Surveying-I

CE-205 (T)

Lecture 2

Chain Survey

Department of civil engineering
UET Peshawar

Lecturer
Engr. Muhammad Rizwan

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Land Surveying

Purpose of Land Surveying

- To Secure data for exact description of the boundary.
- To determine its area.
- To Secure Necessary data for making a plan.
- To reestablish the bounders.
- To divide a piece of land into a number of units.

Method of Land Surveying

- **Two general methods**

1. Triangulation

- **The lines of survey form a network of triangles .**
- Denotes a system of surveying in which the sides of the various triangles are computed from :
  - (1) a single line measured directly , called BASE LINE.
  - (2) the three angles of triangle measured accurately with theodolite.
- Basis for Geodetic or Triangulation Survey.

2. Traversing

- In Traverse Surveying the direction of survey line are fixed by angular measurement and not by forming a network of triangles as done in chain survey.
- Framework consists of Series of connected lines
  - Length measured by chain or tape
  - Angle measured by an angular instrument.

Chain Triangulation Or Chain Surveying

- **It is a system of surveying in which sides of various triangles are measured directly in the field and NO angular measurement are Taken.**

- The simplest kind of Surveying
- When Level of accuracy required is not high.

- **<u>Suitable when</u>**
- Ground is fairly level and simple
- Plans are required on large scale e.g fields
- Area is small in extent.

- **<u>Not Suitable</u>**
- For Large Area.
- Too many details.
- Wooded countries
- Undulating areas

Chain Surveying

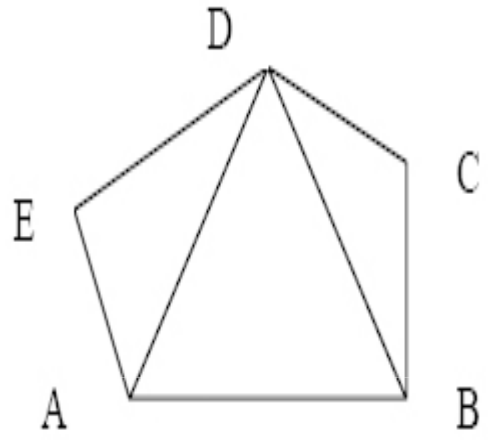
- Principle of chain survey is Triangulation
- Since the triangle is a simple plane geometrical figure, it can be plotted from the measured length of its sides alone.

- In chain surveying, a NETWORK of TRIANGLES is preferred.
-
- Preferably all the sides of a triangle should be nearly equal having each angle nearly 60 to ensure minimum distortion due to errors in measurement of sides and plotting.

- Generally such an **ideal condition** is not practical always. Usually attempt should be made to have **WELLCONDITIONED TRIANGLES** in which no angle is smaller than 30 and no angle is greater than 120.

MEASUREMENT OF AREA BY CHAIN TRIANGULATION

- **PROCEDURE:**
  » Let ABCDE be the given field whose area is to be measured, fix the pegs at A, B, C, D & E.
  » Divide area into three triangles ADE, ABD and BCD by joining AD and BD.
  » Measure the lengths AB, BC , CD, DE, EA, AD and BD.
  » Calculate the area of the triangles.
  » The sum of the areas of the three triangles is the area of the given field.
- RESULT:
  The area of the given field = _____



FORMULA:

$$\text{Area of the triangle } \Delta = \sqrt{s\,(s-a)\,(s-b)\,(s-c)}$$

Where $S = (a + b + c) / 2$

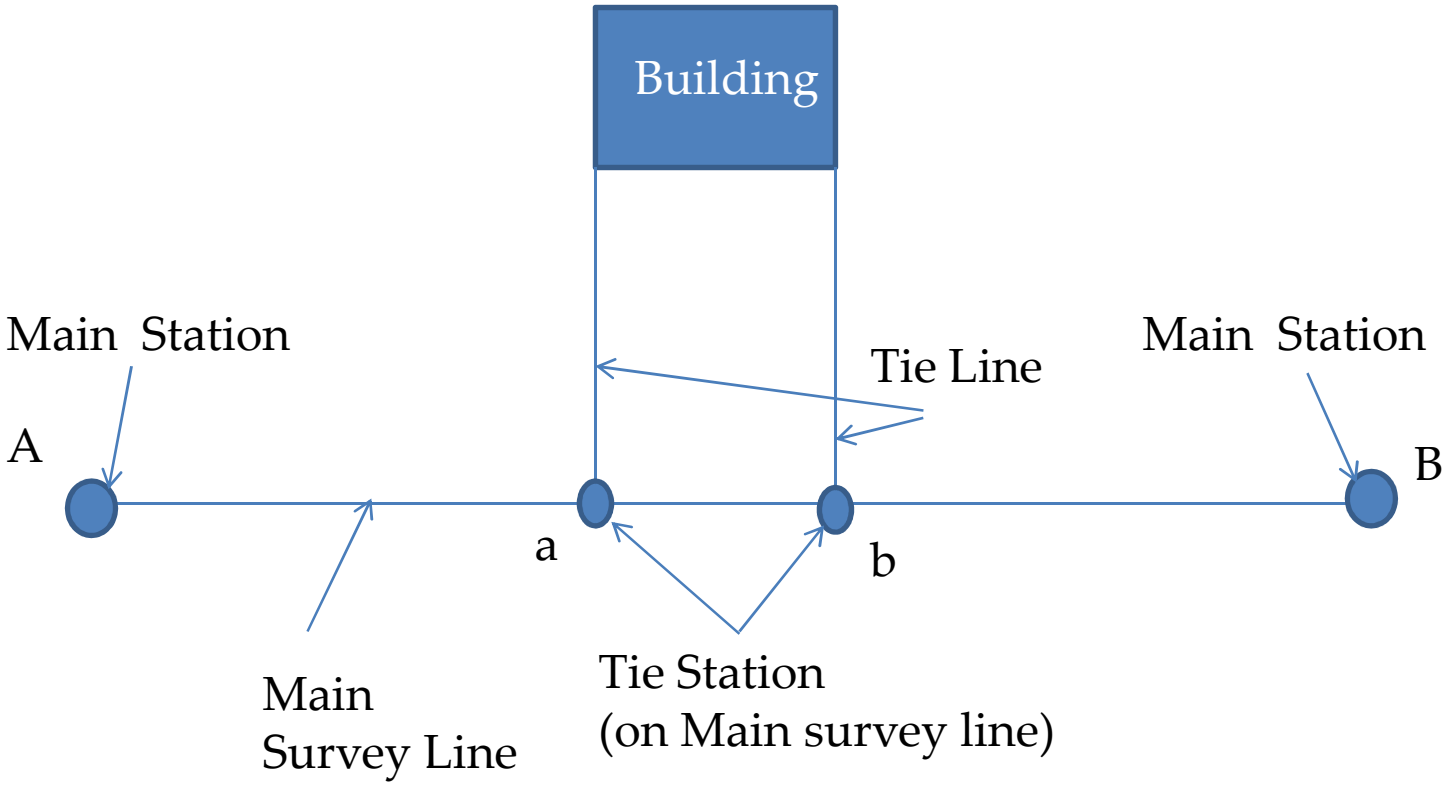
A, b, c, are the sides of the triangle.

