Survey and Setting out Construction Works
Training Module for Barefoot Technicians

Learning Unit 1.4
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Training Module for Barefoot Technicians
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Technical Team
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Learning Unit- 1.4
Basic Surveying and Setting Out

Purpose of the learning Unit

The purpose of this learning unit is to enable you to do simple contour survey and slope calculation using A-Frame, Pipe level (Hydrometer) and other tools for MGNREGA works. This learning unit also enables the BFT to do lay out / mark out of simple works on ground to start the works.

The surveying and setting out requirements for labour-based infrastructure works vary with the types of works to be executed. The construction of new roads requires a complete survey by the Engineer to establish the alignment. The simple MGNREGS works can be given mark out by the BFT. The engineer provides at worksite with the relevant reference points and levels for tough works. This module describes simple methods for setting out on site for simple works. BFT is expected to know, how to use some tools like 'A' frame and hydro meter in giving mark outs at the work site.

Elements of the learning Unit

1. Appreciate the need for survey
2. Identify and use simple measuring aids and instruments
3. Set out and measure straight lines using tapes
4. Identify and set out contours using the A-frame
5. Transfer levels and determine gradients using Pipe level (Hydrometer)
   Marking out of MGNREGS Works on the site
Element 1
What is Survey and its necessity
Learning Activity outcome

This specific outcome is to enable you to describe the need of survey and methods of doing it.

Summary

This learning unit explains definition and objectives of survey. Also it makes BFT understand the procedures of doing it. It explains which tools and instruments are to be used for specific purpose.

What is Surveying?

Surveying is process of determining the relative positions of various points or stations on the earth surface by measuring the horizontal distances, vertical distances, angles and taking the details of these points and preparing a map or a plan of any suitable scale.

Surveying is process of determining the relative positions of various points or stations on the earth surface by measuring the horizontal distances, vertical distances, angles and taking the details of these points and preparing a map or a plan of any suitable scale. Figure 2

The primary aims of field surveying are:

(a) To measure the Horizontal Distance between points.
(b) To measure the Vertical elevation between points.
(c) To find out the Relative direction of lines by measuring horizontal angles with reference to any arbitrary direction.
(d) To find out Absolute direction by measuring horizontal angles with reference to a fixed direction.

Figure 2

Figure 3
Objectives of Surveying

(a) To collect field data;
(b) To prepare plan or map of the area surveyed;
© To set out field parameters at the site for further engineering works.

Why is Surveying required in the context of MGNREGS works?

Surveying is of utmost importance in the planning and execution of many permissible works under MGNREGS. Watershed works try to regulate the momentum of water and minimise the damage caused due to flow of surface water (Pl. refer to element no 03 of learning unit 2.2 MGNREGS permissible works for elaboration on watershed). Calculation of elevations and slopes is essential for deciding on the type of structures appropriate for each location.

For an example, in case of small earthen dams, we need to estimate their height, slope and the volume of earth required to build them. Surveying comes to our aid in all these tasks, by making them simpler and easier.
What is required for Surveying?

There are several types of surveying instruments depending on purpose and accuracy. In case of drawing contour lines and measurement of slopes, Pipe levels and A-Frame are very useful, which are inexpensive and simple instruments. They are both lightweight instruments, which can easily be used by anyone with a basic knowledge of arithmetic. They are of use where the distances to be covered during survey are not very long. For surveys involving longer distances or for more complex technical surveys (such as planning water harvesting structures like dams and marking out their full reservoir levels) more sophisticated instruments like Abney Level, Dumpy level and Theodolites etc are used. These are more expensive and need more calculations on the readings.

**Remember**

- Tools for Length Measurement - Measuring Tape
- Tools for Level Measurement - Pipe Level, Abney Level
- Tools for Contouring - A frame, Pipe level (Hydrometer)
- Tools for Leveling - Plumb bob
**Work book**

1. Explain the need of survey for Mahatma Gandhi NREGS work.

2. Write the name of 6 survey tools and equipments used for Works.
   I. ____________________   II. ____________________
   III.____________________  IV._____________________ 
   V.______________________  VI._____________________

3. We can draw contour on ground by using:
   a. A-frame                    b. Pipe Level
   c. Dumpy Level               d. All above

4. Match the table
   Plumb bob                     Length
   A- Frame                      Level
   Tape                          Verticality
   Hydrometer                    Contour
   Ans_________________________
Element 2
Measuring Aids and Instruments
Learning Activity Outcomes

This Specific Outcome is to enable you to describe common simple measuring aids and instruments, identify their purpose and use them for setting out works.

