SUMMARY

1. Accessories used in Chain survey

(i) Chain (ii) Tape (iii) Ranging Rods (iv) offset rod (v) Cross staff (vi) Arrows (vii) Plumb bob (viii) pegs

2. Ranging is the operation of establishing intermediate points on a straight line between two end stations.

3. Types of Ranging

(i) Direct Ranging (ii) Indirect Ranging

4. Base line is the longest line of all the survey lines and which runs across the area.

5. Check line is used to check the accuracy of the frame work as well as plotting work.

6. Offset is a length measured from a point on a chain line to a detail.

7. Tie line is a line which joins two tie stations.

8. Types of Chains

(i) Metric chain (ii) Engineer's chain

(iii) Gunter chain (iv) Revenue chain

9. Obstacles in chain surveying

(i) Chaining free but vision obstructed

(ii) Chaining obstructed but vision free

(iii) Both chaining and vision obstructed

10. Methods of calculating Land area

(i) Average ordinate rule (ii) Simpson's rule (iii) Trapezoidal rule

Learning Objectives

After studying this unit, the student will be able to understand

- Chain surveying and purpose of the equipment
- Studying the metric chain and reading the length.
- Types of survey stations and survey lines and their purpose
- Conventional signs used in chain surveying and recording field notes in the field book.
- Various types of obstacles we need to overcome in the process of measuring distance between two points.
- Methods of calculating area of a given piece of land with irregular boundary.

Chain Surveying

2.0 Introduction

Chain surveying is the simplest and the most accurate kind of surveying. In this the area is divided into network of triangles since the triangle is the only figure which can be plotted without any angular measurements. Chain surveying is adopted in the following situations.

1) When the ground is flat and with simple details.

2) When the area to be surveyed is small.

3) When large scale mapping is desired.

2.1 Purpose and Principle of Chain Survey

Chain surveying has the following purposes.

1) To collect necessary data for exact description of the land.

2) To calculate the area of the plot

3) To prepare the plan of the site

4) To demarcate the boundaries of the land

5) For division of land into smaller units.

Principle of chain surveying:

The triangle is the simplest figure that can be plotted from the lengths of its sides. Based on this, the principle of the chain surveying is to divide the area into a network of well conditioned triangles. The error will be least in plotting a triangle is when no angle of the triangle is less than 30^0 and more than 120^o. Such triangles are called well conditioned triangles. Chain surveying is also called as chain triangulation.

2.2. Equipments Used in Chain Surveying and their Functions

The following equipments are used in chain surveying

1) Chain

2) Tape

3) Ranging rod

4) Offset rod

5) Cross staff

6) Arrows

7) Pegs

8) Plumb bob etc.

1. Chain: This is an instrument used for measuring distance. There are four types of chains.

i) Metric chain.

ii) Engineer's Chain.

iii) Gunter Chain.

iv) Revenue chain.

(i) Metric chain: In metric system the chains of 20m and 30m are commonly used. The chain is made with galvanized steel wire of 4mm diameter. Each meter is divided into 5 links of 20mm length. It is provided with brass handles on either ends. The tallies are fixed at every 5m length and small brass rings are provided at every meter length. The chain is shown in the fig 2.1.

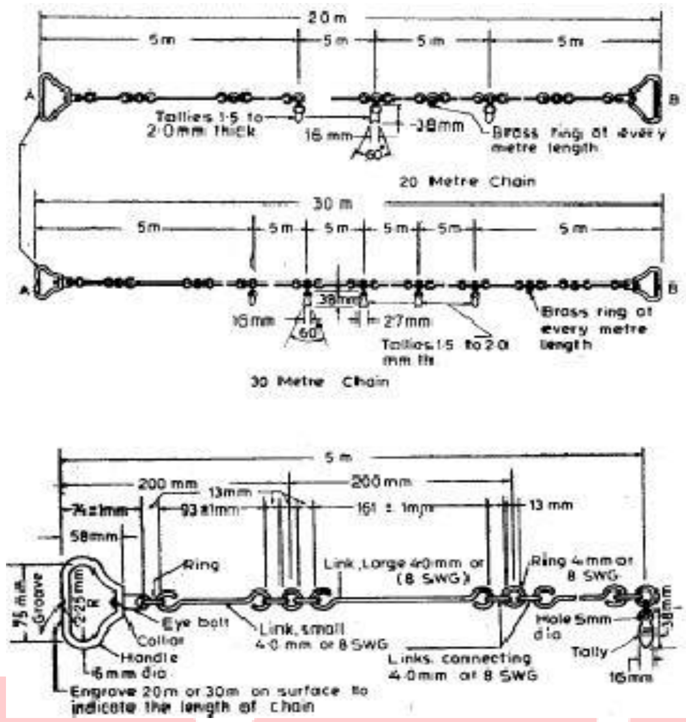

Fig. 2.1

(ii) Engineer's chain: The Engineer's chain is 100ft length and made of 100 links.

(iii) Gunter chain: It is 66 feet long and having 100 links. It is useful for measuring the distance in miles and areas in acres. 10 square Gunter chain = 1 acre = 4840 sq. yards.

(iv) Revenue chain: This chain is of 33ft length and is divided into 16 links.

2. Tape: The tapes are divided according to the materials used as following

(i)) Metallic tapes (ii) Steel tapes (iii) Invar tapes

(i) Metallic tapes: This tape is made with water proof linen with brass, copper wires to avoid stretching. The tapes available in lengths 2, 5, 10, 20 and 30m.

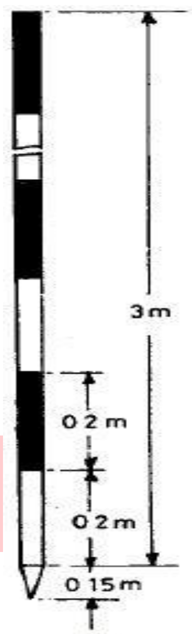

Fig. 2.2 Ranging rod

(ii) Steel tapes: This is most accurate tape for taking measurements. If carelessly handled it gets broken.

(iii) Invar tapes: If the measurements are to be made with highest precision this tape is used. These are 6mm wide and available in lengths of 30, 50 and 100m.

3. Ranging rods: Theses are wooden or metal poles 2m or 3m long and having a diameter of 30mm. They are provided with iron shoes at the lower ends to facilitate easy driving in the ground. They are painted in bands alternatively in black and white or red and white. Ranging rods used for ranging a line.

