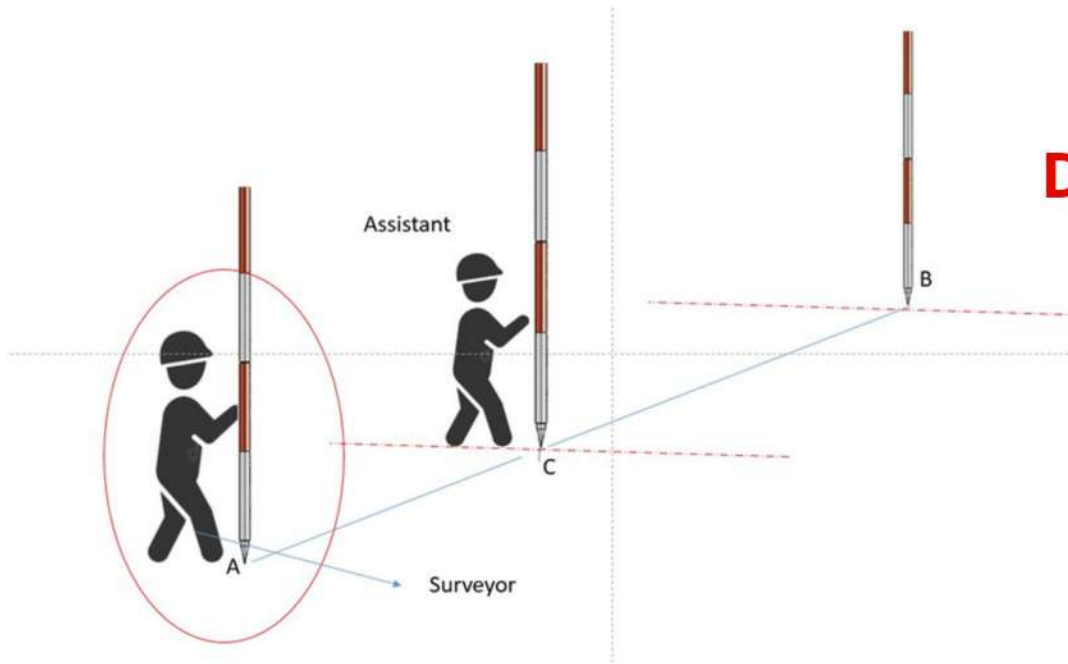
Methods of Ranging

There are two methods of ranging

- Direct ranging
- Indirect ranging

Direct ranging:

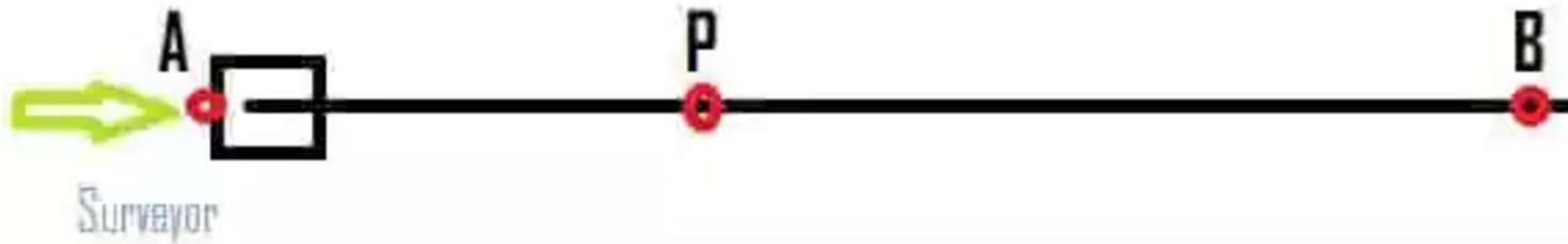
- Direct ranging is done when the two ends of the survey lines are intervisible.
- In such cases ranging can either be done by eye or through some optical instruments such as line ranger or a Theodolite.



Methods of Ranging

Ranging by Eye

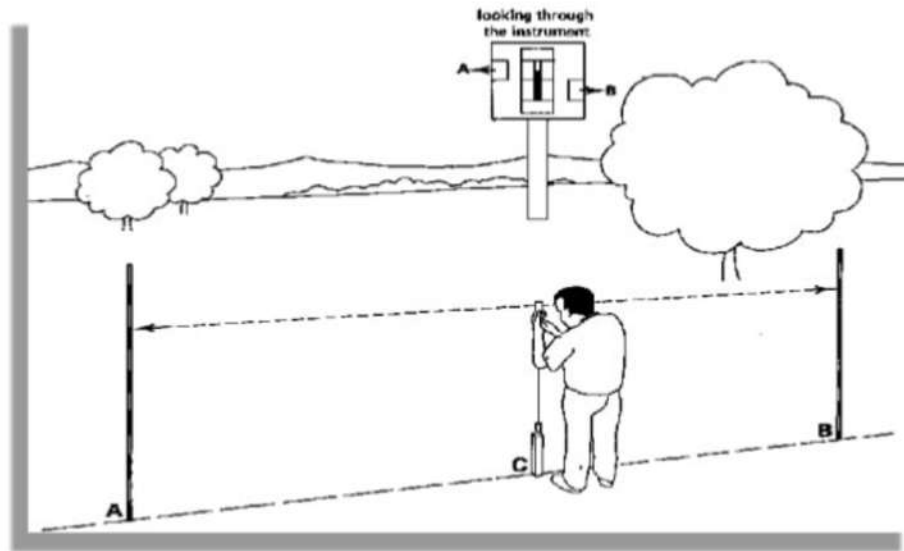
- let A and B are the two intervisible points at the ends of the survey line. The surveyor stands with a ranging rod at the point A by keeping the ranging rod at the point B. The ranging rod is held at about half metre length.



Methods of Ranging

Ranging by Line Ranger

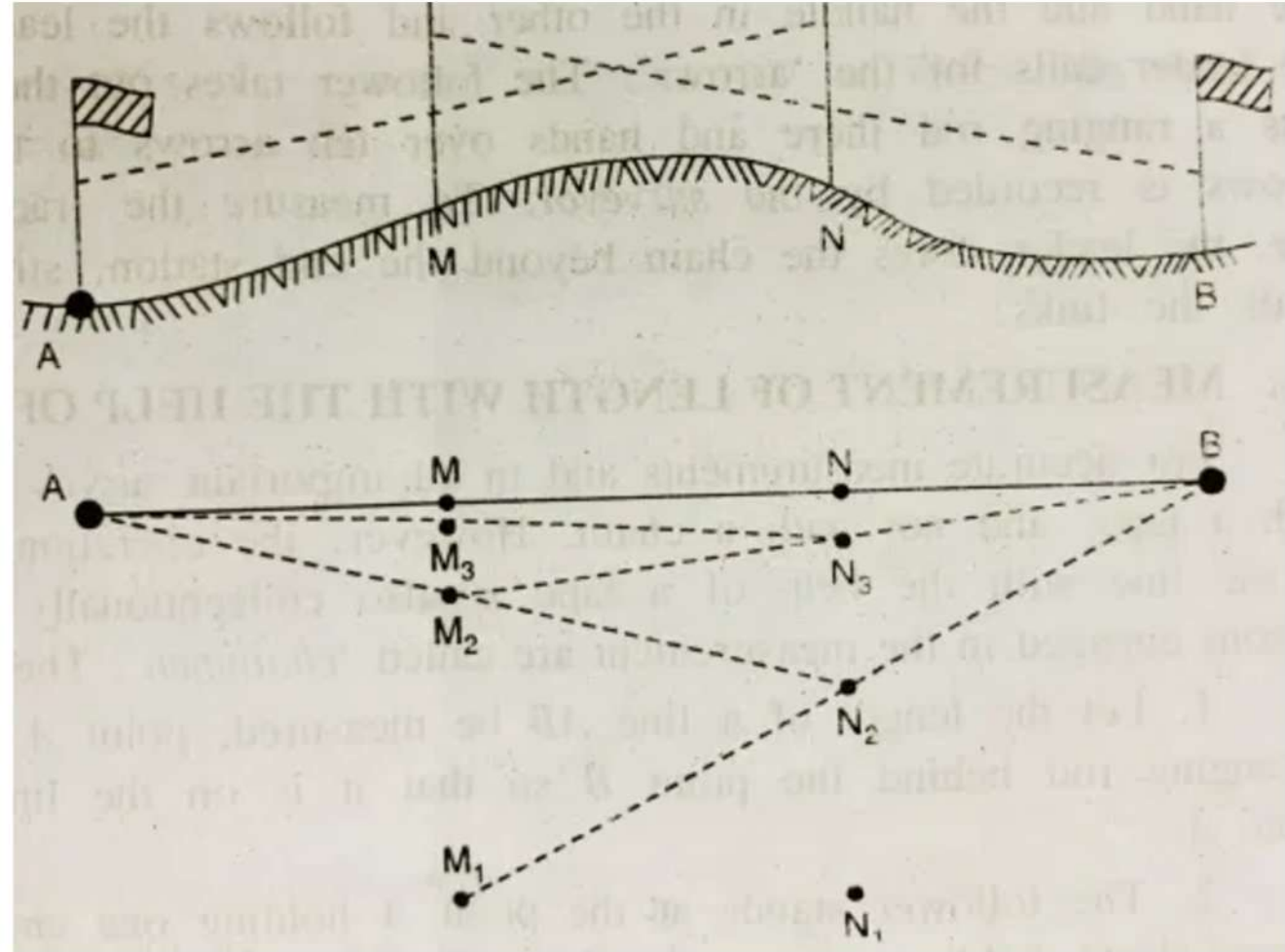
- A line ranger that has either two plane mirror arrangement or two isosceles prisms that are placed one over the other.
- The diagonals of the prism are arranged and silvered such that they reflect incident rays.



Methods of Ranging

Indirect Ranging

- Indirect ranging is employed when the two points are not intervisible or the two points are at a long distance.
- This may be due to some kind of intervention between the two points.



The important steps we follow while chain surveying are

Reconnaissance:

- It is the preliminary phase of each type of surveying. This step includes inspection of the land and preparing the key plan according to the inspection.

Station Fixing:

- The station should be fixed in a such way that, most of the points can be surveyed and we get a maximum area accessible from the same point. This step included fixing of ranging rods and driving pegs.

Offset

- The lateral distance measured from the chain line to the object is called offset.

Offsetting

- The process of measuring lateral distances from the chain line to the objects which are to be plotted is called as offsetting.
- It is done to locate the objects with reference to the chain line.
- These are measured on either side of a chain line

Offset

Classification of offsets

Based on length of chain line

- Short offset
- Long offset

Based on direction of chain line

- Perpendicular offset
- Oblique offset

Offset

- The length of offset depends upon the degree of accuracy required, scale used, method of setting out the perpendicular and nature of the ground.
1. **Short offset - Less than 15m**
 2. **Long offset - More than 15m**

Perpendicular offset

- It is also known as rectangular offset or right offset.
- The distance measured at right angles to the chain line from the objects is known as perpendicular offset

Questions

1. The ruling principle of surveying is to

- (a) work from whole to part
- (b) work from part to whole
- (c) work from line to area
- (d) work from point to area

3. In order to determine the natural features such as valleys, rivers, lakes etc, the surveying preferred is

- (a) city surveying
- (b) local surveying
- (c) topographical surveying
- (d) cadastral surveying

2. Surveys which are carried out to provide a national grid of control for preparation of accurate maps of large areas, are known

- (a) Plane survey
- (b) Topographical survey
- (c) Geographical survey
- (d) Geodetic survey

4. A survey which are made to fix the property line, the calculation of village land area or the transfer of land property from one owner to another is known as

- (a) Topographical surveying
- (b) Cadastral surveying
- (c) City surveying
- (d) Engineering surveying

Questions

5. The maximum tolerance in 20m chain is

- | | |
|----------------------|----------------------|
| (a) $\pm 2\text{mm}$ | (b) $\pm 3\text{mm}$ |
| (c) $\pm 5\text{mm}$ | (d) $\pm 8\text{mm}$ |

9. The Instrument which register the number of paces of the person carrying it

- (a) Passometer
- (b) Pedometer
- (c) Odometer
- (d) Speedometer

10. What is the length of Surveyor's chain?

- | | |
|-------------|--------------|
| (a) 33 feet | (b) 133 feet |
| (c) 66 feet | (d) 100 feet |

11. The total number of links in a 30 m chain is

- | | |
|---------|---------|
| (a) 200 | (b) 150 |
| (c) 100 | (d) 50 |

Questions

14. The length of a line measured with a 20-metre chain was found to be 250 metres. Calculate the true length of the line if the chain was 10 cm too long

- (a) 382.93 m
- (b) 12.42 m
- (c) 251.25 m
- (d) 98.6 m

15. The representative fraction 1/1800 means that the scale is

- (a) 1cm=0.18m
- (b) 1cm=1.8m
- (c) 1cm=18m
- (d) 1cm=180m

19. An example for a level surface is

- (a) Surface of earth
- (b) Surface of sea
- (c) Surface of reservoir
- (d) Surface of a lake

20. The Mean Sea Level (MSL) adopted by line Survey of India for reference is located at

- (a) Karachi
- (b) Kolkata
- (c) New Delhi
- (d) Mumbai

22. Any line which is equidistant from mean sea level is called as

- (a) horizontal line
- (b) level line
- (c) datum line
- (d) vertical line

23. A plumb line is a line

- (a) lying on a level surface
- (b) lying on a horizontal plane
- (c) perpendicular to a level surface
- (d) that joins two points on ground

53. What is the lateral surface measured from chain to object?

- ☒ (A) Offset
- (B) Long offset
- (C) Short offset
- (D) Oblique offset
- (E) Answer not known

54. The Process of a location of intermediate points on a survey line is

- (A) Aligning
- (B) Extending
- ☒ (C) Ranging
- (D) Offsetting
- (E) Answer not known

Questions

57. Negative cumulative errors in chaining caused due to

- (A) Length of chain shorter than standard length
- ☒ (B) Length of chain more than standard length
- (C) Bending of links while measuring
- (D) Removal of rings during adjustments
- (E) Answer not known

59. The distance between two points measured with a 20 m chain was recorded as 200 m. It was afterwards found that the chain was 3 cm too long. What was the true distance between the points?

