CE 0732-1202

SURVEYING I LAB

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University of Global Village (UGV), Barishal

BASIC COURSE INFORMATION

Course Title	SURVEYING I LAB
Course Code	CE 0732-1202
Credits	01
CIE Marks	30
SEE Marks	20
Exam Hours	2 hours (Semester Final Exam)
Level	2^{nd} Semester

Course Title: Surveying I Lab

Covered Course: Surveying Sessional

COURSE CODE: CE 0732-1202
CREDIT: 01

CIE MARKS: 30

SEE MARKS: 20

CLO1	**Perform diverse surveying methods, including chain survey, plane table survey, leveling, and contouring, with accuracy and efficiency.**
CLO2	**Interpret and analyze survey data to create topographical maps, elevation profiles, and layout plans for civil engineering projects.**
CLO3	**Apply surveying techniques to solve real-world engineering problems, such as house setting and highway curve alignment.**
CLO4	**Demonstrate the ability to plan and execute survey tasks independently and collaboratively in a team environment.**

SL.	Content of course	Conduct Hours	CLOs
01	Chain Surveying	10	CLO1
02	Plane Table Surveying	10	CLO3
03	Leveling	10	CLO1
04	House Setting	10	CLO2
05	Height Measurement	10	CLO3
06	Highway Curve Setting	10	CLO2
07	Contouring	10	CLO1

REFERENCE BOOKS:

1. B.C. Punmia, 2016, Surveying Volume 1– 16th Edition, Laxmi Pulications (P) Ltd.

2. B.C. Punmia, 2016, Surveying Volume 2– 16th Edition, Laxmi Pulications (P) Ltd.

3. B.C. Punmia, 2016, Surveying Volume 3– 16th Edition, Laxmi Pulications (P) Ltd.

WEEK	TOPIC	TEACHING-LEARNING STRATEGY	ASSESSMENT STRATEGY	CORRESPO-NDING CLOs	PAGE
01-02	Chain Surveying	Lecture, Field Experiment	Individual instrument measuring	CLO1	07-13
03-04	Plane Table Surveying	Lecture, Field Experiment	Individual instrument measuring	CLO3	14-18
05-06	Leveling	Lecture, Field Experiment	Individual instrument measuring	CLO1	19-22
07-08	House Setting	Lecture, Field Experiment	Individual instrument measuring	CLO2	23-25
09-10	Height Measurement	Lecture, Field Experiment	Individual instrument measuring	CLO3	26-30
11-12	Highway Curve Setting	Lecture, Field Experiment	Individual instrument measuring	CLO2	31-34
13-14	Contouring	Lecture, Field Experiment	Individual instrument measuring	CLO3	35-39
15-16	Doubt Solving	Discussion			40-41
17	Final Assessment	Lab Quiz, Practical exam	Written, Viva	CLO1	42-43

ASSESSMENT PATTERN

CIE- Continuous Internal Evaluation (30 Marks)

SEE- Semester End Examination (20 Marks)

SEE- Semester End Examination (40 Marks) (should be converted in actual marks (20))

Bloom's Category	**Tests**
Remember	**05**
Understand	**07**
Apply	**08**
Analyze	**07**
Evaluate	**08**
Create	**05**

CIE- Continuous Internal Evaluation (100 Marks) (should be converted in actual marks (30))

Bloom's Category Marks (out of 100)	Lab Final (30)	Lab Report (10)	**Continuous lab performance** (30)	Presentation & Viva (10)	External Participation in Curricular/**Final Project Exhibition** (10)
Remember/**Imitation**	05		05	02	Attendance 10
Understand/**manipulation**	05	05	05	03	
Apply/**Precision**	05		05		
Analyze/**Articulation**	05		05		
Evaluate/**Naturalisation**	05	05	05		
Create	05		05	05	1