4. Offset rods: This is mainly used to measure offsets of shorter lengths. It is usually 2m long.

5. Cross staff: Cross staff is an instrument used for setting perpendicular offsets. These are three types.

i) Open cross staff

iii) Adjustable cross staff

iii) French cross staff

Fig. 2.3 Open Cross Staff

(i) Open cross staff: It consists of 4 metal arms at right angles to each other having eye vane at two adjacent ends and object vane at the other ends.

(ii) Adjustable cross staff: With this cross staff the object can be set at any angle.

(iii) French cross staff: This cross staff is an octagonal brass tube with slits on its eight faces. With this cross staff we can set the object at an angle of 45^0 also.

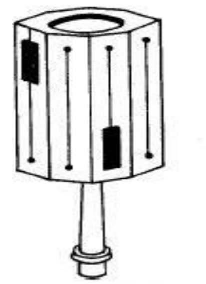

Fig. 2.4 French Cross Staff

Optical Square: This is an instrument used for setting out right angles to the chain lines and to find out the foot of the perpendicular on the chain line from an object. It works on the principle of reflection.

6. Arrows: These are used for marking the ends of a chain during the process of chaining. These are steel pins 400mm long and are pointed at one end.

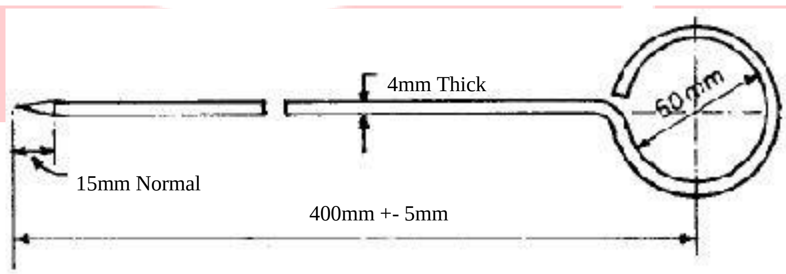

Fig. 2.5 Arrows

7. Pegs: These are made from hard timber and tapered at one end. The lengths varies from 120 to 600mm. these are driven into ground to mark the instrument stations.

8. Plumb bob: It is used to define the vertical line while measuring distance along slopes.

2.3 Coventional Signs

Conventional signs are symbols of objects represented on a map or in the field book.

Some of the common conventional signs used in chain surveying are given in fig.2.15.

Errors in Chaining

Errors will be introduced in chaining due to the following reasons.

a). Instrumental errors: these are due to defective conditions of instrument. E.g. a chain may be either too long or too short.

b). Natural errors: These are due to variations in the natural phenomena e.g. changes in length due to temperature.

2.5. Correction Due to Incorrect Length of the Chain or Tape

If a chain has been damaged and it may be too short or too long of the true length of the chian, and all the measurements taken will be too long or too short, conversely a contracted or stretched chain will give incorrect measurements of the true lengths.

The correct lengths of a measured distance is found from

$$\text{Correct Length} = \text{Measured Length} \times \frac{\text{Incorrect length of chain}}{\text{Correct length of chain}}$$

$$\text{Or Correct Length} = \text{Measured Length} \times \frac{L'}{L}$$

where L' = Incorrect length of chain or tape

L = Correct length of chain or tape

If an area has been calculated then,

$$\text{Correct area} = \text{Calculated area} \times \left[\frac{\text{Incorrect length of chain}}{\text{Correct length of chain}}\right]^2$$

If an volume has been calculated then,

$$\text{Correct volume} = \text{Calculated volume} \times \left[\frac{\text{Incorrect length of chain}}{\text{Correct length of chain}}\right]^3$$

Example 2.1: A 30m chain was found to be 10cm too long after chaining a distance of 1360m. Find the true distance.

Correct length of the chain = 30m

Incorrect length of the chain = 30 + 0.10 = 30.10

Measured distance = 1360m

$$\text{True distance} = \text{Measured distance} \times \frac{\text{Incorrect length of chain}}{\text{Correct length of chain}}$$

$$1360 \times \frac{30.10}{30.00} = 1364.53 \text{ m}$$

Example 2.2 : A road actually 1330 m long was found to be 1326 m when measured with a defective 30 m chain. How much correction does the chain need. ?

Solution :

$$\text{True length} = \text{Measured length} \times \frac{\text{Incorrect length of chain}}{\text{Correct length of chain}}$$

True length = Measured length x L'/ L

True length = 1330 m

Measured Length = 1326 m

Length of the chain = 30 m.

1330 = 1326 x L' / 30

$$L' = \frac{1330 \times 30}{1326} = 30.09 \text{ m}$$

The chain is 0.09 m (9cm) too long

Correction = -9 cm (Ans).

Example 2.3 : A 20 m chain was found to be 6 cm too long at the end of the days work after measuring 6000 m. If the chain was correct before the commencement of the work, find the correct length of the line.

Solution : The increase of 6 cm should be taken as gradually.

mean in correct length of the chain L' = 20+(20.06/2) = 20.03 m.

Correct length of the chain , L = 20m. Measured Distance = 6000 m

True distance = 6000 x 20.03 /20 = 6009 m(Ans).

Example : 2.4 : A 30 m chain was found to be 6 cm too long after chaining a distance of 4000 m. It was tested again at the end of day's work and found to be 8 cm too long after changing a total distance of 7800 m. If the chain was correct before the commencement of the work, find the true distance.

Solution : Chain length before commencement of the work = 30 m

Chain length after measuring 4000 m = 30.06 m.

Mean incorrect length of the chain (L') = (30 + 30.06) / 2 = 30.03 m.

True distance = Measured distance x L'/ L

True distance = 4000 x (30.03)/30 = 4004 m .... (i)

Remaining distance measured after measuring 4000 m

= 7800 - 4000 = 3800 m

The distance of 3800 m was measured with the chain which was 6 cm too long in the begining and 8 cm too long at the end of the chaining.

L' = (30.06 + 30.08)/2 = 30.07 m

True distance = 3800 x (30.07) / 30 = 3808.9 m .... (ii)

Total True distance = (i) + (ii)

= 4004 + 3808.9 = 7812.9 m (Ans)

Example : 2.5 : Ametalic tape originally 20 m is now found to be 20.2 m long. A house 40 m x 30 m is to be laid out. What measurement must be made using this tape ? What should the diagonal read ?