Summary

This element explains about the length measuring tools, leveling tools and some accessories used during survey. At the end of unit BFT will be able to find out the tools for specific measurements.

The setting out of works should be done using the simplest instruments and methods possible.

*Elementary simple measuring aids and instruments for site work setting out:*

<table>
<thead>
<tr>
<th>Pegs: Pegs are used for survey purposes and for setting out all the activities. On labour-based sites usually wooden sticks are used of approximately 50 cm length and strings. On one end they are pointed so that they can easily be hammered into the ground. Survey pegs, for example chainage pegs, are cut at the edge so that a clear marking can be made. (BFT shall do field exercises on this during training)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement tape: A measurement tape is generally used for measuring the distance between two points. There are different types of tapes. The most common length of tape measure used for setting out is 30 metres. The tapes are made of steel, synthetic or linen. Although the former is stronger, the numbers/marking on the tape may become unreadable after a period of use. Note: The location of the 'zero point' may differ from tape measure to tape measure. (BFT shall carry out field exercises on this during training)</td>
</tr>
</tbody>
</table>

Survey and Setting Out Construction Works
Ranging Rods:

Ranging rods are generally used for taking long distance measurements and to set out straight lines. Ranging rods are round sticks usually 2 metres long with a diameter of approximately 2.5 cm. They are made of various materials (metal, hard plastic, wood) and are usually provided with a pointed metal end. They are painted red and white with black marking at the 1 metre point. The lengths of the red/white sections are 50 cm. (BFT shall do field exercises on this during training)

Boning Rods (also called Travelers):

Boning rods are used to set out horizontal lines or lines with a constant slope. In particular they are used for setting out canal excavation works, but also for roads and dyke construction. Boning rods are T-shaped and of a uniform height. They can easily be manufactured by nailing a wooden plank of 80 cm length and 10 cm height on another plank of 130 cm length and 10 cm width so that the end result looks like a “T”. The horizontal plank should be painted in clearly visible colours. Boning rods have to be used in a set of three. (BFT shall do field exercises on this during training)
Templates:
These are used to control certain shapes of the road. For example, to control the correct shape for the slope and ditch, a template of the standard slope-ditch size can be used by the labourers to continuously check whether the correct shape is being dug. Templates are very useful control aids as any labourer can see the exact size and shape of the work she/he is required to carry out. They are usually made of wood and tailor-made for each particular project in accordance with the standard measurements (see specifications).

\[ h = \text{height of ditch} \]
\[ w = \text{width of ditch} \]
\[ s = \text{slope} \]

Note: Always use templates together with spirit level

from shoulder to centre line (2.50 - 3.00 m)

Camberboard

camber gradient 10%
**Spirit Level:**

Spirit level (see fig A alongside) is used for construction work and to ensure the line is at level/horizontal. These are available in all different sizes. For construction work robust and long spirit levels are ideal. Always ensure that the spirit level is properly adjusted before you buy it.

If the spirit level is not long enough, then a straightedge of 2.50 m to 3.50 m, usually out of wood, can be used (see fig B alongside). Always ensure that your straightedges on site are actually straight on both sides.

(BFT Shall do field exercise on this during training)

**A-frame:**

An A-frame is an instrument used to mark out contour lines on the ground. It is generally made of three wooden planks of 2 metres each and a rope tied with a plum bob or weight. This is a simple and inexpensive instrument that can be made with locally available materials and is easy to operate.