- ☒ (A) 200.3 m
- (B) 200.03 m
- (C) 199.97 m
- (D) 197 m
- (E) Answer not known

58. Calculate the true distance between two points

If measured distance = 720 m

Length of chain = 20 m

And error in chain = (+) 4 cm

- | | |
|----------------------|--|
| (A) 720.44 m | ☒ (B) 721.44 m |
| (C) 722.44 m | (D) 723.44 m |
| (E) Answer not known | |

55. Clino meter is most commonly used for measuring :

- | | |
|---|-------------------------|
| (A) Vertical distance | (B) Horizontal distance |
| ☒ (C) The angles of slope | (D) Horizontal angle |
| (E) Answer not known | |

Questions

153. Length of Gunter's chain is

- (A) 20 feet
 (B) ☒ 66 feet
 (C) 16 feet
 (D) 100 feet
 (E) Answer not known

156. A long offset is to be measured more than

- (A) 5 m
 (B) 10 m
 (C) ☒ 15 m
 (D) 20 m
 (E) Answer not known

155. Which of the following is an obstacle to alignment?

- (A) Lake
 (B) Pond
 (C) River
 (D) ☒ House
 (E) Answer not known

157. Match the following.

Type of Chain	Length of chain
(a) Engineer's chain	1. 30 m
(b) Gunter's chain	2. 100 ft
(c) Revenue chain	3. 66 ft
(d) Metric chain	4. 33 ft

	(a)	(b)	(c)	(d)
(A)	4	1	3	2
(B)	3	4	2	1
(C)	3	2	4	1
(D) ☒	2	3	4	1

(E) Answer not known

Questions

159. What is the limit of error for 30 m chain as per IS?

- (A) ± 2 mm (B) ± 4 mm
(C) ± 6 mm ☒ (D) ± 8 mm
(E) Answer not known

160. The temperature variation is _____ error in chain surveying.

- (A) Personal error (B) Compensating error
☒ (C) Cumulative error (D) Instrumental error

161. It is necessary to take into account the curvature of the earth in

- (A) Chain surveying (B) Compass surveying
(C) Plane surveying ☒ (D) Geodetic surveying
(E) Answer not known

162. _____ of the following survey is used to define the property line.

- (A) Topographical survey (B) City survey
(C) Land survey ☒ (D) Cadastral survey
(E) Answer not known

54. In chain survey leader work is

- (A) Following the survey work
(B) Observing the ranger
☒ (C) To drag the chain forward
(D) To pick up the arrows
(E) Answer not known

Questions

57. How is metric chain composed?

- (A) Brass wire of 4 mm dia
- (B) Copper wire of 4 mm dia
- ☒ (C) Mild steel wire of 4 mm dia
- (D) Aluminium wire of 4 mm dia
- (E) Answer not known

61. The disturbances to chaining like bush, water pond, river, building etc are called _____ to chaining.

- ☒ (A) Obstacles
- (B) Distractions
- (C) Distance
- (D) Stoppage
- (E) Answer not known

59. The operation of measuring a distance between two points with the help of a chain or tape is called

- (A) Off setting
- (B) Ranging
- (C) Taping
- ☒ (D) Chaining
- (E) Answer not known

60. Identify the name of surveying in which is determined by natural and artificial features of the country?

- (A) City surveying
- (B) Cadastral survey
- (C) Engineering survey
- ☒ (D) Topographical survey
- (E) Answer not known

58. 20 chain is equal to _____ furlong.

- (A) 1
- ☒ (B) 2
- (C) 3
- (D) 4
- (E) Answer not known

Questions

62. _____ is used to mark the intermediate station.

- ☒ (A) Ranging rod (B) Tripod stand
(C) Spirit level (D) Chain

64. The survey in which the curvature of earth is taken into account is known as

- (A) Plane surveying ☒ (B) Geodetic surveying
(C) Aerial surveying (D) Mine surveying
(E) Answer not known

153. The longest chain line in chain surveying is known as

- (A) Check line (B) Survey line
☒ (C) Base line (D) Tie line
(E) Answer not known

155. How much distance the talley in the metric chain?

- ☒ (A) 5 m (B) 10 m
(C) 15 m (D) 20 m
(E) Answer not known

156. Engineering chain is _____ feet long.

- (A) 66 ☒ (B) 100
(C) 150 (D) 180
(E) Answer not known

159. Type of tape length is elongated when stretched and shortens by sagging in wind weather

- (A) Metric tape (B) Metallic tape
☒ (C) Cloth tape (D) Invar tape
(E) Answer not known

160. _____ chain are of 20 m length. They have 100 link with talleys at every 2m. Each link is of 0.2 m.

- ☒ (A) Metric chain (B) Surveyor's chain
 (C) Engineer chain (D) Gunter chain
 (E) Answer not known

_____ சங்கிலி 20 மீ நீளமும், ஒவ்வொரு 2 மீட்டர்க்கும் டாலியுடன் 100 இணைப்புகள் உள்ளன. ஒவ்வொரு லிங்க் 0.2 மீட்டர் நீளம் கொண்டவை.

- (A) மெட்ரிக் செயின் (B) சர்வேயர் செயின்
 (C) இன்ஜினியர் செயின் (D) கன்டர் செயின்
 (E) விடை தெரியவில்லை

161. _____ is commonly used for measuring offset.

- ☒ (A) Linen or cloth tape (B) Metallic tape
 (C) Steel tape (D) Invar tape
 (E) Answer not known

172. Optical square is used in _____ surveying.

- (A) Theodolite
 (B) Compass
 (C) Plane table
☒ (D) Chain survey
 (E) Answer not known

21. The mechanical instrument used to determine the area of irregular shaped polygons is called as

- (A) Odometer
 (B) Inclinator
☒ (C) Planimeter
 (D) There is no such instrument only graphical method is possible to find the area of irregular polygon
 (E) Answer not known

Questions

22. The simple device to be attached with bicycle for determining the distances approximately is

- (A) Speedometer
- (B) ☒ Odometer
- (C) Perambulator
- (D) Passometer
- (E) Answer not known

58. Chain surveying is adopted for preparing plans of

- (A) ☒ Small areas
- (B) Large areas
- (C) Bushy areas
- (D) Areas with ups and downs
- (E) Answer not known

169. Surveyor's chain is also known as

- (A) Metric chain
- (B) Engineer's chain
- (C) Revenue chain
- (D) ☒ Gunter's chain
- (E) Answer not known

170. The obstacle which obstructs chaining but not vision is

- (A) ☒ River
- (B) Hill
- (C) Raising ground
- (D) Thick forest
- (E) Answer not known

13. The surveys are to fix the boundaries of municipalities are

- ☒ (A) Cadastral surveys (B) City surveying
(C) Engineering surveys (D) Military surveys

113. The survey used for determining points of strategic importance is

- (A) Archaeological survey (B) Topographical survey
(C) Engineering survey ☒ (D) Military survey

151. In chain, Handles are connected to the link by

- (A) Flexible joint (B) Rigid joint
☒ (C) Swivel joint (D) Ball and socket joint

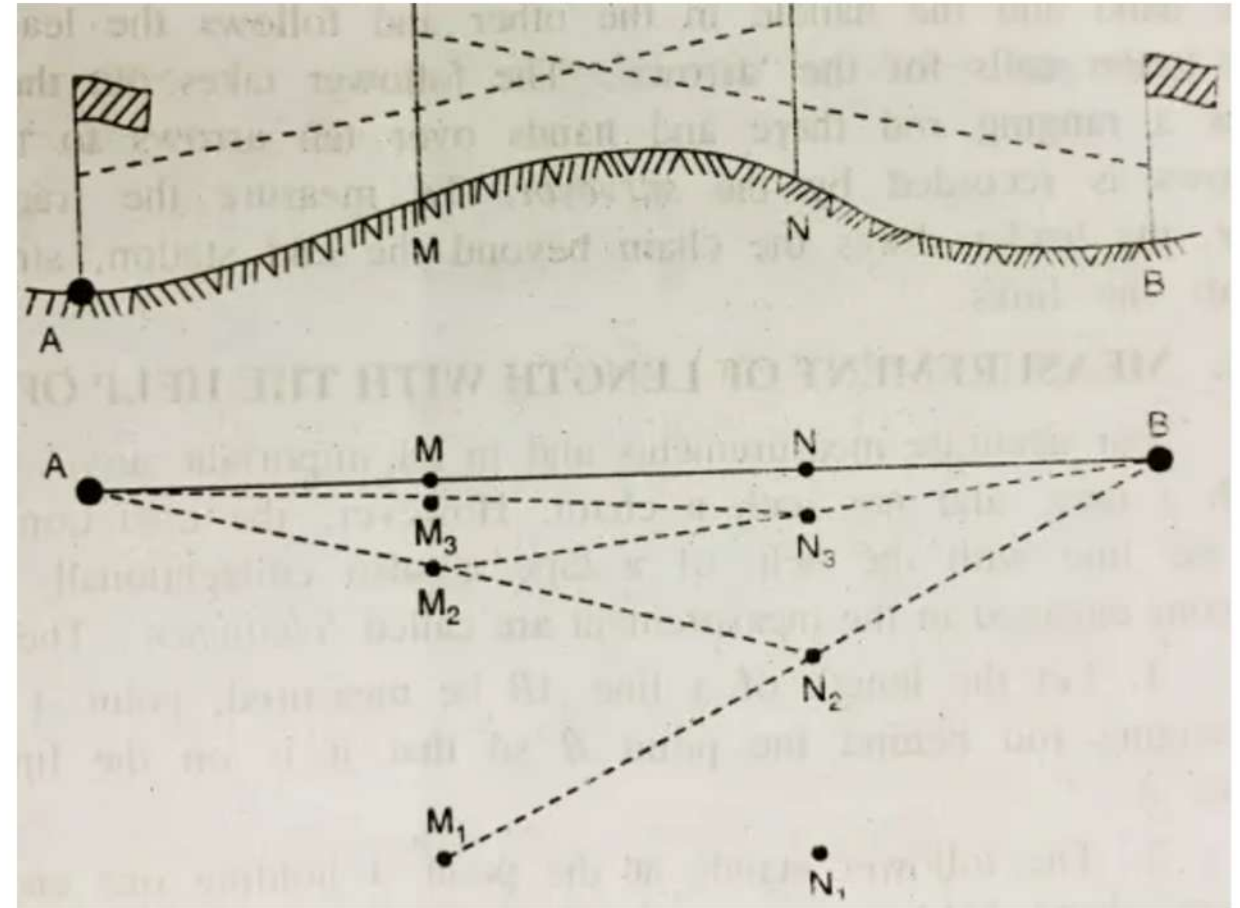
Obstacles in chain surveying

Type of obstacles

- **Obstacles to ranging**
- **Obstacles to chaining**
- **Obstacles to both chaining & Ranging**

Obstacles to ranging:

Case (i) Both ends of the line may be visible from intermediate points on the chain line.



Correction for Slope:

Horizontal distances can also be determined by applying negative corrections to the distance measured along the slope.