Survey Station

- Survey Stations is a point of importance at the beginning and end of chain line.
- Two kinds

- **1. Main Station**
- These are the end of survey line i.e which connect boundaries.
- Line joining Main stations is called Main survey line or chain line.
- Represented by Circle, Capital letters A B.. or number 1 2.. Or (A)

- **2. Subsidiary or Tie Station**
- These are the points selected on main line, Where it is necessary to run axillary lines to locate interior details such corner, tree ,building etc.
- Line joining tie station are called tie lines or subsidiary lines
- Represented by Small letters a, b

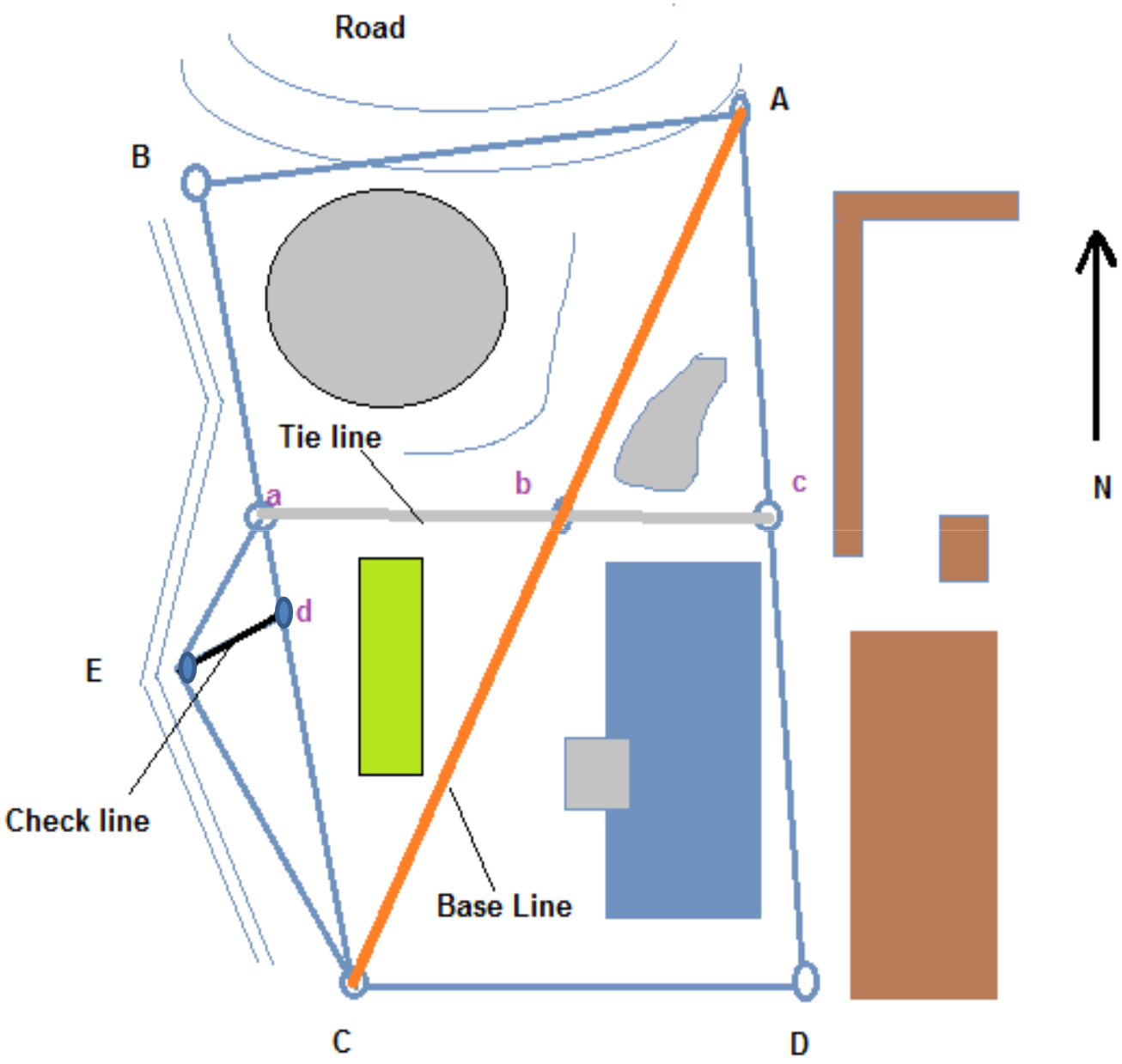

Building
Main Station
A
Tie Line
Main Station
B
a
b
Main
Survey Line
Tie Station
(on Main survey line)

Selection Of Survey Station

The following points should be kept in mind while selecting a station:

- Should be mutually visible.
- Main principle should b strictly observed
- If possible, line through the whole length of area should b drawn
- All triangles well defined
- A check line should provided each triangle
- Survey lines should be as few.
- A number of tie lines should be drawn
- Position of survey lines should be such that to avoid obstacles to chaining and ranging
- It should be on level ground
- The sides of triangle should pass as close to the boundary as possible.

- Base line
- Check line
- Tie line



Base Line

- The longest of the chain lines used in making a survey is generally regarded as Base line.
- Most important line.
- It fixes up direction of all other lines, as on base line, is built framework of a survey.
- Should be laid on level ground , as possible through the center and length of the area.
- Should be correctly measured and should be measured twice or thrice.
-

Check Line

- A check line also called proof line, is a line joining the apex of a triangle to some fixed point on the opposite side.
- A check line is measured to check the accuracy of the framework.

- Thus there is a complete check on the field measurement as well as on the accuracy of the plotting work.

Tie Line

- A tie line is a line joining fixed points termed as Tie station on the main survey lines.

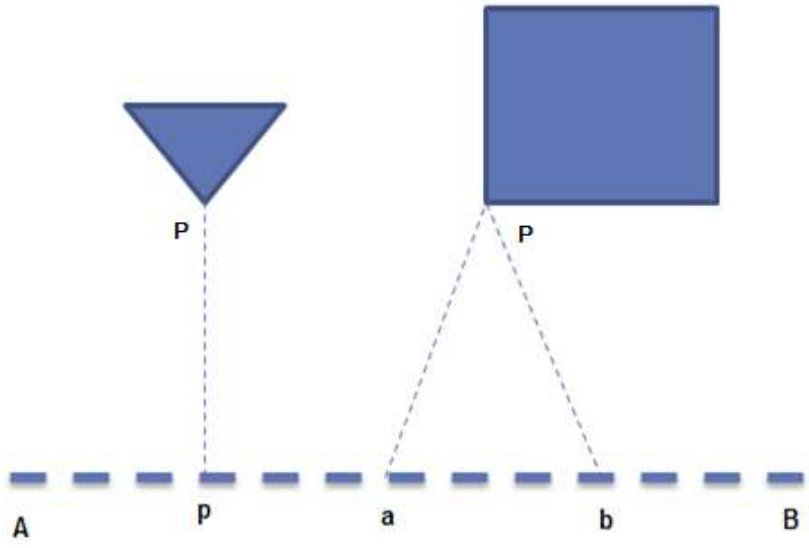
- A tie line usually fulfill a dual purpose i.e it checks the accuracy of the framework and enables the surveyor to locate the interior details which are far away from the main chain line