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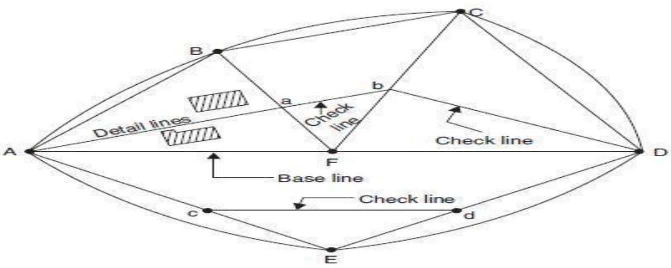
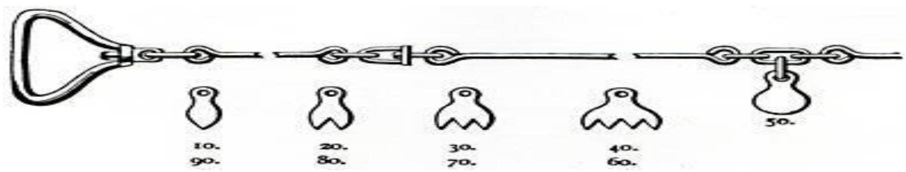
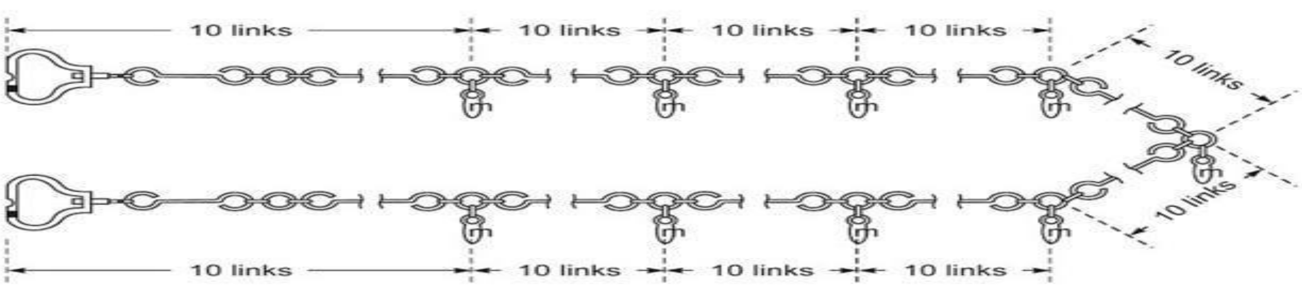
<u>WEEK 01-02</u>

Fieldwork No. 1
CHAIN SURVEYING







Objective: To plot a small area by chain surveying

Theory:

Chain surveying is that type of surveying in which only liner measurements are made in the field. It is a method of surveying in which the area to be divided into a number of triangles. The lengths of the sides are measured and the interior details are recorded. The whole area is then plotted on a drawing sheet to a suitable scale to prepare a map.

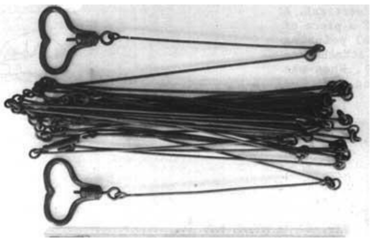
The principle of chain surveying is triangulation. This means that the area to be surveyed is divided into a number of small triangles which should be well conditioned. To divide a small area into a number of triangles, measure the perpendicular distance (offsets) of various objects in the field from the line and record in the field book from which the area can be plotted on a drawing sheet to a suitable scale.

Significance:

Chain survey is the simplest and commonest method used in surveying exercises. Because of its ease of use, it is used during reconnaissance survey as a quick method of surveying to get a rough idea in the location to be surveyed. After participating in this fieldwork students will become more comfortable with handling chain and ranging rods. They will be more aware to obstacles in chaining and ranging and will learn to overcome the difficulties in chaining and ranging.

Instruments:

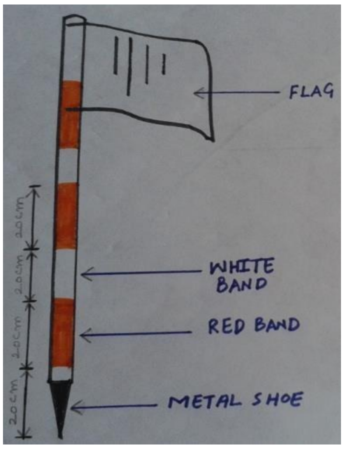
1. Chain (Engineer's chain)
2. Tape
3. Arrows
4. Ranging rod
5. Offset rod
6. Optical square
7. Wooden Hammer
8. Field book
9. Pencil