Correction for slope if the vertical distance between first and the last points is known

$$\text{Slope correction} = \frac{h^2}{2L}$$

Error due to	Error	Correction
Standardization	Positive or negative	Positive or negative respectively
Temperature	Positive or negative	Positive or negative respectively
Pull	Positive or negative	Positive or negative respectively
Slope	Always positive	Always negative
Sagging	Always positive	Always negative
Wrong alignment	Always positive	Always negative

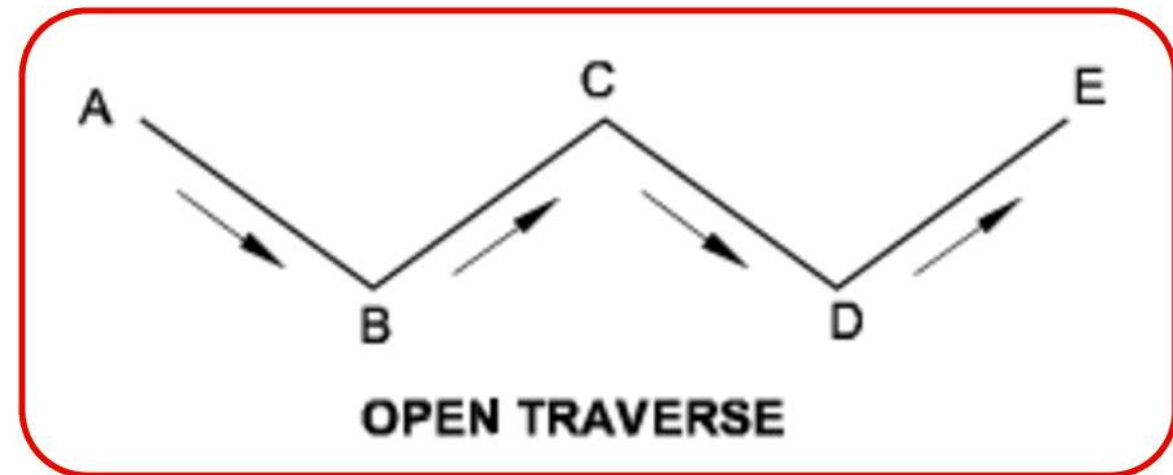
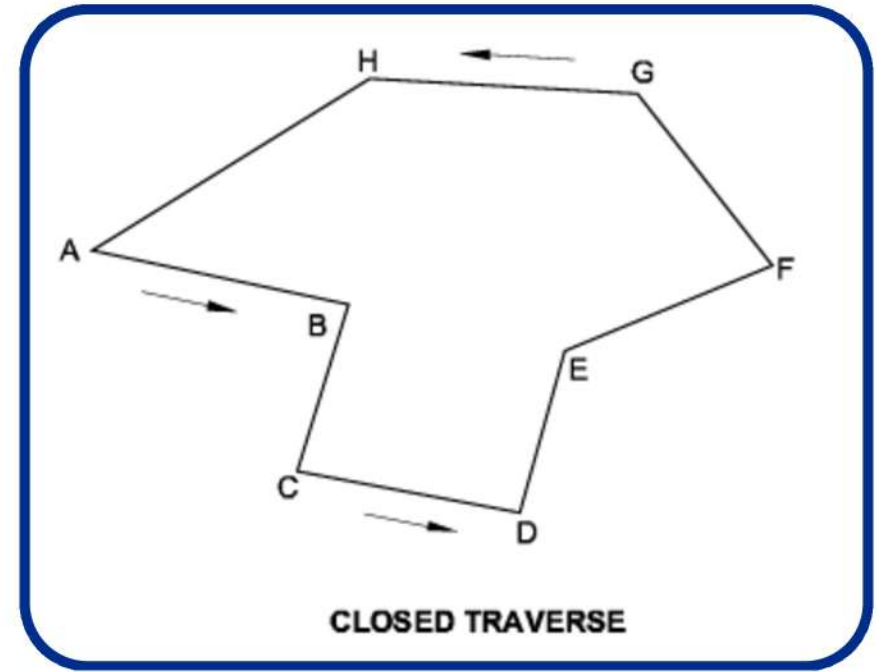
Compass surveying

- Is a type of surveying in which the directions of surveying lines are determined with a magnetic compass, and the length of the surveying lines are measured with a tape or chain or laser range finder.



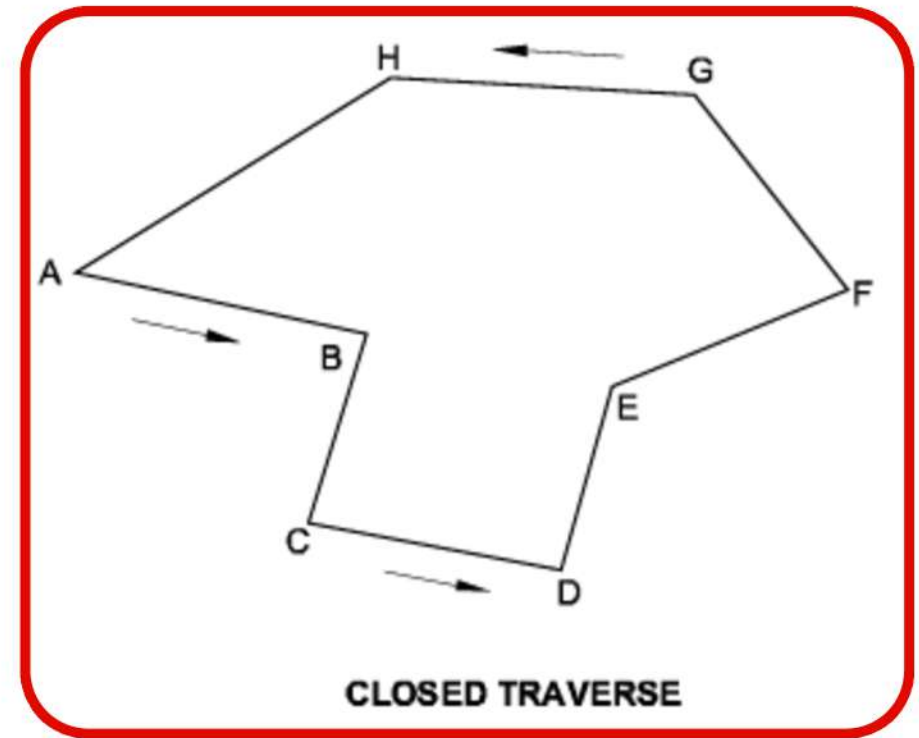
Traversing

- Traversing is that type of survey in which **a number of connected survey lines form the frame work and the directions and lengths of the survey line are measured with the help of an angle measuring instrument and a tape respectively.**
- When the lines form a circuit which ends at the starting point is called closed traverse.



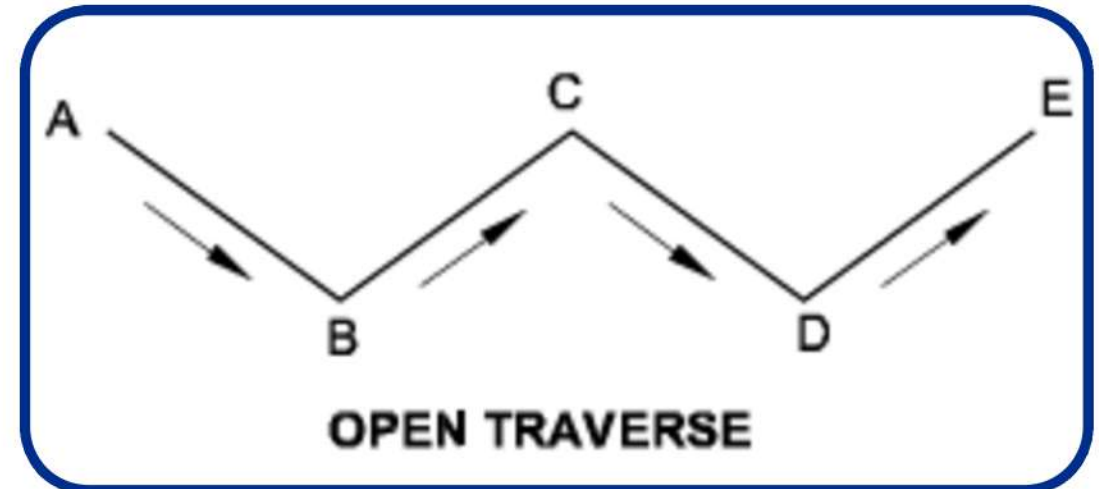
Close Traverse

- It is a traverse which starts from a point of known location and closes at either at the same point (or) another point of known location



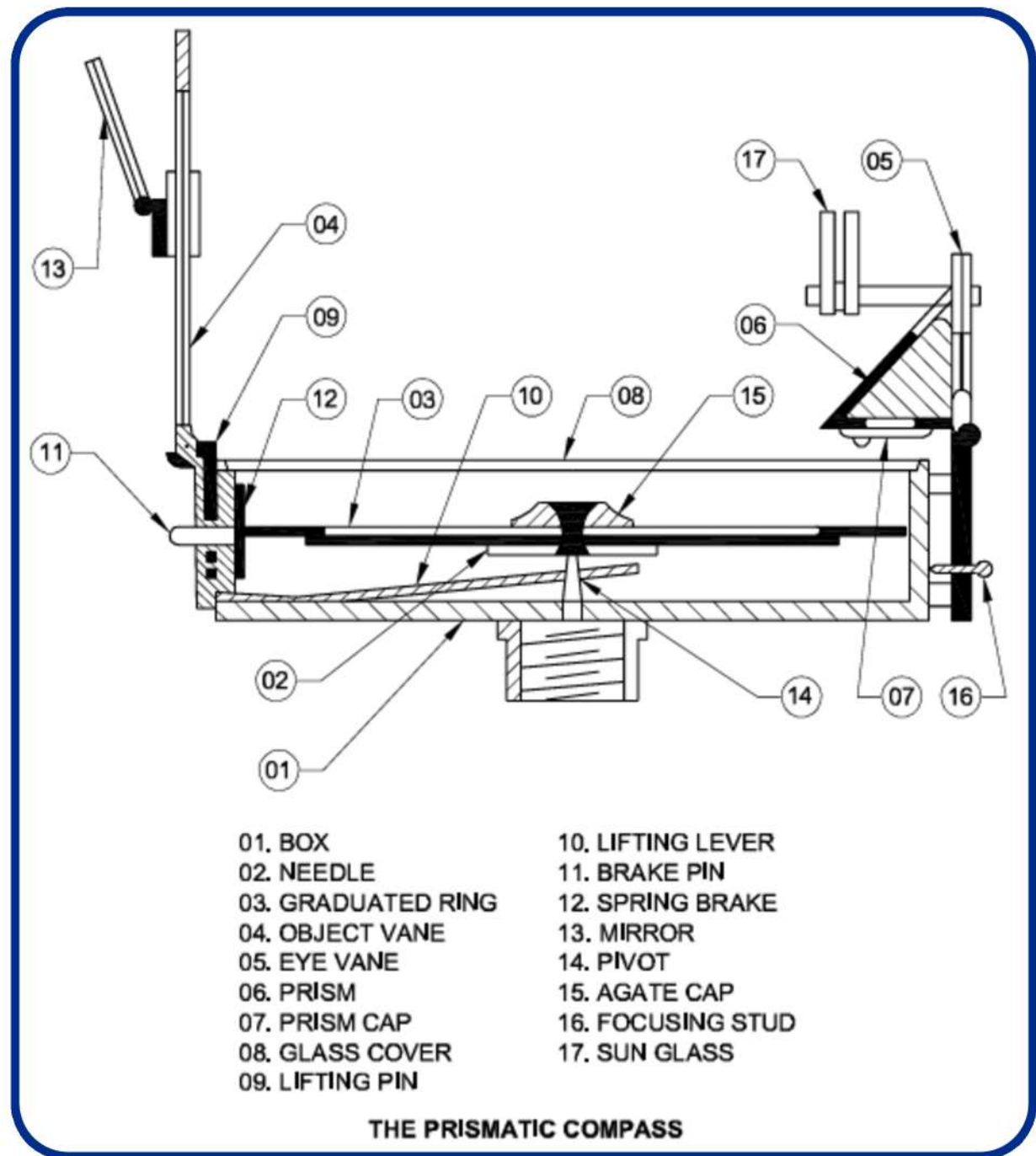
Open Traverse

- It is a traverse which starts from a point of known location and closed at another point of unknown location.



Compass

- A compass is a small instrument which consists essentially of a magnetic needle, a graduated circle and a line of sight.
- When the line of sight is directed towards a line, the magnetic needle points towards magnetic meridian and the angle which the line makes with the magnetic meridian is read at the graduated circle.



Compass

- **Types of compass: The two forms of the compass commonly used are.**

1. The prismatic compass

2. The surveyors compass

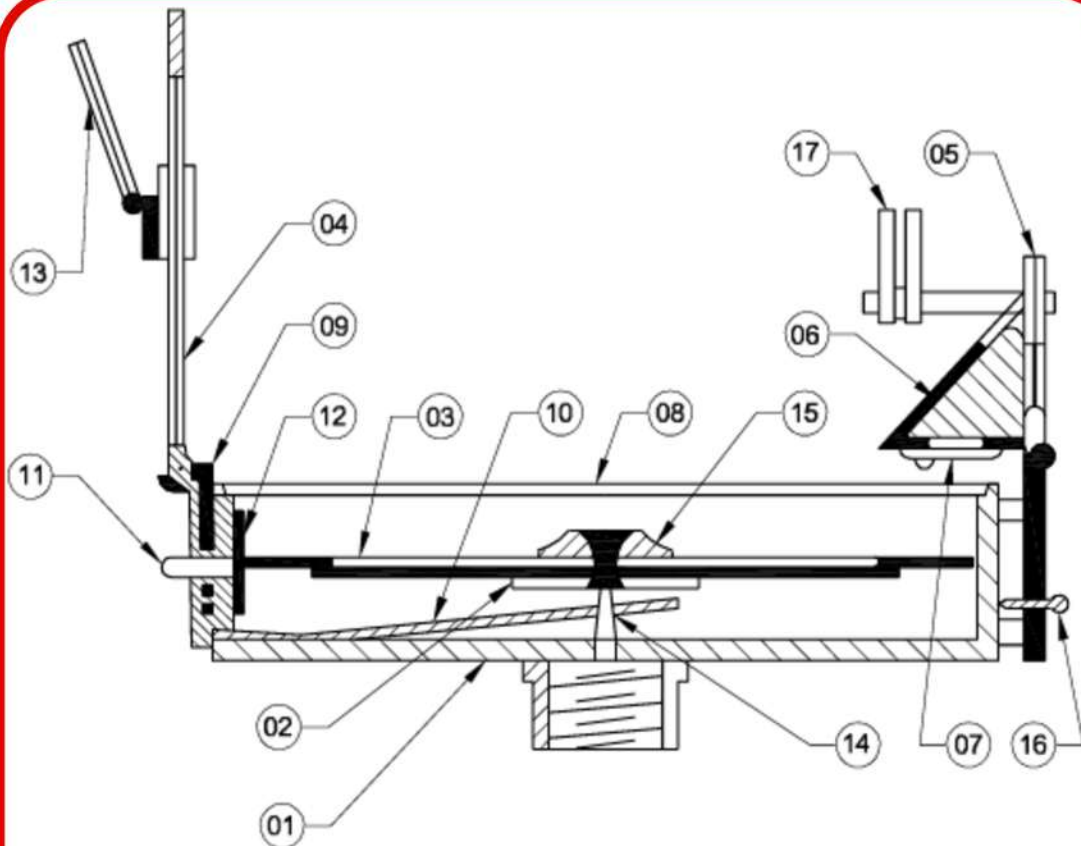
3. Trough compass

4. Compass and level

Prismatic compass

- It is the most convenient portable magnetic compass, which can either be used as a hand instrument or can be fitted on a tripod.