Offsets

- The Lateral Distance to locate the object / detail to left or right of the Main survey line is known as Offset.
- To Locate Position of details such as boundary, building tree, river etc.
- **There are Two kinds of Offsets**

1. Perpendicular / Right angled Offset

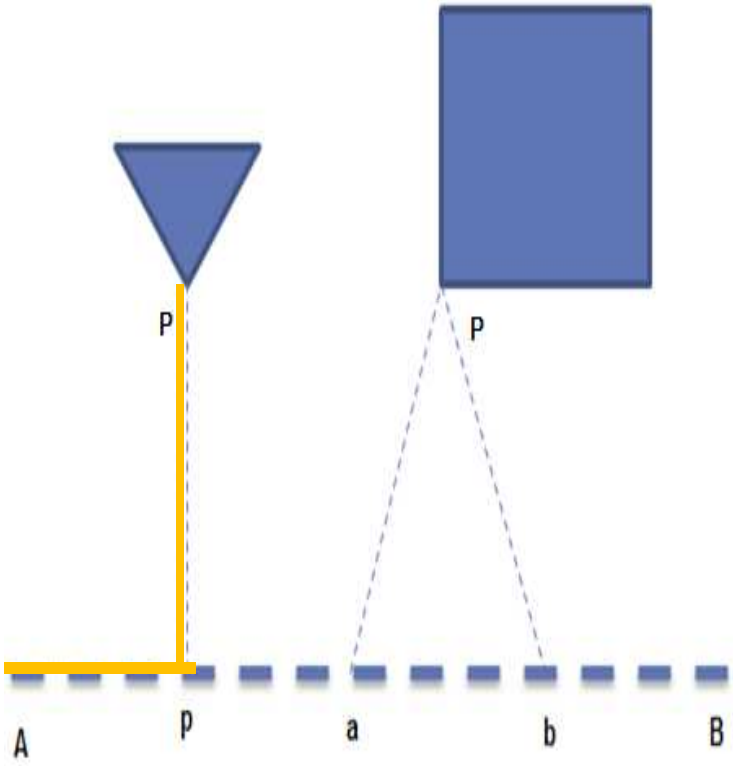
2. Oblique Offset/ Tie-line Offset



Taking Offset

- For every offset we need two measurement
- 1. Distance along the chain line is called Chainage (Ap)
- 2. The length of Offset (pP).

- The follower will hold the zero end and will swing it along the chain line until he got the least reading which will be the foot of perpendicular offset

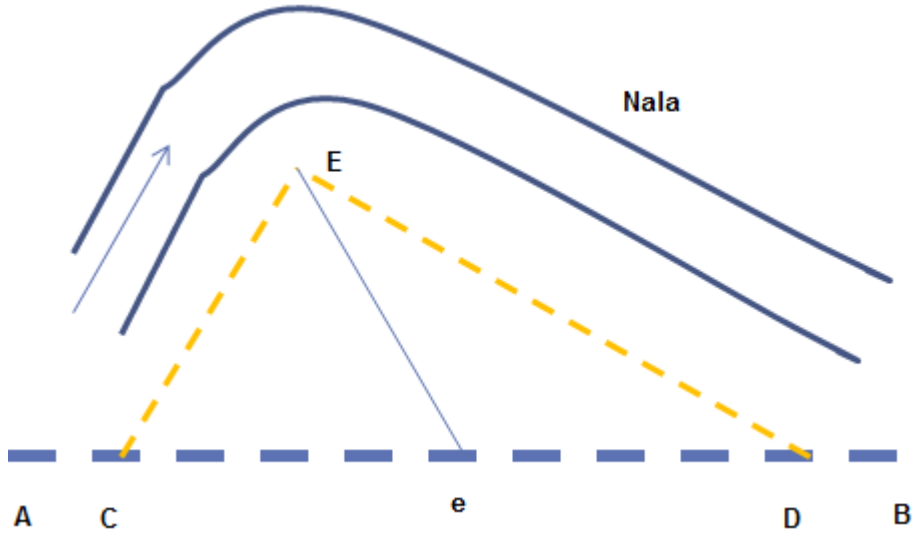


Short offset

- The offset are called short when they are less than 15m in length and long when their length exceeds 15m.
- When offsets are short the perpendicular direction is judged by eye only or by
- Offset should be as short as possible because they are less liable to error du to incorrect length of tape or incorrect direction.
- Short offset can be measured quickly and accurate.

Long Offset

- Where much accuracy is desired the long offset should be as far as possible be avoided.
- They can be avoided by arranging the main survey line or by running subsidiary lines from the main lines.
- Example Nala.



- CE and DE are subsidiary lines
- eE is check line

How to take Offsets to different objects

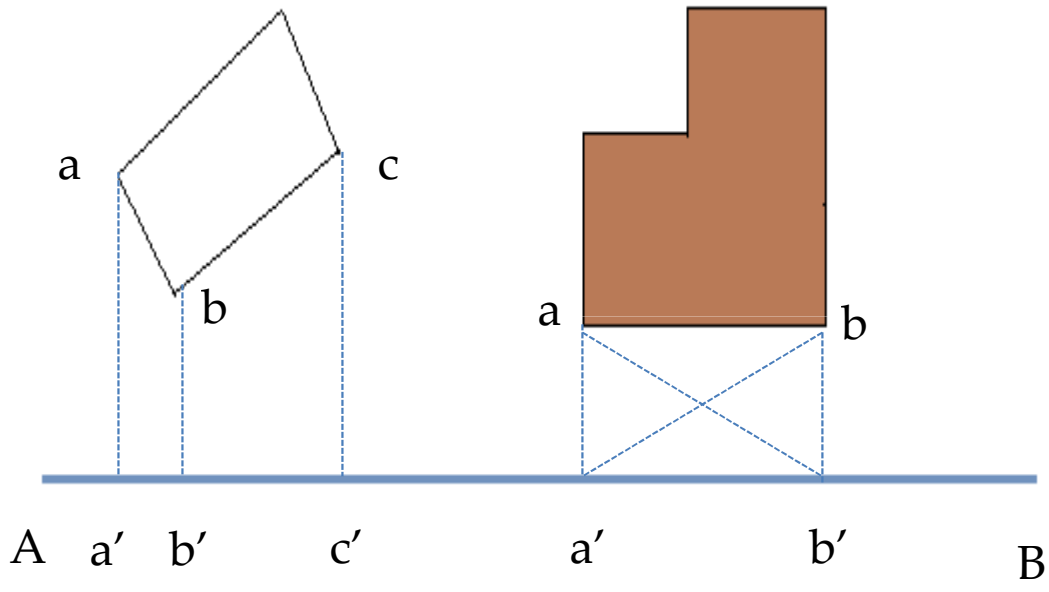
1. Round object
2. If the boundary is straight
3. When object changing direction
4. For irregular boundary
5. If boundary is fair curve
6. When the object such as road crossing the survey line
7. To locate a gate
8. Locating positions of corners and intersections.
9. Locating of building

Assignment.