Solution : True distance = distance to be measured x L' / L

L ' = 20.2 m

L = 20 m

40 = Length to be measured x (20.2 / 20)

Length to be measured = 40 x (20/20.2) = 39.6 m

Similarly, breadth to be measured = 30 x (20 / 20.2) = 29.7 m

Hence measurements to be made with 20.2 m tape instead of 20 m tape are 39.6 m x 29.7m (Ans).

Diagonal measurement $= \sqrt{(39.6)^2 + (29.7)^2}$

$= \sqrt{1568.16 + 882.09}$

$= \sqrt{2450.25}$ = 49.50 m (Ans).

Example 2.6 : A field was surveyed by a chain and the area was found to be 228.30 sq.m. If the chain used in the measurement was 0.6 percent too long. What is the correct area of the field ?

Solution : True area = Measured Area x $(L'/L)^2$

Measured area = 228.30 sq.m

L' = 100 + 0.6 = 100.6 units.

L = 100 units.

True area = 228.30 x $(100.6/100)^2$

= 231.05 Sq.m (Ans).

Types of Survey Lines

These are the lines joining the main survey stations following are the types of survey lines.

i) Base line

ii) Tie line

iii) Check line

2.6.1 Base Line : A line which is generally longest of all the survey lines and upon which the entire frame work is built up is known as a base line. It generally runs in the centre of the area to be surveyed and should laid off on the level ground.

2.6.2. Tie Line : A line joining two Tie stations is known as a Tie line. It is run to take the interior details which are far away from the main lines and also to avoid long offsets.

2.6.3. Check Line : A line which is used to check or prove the accuracy of the frame work as well as the plotting work is known as the check line. It is a line which runs from apex of a triangle to any other fixed points on any two sides of a triangle.

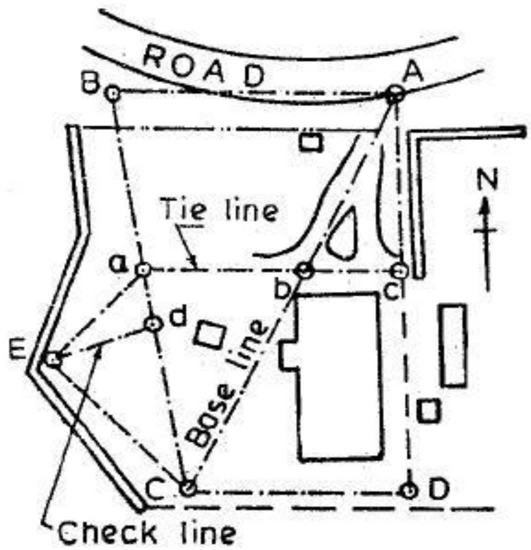

Fig. 2.6

2.7. Types of Survey Stations

The beginning and end of a chain line is called survey station. There are two types of survey stations.

a) Main survey station b) Tie station or Subsidiary station.

a) Main survey station: These are important points at the beginning and at the end of the chain lines.

b) Tie station: These are points selected on the main surveylines for locating the interior details.

2.8 Fixing of Survey Stations

The following points should be kept in mind while fixing a survey station

1) Main stations should be located on plane ground and should be mutually visible.

2) The fundamental principle of surveying i.e. working from whole to part should be observed. Along line should be laid across and other triangles should be built onit.

3) The network should consist only well conditioned triangles.

4) Long offsets should be avoided.

5) The number of survey lines is to be made minimum as far as possible.

6) Survey stations should not be fixed on thoroughfares.

2.9. Different Operations in Chain Surveying

2.9.1. Ranging : In measuring the length of a survey line, it is necessary that the chain should be laid on the ground in a straight line between the end stations. If the line is short, it is easy to put the chain in true alignment. But if the line is long, it is necessary to place intermediate ranging rods to maintain the direction. Fixing of intermediate points in a straight line between the two end stations is known as ranging.

Ranging is of two types: a) Direct ranging b) Indirect ranging.

(a) Direct Ranging

Direct ranging is adopted when the two end stations are mutually visible. The ranging is carried out by an eye or a line ranger.

Ranging by Eye

The ranging by eye is done by the following steps.

1) Fix ranging rods at each end of the line.

2) Stand about 1.5m beyond the first ranging rod.

3) Direct the assistant to hold the ranging rod vertically where the intermediate point to be fixed.

4) Direct the assistant to move left or right using code of signals until the three ranging rods are in straight line.

5) Check the verticality of the rods by sighting the lower ends of the rods.

6) As and when the intermediate point is in straight line, signal the assistant to fix the ranging rod.

The following code of signals may be used in directing the assistant into line.

Rapid sweep with right hand – move rapidly to the right.

Rapid sweep with left hand – move rapidly to the left.

Slow sweep with right hand – move slowly to the right.

Slow sweep with left hand – move slowly to the left.

Right arm extended – move continuously to right.

Left arm extended – move continuously to left.

Right arm up and moved to the right – plumb the rod to the right.

left arm up and moved to the left – plumb the rod to the left.

Both hands up and brought down – correct.

Both arms extended forward

horizontally and the hands depressed – fix the ranging rod in position.
briskly.

Ranging by Line Ranger

Line ranger is an optical instrument used for fixing intermediate points on a chain line. It consists of two right angled isosceles triangular prisms placed one above the other.

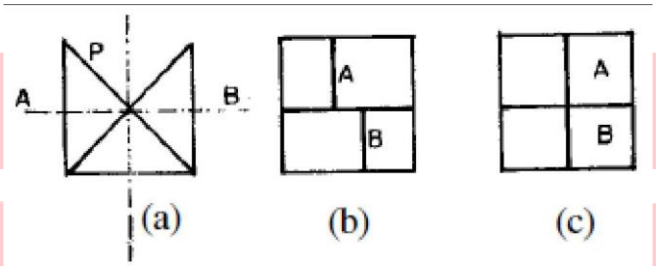

Fig. 2.7

For fixing an intermediate station P on the line AB, the observer stands as near P as possible and holds the instrument at his eye level. Rays of light coming from the ranging rods at Aand B are reflected by the upper and lower prisms respectively and reach the eye. If the images of Aand B are in separate lines as shown in fig (b), the observer moves a little perpendicular to AB such that both images will be in the same line as in fig(c).