- | | |
|--------------------|-------------------|
| 01. BOX | 10. LIFTING LEVER |
| 02. NEEDLE | 11. BRAKE PIN |
| 03. GRADUATED RING | 12. SPRING BRAKE |
| 04. OBJECT VANE | 13. MIRROR |
| 05. EYE VANE | 14. PIVOT |
| 06. PRISM | 15. AGATE CAP |
| 07. PRISM CAP | 16. FOCUSING STUD |
| 08. GLASS COVER | 17. SUN GLASS |
| 09. LIFTING PIN | |

THE PRISMATIC COMPASS

Prismatic compass

- Graduations are marked on the ring in a clockwise **direction with 0 or 360** at south end of the needle.
- The prismatic compass measures the bearings of lines in the **whole circle system**.
- cylindrical **metal box - 8 cm to 12 cm** diameter
- The ring is graduated to half a degree and is read by a reflecting prism

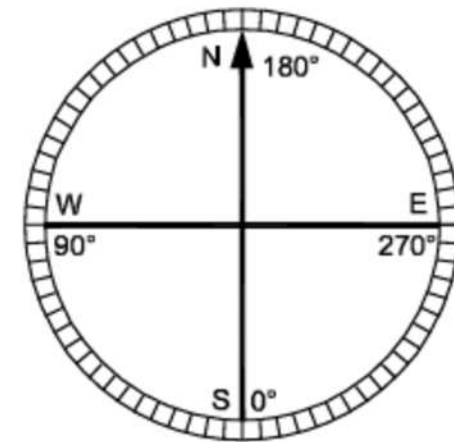
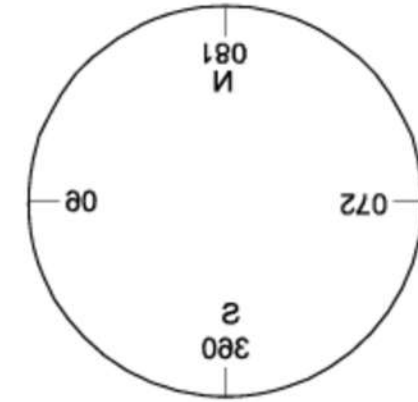
Prismatic compass

Temporary Adjustments Of A Prismatic Compass

1. Centering
2. Levelling
3. Focussing

Permanent Adjustment Of Prismatic Compass

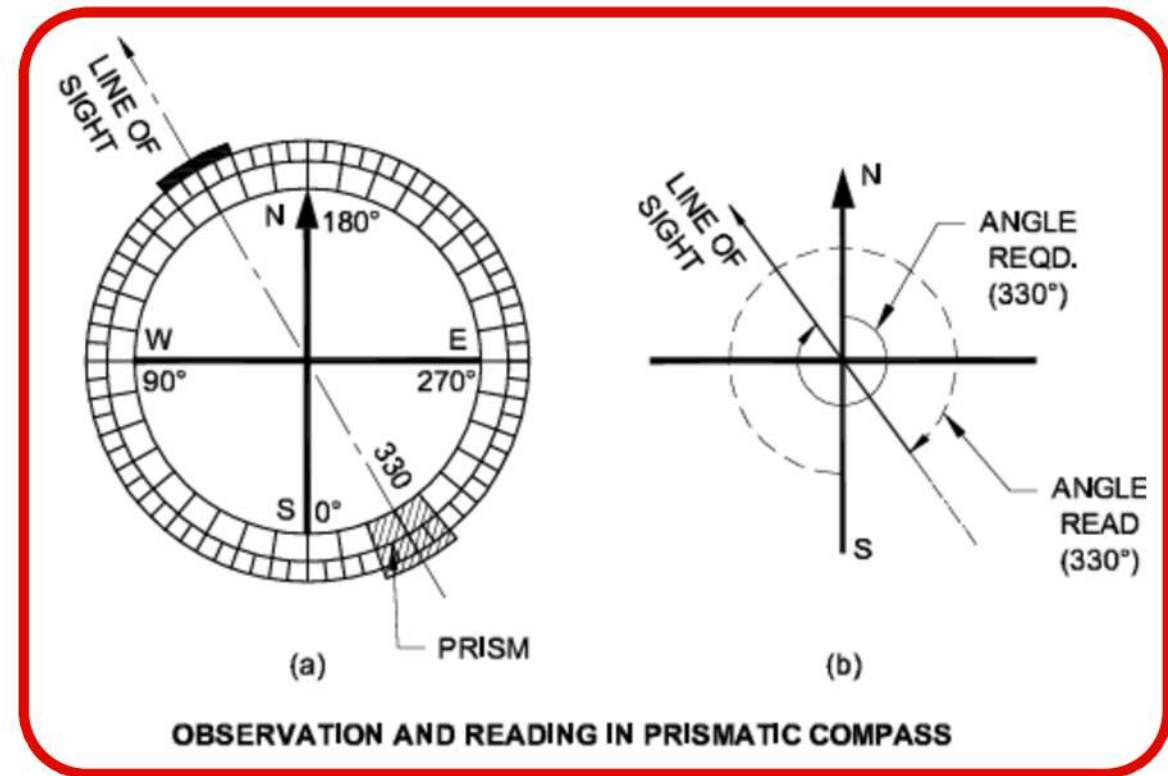
1. Adjustments of levels
2. Adjustments for sight vanes
3. Adjustments of the needle and pivot



SYSTEM OF GRADUATION IN PRISMATIC COMPASS

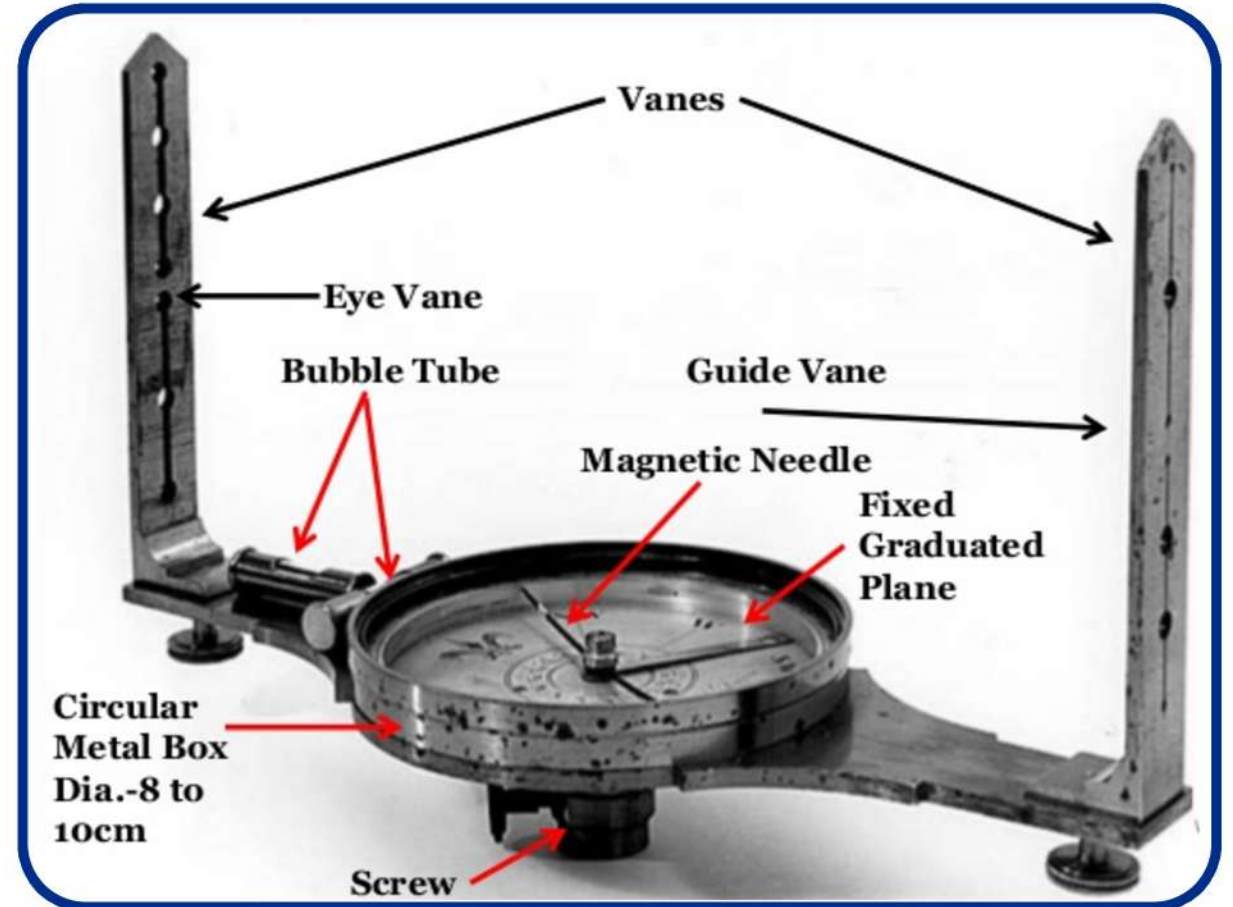
Prismatic compass

- In the prismatic compass graduations are marked on the ring in a clockwise direction with **0 or 360 at south end of the needle.**
- So that **90 is marked at the west 180 at the north and 270 at the east.**
- The greatest advantages of prismatic compass is that both sighting the object as well as reading circle can be done simultaneously without changing the position of the eye.

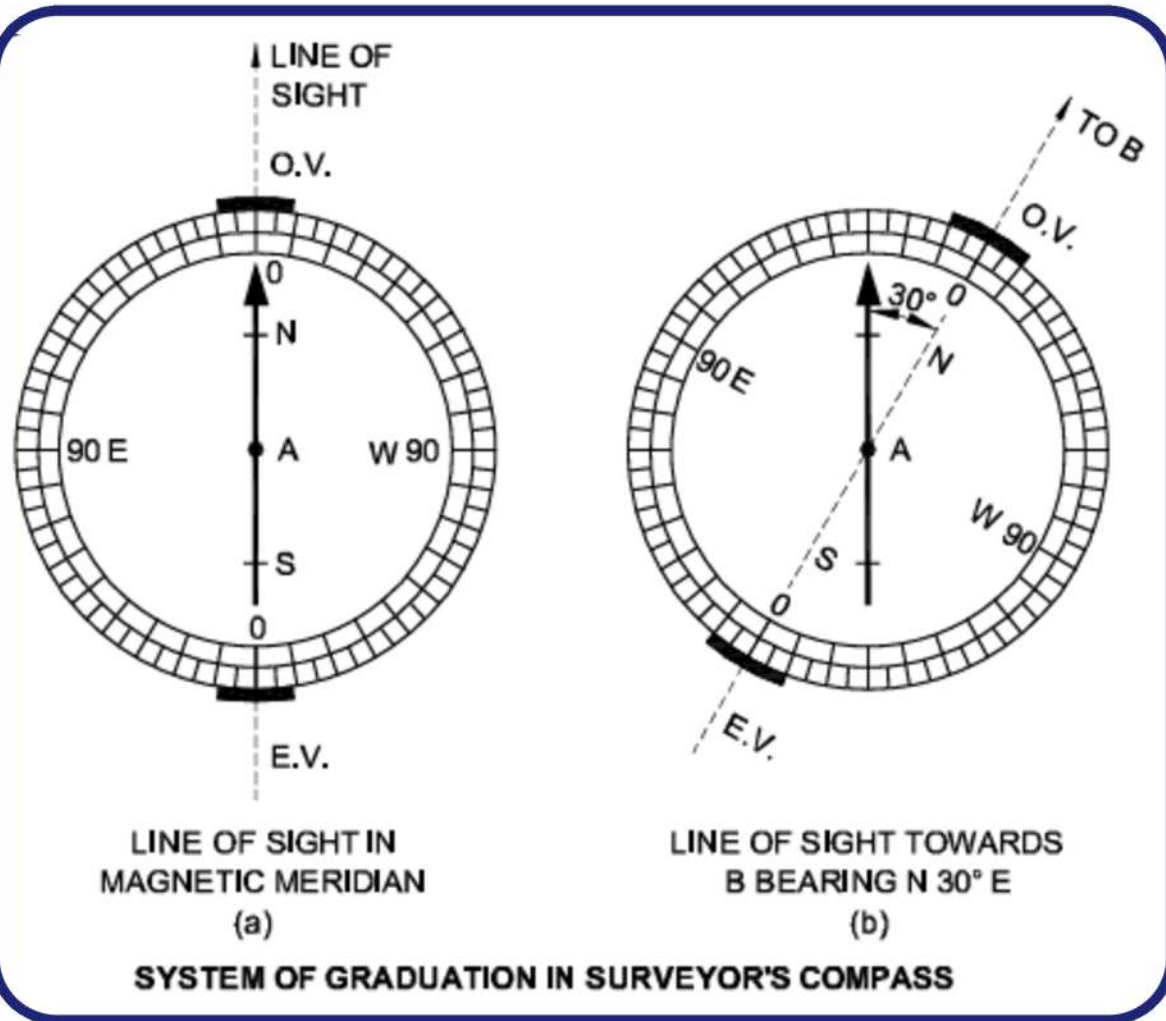


Surveyors compass

- It is similar to prismatic compass except with a following few modification.
- The graduated ring is directly attached to the circular box and not with the magnetic needle.
- The magnetic needle floats freely over the pivot.
- No prism is attached to the eye vane and it is having a narrow vertical slit.