Locating Building

- **A**. In locating buildings offset are taken to the corners only and in addition, the dimension of the building are also measured and recorded.
- **B**. another method when building near to chain line

  (aa' bb', a'b, b'a ar measured)

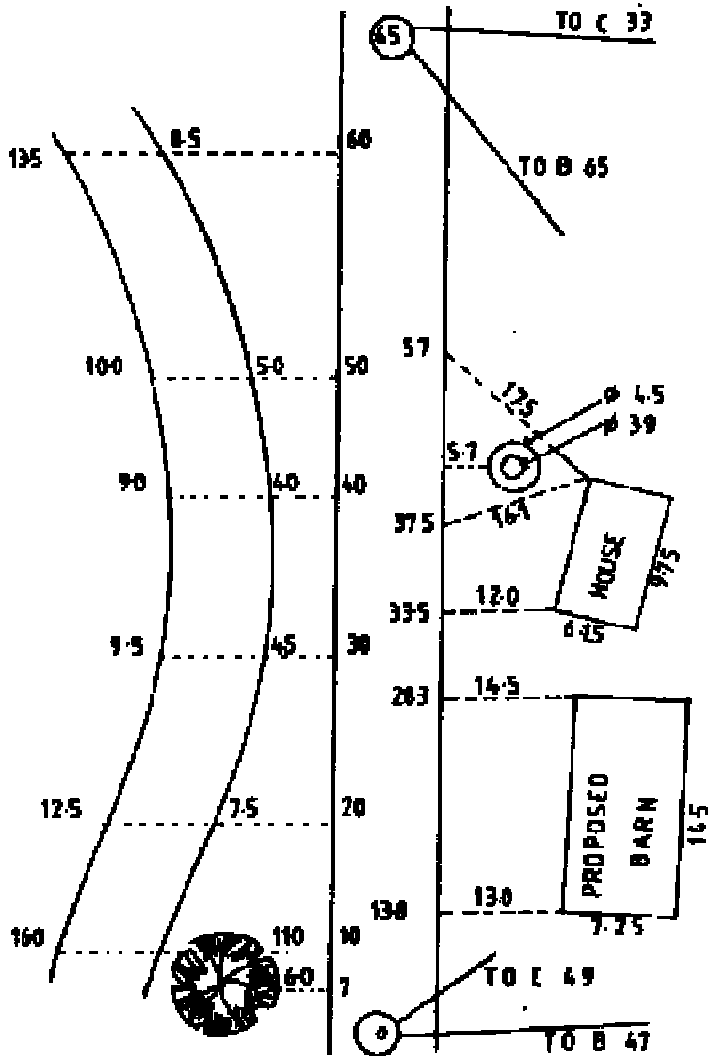


A B

Booking Field Notes

- The book in which survey work is recorded by measurement and sketches is called Field book.
- Oblong book of convenient size.
- There are two forms of field book

1)single line and 2) double line



Field Work

Equipment

The equipment required for a chain survey should include:

- A chain and 10 arrows
- 20 m metallic tape
- Ranging rods
- Offset rods
- Optical square or cross staff or box sextant
- Plumb bob
- Survey field book
- Pegs
- Pencils
- Hammer nail, chalk etc

Field Work

- **A Chain survey may be executed in the following steps:**

1. Reconnaissance

Walk the whole area and thoroughly examine the ground, note position of boundaries ,road ,river etc, various difficulties to chain lines, select stations, prepare a neat sketches called index sketches or key plan.

2. Marking stations

With ranging rod , or wooden peg. Driving a nail or spikes if hard surface, embedding stone with a cross mark.

3. Reference sketches

After marking station they should be referenced i.e located by measurement called ties taken from 3 permanent point which are easily identified such corner of building

4. Running survey line

After the preliminary work chaining start from base line and carried throughout all the line of the framework continuously . Chaining and locating nearby detail. So chain is laid and kept lying , offset are taken .

Instruments For Setting-Out Right Angles

- The following instruments may be used for

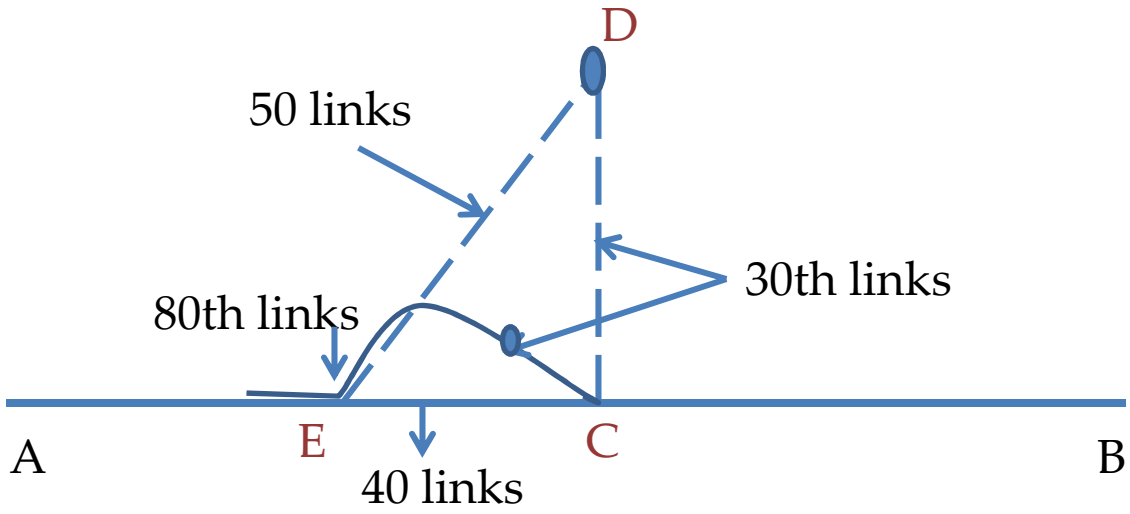
- 1. Finding the foot of perpendicular from a given point to a line
- 2. Setting out a right angle at a given point on a line.

- Cross Staff

  The open 2) The French 3) The adjustable
- Optical square
- With chain or tape

Right Angle with Chain Or Tape

- 3 4 5 method



Obstacles In Chaining

- Various obstacles or obstructions such as wood , hills, ponds rivers etc continually met with the chaining.
- It is however necessary that chaining should be continued in a straight line.

- The various obstacles may be classed as:

- **A. Chaining Free, Vision Obstructed.**
- **B. Chaining Obstructed, Vision Free.**
- **C. Both Chaining and Vision Obstructed**.