The required position of P will be then exactly below the center of the instrument. One of two prisms can be adjusted by a screw. To test the instrument it is held at the mid point of a line and the ranging rods at the end station observed. If both rods appear in the same line, the instrument is in adjustment. Otherwise, the fixing screw of the movable prism is slackened and the prism slightly rotated so that both ranging rods appear in one line. Then the prism is fixed by tightening the fixingscrew.

(b) Indirect Ranging

Indirect ranging is adopted when the ends of the line are not mutually visible due to high intervening ground or the distance is too long. The process is also known as reciprocal ranging.

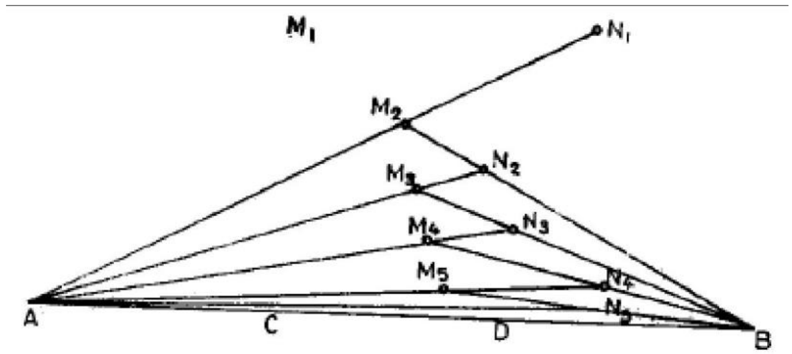

Fig. 2.8

Let A and B are the ends of a chain line which has a rising ground intervening between them. Two chainmen with ranging rods take the position M_1 and N_1 such that they are as nearly is line with A and B as they could judge and such that the chainman at M_1 could see N_1 and B and chainman at N_1 can see M_1 and A. First chainmen at N_1 direct M_1 to M_2 so that he comes in line with A and N_1. Then the chainman at M_2 directs N_1 to N_2 such that he comes in line with B and M_1. This process is repeated so that they align each other successively directing each other until they are in the line AB.

2.9.2. Chaining a Survey Line

To chain a survey line the follower holds the chain in contact with the peg at the beginning of the line and then leader moves forward in line with the ranging rod fixed at the end of the chain line. The follower gives necessary directions in this regard so that leader moves in correct alignment. The leader takes ten arrows in one hand and the handle in the other hand along with a ranging rod. At the end of the chain the leader holds the ranging rod vertically in contact and the instructions are given by the follower to move left or right using the code of signals. The leader then holds the handle in both the hands keeping him self in a straight line and straightens the chain by jerking it and stretches over the mark. He then fixes an arrow at the end of the chain. The leader then moves forward with the remaining nine arrows in hand. The follower holding the rear handle of the chain comes up to the arrow fixed by the leader and calls chain so that the leader stops moving forward. The process is repeated till all the arrows are fixed by the leader. The follower who collected all these arrows hands over to leader. The number of arrows in the hand of the follower shows number of chain lengths measured. In this way the whole length of a survey line is measured.

2.9.3. Setting out Right Angles

The easiest way of setting out a right angle to the chain line is by the 3, 4, 5 rule. Triangles with sides in proportion 3:4:5 will be right angled.

1) Let PQ is chain line and B is a point on chain line at which a perpendicular is to be erected.

2) By measuring 9m from B the point A is located.

3) Keeping zero end of the tape at A and 12m at B.

4) Stretch the tape laterally and put an arrow at 15m mark i.e. at point C.

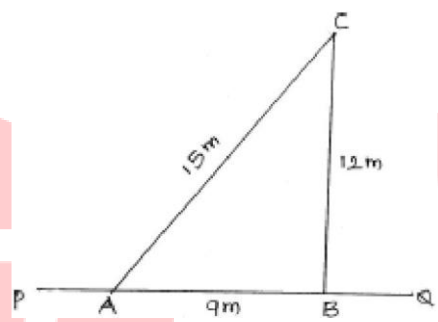

Fig. 2.9

5) Now CB will be perpendicular to the chain line PQ.

The instruments commonly used for setting out right angles are

1) Cross staff 2) Optical square.

2.9.4 Chaining Along a sloped Ground

Since the distances required for plotting purposes are horizontal distances however, as a matter of convenience, they are sometimes made on sloping ground, but they are afterwards reduced to their horizontal equivalents. There are two methods of determining horizontal distances when chaining on sloping ground .(1) Direct method and (2) Indirect method.

Direct method: By stepping; in the stepping method, horizontal distances are directly measured on the ground by the process of stepping which consists in measuring the line in short horizontal lengths, for this purpose, the chain is stretched horizontally with one end resting on the ground at a convenient height less than 1.8m and the point vertically below this end is then accurately found on the ground by suspending a plumb bob and then marked. The next step is then commenced from this point and the process is continued in correct alignment until the end of the line is reached.

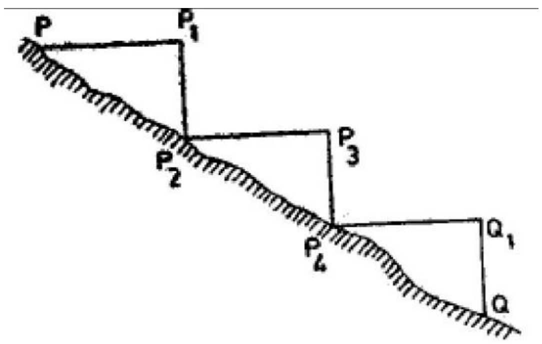

Fig. 2.10

The total horizontal distance $PQ = PP_1 + P_2P_3 + P_4Q_1$

Indirect Method: First Method : This method of stepping is not a very accurate method. The best way is to determine the land slope from the horizontal by using a Clinometer.

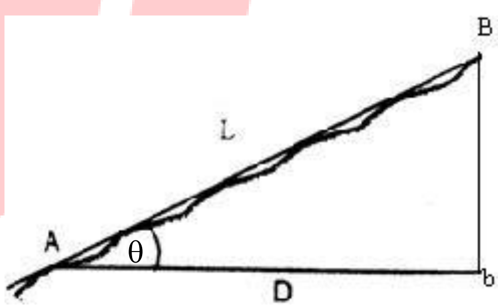

Fig. 2.11

Knowing the sloping distance say L and angle of slope say θ the horizontal distance $D = L \cos\theta$.