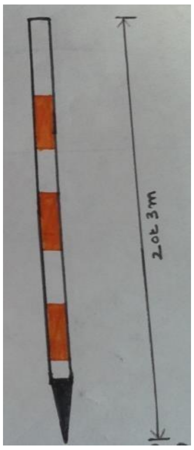
Chain

Tape

Arrow



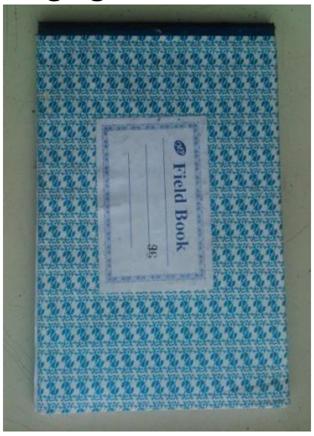
Ranging Rod



Offset Rod

Wooden Hammer

Optical Square



Field Book

Pencil

Figure 1.1: Instruments Used in Chain Surveying

Procedure:

The entire procedure for chain surveying can be divided into three major groups. *a. Field work*

b. Keeping of records in the field book

c. Plotting of data to prepare maps.

a. Field work: It includes reconnaissance, selection of station, measurement of lines and taking offsets of different objects in the field.

i. **Reconnaissance:** Before starting the actual survey measurement, the surveyor will work around the area to fix the base position of survey lines and survey position. During reconnaissance, the surveyor will prepare a rough sketch of the area showing the possible stations and from there the arrangement o different lines.

ii. **Selection of station:** The station should be marked by driving wooden pegs. If possible, every station should be located with respect to three permanent objects.

iii. **Measurement of lines and taking offsets:** After selecting survey station, the chaining will be started from base line. Two ranging rods are fixed on the two station in a survey line and distance is measured with chain. The chain should be properly stretched so that no sag in it. As the measurement proceeds, offsets are taken on the both sides of the survey lines and recorded in the field book. Offsets should be taken in order of their chainages. In this way, all the lines including tie and check lines are measured and offsets taken and recorded in the field book.

b. Keeping of records in the field book: All the details including a rough sketch of different types of stations, offsets etc. in the field are recorded in a book called Field Book. The record keeping starts from the bottom of the end page of the field book.

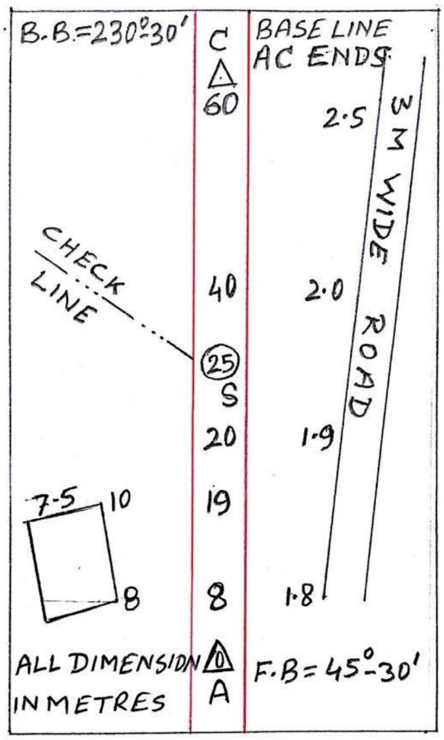


Figure 1.2: Dara records in Field book

c. Plotting of data to prepare maps:

- Before plotting the details of chain survey on a drawing paper, a suitable scale should be chosen first because drawings are prepared to a reduced scale.
- The triangle is first plotted from its known sides according to a suitable reduce scale.
- Then tie lines and check lines are drawn and checked the accuracy of the work.
- Now offsets like building, trees, electric posts etc. lines are taken up one by one.

Types of Chains:

1. Engineer’s chain: 100 feet long, 100 links, 1 feet per link

2. Gunter’s chain: 66 feet long, 100 links, 0.66 feet per link
3. Metric Chain
4. Revenue Chain
5. Steel Band or Band Chain

Field book:
Field book is an oblong book hinged at the narrow edge having a chain represented in it either by one or two red or blue lines ruled down the centre of the length of each page.

Check lines: These lines are selected to check the accuracy of the plotted network of triangles. It joins the apex of a triangle to some fixed point on the opposite side. This can be any other line also, such as joining two fixed points on the sides of the triangle. The measured length should agree with its length on the plotted plan.

Tie Line: This line is selected to pass closer to the details which are otherwise away from the main survey lines to avoid long offsets. This can also be used as a check line at the same time.