(BFT shall do field exercises on this during training)
### Pipe level (hydrometer):

The pipe level is a measuring instrument used for calculating the slope, leveling, and drawing contours on the ground. It consists of one plastic tube (commonly used by masons) of 8 metres length and two wooden calibrated poles of 1.5 m height. It is inexpensive, can be manufactured locally and is easy to operate. (BFT shall do field exercises on this during training)

![Pipe Level](image)

### Line Level:

A line level is a small spirit level of about 80 - 120 mm length. It has a hook on each end of the level which is used for hooking the level onto a smooth line. The level is used together with a line, ranging rods (or profile boards) and a tape measure. The line level requires two people to operate. The line level can be used to:
- transfer levels
- check existing gradients
- set out gradients

**Always check:**
- that the line is smooth or of nylon
- keep the line tight,
- level is in the middle between the two ranging rods,
- check the accuracy of the level regularly.

**Check accuracy of line level:**
- Place two ranging rods 20 m apart,
- Fix a line on the 1 m mark on one rod and transfer the level to the other rod = mark this level. The line should be kept tight and the bubble on the line level should be in the middle,
- Keep line in place, unhook the line level and turn it around
- Adjust the line again and make sure the bubble on the line level is in the middle. Mark the new level on the rod and measure the difference between the two levels.

### Plumb Bob:

The plumb bob is usually used by masons to check the vertical alignment of walls. The distance plate is slightly wider than the plumb bob itself and can be freely moved along the string line. In this way the plate can be held against the top of the wall while the plumb bob hangs on the lower end. If the plumb bob nearly touches the wall, then the top and bottom point of the wall are in a vertical line. The alignment of the wall can then be checked by sighting the string line with the wall line. If they are parallel to each other then the wall is straight (vertical).

(BFT shall do field exercises on this during training)

![Plumb Bob](image)
Work Book:

1. Describe the use of following measuring aids:

- Pegs

- Ranging Rods

- Plum Bob

- A- frame

- Hydrometer

- Measuring tape
Notes: Campus / Field Exercise
Element 3
Giving lay outs/settling out of straight lines and lines of different angle on the ground
Learning Activity Outcomes

This Specific Outcome is to enable you to give layout of straight lines, setting right angles and other angled lines using different aids and instruments as stated above.

Summary

This element explains about how to draw straight lines of different lengths, setting perpendicular lines and other angled lines on the ground, using measuring tape and pegs. Actually these skills are required to giving layout for the works like roads, drainage Channel, earthen dam, cattle sheds, orchards etc.

<table>
<thead>
<tr>
<th>Job Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity: Setting Out Straight Line</td>
</tr>
</tbody>
</table>

Process of marking 100mt straight line on the ground with the help of 30m Measuring Tape (MT) – Refer to Figure 9.1, 9.2 & 9.3

1. Assume starting point of line is “A” and the end point (at an approximate distance of 100m) is “E”.
2. Fix the ranging rods at both end
3. Place the zero mark of the measuring tape at point “A” and range the line between points A-E with ranging rods. Roll out the tape towards point “E” and mark a point at 30m with lime dust and fix a peg. We call this point as “B”.
4. Now place the zero mark of the measuring tape at point B and repeat the above process for point C and D till reaching 90m.
5. From point D measure 10m length and mark the end point as “E” with lime and insert a peg.
6. Mark the straight line A-E with rope and lime dust.

![Figure 9 - Setting out straight line](image.png)

<table>
<thead>
<tr>
<th>Persons:</th>
<th>Tools:</th>
<th>Materials:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. BFT</td>
<td>1. Pegs: No. as per distance</td>
<td>1. Lime dust</td>
</tr>
<tr>
<td>2. Two support persons</td>
<td>2. Fiber Tape (30mt) - 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Carpenter hammer - 1</td>
<td></td>
</tr>
</tbody>
</table>
Do's and Don'ts

1. Be sure that the distance between two points is shortest, to make a straight line.
2. The tape is held tight and horizontal.
3. If distance between both points is less than the tape length, then note the reading of Tape accurately in the note book.
4. If the distance between two points is more than the length of measuring tape, then note no of measurements of complete tape.

**Work sheet for setting out 90°, 45° and 30° angles using tape and Pegs:**

a) **Setting out of a right angle (90°):** This is mostly used to give layout for WHSs, foundation of buildings, roads etc.