Second Method : The distance along with the slope is measured with chain and the difference in the elevation between the first and the end stations is found with the help of a levelling instrument (Fig. 2.12) knowing the sloping distance l and the difference in the elevation h, the horizontal distance can be found from the relation, $D = \sqrt{l^2 - h^2}$

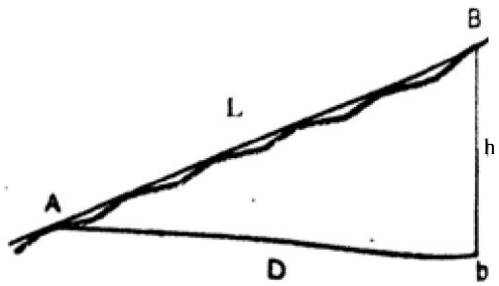

Fig. 2.12

Hypotenusal Allowance Method : Another method is to measure the distance along the slope and apply a correction to get the horizontal distance. Let θ be the angle of the slope. Let AC be the distance measured along the slope and AC_1 horizontal distance, 1chain or 100 links.

AC =100 Secθ links. Therefore
Correction BC = AC -AB = 100(sec θ -1) links per 100 link chain.

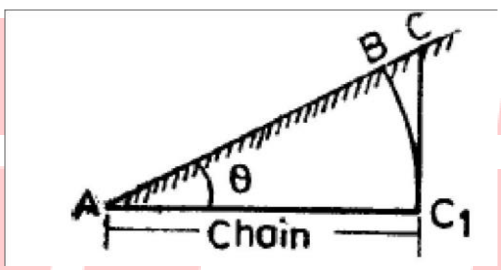

Fig. 2.13

This correction is known as the hypotenusal allowance. The leader must place the arrow ahead of his end of the chain on slopping ground by this amount so that the horizontal distance would be 1 chain.

Example 2.7 : The distance between two points A and B measured along a slope is 504 m. Find the horizontal distance between A and B when (a) the angle of slope is 12^o, (b) the slope is 1 in 4.5, and (c) the difference in elevation of A and B is 65m.

Solution : Let l = the distance measured along the slope between A and B.

D = the horizontal distance between A and B.

θ = the angle of slope.(a) l = 504 m, $\theta = 12^o$

then $D = l \cos\theta = 504 \cos 12^o = 504 \times 0.9781$

$= 492.96$ m (Ans.).

(b) The slope being 1 in 4.5 (i.e. 1 vertical to 4.5 horizontal)

$\tan\theta = 1/4.5 = 0.222 \therefore \theta = 12^o 32'$

Hence $D = l \cos\theta = 504 \times \cos 12^o 32'$

$= 504 \times 0.9762 = 492$ m (Ans).

(c) l = 504, h = 65.

$D = \sqrt{l^2 - h^2} = \sqrt{(504)^2 - (65)^2} = 499.80$m (Ans).

Example 2.8 : Find the hypotenusal allowance per chain of 20 m length, the angle of slope of the ground is 10^o.

Solution : Hypotenusal allowance = $100 (\sec\theta - 1)$

$= 100 (\sec 10^o - 1) = 1.54$ links

$= 0.31$ m. (Ans).

Principles Used in Chain Triangulation

The principle of the chain triangulation is to divide the area into a network of well conditioned triangles. The error will be least when plotting a triangle when no angle of the triangle is less than 300 and more than 1200.Such triangles are called well conditioned triangles. Chain surveying is also called as chain triangulation.

2.11 Recording Field Notes

Field book: It is a book in which the field measurements and relevant notes are recorded. It is about 200mm x 120mm in size and opens length wise. Each page is ruled with a single line or central column about 15mm wide running up the long length of the pages. The pages of the field book are machine numbered.

A specimen page of a field book is shown in the fig 2.14.

At the commencement of the line in the book is written (1) The name and number of the survey line.(2) The name, number of the station, and (3)The symbol denoting the station.

Tie and subsidiary stations should be indicated by a circle or oval round their chainage figures. Offsets written opposite of them on right or left of the column.. As the work proceeds, the nature and form of the objects to which offsets are taken should be sketched with conventional signs and with names written along them. The sketch is not drawn to scale.

The following points should be kept in view while booking the field notes:

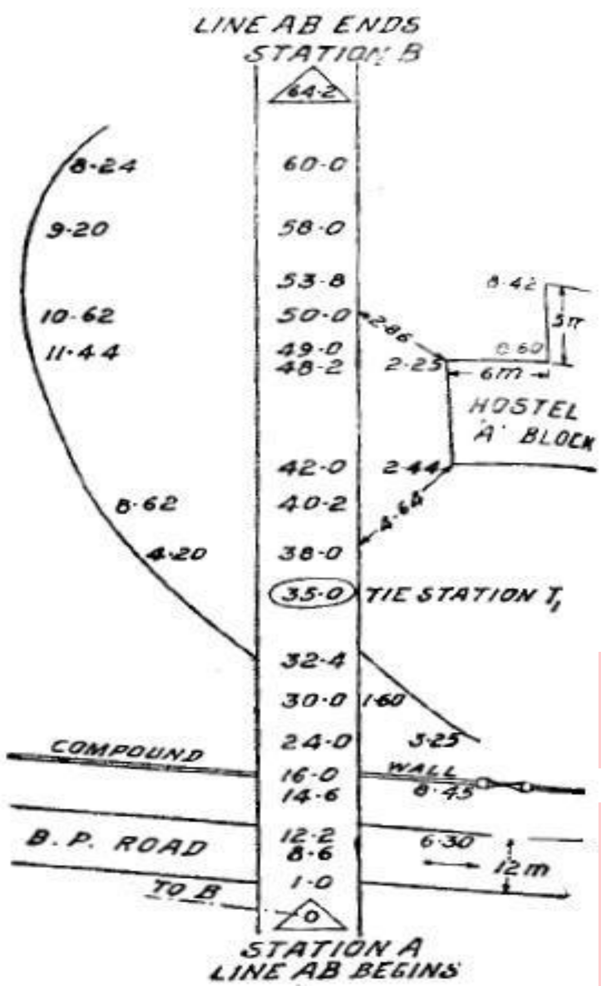

Fig. 2.14

1) Each chain line should be started on a separate page.

2) The survey should always face the direction of chaining and all measurements should be recorded as soon as they are taken.

3) The notes should be complete and nothing should be left to memory.