A. Chaining Free, Vision Obstructed

- **Two further cases**
- **Case1** . Both ends are visible from intermediate point on the line
- (Reciprocal ranging/Indirect ranging).

- **Case2** . Both ends are not visible from some intermediate point.

Case 1: Indirect Ranging / Reciprocal Ranging

- **PROCEDURE:**

  » Fix the two ranging rods at the given stations A and B which are not intervisible due to raising ground.

  » Select two intermediate points M1 and N1 such that from each point both A and B are visible.

  » The person at M1 directs the person at N1 to move new position N2 in line with M1B.

  » The person at N2 then directs the person at M1 to move to a new position M2 in line with N2A.

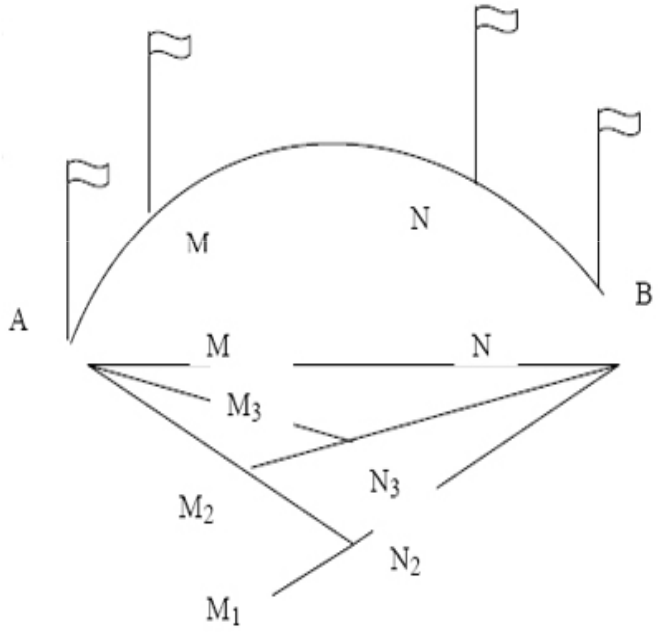
  » The person at M2 directs the person at N2 to a new position N3 in line with M2B.

  » The person at N3 directs the person at M2 to a new position M3 in line with N3A.

  » The process is repeated till the points M and N are located in such a way that M finds the person at N in l with AB and the person at N finds the person at M in l with AB.

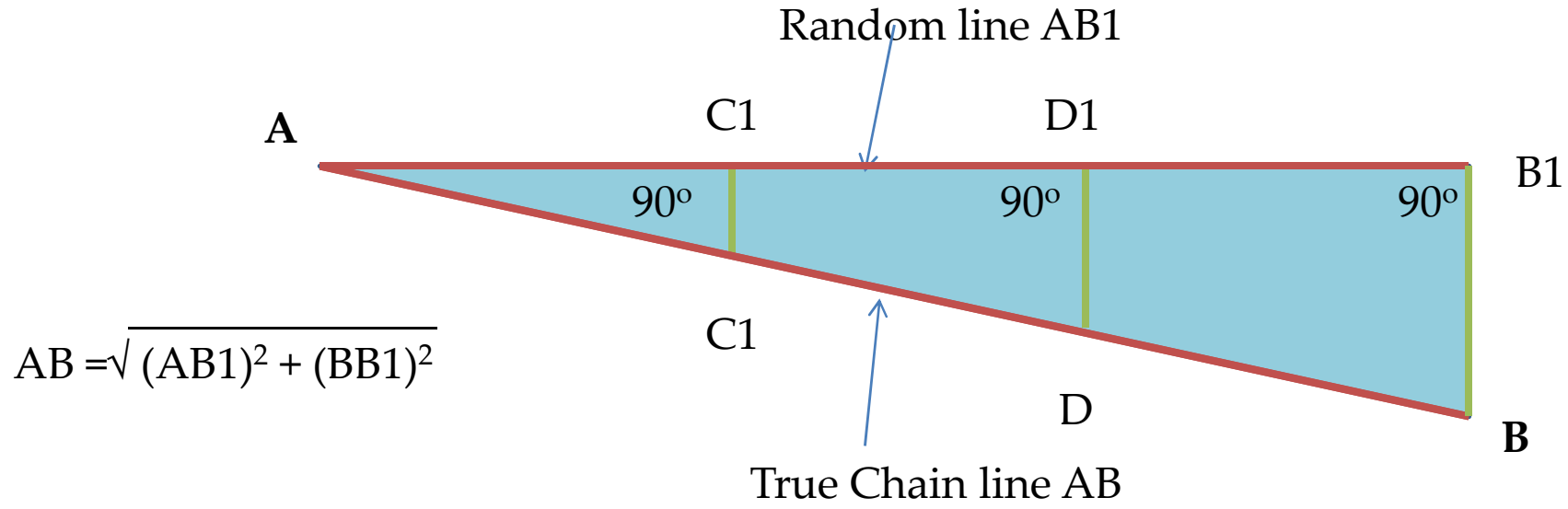
  » After fixing the points M and N, other points are also fixed by direct ranging and the length of the line is measured.

  Result: **Distance of AB = distance AM + distance MN + distance NB**



Case2: Both Ends are not visible from some Intermediate pint

- This occurs when it is desired to run a line across a wooded field, trees or underbrush preventing the fixing of intermediate point.
- Random line method is suitable.



$$AB = \sqrt{(AB1)^2 + (BB1)^2}$$

B. Chaining Obstructed, Vision Free

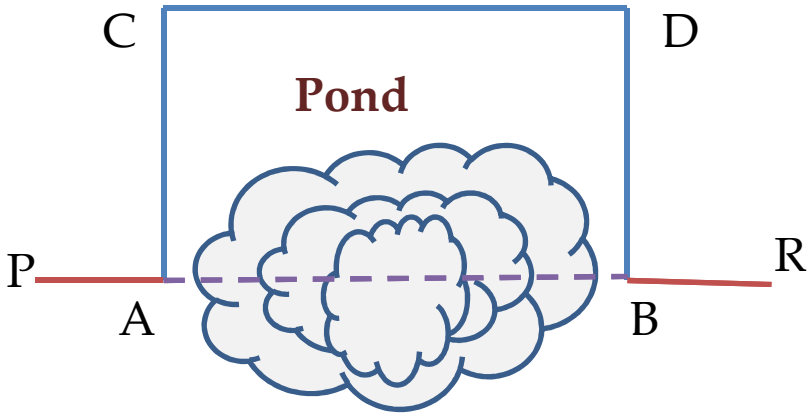
- For example pond, plantation, river etc.

- **Two further cases**
- **Case1** . When it is possible to chain round the obstacle e.g pond.

- **Case2** . When it is not possible to chain round the obstacle e.g River.