The right angle is established by measuring a triangle Figure 10- Setting out Right angle with side lengths of 3, 4 and 5 metres as described below and also refer the figure 10 and 11. Figure 11 - Setting out Right angle

1. Measure the length AB of 4 metres along the centerline of the road. Set pegs exactly at points A and B.
2. Hold the zero point of the tape measure on the peg A
3. A second person holds the mark 8.00 metres on the tape measure on peg B.
4. A third person holds the tape measure on mark 5.00 metres, which will lead to point C when the tape measure is pulled tight. Set a peg on point C

b) **Setting out of a 45° angle:**

The process of setting 45 degree angled lay out is described below along with the figure 12.
1. Establish first a right angle as shown above.

2. Set out the same distance on both of the two lines (L) starting from the intersection point B, e.g. 3.00 metres and fix the pegs A and C.

3. Span a string line between points A and C and measure this length A to C.

4. Divide the length A to C by two and set the peg D exactly in the middle of this length. Establish the new line B to D with a string line and extend beyond peg D if necessary.

Setting out of 30° and 60° angles:

1. Establish first a right angle as shown above.

2. Set out the same distance on both of the two lines (L) as shown in figure 13. Starting from the intersection point B, e.g. 3.00 metres and fix the pegs A and C.

3. Span a string line between points A and C and measure this length A to C.

4. Divide the length A to C by three and set pegs D (for 30°) after a 1/3rd of the length A to C, or E (for 60°) after 2/3rd of the length A to C.

5. Establish the new lines B to D or B to E with a string line and extend beyond peg D or E if necessary.
**Do's and don'ts**

- Horizontal distance requires tape to be horizontal
- In case of tape measurement all points must be aligned straight or should remain in same line.
- For determining 30° 45° and 60° remember AB should be equal to BC (see the given example in this unit).

**Work Book:**

1. What precaution should be taken during marking a straight line?

2. Write the process of marking Right Angle (90°) on ground.

3. What is the relationship between AB and BC of Figure 13 during setting out angle 60°.

![Diagram](image)

*Figure 13- Setting out 30° and 60°*

Ans.
Notes: Class room

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Notes: Campus / Field Exercise

Survey and Setting Out Construction Works
Element 4

Setting out of contours using A-Frame
Learning activity out comes

This Learning Element is to enable BFT to make A-Frame and use it to identify and mark the contours on the ground.

Summary

A-Frame is a simple wooden instrument, used mainly for identifying contour lines. The simplest form of an A-frame is two similarly sized wooden or steel poles laid up against one another and arranged in a 45-degree or higher angle. A third pole is kept horizontal, connecting these two poles. These poles are then tied together with rope or welded together as shown in Figure 14.

Figure 14- A Frame
Job Sheet

Making of A-Frame

- Take two bamboo poles of nearly the same height.
- One end of each of these poles will go into the ground.
- These ends should be sharpened with a knife or a saw. Take care, however, not to sharpen them so much that the poles start sinking if kept on the ground.
- At the other end, leave about 6 to 8 inches length on both the poles and join the poles together in the shape of the letter 'A' as shown in Figure 15.
- Mark the point at which the two poles are joined together.
- Now with a saw, make a notch on each of the poles at the marked spot and fit the poles into each other at the notches as shown in Figure 16.
- Tie a rope tightly around this point so as to fasten the two poles together. Check to ensure that the pole assembly is not loose. If the rope is loose, take it off and fasten it once again, this time tighter.
- Let these two poles be called foot A and foot B of the A-Frame.
- Now place the third pole across these two poles to complete the letter 'A' as shown in Figure 17. Mark the points where this third pole meets poles A and B, (Figure 17).

Figure 15: Two pole joined together to form the letter 'A'