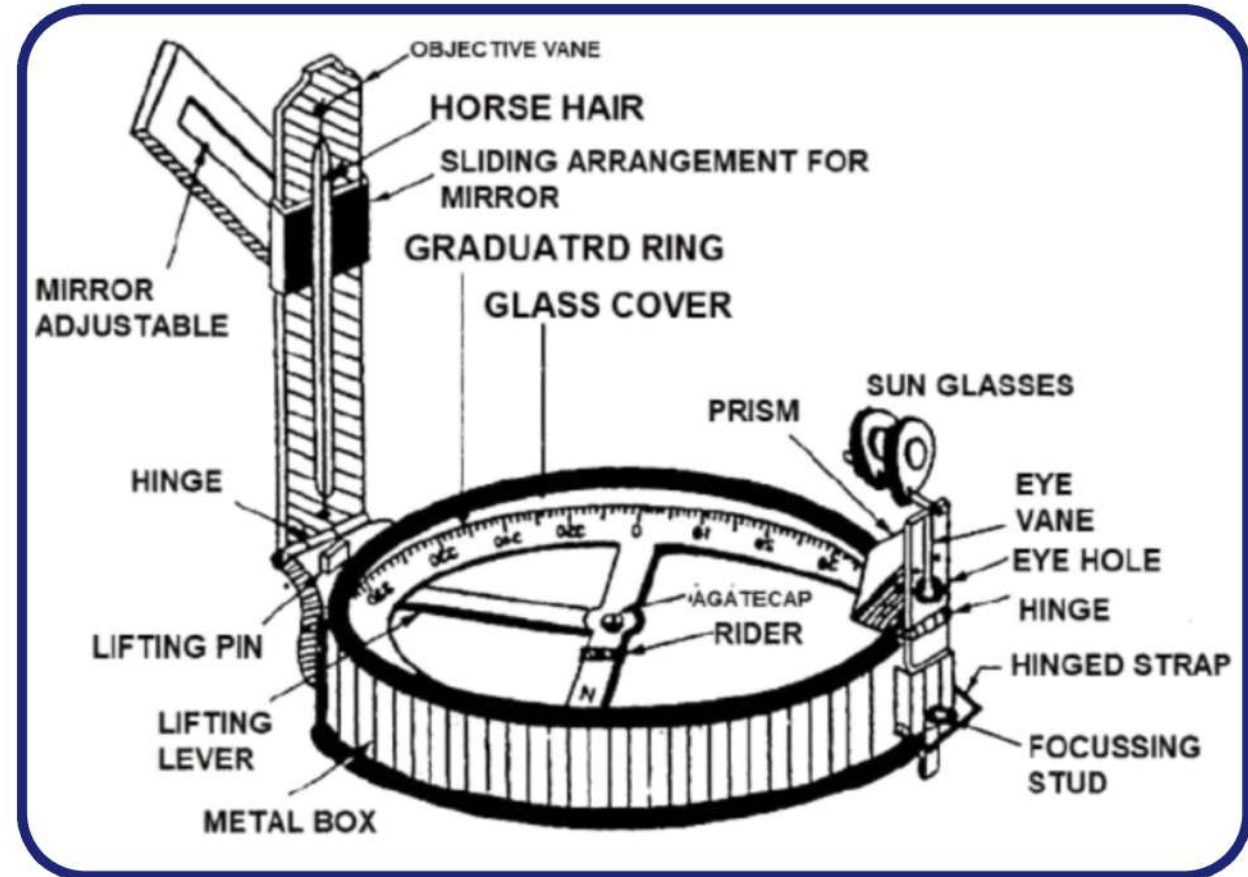
Surveyors compass



- Readings are taken **directly with naked eye against the north end of the needle.**
- The ring is graduated in quadrated system of having **0 degree at north and south ends, 90 degree at East and west ends.**

Surveyors compass

- The graduated ring is directly attached to the circular box and not with the magnetic needle
- The **magnetic needle floats freely over the pivot.**
- **No prism is attached to the eye vane** and it is having a narrow vertical slit.
- Reduced bearings are observed by surveyors compass.
- The **least count of a surveyors Compass is 15 minutes (15').**



Surveyors compass

Temporary Adjustments Of A Surveyor's Compass

- 1. Centering
- 2. Levelling

Permanent Adjustment Of Surveyor's Compass

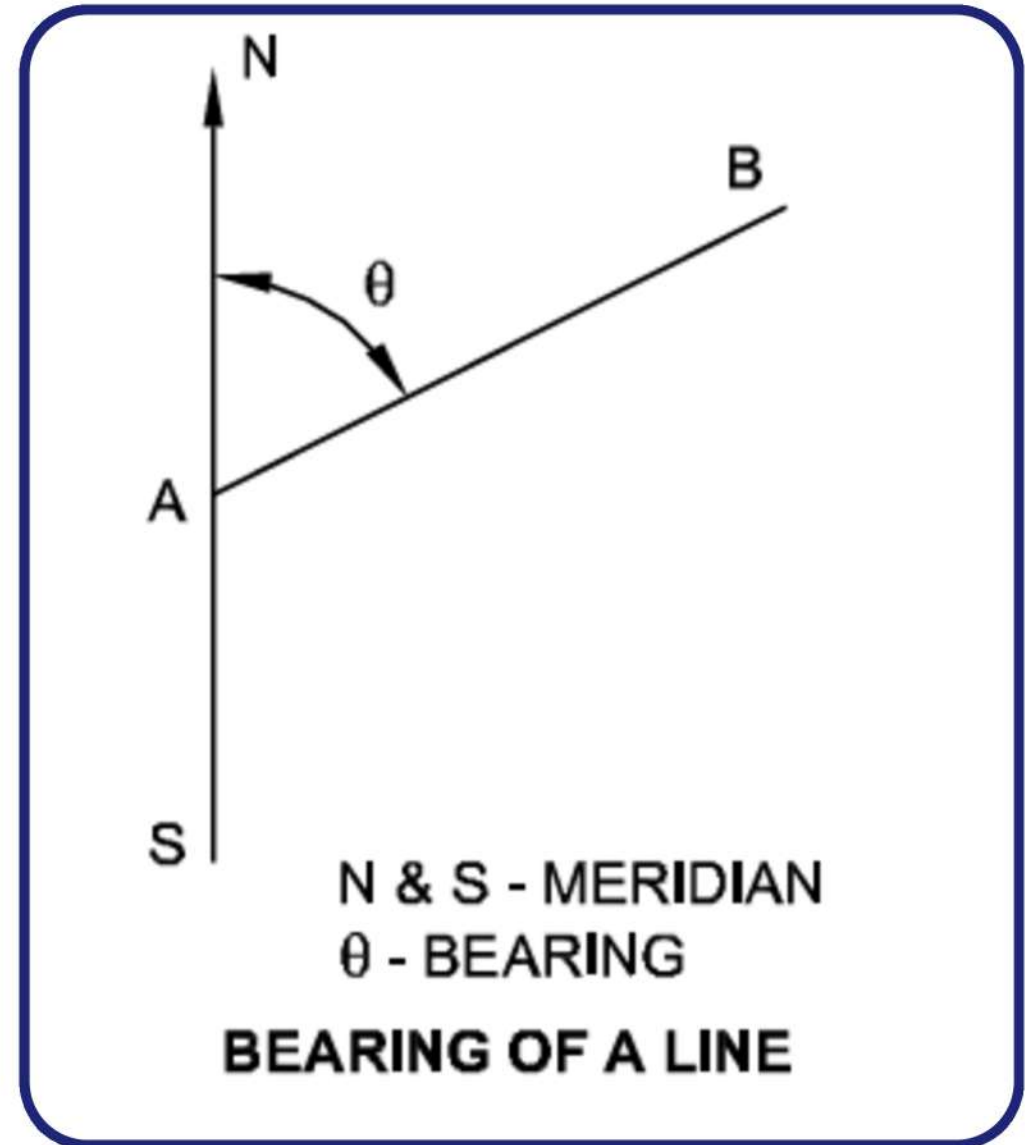
- 1. Adjustment of levels
- 2. Adjustment of sight vanes
- 3. Adjustment for sensitivity of the needle
- 4. Adjustment for straightness of the needle.
- 5. Adjustment of pivot.

Comparison between prismatic compass and surveyors compass

No.	Item	Prismatic compass	Surveyor's compass
1	Magnetic needle	The needle is broad type and needle does not act as index.	The needle is of edge bar type of needle and acts as the index also.
2	Graduated ring	The graduated ring is attached with the needle. The ring does not rotate along with the line of sight. The graduations are in Whole circle bearing system, having 0° at south end 90° at west, 180° at North and 270° at East.	The graduated ring is attached to the box and not to the needle. The ring rotates along with the line of sight. The graduations are in Quadrantal bearing system having 0° at North and South, 90° at East and West. East and west are interchanged
3	Sighting vane	The graduations engraved are inverted The object vane consists of metal vane with a vertical hair The eye vane consists of a small metal vane with a slit	The graduations engraved are erect. The object vane consists of a metal vane with a vertical hair. The eye vane consists of a metal vane with a fine slit.
4	Reading	The reading is taken with the help of a prism provided with the eye vane. Sighting and reading can be done simultaneously from one position of the observer.	The reading is taken by directly seeing through the top of the glass. Sighting and reading cannot be done simultaneously from one position of the observer.
5	Tripod	It is used with or without Tripod	It cannot be used without a Tripod.

Bearing of a line

- It is the horizontal angle which a line make with some reference direction also known as meridian.
- True meridian.
- Magnetic meridian.
- An assumed meridian.



Compass surveying

True Meridian

- True meridian of a place is a direction indicated by an imaginary circle passing round the earth through that place and the two north and south poles.

True bearing

- The horizontal angle between a line and the true meridian is called true bearings of the line.
- It is also called as azimuth.

Compass surveying

Magnetic meridian

- The direction indicated by a freely suspended and properly balanced magnetic needle unaffected by local attractive forces is called the magnetic meridian.

Magnetic bearings

- The horizontal angle which a line makes with this meridian is called magnetic bearings or simply bearings of the line.

Compass surveying

An assumed or Arbitrary meridian

- Arbitrary meridian is any convenient direction towards a permanent and prominent mark or signal such as a church spire or top of a chimney.
- Such meridians are used to determine the relative positions of lines in a small area.