4) Over writing and erasing of notes should be avoided. If any entry is wrong any change in the notes is necessary, a line should be drawn through it and a correct one written above it.

5) Explanatory notes and reference to other pages where ever necessary should be added.

6) Sketches of the various features located should be neat.

7) The complete record of the survey should include the following:

(i) Name of the survey (ii) Site of the survey(iii) The date ofsurvey (iv) The length of the chain used and whether tested or not.(v) The rough sketch of the area to be surveyed showing north direction, proposed stations, main and tie lines etc.(vi) The names of the members of the party, and (vii) The page index of the chain lines and stations.

Conventional signs:

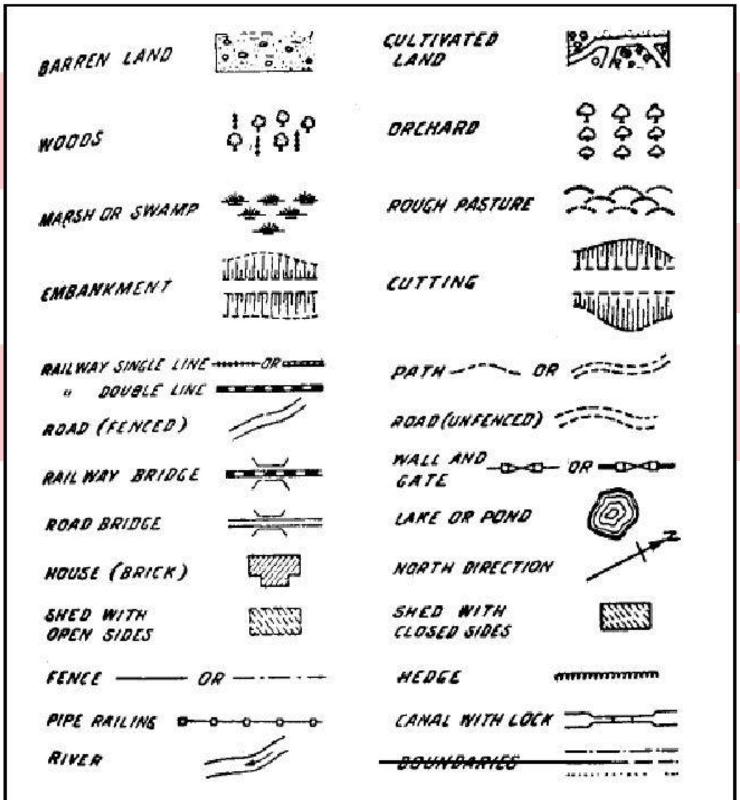

Fig. 2.15

Conventional Signs

In chain surveying, while drawing maps or entering details of the objects in field book symbols which are conventional are used to represent the objects.

Some of the common conventional signs used in surveying are given in figure above.

2.12. Obstacles in Chain Surveying

Obstacles some times interfere with chaining. In such cases the obstructed distances are found indirectly using the help of geometrical constructions. Obstacles may be classified into three categories.

1) Chaining free but vision obstructed

2) Chaining obstructed but vision free

3) Both chaining and vision are obstructed.

1. Chaining free but vision obstructed:

In this it is possible to move chain between the two end stations but they are not visible to each other due to obstructions. There are two cases i) it is not possible to see both ends from intermediate stations. Ex: a hillock in between two stations.

ii) It is possible to see both the ends from any intermediate station.

Case (i): In this case, the problem may be overcome by indirect ranging.

Case (ii): This case occurs when a pond, a tree intervenes, preventing the fixing of intermediate stations. In this case random line method may be used. Let AB be the line whose length is required. Fig (2.16).From A run a line AB_1 called a random line, in any convenient direction. Chain the line to B from A making BB_1 perpendicular to AB_1 and measure BB_1.

Then $AB = AB_1^{\,2} + BB_1^{\,2}$

Intermediate points such as C can be located on the line AB by measuring AC_1.

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

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

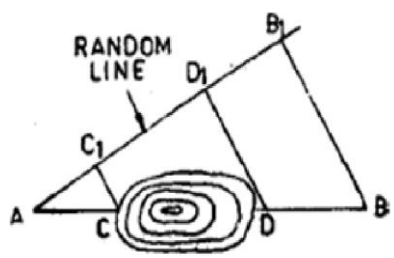

Fig. 2.16

Thus C can be located.

2. Chaining obstructed but vision free.

This is the case when a pond, river or plantations intervenes. Two convenient points have to be located on the chain line on either side of the obstacle and the distance between them found.

There are two cases.

i) In which it is possible to chain round the obstacle e.g. a pond, a bend in the river etc.

ii) In which it is not possible to chain round the obstacle, e.g. a river.

Case i): Several methods are available; however, a few are described below.

Let AB be chain line and a pond intervenes.

1) Two convenient points C and D are selected on the chain line on either side of the obstacle. Erect equal perpendiculars CE and DF and measure the length EF

Then CD = EF

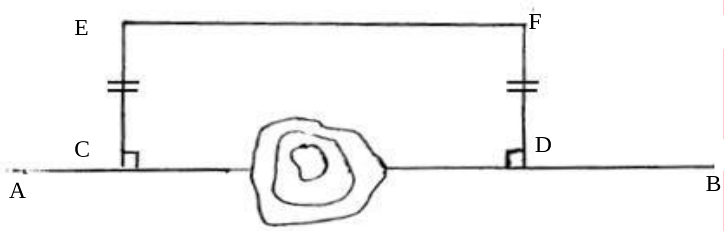

Fig. 2.17

2) Select a point C on the chain the AB (fig 2.18) on one side of the obstacle and setout CD to clear the obstacle. At D erect a perpendicular DE to clear the obstacle, cutting the chain line at E. Measure CD and DE then CE = $\sqrt{CD^2 + DE^2}$

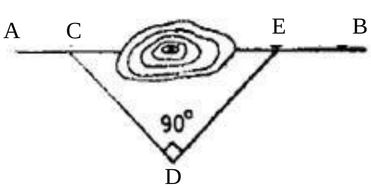

Fig. 2.18

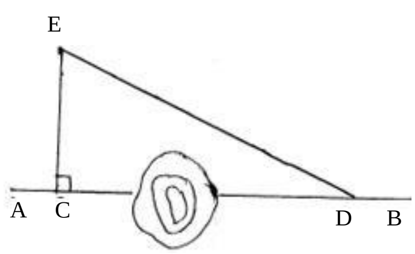

Fig. 2.19

3) Select two points C and D (fig 2.19) on either side of the obstacle. Set out perpendicular CE of length such that DE clears the obstacle. Measure CE and DE then.