Figure 16: Notch at the end of pole

Figure 17: The 3 poles joined to form an A-Frame
Job Sheet
Making of A-Frame

- Make notches on these two points and fasten the third pole on them with the thick rope as before. Let the third pole be called pole D (Figure 17).
- Take a thin thread and tie a small stone to it (see Figure 18).
- Tie the other end of the thread at point C of the A-Frame.
- Let the stone hang from point C in such a way that it is below the third pole (D), but remains suspended above ground level.
- Place the A-Frame on the ground. Call the points where the two feet touch the ground X and Y. Note where the thread with the stone cuts pole D of the A-Frame.
- Mark this spot as K (Figure 19). Now place the frame at X and Y again, but this time with the feet reversed (i.e., the foot of the A-Frame which was earlier on X should now be placed at Y and vice versa). Once again mark the spot where the thread with the stone cuts pole D. Call this spot L (Figure 20).
- Then with another piece of thread find the midpoint between K and L and mark this point as O as shown in Figure 21. This point O is the centre point of the A-Frame. Deepen the mark at point O with a saw. Now erase the marks made at points K and L so that there are no mistakes when taking readings.
- If the A-Frame is placed on level ground, the thread with the stone will always cut the third pole (D) at the centre point O. This is the principle on which the A-Frame works.
Materials:
- 3 bamboo poles each about 6-7 feet long
- A fine thread
- A thick, strong rope
- A small stone (flat in shape) or Plumb bob as weight
- A hand saw

Do's and Don'ts
- The A-Frame should be fastened securely. If it is not, then the readings will be wrong.
- Making notches at the joints helps the A-Frame to remain securely together
- If bamboo is not available then wooden sticks of similar length can be used. In such a situation, holes can be drilled into the sticks and they can be fastened together with the help of nuts and bolts
- The thread and stone unit should be fastened at point C at the centre of both feet A and B of the A-Frame and should be free to swing like a pendulum.
- The stone should be relatively flat, otherwise it will keep getting untied and create a problem during measurement. If Plumb is available, use it in place of stone.
- The feet of the A-Frame which have to be kept on the ground should not be too sharp or pointed since this will cause the A-Frame to sink into the ground and the accuracy of the readings will be adversely affected.
**Job Sheet**

**Use of A-Frame for Marking Contours**

- Suppose you want to find the contour at some point P.
- Place foot A of the A-Frame at P.
- Place the other foot B on some point which at first sight seems to be at the same elevation as P.
- Watch the thread with the stone as it stabilizes at the new position.
- If this thread intersects pole D of the A-Frame at its centre point O, then the new point is on the same contour as the earlier one.
- If however, the thread is to the right or left of O then keeping foot A where it is, shift foot B of the A-Frame to a new point nearby. Do this repeatedly until you find a point where the thread intersects O.
- If such a point, say Q (see Figure 22), is found, then Q and P are at the same contour.
- Now fix a marker on the ground at point P and keeping foot B at Q, move foot A of the A-Frame forward to another point which seems to be at the same elevation as Q.
- When such a point (say R) is found through the above process, you have another point on the contour.
- Fix a marker at Q and move foot B forward.
- Repeat this process until the contour is marked completely. The marked contour can be used to plan structures such as contour bunds and trenches.

*Figure 22: Marking Contours with an A-Frame*
**Do's and Don'ts**

- Always keep the A-Frame straight at the time of taking readings, otherwise the stone and thread unit will not move freely and the readings may go wrong.

- The thread on which the stone hangs should neither be too long nor too short. If it is too long, then it will touch the ground and if too short then it won't touch the middle pole and taking readings will be impossible.

**Figure 23: Contour lines**

<table>
<thead>
<tr>
<th>Things to remember</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) The poles used for A Frame shall be straight and firm.</td>
</tr>
<tr>
<td>(b) Rope shall be tightly tied so that Frame is not disturbed while using.</td>
</tr>
<tr>
<td>(c) Before using the A-Frame it shall be checked on a smooth level surface and ensure it is Ok.</td>
</tr>
<tr>
<td>(d) While fixing the contour point ensure, the plumb rope is in the middle.</td>
</tr>
</tbody>
</table>
**Work Book:**

1. A- Frame is generally used for measuring_______________________________

2. What is the appropriate size of poles used for making A-frame?
   Ans______________________________________________________________

3. How to calibrate a A-frame?
   Ans______________________________________________________________

4. Write the problems you would face during the usage of A-frame.
   Ans______________________________________________________________

5. What precautions should be taken during the marking of the contour with A-frame?
   Ans______________________________________________________________
Element 5

Identify and setting out levels and slopes using Pipe level (Hydrometer)
Learning Activity outcome

This specific outcome is to enable you to make Hydrometer and its use to calculate slope, height and also mark the contours on the ground.