Arbitrary Bearings

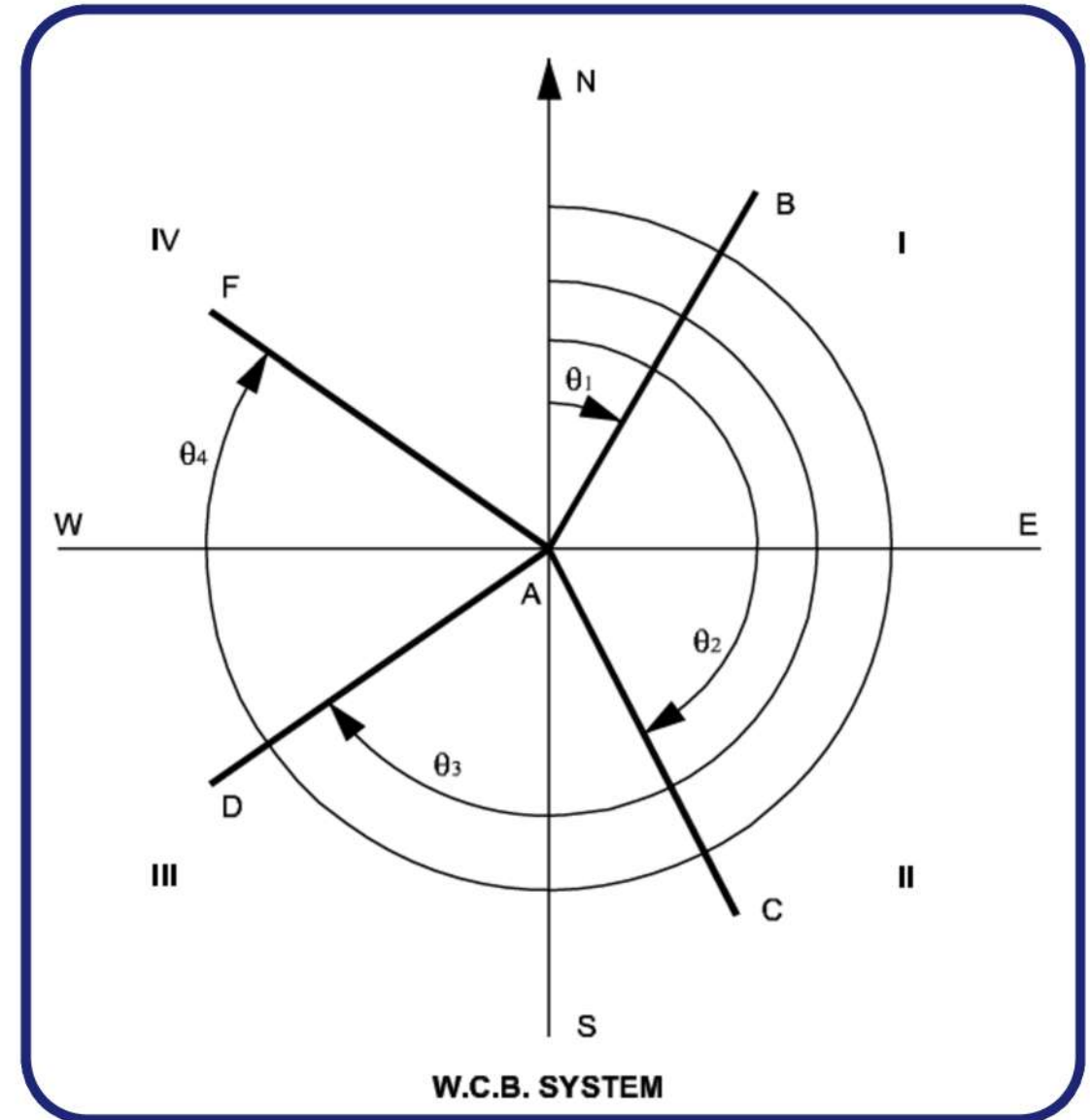
- Arbitrary bearings of a line is the horizontal angle which it makes with any arbitrary meridian passing through the one of the extremities or the horizontal angle between a line and this arbitrary meridian is called arbitrary bearing of the line.

Designation of Bearings

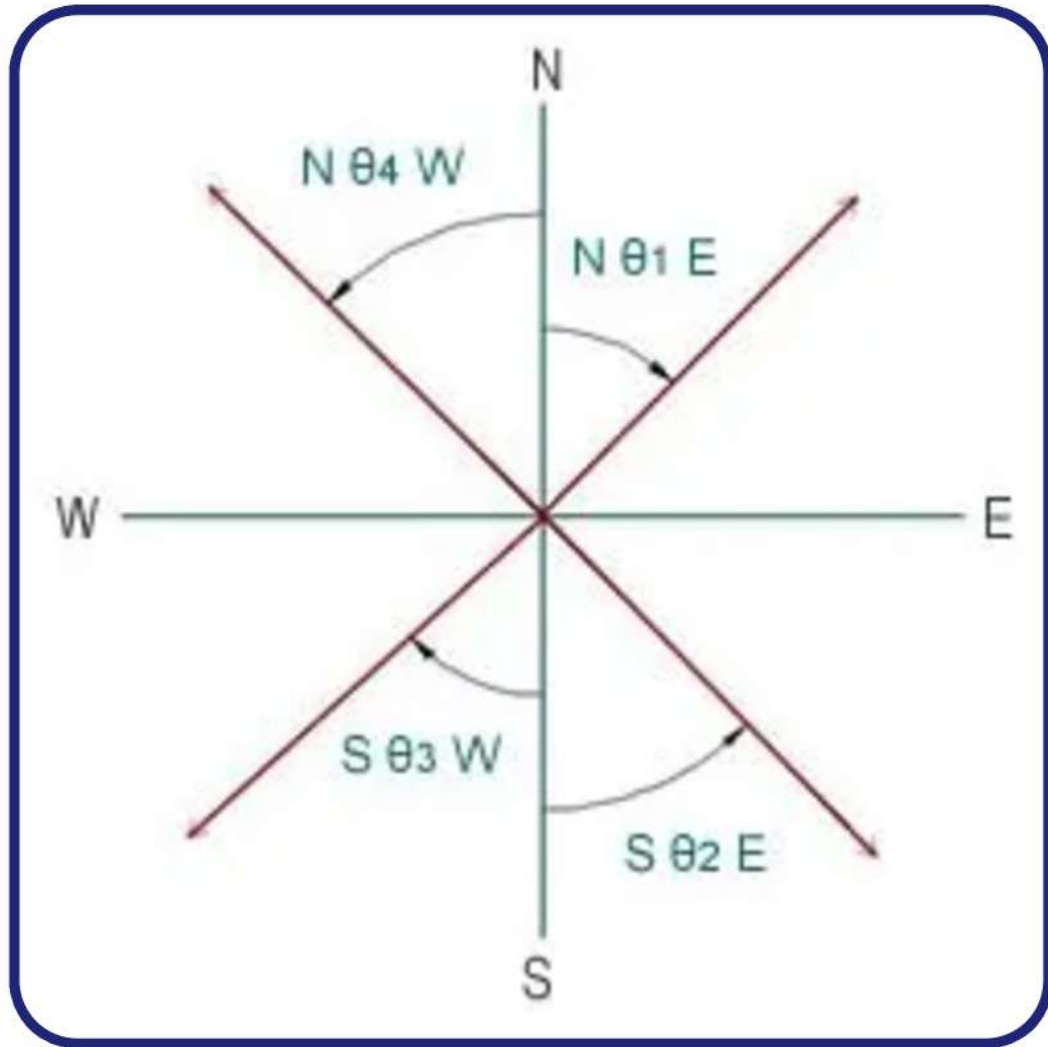
- The bearings are expressed the following two ways:
 1. Whole circle bearings
 2. Quadrantal bearings.

Whole circle bearing (W.C.B)

- In this system, the bearings of a line, is measured from the magnetic north in clockwise direction.
- The value of the bearing thus varies from 0 degree to 360 degree.
- The prismatic compass measures the bearings of lines in the whole circle system.



Quadrantal bearings



- In this system, the bearings of a line is measured east ward or westward from north or south which ever is nearer.
- Thus both North and South are used as reference meridians and the directions can be either clockwise or anticlockwise depending upon the position of the line.
- These bearings are observed by surveyors compass.

The conversion of W.C.B into R.B

Line	W.C.B between	Rule for R.B	Quadrant
AB	0° and 90°	$R.B = W.C.B$	NE
AC	90° and 180°	$R.B = 180^{\circ} - W.C.B$	SE
AD	180° and 270°	$R.B = W.C.B - 180^{\circ}$	SW
AF	270° and 360°	$RB = 360^{\circ} - W.C.B$	NW

The conversion of W.C.B into R.B

The conversion of R.B into W.C.B

Line	R.B	Rule for W.C.B	W.C.B between
AB	N α E	W.C.B = R.B	0 ⁰ and 90 ⁰
AC	S β E	W.C.B = 180 ⁰ - R.B	90 ⁰ and 180 ⁰
AD	S θ W	W.C.B = 180 ⁰ + R.B	180 ⁰ and 270 ⁰
AF	N ϕ W	W.C.B = 360 ⁰ - R.B	270 ⁰ and 360 ⁰

Reduced bearing

- The bearing of a line taken in the progress of the survey or in the forward direction is the fore or forward bearing (F.B) of the line.
- While its bearing taken in the reverse or opposite direction is known as reverse or back bearing
- In the whole circle system, the fore and back bearings of a line differ exactly by 180 degree.
- **B.B of a line = F.B $\pm$ 180 degree**

Fore Bearings and Back Bearings

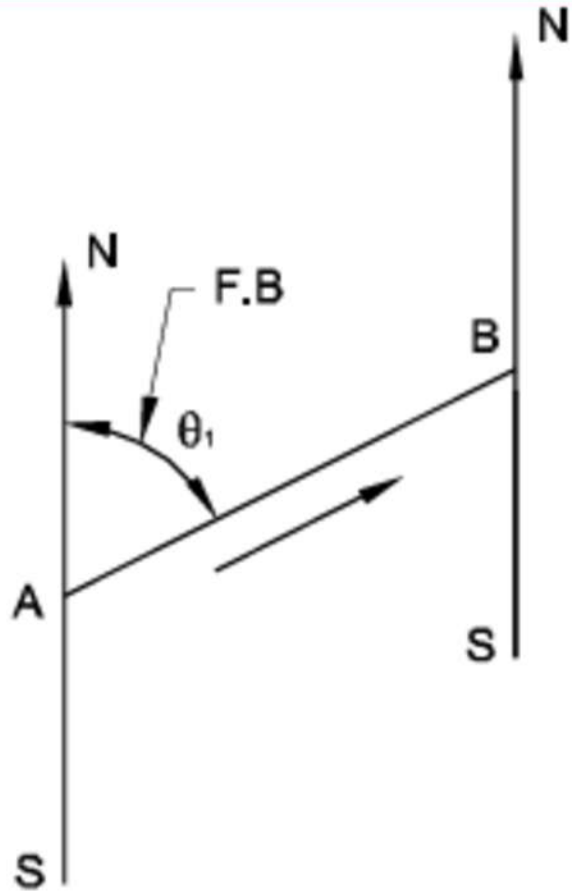
- Every line has two bearings, observed one at each end of the line.
- The bearing of a line taken in the progress of the survey or in the forward direction is the fore or forward bearing (F.B) of the line.
- While its bearing taken in the reverse or opposite direction is known as reverse or back bearing (B.B).

- In the whole circle system, the fore and back bearings of a line differ exactly by 180 degree.

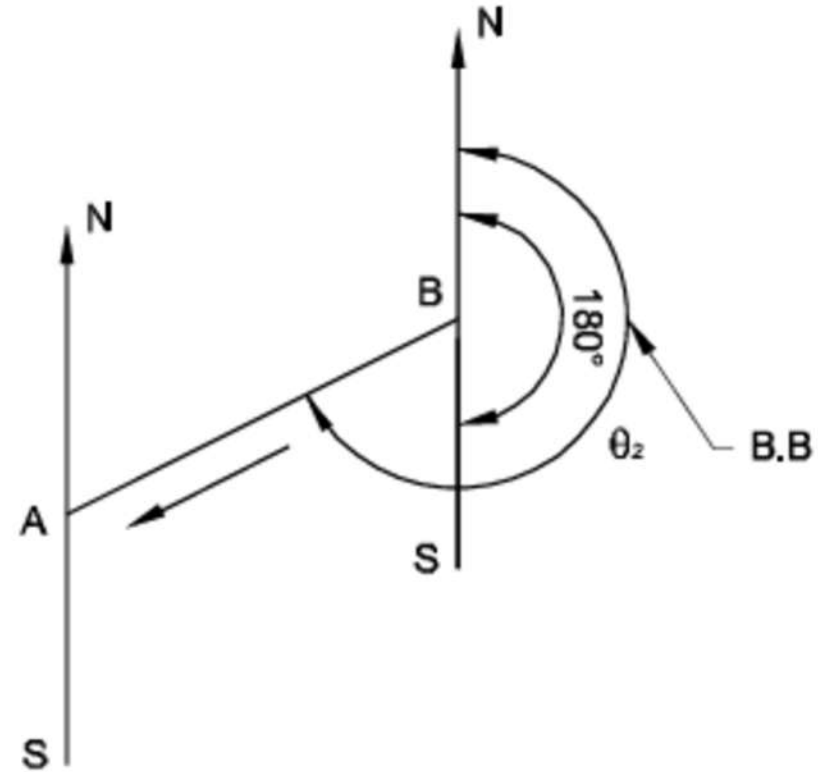
$$\text{B.B of a line} = \text{F.B} \pm 180 \text{ degree}$$

Use plus sign if the given F.B is less than 180° and minus sign if it exceeds 180° .