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

Case ii): The typical example of this class of obstacle is a river. There are several methods, of which a few are given below.

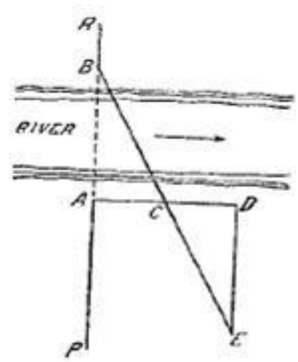

Fig. 2.20

1) Select two points A and B (fig 2.20) on the chain line PR on opposite banks of the river. Setout a perpendicular AD and bisect it at C. At D erect a perpendicular DE and mark the point E in line with C and B. Measure DE. Since the triangles ABC and CED are similar. AB = DE

2) As before select two points Aand B. Fig (2.21). Set out a perpendicular AD at A. with cross staff erect a perpendicular to DB at D, cutting the chain line at C. Measure AD and AC.

Since the triangles ABD and ACD are similar

$$\frac{AB}{AD} = \frac{AD}{AC} \qquad \text{Hence ,} AB = \frac{AD^2}{AC}$$

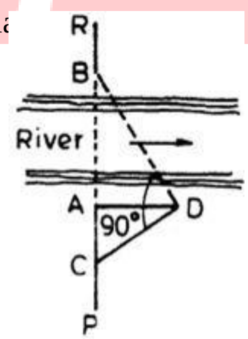

Fig. 2.21

3. Chaining and vision both obstructed: In this case the problem consists in prolonging the line beyond the obstacle and determining the distance across it. Abuilding is a typical example of this type of obstacle. Point C is chosen on the chain line AB as near as possible to the building and rectangles EFGC, DHJK are setup on either side of the obstruction, JH is ranged in line with FG. Then EF= CG=DH=KJ, FGHJ is a straight line and GH = CD, the missing portion of the chain line AB.

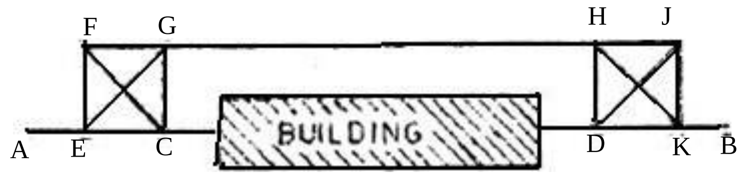

Fig. 2.22

Example 2.9 : To continue a survey line A B to over come the obstacle a line BC 200 meters long was set out perpendicular to AB and from C angles BCD and BCE were set out at 60° and 45° respectively. Determine the lengths which must be chained off along CD. Determine the obstructed length BE.

Solution :

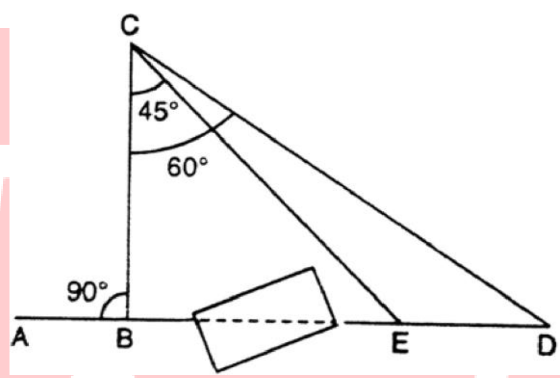

Fig. 2.23

$\angle ABC = 90^o$

From Δ BCD, CD = BC sec 60^o = 200 x 2 = 400 m

From ΔBCE, CE = BC sec 45^o = 200 x 1.4142 = 282.84 m

BE = BC tan 45^o = 200 x 1 = 200 m (Ans).

Example 2.10 : There is an obsticle in the form of a pond on the main chain line AB. Two points C and D were taken on the opposite sides of the pond. On the left of CD, a line CE was laid out 100m in length and a second line CF, 80 m long was laid out on the right of CD, such that E,D and F are in the same straight line. ED and DF were measured and found to be 60 m and 56 m respectively. Find out the obstructed length CD.

Solution :

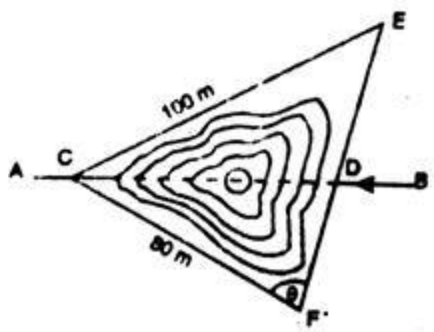

Fig. 2.24

In fig. (2.24) C D is the obstructed length of the pond on the chain line AB. CE and CF are known to be 100 m and 80 m respectively.

And EF = 60 + 56 = 116 m

Let angle CFE = θ , then in triangle CFE,

$$\text{Cos } \theta = \frac{FC^2 + FE^2 - CE^2}{2.FC.FE}$$

$$= \frac{80^2 + 116^2 - 100^2}{2 \times 80 \times 116}$$

Also in triangle CFD,

$$\text{Cos } \theta = \frac{FC^2 + FE^2 - CD^2}{2.FC.FD} = \frac{80^2 + 56^2 - CD^2}{2 \times 80 \times 56}$$

$$\text{Therefore } \frac{80^2 + 116^2 - 100^2}{2 \times 80 \times 116} = \frac{80^2 + 56^2 - CD^2}{2 \times 80 \times 56}$$

or CD = 69.123 m (Ans).

Example 2.11: A survey line BAC crosses a river A and C being on the near and distant banks respectively. Standing at D, a point 50 m measured perpendicularly to AB from A, the angle BDC = 90^o and AB being 25 metres. Find the width of the river.

Solution :

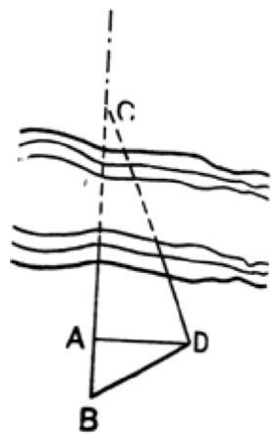

Fig. 2.25

In Δ ABD, AB = 25 m, AD = 50m

tan $\angle$BDA = 25/50 = 0.5 m or $\angle$BDA = $26^o\,34'$

$\angle$ADC = 90^o - $26^o\,34'$ = $63^o\,26'$

From Δ ADC, CA = AD tan $\angle$ADC

= 50 x tan $63^o 26'$ = 100 m (Ans).