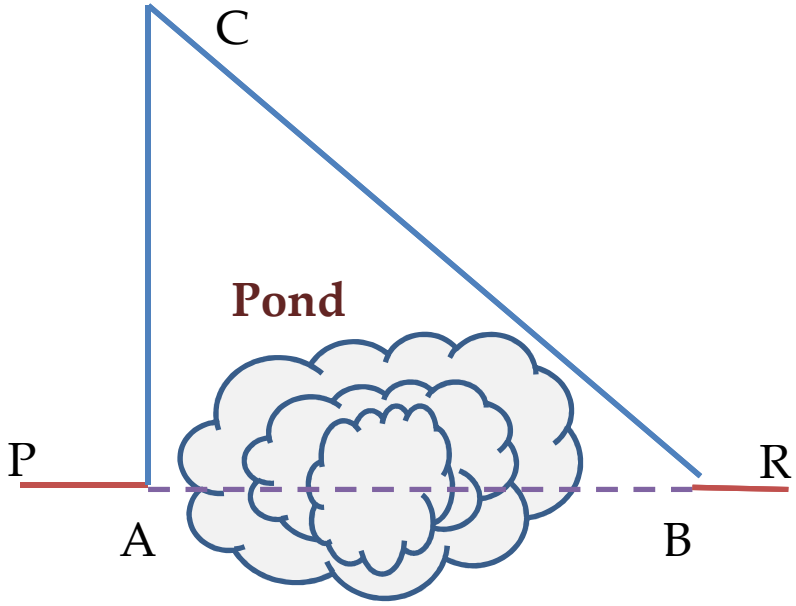
Case1 . When it is possible to chain round the obstacle

- Several methods available.



AB = CD

Method 1



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

Method 2

- Method 3
- Select two points A and B on line PR on each side of the obstacle. Set out a line CAD such that CB and DB clear obstacle. Measured distance AC, CB, and DB.
- Then apply cosine formula to calculate the width AB for BCD
- In Δ BCD

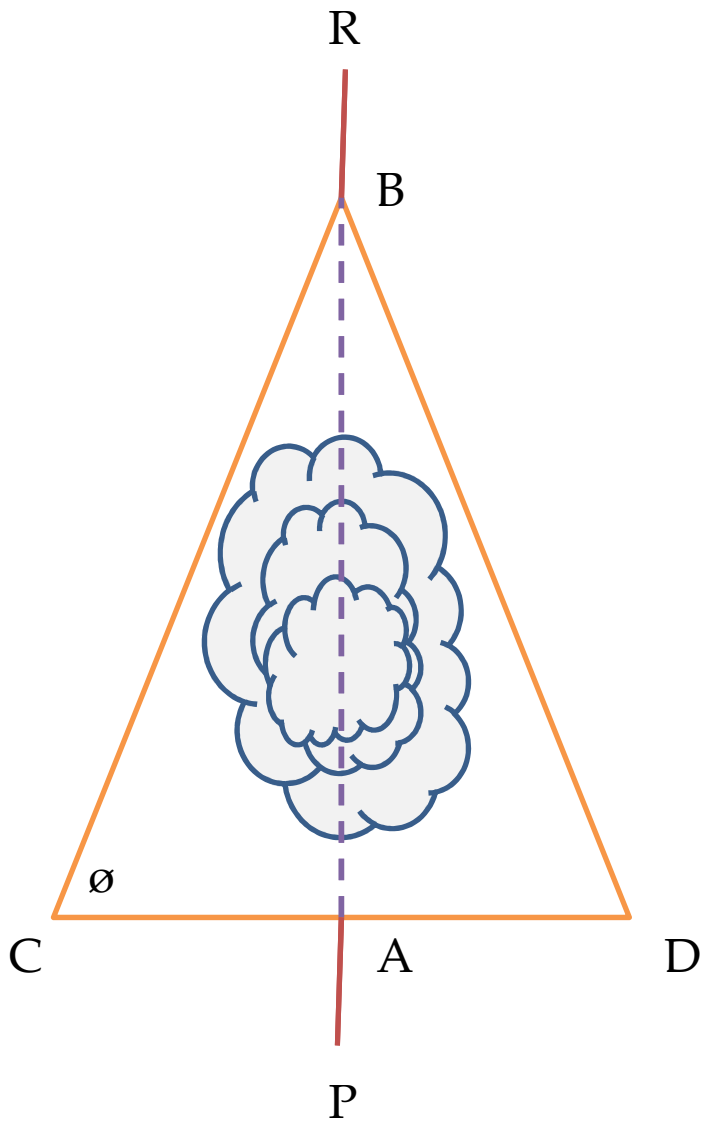
- In Δ BCA

$$BD^2 = CB^2 + CD^2 - 2 \times CB \times CD \times \cos(\text{ø}) \ldots (1)$$

- **Equating the values of Cos(ø)**

$$AB^2 = CB^2 + CA^2 - 2 \times CB \times CA \times \cos(\text{ø}) \ldots (2)$$

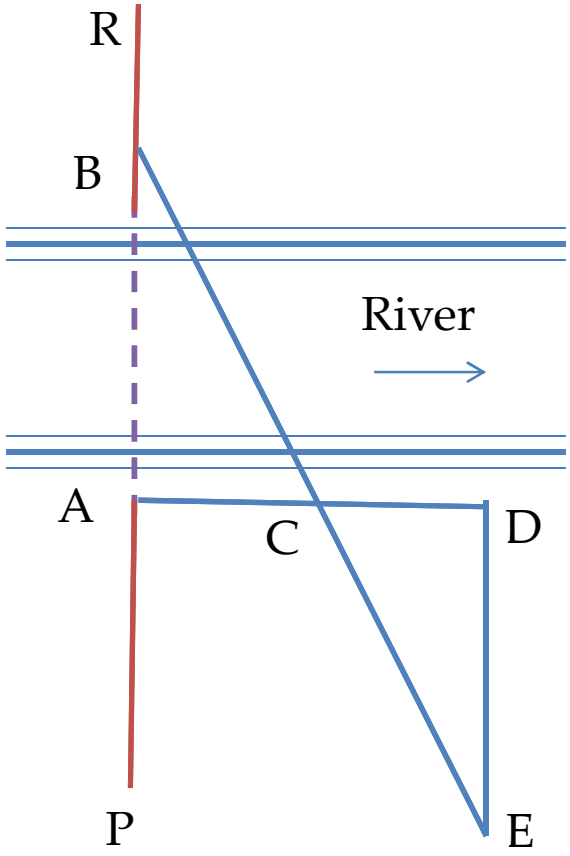
$$AB = \sqrt{\frac{CB^2 \times AD + DB^2 \times AC}{CD} - AC \times AD}$$



Case2 . When it is Not possible to chain round the obstacle

- Typically for rivers.