Summary

Hydrometer is a measuring instrument used for calculating the slope, height, leveling, and drawing contours on the ground. Hydrometer consists of one plastic tube (used by Mason) of 8mt length and two wooden calibrated poles of 1.5mt height. It is cheaper, can be manufactured locally and easier to handle.

The Pipe Level is shown below

Figure 24: Pipe level is made of a pipe fastened on two wooden staffs

Figure 25: The scale’s markings
Making of Hydrometer or Pipe Level

- Tie one end of the pipe to one of the wooden scales as shown in Figures 24 and 25.
- You should tie it in such a way that about 6 inches of the pipe is jutting out.
- Fasten the pipe on the scale at 2-3 places with the help of the transparent tape or thread, so that the pipe stays close to the scale.
- In the same way, fasten the other end of the pipe on the second scale.
- Collect some water in a broad vessel like a bucket.
- Keep the vessel on a slightly elevated surface and dip one end of the pipe and scale into the water.
- Suck at the other end of the pipe until water starts flowing into your mouth (see Figure 26).
- Remove the pipe from your mouth and make sure that there are no bubbles in the pipe.
- If you spot a bubble let it flow out of the pipe.
- Press both ends of the pipe with your thumbs and place them together on the ground.
- If the pipe is full of water on both ends, place one end slightly lower than the other and let some water flow out.
- At this point, if you keep both ends of the scale at the same spot, you should have about 50 to 60 cms of water in the pipe. Now the pipe level is ready to use (Figure 27).
- Water which is stationary (not flowing), always attains the same level. It is this simple principle on which the pipe level works.
<table>
<thead>
<tr>
<th>Persons required</th>
<th>Materials required</th>
</tr>
</thead>
<tbody>
<tr>
<td>• BFT-1</td>
<td>• Two wooden poles, each 1.5mt long.</td>
</tr>
<tr>
<td>• Assistanta-2</td>
<td>• Thin, transparent pipe, about minimum 8mt long (Used by Mason)</td>
</tr>
<tr>
<td></td>
<td>• Fine thread or transparent adhesive tape</td>
</tr>
<tr>
<td></td>
<td>• Measuring Tape</td>
</tr>
<tr>
<td></td>
<td>• Marker</td>
</tr>
<tr>
<td></td>
<td>• Lime powder</td>
</tr>
</tbody>
</table>
**Job Sheet**

**Setting Out Contour using Pipe Level or Hydrometer**

![Diagram](image)

**Figure 28: Using the pipe level to mark contours**

- Keep one scale of the pipe level (call it S1) on any one point in the area where you want to mark contours.
- Identify another point in the neighborhood of the first one, which in your judgment, seems to be at the same elevation.
- Keep the other scale (call it S2) at this newly identified point. Now compare the water levels indicated by the two scales.
- If the water level reading in both scales is the same it means that the two points are at the same elevation.
- Remember that while viewing the readings, move from the bottom to the top of the scale and not from the top to the bottom.
- If the readings in the two scales are not equal, keep S1 at the same spot and shift S2 to another point.
- If the reading on S2 is higher than reading on S1, it means that S2 is at a lower elevation and hence S2 should move to a higher point.
- If reading on S2 is lower than S1, it means that S2 is at a higher elevation and hence S2 should move to a lower point.
• Keep doing this until the readings at the two points become equal.

• Once you get the same reading in both scales, fix a peg in the ground at the spot where S1 was kept.

• Then keeping S2 where it is, move scale S1 from its original position.

• Put S1 at a spot which seems to be at the same elevation as S2 and take the readings in both scales.

• If they are not equal shift S1 to another spot according to the procedure described earlier. Keep doing this until the readings in both scales are the same.

• Then fix a peg in the ground at the spot where scale S2 was kept.

• Then keeping S1 where it is, move S2 to a new spot.

• This process should be repeated for as far as we want to mark the contour as shoun in Figure 28.

• The pegs that you have fixed all mark points at the same elevation.

• If you join these points together in a line you will get a contour line.

• Keep scale S1 of the pipe level at point A as shown in Figure 29.

• Then move S2 to point B.

• Take the water level readings in both scales.

• Remember that the readings have to be viewed from the bottom to the top and not from the top to the bottom.