Calculation of Areas

One of the purposes of land surveying is to find the area of a piece of land.

Following are the methods of finding the area of a piece of land with irregular boundary..

i) Average ordinate rule.

ii) Simpson's rule

iii) Trapezoidal rule.

i) Average ordinate rule: In this method, the base line is divided into a number of equal divisions and ordinates are drawn at each point of division and measured. The average length of the ordinate multiplied by the base line length and divided by the number of ordinates gives the required area.

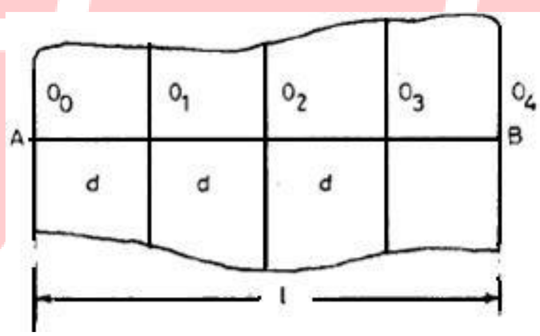

Fig. 2.26

$$\text{Area of the land} = \frac{O_o + O_1 + O_2 + \ldots\ldots O_n}{n+1} \times L$$

where O_o, O_1, O_2 **....** O_n = Ordinats taken at each division

L = Length of the base

n = no. of equal divisions of base line

(ii) **Simpson's rule:** In this method the area is divided into strips of equal width d and the number of these strips must be even and this rule is suitable for areas consisting long thin pieces of land.

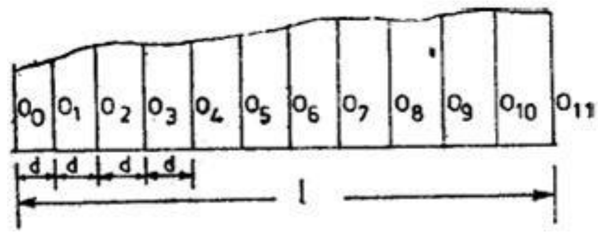

Fig. 2.27

$$\text{Area of the land} = \frac{d}{3}\left[(\text{sum of first and last ordinates}) + 2(\text{sum of the other odd ordinates}) + 4(\text{sum of even ordinates})\right]$$

where d = width of strip

iv) **Trapezoidal rule:** In this method the area is divided into a number of equal strips, but any number of strips may be used unlike the Simpson's rule which requires an even number of strips.

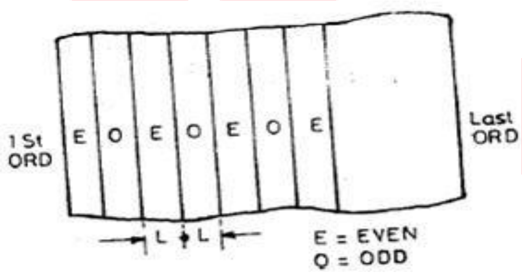

Fig. 2.28

The area land = width of strip [((sum of 1st and last ordinates)/2)
+ (sum of all the other ordinates)]

Example 2.12. The following perpendicular offsets in meters are taken at 5 m interval from a survey line to an irregular boundary line. 4.2, 3.5, 2.5, 3.0, 4.0, 4.5, 5.5. Calculate the area by (1) Average ordinate rule (2) Simpson's rule (3) Trapezoidal rule.

Solution:

(1) By Average ordinate rule.

$$\frac{O_o + O_1 + O_2 + ...O_n}{n + 1} \times L$$

where O_o, O_1, O_2 ...... O_n = Ordinats taken at each division

L = Length of the base

n = no. of equal divisions of base line

Interval between offset =5 m No. of divisions = 6

Length of survey line = L = nd = 6 x 5 = 30m

Σo = Sum of offset s= 4.2 + 3.5 + 2.5 + 3.0 + 4.0 + 4.5 + 5.5 = 27.2m

Area = Σo x L/(n+1)=27.2 x 30/7=116.57 sqm.

(2) By Simpson's rule:

The area of the land = $\frac{d}{3}$ [(sum of first and last ordinates) + 2(sum of the other odd ordinates) + 4(sum of even ordinates)]

= 5/3 (4.2+5.5) + 2(2.5+4.0) + 4(3.5+3.0+4.5)

= 5/3 x 66.7 = 111.17sqm

(3) By trapezoidal rule:

The area of land =

width of strip x [(sum of 1st and last ordinates)/2) + (sum of all other ordinates)]

Area = 5 |(4.2+5.5)/2 + (3.5 + 2.5 + 3.0 + 4.0 + 4.5)| =111.75 Sqm.

Department of Civil Engineering

Surveying by Alok D

Session: Aug 2020 – Dec 2020

Worksheet

Short Answer Type Questions

1. Write the principle of chain surveying
2. Define Baseline
3. Define Ranging and write types of ranging
4. Write types of obstacles in chain surveying
5. What is a check line?
6. What is a tie line?
7. Write the types of survey stations
8. Draw the conventional signs for the following. a) Pond b) Building
9. What is a well conditioned triangle?
10. What is the use of cross staff?
11. A distance of 1200m is measured with 20m metric chain, after the measurement, it is found that the chain is 10cm long. Correct the measured distance.
12. Write the methods of calculating areas.

Long Answer Type Questions

1. Name and explain the accessories used in chain surveying.

2. Write types of obstacles in chain surveying and explain various methods when a survey line is obstructed by a River.

3. Explain the procedure of indirect ranging.

4. Explain the procedure for chaining up a hill slope.

5. Explain the procedure of ranging by line Ranger.

5. The following perpendicular offsets in meters are taken at 5m internals from a survey line to an irregularly boundary line: 4.25, 3.50, 2.95, 2.48, 2.90, 3.68, 4.20, 3.85 and 4.15

Calculate the area in sq. meters enclosed between the surveyline, the irregular boundary line and the first and last ordinates by i) Average ordinate rule ii) Simpson's rule and iii) Trapezoidal rule .

Chain surveying -AD