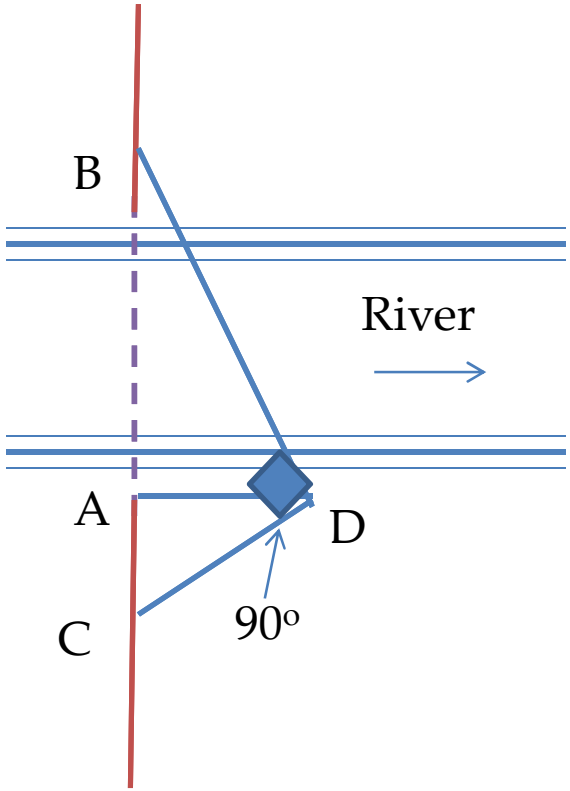
- **Method 1**
- Select two points on chain line PR, A and B. Set out perpendicular AD. Bisect it at C. At D draw perpendicular DE such that point E becomes inline with C and B.
- Measure DE.
- ΔABC and ΔCED are similar.
- So **AB=DE**



- Method 2
- Select two points. Setout ⊥ AD at A. erect ⊥ BD at D, cutting chain at C.
- Measure AD and AC.
- Δ ABD and Δ ACD are similar

$$\frac{AB}{AD} = \frac{AD}{AC}$$

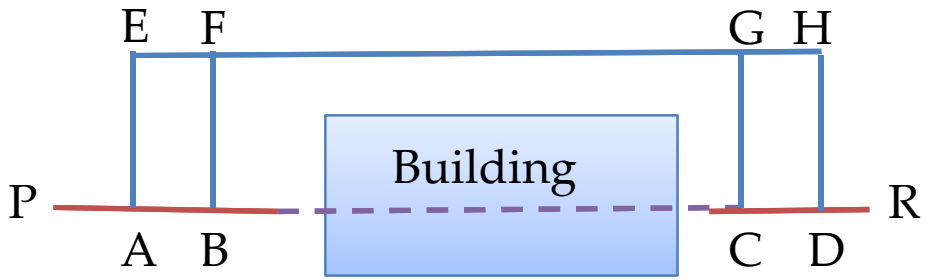
So $$AB = \frac{AD^2}{CA}$$



C. Both Chaining and Vision Obstructed

- Typical example is building.

- **Method 1**
- Select two points on chain line PR, A and B and erect ⊥ AE and BF of equal length. Prolong EF line pass the obstacle and select two G and H and erect ⊥ to chain line.

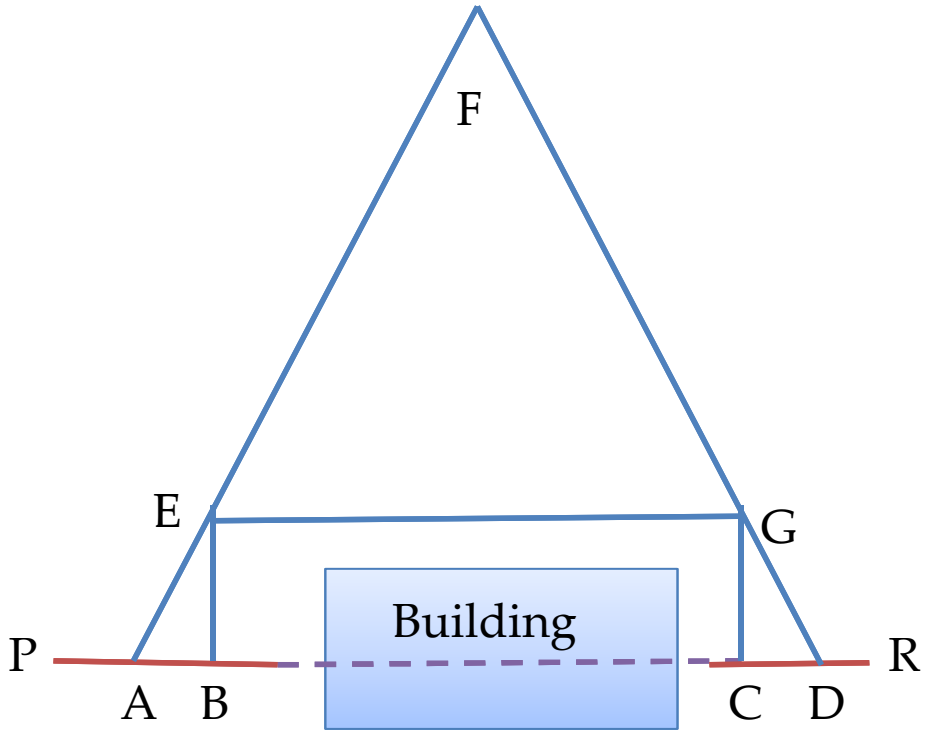


- **BC=FG**

- **Method 2**

- Select point B and erect ⊥ BE. Mark an other point A such that AB=BE.
- Join AE and produce it to F. Draw ⊥ on F making FA= FD. Mark a point G on FD such that FG=EF locate C, now measure EG.

- AB=EG



Example 1

- While chaining across a pond two points A and B were taken on opposite side of the pond. A line CB 270 m long was laid on left of AB and an other line BD was laid down on the right of line AB is 315 m, such that points C,A and D becomes inline with each other. CA and AD were then measured and found to be 156 m and 174 m respectively.
- Find the length AB
- **Solution**:

$$BD^2 = CB^2 + CD^2 - 2 \times CB \times CD \times \cos(\text{ø}) \ldots (1)$$

$$\cos(\text{ø}) = \frac{CB^2 + CD^2 - BD^2}{2 \times CB \times CD}$$

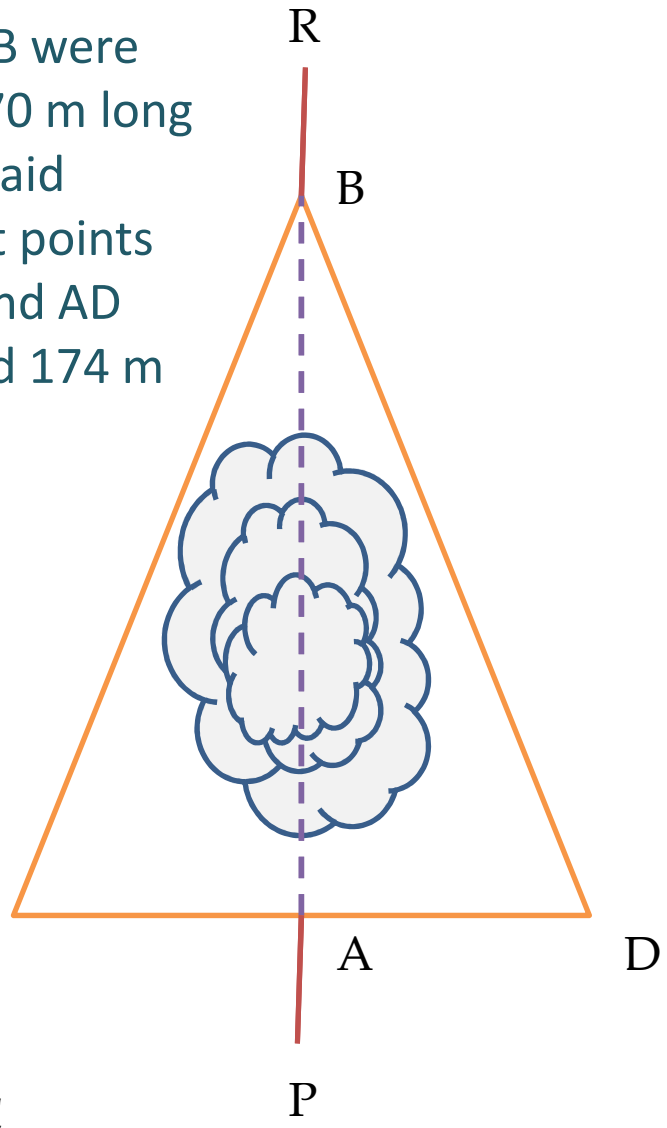
$$\text{Ø} = 62^o\ 23`$$

$$AB^2 = CB^2 + CA^2 - 2 \times CB \times CA \times \cos(\text{ø})$$

$$AB = 244.2 \text{ m}$$

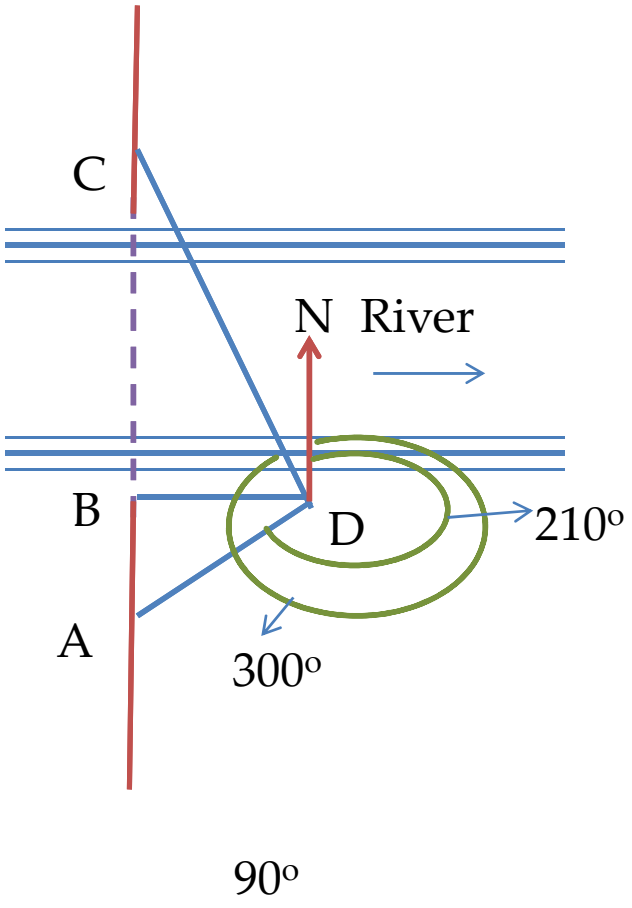
OR

$$AB = \sqrt{\frac{CB^2 \times AD + DB^2 \times AC}{CD} - AC \times AD} = 244.2\text{m}$$



Example 2

- A chain line ABC crosses a river, B and C on near and distant banks respectively. The respective bearings of C and A from D , a point 45m measured at right angle to AB from B are 300° and 210°. AB being 45m.
- Chainage of B is 1000 m. Find chainage of C.
- **Solution:**
- Bearing of DC=300°
- Bearing of DA= 210°
- ADC=bearing DC-bearing DA= 300° - 210°
- =90°
- Δ BCD and Δ ABD are similar



$$\frac{BC}{BD} = \frac{BD}{AB}$$

$$BC = \frac{BD^2}{AB} = (45)2 / 24 = 84.38 \text{ m}$$

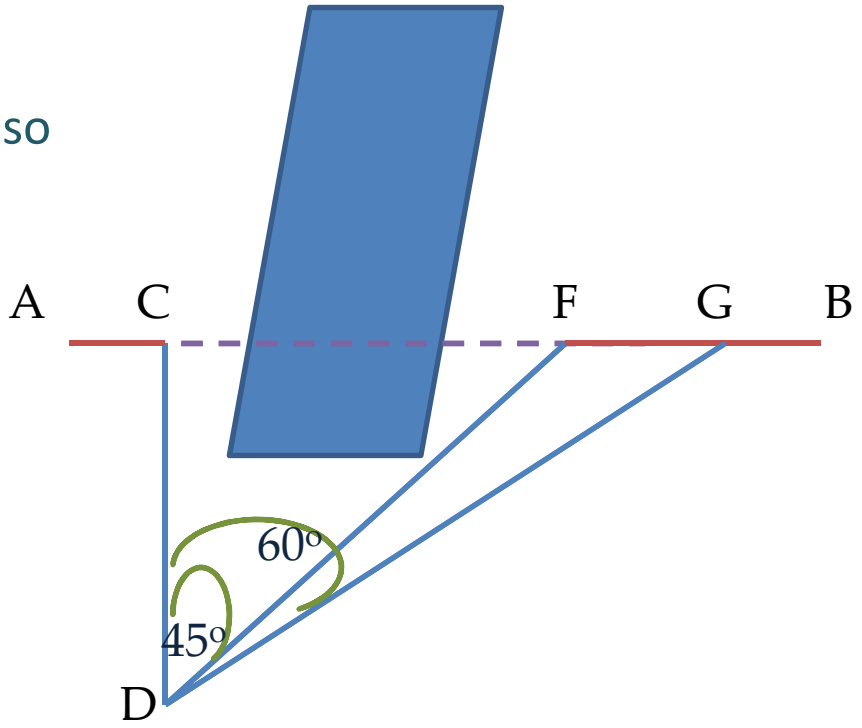
Chainage of B = 1000 m

Chainage of C = 1000 + BC = 1000 + 84.38

= 1084.38 m

Example 3

- A survey line AC intersect a building. To prolong the line behind the building per CD 120m long drawn at C. From D two lines DF and DG are drawn at angle 45° and 60° respectively.
- Determine the length DF and DG and also obstructed length CF.
- **Solution:**



- DF = CD x Sec 60° = 240 m
- DG = CD x Sec 45° = 169.63 m

- CF = CD tan 45° = 120 m

Assignment No 2

A: How to take Offsets to different objects?

B: Field Work

C: Problem 18, 19, 20 21,22

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References

- Surveying & Leveling (part 1) by T P Kanetkar & S V Kulkarni (Part 1)