Fore Bearings and Back Bearings



FORE BEARING OF A LINE AB
W.C.B. SYSTEM



BACK BEARING OF A LINE AB
W.C.B. SYSTEM

Problems on conversion of bearing

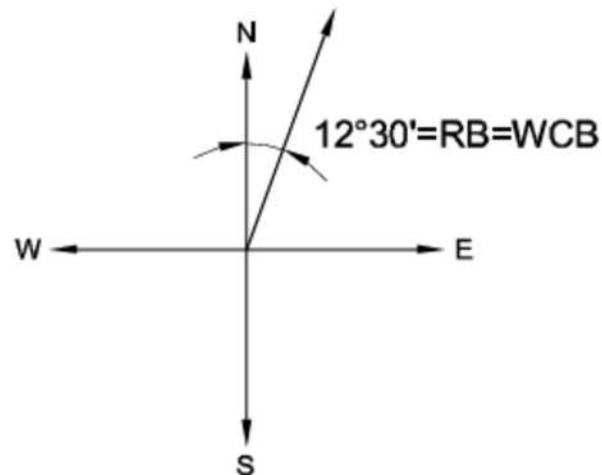
- Convert the following W.C.B to quadrantal bearings
i) $12^{\circ} 30'$ ii) $160^{\circ} 30'$ iii) $210^{\circ} 30'$ iv) $285^{\circ} 30'$

Solution

i) W.C.B = $12^{\circ} 30'$

W.C.B = $12^{\circ} 30'$ which is less than 90°

$\therefore$ R.B = N $12^{\circ} 30'$ E



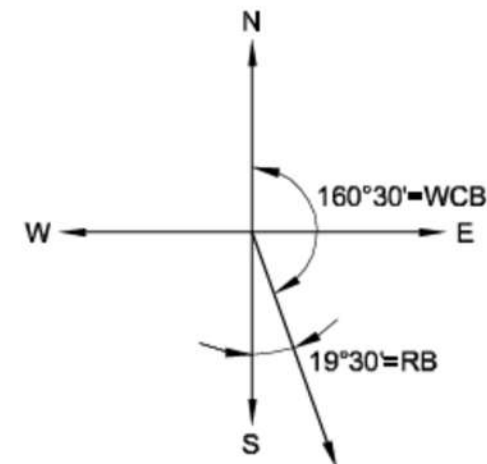
ii) W.C.B = $160^{\circ} 30'$

The W.C.B is within 90° to 180°

$\therefore$ RB = $180^{\circ} - \text{W.C.B}$

= $180^{\circ} - 160^{\circ} 30'$

S $19^{\circ} 30'$ E



Solution

Problems on conversion of bearing

- Convert the following W.C.B to quadrantal bearings
i) $12^{\circ} 30'$ ii) $160^{\circ} 30'$ iii) $210^{\circ} 30'$ iv) $285^{\circ} 30'$

Solution

3. W.C.B = $210^{\circ} 30'$



4. W.C.B = $285^{\circ} 30'$



Problems on conversion of bearing

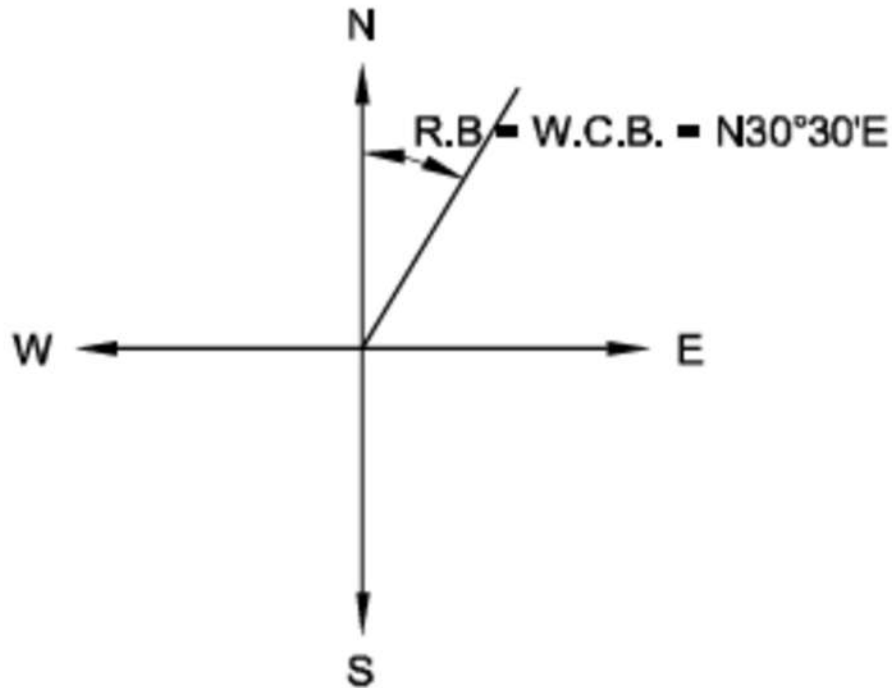
- Convert the following quadrantal bearings to whole circle bearings.

i) $N 30^{\circ} 30' E$ ii) $S 70^{\circ} 30' E$ iii) $S 36^{\circ} 30' W$

iv) $N 85^{\circ} 30' W$

Solution

i) Q.B = $N 30^{\circ} 30' E$
W.C.B = R.B = $30^{\circ} 30'$



Problems on conversion of bearing

- Convert the following quadrantal bearings to whole circle bearings.

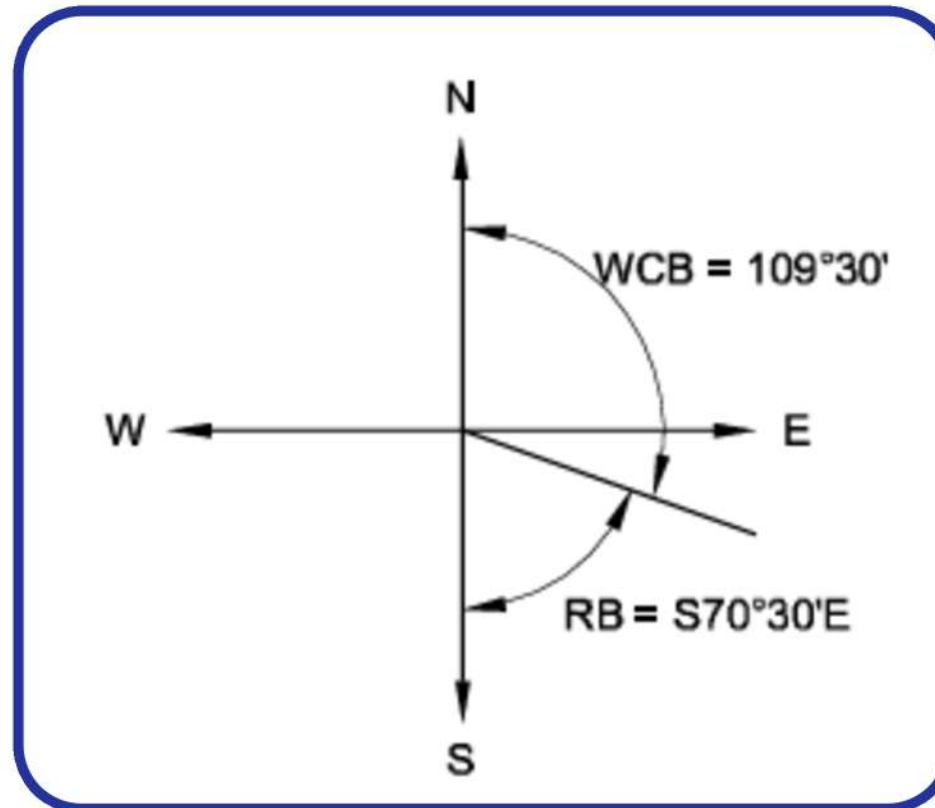
i) $N 30^{\circ} 30' E$ ii) $S 70^{\circ} 30' E$ iii) $S 36^{\circ} 30' W$

iv) $N 85^{\circ} 30' W$

Solution

ii) Q.B = $S 70^{\circ} 30' E$
W.C.B = $180^{\circ} - R.B$
= $180^{\circ} - 70^{\circ} 30'$

$109^{\circ} 30'$



Problems on conversion of bearing

- Convert the following quadrantal bearings to whole circle bearings. i) N $30^{\circ} 30'$ E ii) S $70^{\circ} 30'$ E iii) S $36^{\circ} 30'$ W
iv) N $85^{\circ} 30'$ W

Solution

3. Q.B = S $36^{\circ} 30'$ W



4. Q.B = N $85^{\circ} 30'$ W



Problems on conversion of bearing

- 1 Convert the following W.C.B to R.B
 - a) $87^{\circ} 30'$
 - b) $120^{\circ} 30'$
 - c) $210^{\circ} 00'$
 - d) $266^{\circ} 30'$
 - e) $310^{\circ} 30'$
 - f) $359^{\circ} 30'$

- 2 Convert the following R.B to W.C.B
 - a) N $46^{\circ} 30'$ E
 - b) S $20^{\circ} 30'$ E
 - c) S $10^{\circ} 30'$ W
 - d) N $50^{\circ} 30'$ W



Example

- Find back bearings of the following observed fore bearings of lines AB $63^{\circ} 30'$; BC $112^{\circ} 30'$; CD $203^{\circ} 30'$; DE $320^{\circ} 30'$

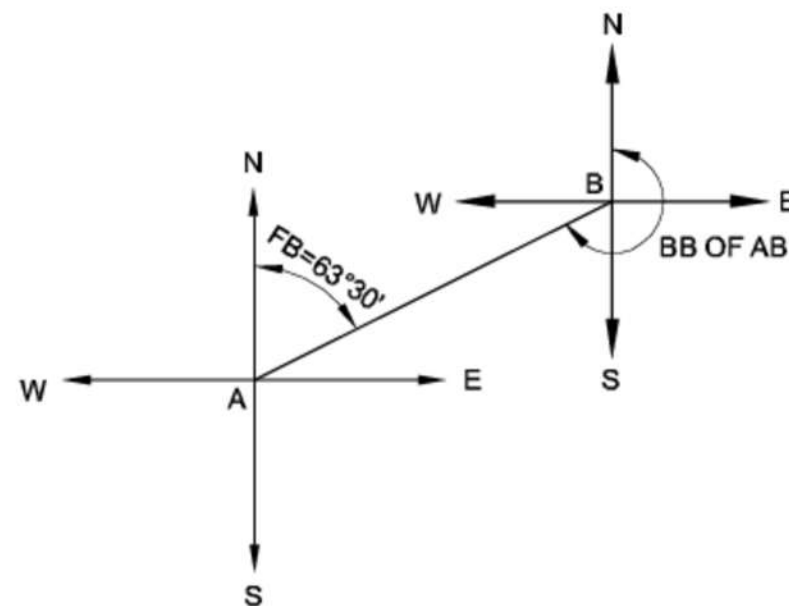
$$B.B = F.B \pm 180^{\circ}$$

Using + sign when F.B is less than 180° and - sign more than 180°

- F.B of AB = $63^{\circ} 30'$ (Fig 1)

$$\begin{aligned} \therefore B.B \text{ of AB} &= F.B \text{ of AB} + 180^{\circ} \\ &= F.B \text{ of AB} + 180^{\circ} \\ &= 63^{\circ} 30' + 180 \\ &= 243^{\circ} 30' \end{aligned}$$

$$B.B \text{ of AB} = 243^{\circ} 30'$$



Example

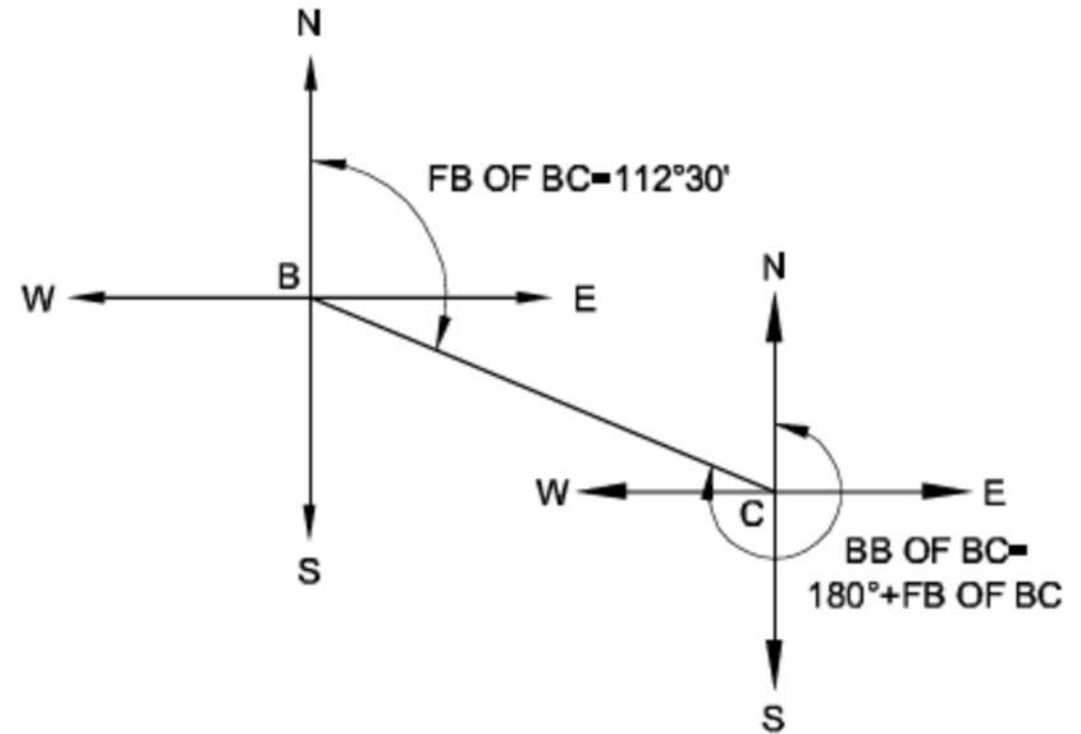
1. Find back bearings of the following observed fore bearings of lines AB $63^{\circ} 30'$; BC $112^{\circ} 30'$; CD $203^{\circ} 30'$; DE $320^{\circ} 30'$

ii) F.B of BC = $112^{\circ} 30'$ (Fig 2)