Offsets: Offsets are lateral distances measured from the survey lines to the objects or features which are plotted. They can be on either side in the chain. There are two types:
1. Perpendicular offsets
2. Oblique offsets

Well-proportioned Triangle:
There is equal liability of error in all the sides of a triangle; the best form is equilateral triangle. In any case, to get a well-proportioned triangle, no angle should be less than 30˚. The following points should be borne in mind:
1. The number of stations should be minimum and as far as possible, they should form well-conditioned triangles.
2. Inter-visibility of stations should be checked.
3. The framework must have one or two base lines. If possible a “base line” should pass through the centre of the area on which the main network will be based. If two base lines are used, they must intersect in the form of letter X.
4. The lines should be arranged in such a way that the offsets are short in length. If necessary, additional lines should be selected to achieve this objective.
5. The main lines should form well-conditioned triangles.
6. Each triangle or portion of the skeleton should be provided with sufficient check lines.
7. The lines should be selected in such a way as to avoid obstacles in chaining and ranging as far as possible.
8. Lines should pass over level ground, if possible.

Errors in Chaining:

It is always very difficult practically to measure length accurately. The permissible error with a steel tape is 1 in 2000 in a flat country and 1 in 3000 for a rough undulated country. The errors may be either cumulative or compensating. A cumulative error is that which occurs in the same direction and tends to accumulate, while a compensating error may occur in both directions and tends to compensate or cancel one another. Errors are regarded as positive (+) or negative (-) accordingly when they make the result too great or too small.

1. **Erroneous length of Chain or Tape (Cumulative, + or -):** The error due to wrong length of the chain is always cumulative and is the most serious. As stated earlier, if the length of the chain is more, the measured distance is \css, the error is negative and the correction is positive. On the other hand, if the length of the chain is less, the measured distance is more, the error is positive and the correction is negative. However, it is possible to apply proper correction if the length is checked from time to time.
2. **Bad ranging (cumulative, +):** If the chain is stretched out of the line, the measured distance will always be more and hence the error will be positive. For each stretch of the chain, the error will be cumulative and the effect will be too great a result
3. **Careless holding and marking (compensating, ±):** The follower may sometimes hold the handle to one side of the arrow and sometimes to the other side. The leader may not insert the arrow vertically into the ground or exactly at the end of a chain. The error of marking due to an inexperienced chainman is often of a cumulative nature, but with ordinary care such errors tend to compensate.
4. **Bad straightening (cumulative, +):** If the chain is not straight, the measured distance will always be too great. The error is, therefore, of cumulative character and positive.
5. **Non-horizontality (cumulative, +):** If the chain is not horizontal, especially in case of sloping or irregular land, the measured distance will always be too great. The error is therefore of cumulative character and positive.
6. **Sag in Chain (cumulative, +):** If distance is measured by stepping or when the chain is stretched above the ground due to undulations of ground, the chain sags and takes the form of a catenary. The measured distance is, therefore, too great and the error is cumulative and positive.
7. **Variation in temperature (cumulative, + or -):** When a chain or tape is used at a temperature which is more than the temperature at which it was calibrated, its length increases. The measured distance is thus less and the error becomes negative. When a chain is used at a temperature which is less than that at which it was calibrated, its length decreases. The measured distance is thus more and the error is positive. In either case, the error is cumulative.
8. **Variation in pull (compensating, ± or cumulative, + or -):** If the pull applied in stretching a chain or tape is not equal to the standard pull at which it was calibrated, its length changes. If the pull applied is irregular, i.e. sometimes more and sometimes less, the error tends to compensate. However, an inexperienced chainman may apply too great or too small a pull every time and the error becomes cumulative.
9. **Personal mistakes:** Personal mistakes always produce quite irregular effects. The most common mistakes are:
    i. Displacement of arrows: If an arrow is disturbed from its position either by knocking or by pulling the chain, it may be replaced wrongly. The error may be a serious one. To avoid this, a cross must be marked at the point at which the arrow is inserted.

ii. Miscounting chain or tape lengths: This is a serious blunder, but may be avoided if a systematic procedure is adopted to count the number of arrows.
iii. Misreading the chain or tape: A confusion is likely between reading a 5 m tally or a 15 m tally, since both are of similar shape. A-chainman may pay more attention on the cm reading on the tape and make the meter reading wrong. A surveyor may sometimes read 6 in place of 9 or 12.46 in place of 12.64. This type of mistakes may be sometimes very serious.

10. **Erroneous booking:** The surveyor may enter 246 in place of 264, etc. To avoid such possibility, the surveyor should first speak out the reading loudly and the surveyor should repeat it while entering in the field book.