• Also keep in mind that point B should not be higher than the height of scale S1 otherwise water will spill out of the pipe at S1.

• This should be remembered particularly when we are trying to calculate the slope.

• Take down the water level readings on both the scales and calculate the difference between the two readings.

• This is the vertical interval or elevation between points A and B.

• Also find out the horizontal distance between the two points.
• This is the vertical interval or elevation between points A and B.

• Also find out the horizontal distance between the two points.

• This is known as the horizontal interval between points A and B.

• Now keeping S2 where it is (i.e., at point B), shift S1 to point C, which as you can see from the figure, is at a higher elevation than point B.

• Once again find out the difference in water level readings in S1 and S2. Also find out the horizontal interval between B and C.

• Repeat this procedure until you reach point E.
Now, sum up the differences in the water-level readings found out at each successive pair of points. That is, sum up the vertical intervals observed between successive pairs of points. This sum is the vertical interval between point A and E.

Similarly, sum up the horizontal intervals found between successive pairs of points. This sum is the total horizontal interval between point A and E.

Now, divide this total vertical interval by the total horizontal interval to get the slope in percentage between points A and E.

Example 1: Calculating Slope

**Slope:** The slope of the land is the ratio of the vertical interval to the horizontal interval and can be expressed as such. Slope is also measured as a percentage or in degrees.

Say the difference in reading in the pipe level between points -

- A and B is 60 cms and the horizontal distance is 3 metres.
- B and C is 40 cms and the horizontal distance is 2 metres.
- C and D is 30 cms and horizontal distance is 3 metre.
- D and E is 50 cms and horizontal distance is 5 metre.

What is the slope from point A to E?

**Solution:** Now between A and E:

Difference in water level reading between A & B = 60 cm (0.6 m) and horizontal interval = 3 m

Difference in water level reading between B & C = 40 cm (0.4 m) and horizontal interval = 2 m

Difference in water level reading between C & D = 30 cm (0.3 m) and horizontal interval = 3 m
Difference in water level reading between D & E = 50 cm (0.5 m) and
Horizontal interval = 5 m
Total Vertical Interval between A & E = (0.60 + 0.40 + 0.30 + 0.50) = 1.80 Mt
Total Horizontal Interval = (3.0 + 2.0 + 3.0 + 5.0) = 13.0 Mt
Average slope between A and E = 1.80 / (13 x 100) = 13.84% or approx 14%

**Do's and Don'ts**

- Water in the pipe will always take on a "U" shape. When taking the reading, always take the scale reading at the trough of the U-shape (Figure 30).
- When taking the reading always read from bottom to top of the scale rather than from the top to the bottom.
- When using the pipe level, keep checking to ensure that it is not bent (Figure 31), folded or pressed at any spot. If it is, the readings will be wrong. This problem can sometimes also arise when it is too hot or too cold. So, remove the bend or press with your hand and smoothen the pipe before going on.
- Check from time to time and ensure that there are no bubbles in the pipe. If there are, remove the bubbles and only then take the readings.
When it is time to shift one scale to a new point, keeping the other where it is, press both ends of the pipe with your thumb so that no water spills out. On moving to a new point to take the next reading, ensure that the thumb has been removed from both ends of the pipe.

When moving the pipe from one place to another, ensure that both pipes are at the same level. In other words, keep both scales together and then move to a new point.

When calculating the slope, keep in mind that one point should not be higher than the height of the scale at the other point, otherwise water will start spilling out of the pipe at the lower point.

After use, take all the water out of the pipe and keep everything safely.

Work Book:

1. What are the material required for making hydrometer.
   Ans:  I.________________________________  II.________________________________
         III.______________________________  IV.______________________________

2. What is the appropriate size of poles using for making hydrometer?
   Ans______________________________________________________________

3. What is slope and how is it calculated?
   Ans______________________________________________________________

4. Calculate the slope between point A and B if:
   • Reading in pipe A is 60 cm
   • Reading in pipe B is 140 cm
   • Horizontal distance between point A and B is 4m.
   Ans______________________________________________________________

Survey and Setting Out Construction Works
Notes: Classroom

Survey and Setting Out Construction Works
Element 6
Marking out of MGNREGS Works on the site
Learning Activity

This learning element explains the procedures for calculating of volume of work to be done based on the available no of wage seekers, calculating dimensions and then marking the dimensions on the ground.