$$\text{B.B of BC} = \text{F.B of BC} + 180^{\circ}$$

$$= 112^{\circ} 30' + 180$$

$$= 292^{\circ} 30'$$



Example

1. The fore bearing of the lines are as follows.

AB : $N 32^{\circ} 30' E$

BC : $S 43^{\circ} 30' E$

CD : $S 26^{\circ} 30' W$

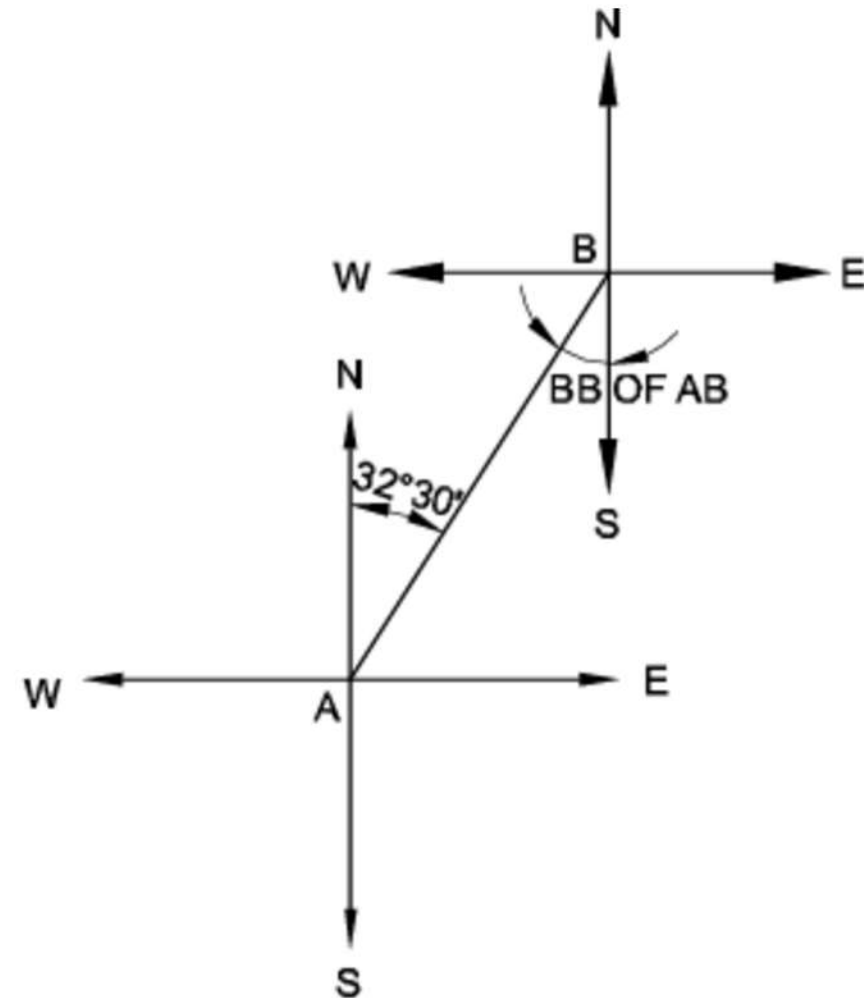
DE : $N 65^{\circ} 35' W$

Find their back bearings

Solution

i) F.B of AB = $N 32^{\circ} 30' E$

$\therefore$ B.B of AB = $S 32^{\circ} 30' W$



Example

1. The fore bearing of the lines are as follows.

AB : $N 32^{\circ} 30' E$

BC : $S 43^{\circ} 30' E$

CD : $S 26^{\circ} 30' W$

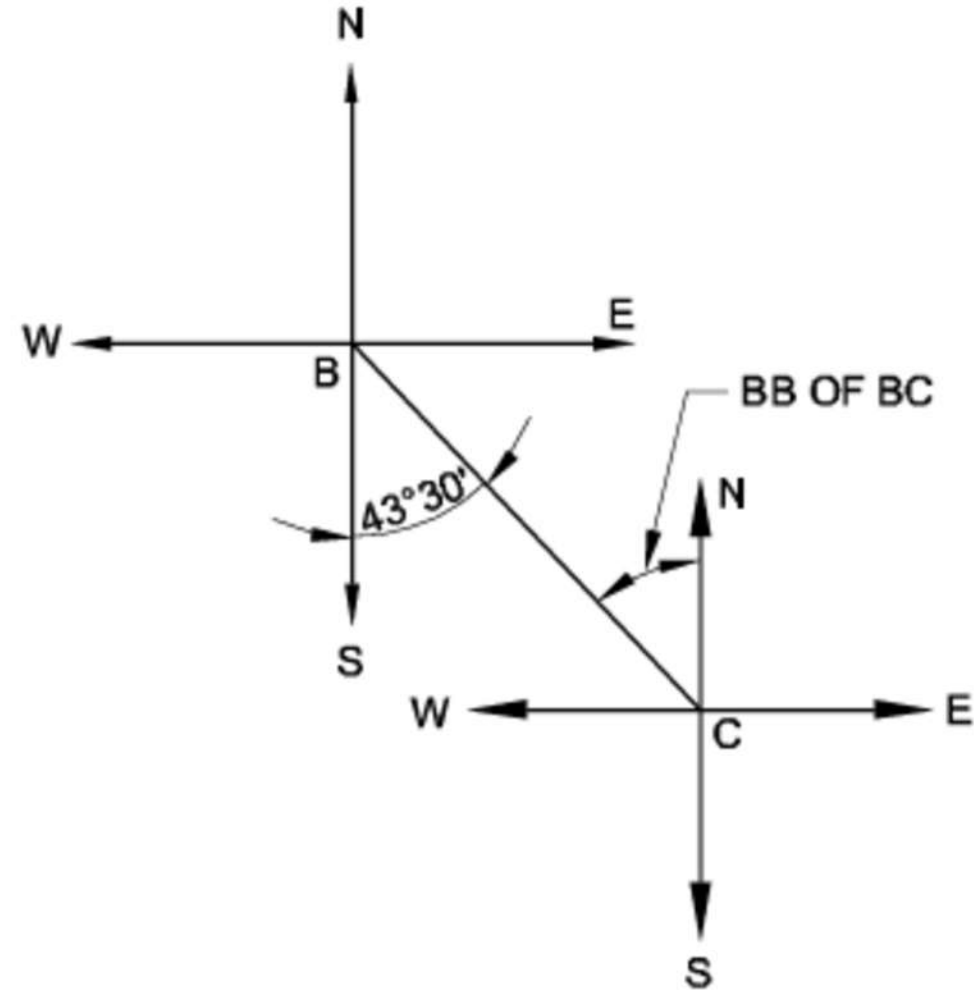
DE : $N 65^{\circ} 35' W$

Find their back bearings

Solution

ii) F.B of BC = $S 43^{\circ} 30' E$

B.B of BC = $N 43^{\circ} 30' W$

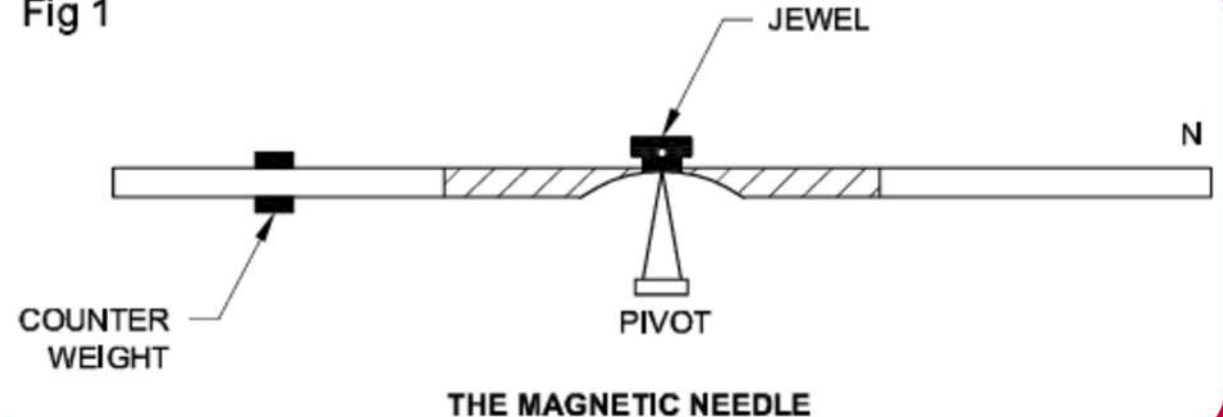


Magnetic declination

Dip of the Magnetic Needle

- Before Magnetisation, the needle remains in the horizontal position if it is properly balanced, but after being magnetised, it cannot remain in the same position due to the magnetic influence of the earth.
- One end of the needle deflects downward towards the magnetic pole. In northern hemisphere the north end of the needle is deflected downward, and in the southern hemisphere the south end points downward.
- This inclination of the needle with the horizontal is known as the dip of the needle

Fig 1



Magnetic declination

Dip of the Magnetic Needle

- The amount of the dip is not uniform, but it varies in different parts of the earth.
- It varies from 0 degree to 90 degree (zero at equator and 90 degree at the poles)

To keep the needle in the horizontal position, it is balanced by placing a brass sliding weight or rider at a suitable point over the higher end of the needle.

Magnetic declination

Dip of the Magnetic Needle

- Inclination of the needle with the horizontal
 1. The amount of the dip is not uniform
 2. zero at equator and 90 degree at the poles

Magnetic declination: The horizontal angle which the magnetic meridian makes with the true meridian

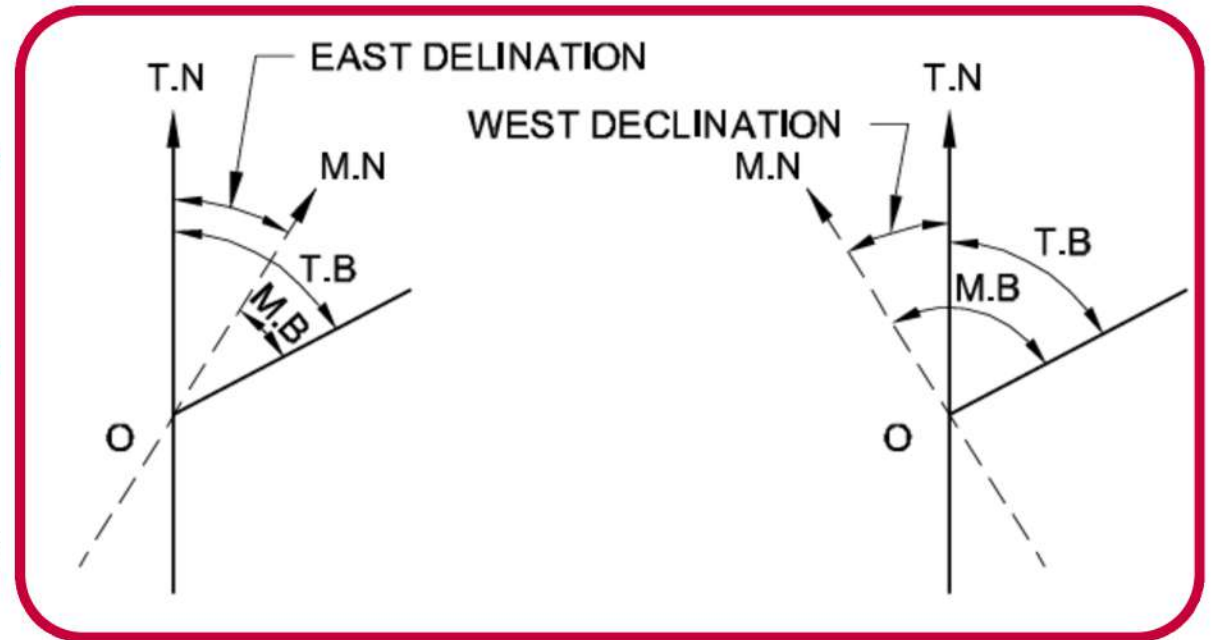
1. Eastern Declination

2. Western Declination

- When the needle is deflected towards east of the true meridian it is called east declination and vice versa

Magnetic declination

- In certain places, the magnetic meridian at a place does not coincide with the true meridian at that place.
- The **horizontal angle which the magnetic meridian makes with the true meridian is known as magnetic declination or declination.**
- When the needle is deflected towards east of the true meridian it is called east declination and west declination when it is deflected towards west of the true meridian.



Magnetic declination

- True bearing of a line = Magnetic bearing of the line $\pm$ declination.
- Magnetic bearing of a line = True bearing of the line $\pm$ declination

Regular variations

1. **Secular variation** : long period
2. **Annual variation**: period of one year (0 to ± 12 Minutes)
3. **Diurnal or daily variation** : Daily (1 to 12 Minutes)
4. **Irregular variations** : occurred by magnetic storms such as earth quakes or volcanic eruptions and their amount may be even 1 degree or degree at a time.
It may occurred at anytime. It cannot be predicted. At noon the sun is exactly on the True meridian. (180 degree)

Local attraction

- Is an error include a needle of magnetic compass due to presence of local magnetic object like: current passing electric wire, steel bridge, some other object etc
- If for any line $|FB-BB| \neq 180$ then stations are affected by local attraction.
- If for any line $|FB-BB| = 180$ then there are two possibilities.
 - i. Both stations are free from local attraction.
 - ii. Both stations are affected by the same value of local attraction.