Corrections for Linear Measurements:

We have seen the different sources or errors in linear measurements. For most of the errors, proper corrections can be applied. In ordinary chaining, however, corrections arc not necessary, but in important and precise works, corrections must be applied. Since in most of the case a tape is used for precise work, the corrections arc sometimes called as "tape corrections", though they can also be applied to the measurements taken with a chain. For precise measurements, the following corrections are made:

1. Correction for Standardization
2. Correction for Slope
3. Correction for Temperature
4. Correction for Pull or Tension
5. Correction for Sag

Chain surveying is recommended when:

1. The ground surface is more or less level 2.
A small area is to be surveyed
3. A small-scale map is to be prepared and
4. The formation of well-conditioned triangles is easy

Chain surveying is unsuitable when:

1. The area is crowded with many details
2. The area consists of too many undulations
3. The area is very large and
4. The formation of well-conditioned triangles becomes difficult due to obstacles

Assignments:

(a) Plot the interior details of the area surveyed in a drawing sheet. (b)
Viva-voce.

Instruction: Drawing has to be submitted individually.

WEEK 03-04

Fieldwork No. 2
PLANE TABLE SURVEYING

Objective: Plotting interior details like trees, buildings, lamp posts using Plane Table surveying.

Theory:

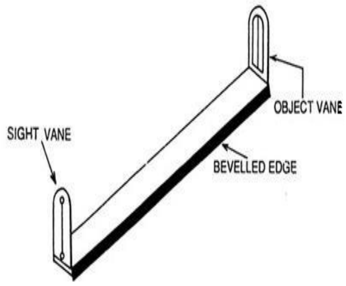
It is a method of surveying in which observations and plotting are done simultaneously. To plot various object like buildings, tress, roads, electric poles or any other permanent object on the drawing sheet by visual observations.

Significance:

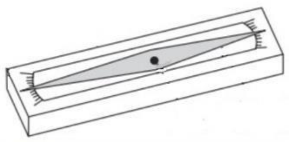
Plane table surveying is used when the ground is not level and smooth, or when distances are so large that they cannot be measured with single tape. After participating in this fieldwork students will become more comfortable with handling alidade. This survey is most suitable for small scale maps.

Instrument:

a. Drawing Board
b. Tripod stand
c. Alidade
d. Trough Compass
e. Plumb bob
f. Plumbing fork or U fork
g. Spirit Level
h. Tape or Chain
i. Drawing Sheet
j. Scotch tape



Drawing Board with Tripod Stand **Alidade** **Drawing Sheet**



Trough Compass **Plumb Bob** **Plumbing Fork** **Spirit Level** **Scotch Tape**

Figure 2.1: Instruments used in Plane Table Surveying

Procedure:

(i) Setting up the table:

- The table is placed over the station A. and centered with the help of the plumb bob in such a way that the point on the drawing sheet should be vertically above station A on the ground.
- Putting a spirit level at any position on the table now levels the table. At every position on the table the bubble should be always at the centre of its run. If not, then adjusting the legs of the tripod does this. In case the spirit level is not available, approximately a round shapes wooden pencil can be used to level the table. The pencil should remain fixed at any position on the table if it leveled.

(ii) Orientation:

- The table is set up over station A. Now a trough compass is placed at one corner of the drawing sheet and moved in such a way that the needle assumes its normal North-South position.
- A line drawn along the longer edge of the compass and arrow is put at the north end. The table is now oriented with respect to the magnetic meridian.
- When the tables is placed over any other station, the trough compass is placed with its longer edge in coincides with the previously drawn N-S line. The table is now rotated until the needle assumes its normal N-S direction.
- Then the screw clamps the table. Now the table is oriented over that station. Since the magnetic needle is subjected to the influence of local attraction, it is not a very accurate method.

<u>Practical Points for Consideration:</u>

1. Levelling the table:

Approximate leveling is done by adjusting the legs of the tripod. The table is kept a few centimeters lower than the observer's elbows when standing in a comfortable position for convenience in drafting, and in order to press down the table on the stand, which might disturb its level. The table is first placed in such a way that it is approximately oriented and centered. The leveling is then completed either by spirit level (in two perpendicular positions), by adjusting the leveling screws if available, or with the ball-and-socket joint of the tripod, if any.

2. Orienting the table:

This involves positioning the table in such a manner that all lines on the are parallel to the corresponding lines on the ground (i.e. lines on the paper and lines on the ground are on the same vertical plane). This is essential when there is more than one station, else wrong positions of the stations will be obtained. The table may be oriented by (1) compass, (2) back sighting or (3) resection.