This specific outcome is to enable BFT to calculate and transfer the dimensions on the ground. More specifically, building skills of BFT to mark out volume of earthwork/ work piece required to be done for the available no of wage seekers at the site.

Summary

This learning element explains the procedures for calculating of volume of work to be done based on the available no of wage seekers, calculating dimensions and then marking the dimensions on the ground.

<table>
<thead>
<tr>
<th>Marking out the dimensions on the ground</th>
<th>The process is described through the example: Say a group of 20 wage seekers are available for a day and as per the sanctioned estimate rate for excavation in Hard soil is Rs.100 per cum. How much work should be done by group to get minimum wage of Rs. 200 for wage seeker? Also how to give a mark out to the wage seekers group?</th>
</tr>
</thead>
</table>

- Available no of wage seekers in the group is 20 and minimum wage rate is Rs. 200/day/person.

- The amount to be given to the group at the end of the day = 20x200=Rs 4,000/-

- To earn Rs.4,000/-, The quantity of earth work to be done= Amount/Rate=4,000/100= 40 cum.
• Calculate the dimensions of earthwork: Based on area available at the site and dimensions stated in the plan, assume the length of pit 20mt, width 2mt and now the calculate Depth for 40cum of earth work = \( \frac{40}{(20 \times 2)} \) = 1.0mt.

• Mark out the length 20mt with the help of measuring tape and using lime dust

• Draw perpendicular lines on both the ends by using 3X4X5 method and mark out 2 mt width

• Make a template (may be a stick) of 1.0mt for measuring uniform depth of pit

• Keep a reference pillar at the centre of the pit for measurement of height

<table>
<thead>
<tr>
<th>Persons required:</th>
<th>Materials required:</th>
<th>Formula for calculation of dimension:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• BFT-1</td>
<td>• Measuring Tape-1</td>
<td>Amount = Quantity x Rate</td>
</tr>
<tr>
<td>• Assistant-1</td>
<td>• Lime powder</td>
<td>Volume = Length X Breadth X Depth (or height)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If Length and breadth are known, then depth can be calculated by using formula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Depth = Volume / (Length X Breadth)</td>
</tr>
</tbody>
</table>

*Figure 32*
## Job Sheet

<table>
<thead>
<tr>
<th>Marking out the dimensions on the ground for stone pitching the earthen embankment</th>
<th>The process is described through an example: Say a group of 10 wage seekers are available for a day and as per the sanctioned estimate rate for stone pitching at upstream face of an earthen embankment is Rs.300 per Sqm. How much work should be done by wage seeker to get minimum wage rate of Rs. 150/ day. Also give a mark out to wage seekers.</th>
</tr>
</thead>
</table>

**Figure 33**
<table>
<thead>
<tr>
<th>Persons required:</th>
<th>Materials required:</th>
<th>Formula for calculation of dimension:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• BFT-1</td>
<td>• Measuring Tape-1</td>
<td>Amount = Quantity x Rate</td>
</tr>
<tr>
<td>• Assistant-1</td>
<td>• Lime powder</td>
<td>Area = Length X Breadth</td>
</tr>
<tr>
<td></td>
<td>Tools</td>
<td>If Length is known, then width can be calculated by using formula: Width = Area / Length</td>
</tr>
<tr>
<td></td>
<td>Calculator</td>
<td></td>
</tr>
</tbody>
</table>

**Do’s and Don’ts**

1. Be sure that the distance between two points is shortest, to make a straight line.
2. The tape is held tight and horizontal. Follow the 3X4X5 method of drawing perpendicular lines.
Work Book:

1. What are tools and material required to give mark out of works?
   Ans: ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

2. Write the formula for calculating volume of a rectangular pit.
   A n s : ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

3. If a group of 20 labourers are available for a day and as per the sanctioned estimate rate for digging of farm pond in hard soil is Rs.100 per cum. How much work should be done by the group to get minimum wage rate of Rs. 200/ day for every labourer.
   Ans: ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
Notes: Campus / Field Exercise