3. Centering the table:

This involves setting the point on the paper vertically above the corresponding ground station using plumb fork. If the plotted point representing the ground station lies on the vertical axis of the plane table, its position does not change when the table is turned about this axis during the orienting operation, otherwise it gets shifted.

In other words, the operation of orienting and centering are interrelated; if perfect centering is called for, repeated orienting and centering may be required.

Methods of Plane Tabling:

a. Radiation b. Intersection c. Traversing d. Resection

Errors in Plane Tabling:

The errors include:

1. Instrumental errors: errors due to bad quality of the instrument. This includes all errors described for theodolite, if telescopic alidade is used.
2. Errors in plotting
3. The expansion and contraction of the drawing sheet.
4. Error due to manipulation and sighting.

Uses of Plane Tabling:

1. To conduct complete surveys for topographical work and for explanatory and reconnaissance surveys.
2. To pick up details after control points have been fixed by more precise surveys, such as tacheometric or photogrammetric surveys.

Intersection Method:

In this method an object is located on the drawing sheet by the intersection of the rays or lines drawn from two stations. This is the swiftest method of locating an object, which is inaccessible. In these methods no linear measurement except the base line is required.

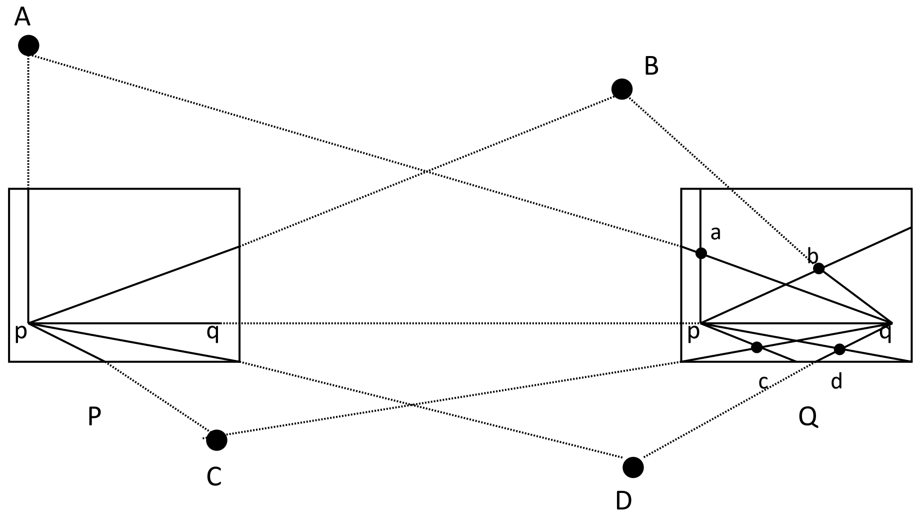


Figure 2.2: Intersection Method

As shown in Fig. 2.2, the base line connecting two points P and Q on the ground is measured. The line is selected in such a way that maximum number of objects in the fields is visible from both P and Q. The plane table is set over the station P, leveled, centered and oriented. From point P, on the drawing sheet rays of the object A, B, C and D are drawn by the alidades. Now the table is placed over station Q and oriented with respect to QP. From this point Q again rays of the same object are drawn with the alidade. The positions of the objects A, B, C and D are obtained on the drawing sheet as a, b, c and d respectively when the rays from q cut the corresponding rays from p.

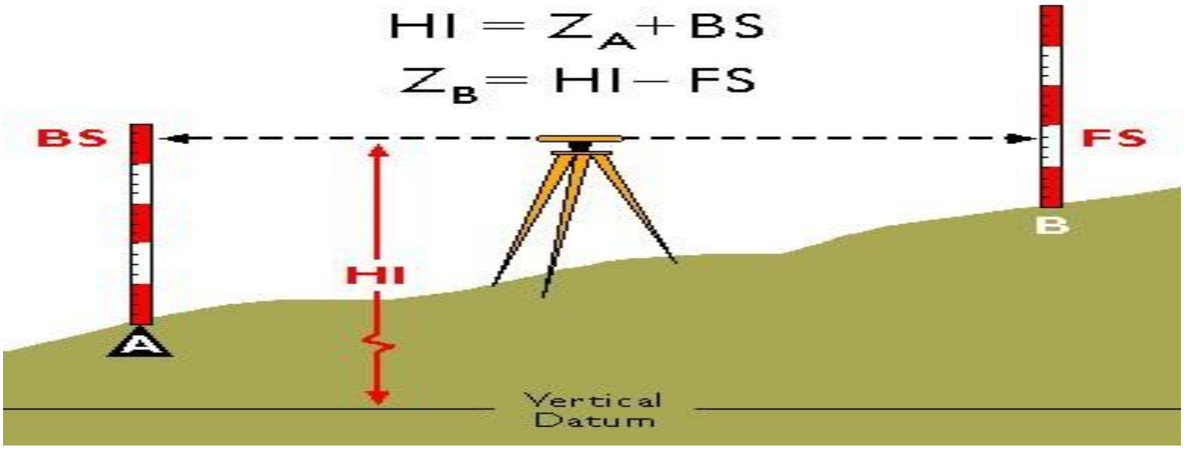
Advantages of Plane Tabling:

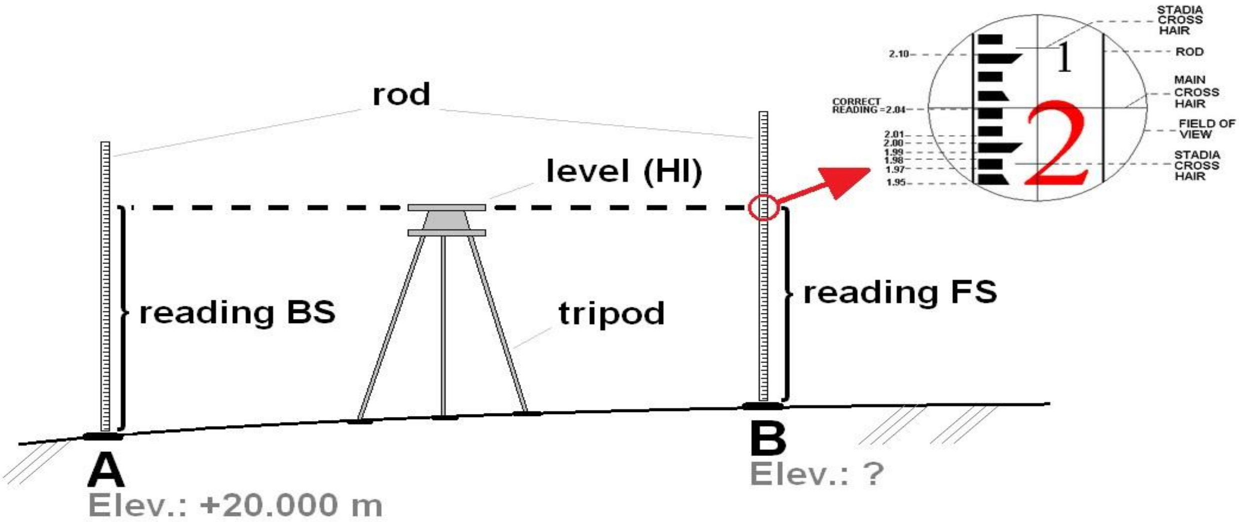
1. There is no possibility of omitting necessary measurements.
2. Surveyor can compare plotted work with actual features of the area.
3. Contour and irregular objects may be represented accurately.
4. It obviates most direct measurements in field. Measurement notes are seldom required, and potential for booking mistakes is eliminated.
5. It is useful in magnetic areas where compasses might not yield accurate readings.
6. It is simple, cheap and does not require much skill to produce satisfactory map.
7. It is most suitable for small scale maps.

Instruction: The final output (drawing) of the features identified on site will be drawn on site. There will be one file from each group.

WEEK 05-06

Fieldwork No. 3
LEVELING





Objective:
To determine the reduced level of different points on the ground

Methodology:
(a) Line of Collimation Method / Height of Instrument Method
(b) Rise and Fall Method

Significance:
Leveling helps the surveyor or cartographer to make contour maps of the land sea surface. This is because it determines the benchmark. It helps pipe transport engineers to ensure appropriate slope of the land that will allow smooth movement of the liquid in the transit e.g water and liquid. In addition, it helps contractors to lay a level ground on which they can elect the building. Besides, it is vital to the construction of routes of transport like roads and railways.

Instrument:
1. Level
2. Leveling Staff
3. Tape or chain
4. Leveling field book (optional)

Figure 4.1: Level

Definitions:
(a) Mean Sea-Level: It is the average elevation of the surface of the sea. In Bangladesh, the mean sea-level at Cox's Bazar is taken as zero.

(b) Datum: It is an imaginary surface with respect to which the heights of different points on the earth surface are determined.

(c) Reduced Level: The reduced level of a point is its vertical distance above or below the datum.

(d) Bench Mark: A bench mark is a fixed point on the ground of known elevation.

(e) Height of the instrument: The elevation of the line of collimation above datum is termed as the height of the instrument.

(f) Level Surface: Any surface parallel to the mean spheroid of the earth is called a level surface and the line drawn on the level surface is known as a level line.

(g) Horizontal surface: Any surface tangential to the level surface at a given point is called a horizontal surface. It is the surface defined by the bubble tube.

(h) Vertical Line: The vertical line is the plumb line at that point.

(f) Station: A station is a point whose elevation is to be determined.

(g) Change point/ Turning Point: It is an intermediate station on which two readings are taken while the position of the instruments is shifted.

(h) Back, Inter and Fore readings: In any set up of the leveling instrument, the first staff reading on a station is termed as back reading (B.R.) and the last staff reading on a station is termed as the fore reading (F.R.) and the reading on the intermediate stations are termed as inter readings (I.R.)

Procedure:

(a) Select any suitable place for setting up the instrument. Place the instrument and try to adjust it. Adjustment procedure should be consist of the followings,
(i) Setting up the level (ii) Leveling up (iii) Elimination of parallax
(b) Consider the station A as Bench Mark whose elevation is 7.00 m
(c) Take staff reading at every station. Mind it at change point (station E) you have to take both back and fore readings.

Errors in Leveling:

1. Instrumental errors (level, bubble tube, staff)
2. Personal errors (errors in reading the staff, errors in recording and computing, errors in sighting and defective focusing, etc.)
3. Errors due to natural causes

Assignments:

(a) Find out the reduced levels of the above points by both methods,
Group 1 : Line of Collimation Method
Group 2 : Rise and Fall Method

(b) Check your result using the following formula: Sum of Back Reading – Sum of Fore Reading = Total Rise – Total Fall = Last R.L. – First R.L.

(c) Draw the profile of the earth surface through this points

(d) If you want to make a road whose elevation is average of the minimum and maximum stations elevation, then show the filling and cutting areas by giving hatch lines on your graph.

(e) Compare the two methods.

(f) Viva-voce

Example of a Data Sheet:

Elevation of Bench Mark (B.M.): 7.00 m (which is the average elevation of Dhaka city)

Station	**Distance (m)**	**Staff Reading at station**			**H. I.**	**Difference**		**Reduced Level (m)**	**Remarks**
		Back (m)	**Inter (m)**	**Fore (m)**		**Rise (m)**	**Fall (m)**		
A	0								B.M.
B	15								
C	30								
D	45								
E	60								Change Point
F	75								
G	90								
H	100								

H.I.: Height of the Instrument

Exam questions: Your exam questions will be given completely on your job.

Submission:

(i) A completed table of showing the Reduced Levels of points measured. (ii) A graph showing the vertical ground profile of area investigated.

Instruction: File has to be submitted individually.

WEEK 07-08

Fieldwork No. 4.
HOUSE SETTING

Objective:
To mark the excavation lines, centre lines of all the columns of the plan of a proposed building on the actual site of work as per plan of the building to facilitate earth cutting.

Requirements:
Detailed plan and drawings of the building and site plan of the area are required. Site plan and detailed plan should be studied thoroughly. These drawings are commonly known as "Foundation Trench Plan" or "Lay-out Plan".

Significance:
House setting is the first step in excavation of earthwork for any construction. After participating this fieldwork

Materials required:
1. Strings
2. Wooden Pegs
3. Lime powder

Procedure:
- (i) First locate any back corner on the ground of the plan.
- (ii) Then establish the two lines intersect at that point by inserting pegs on the ground at some distances (say 6 ft). Check with 3-4-5 rule.
- (iii) Fixed other two exterior lines.
- (iv) Check the diagonals after fixing the perimeter of the building. (v) All the pegs lie on the column line are driven at equal distances (vi) Intersection of rope indicates the position of the column.
- (vii) Mark the excavation lines on the ground with the help of lime powder.
- (viii) Check the diagonals of all grids and adjust if necessary.
- (ix) Mark the plinth level
- (x) From the plinth level fixed the depth of the footings by using water level at two points.

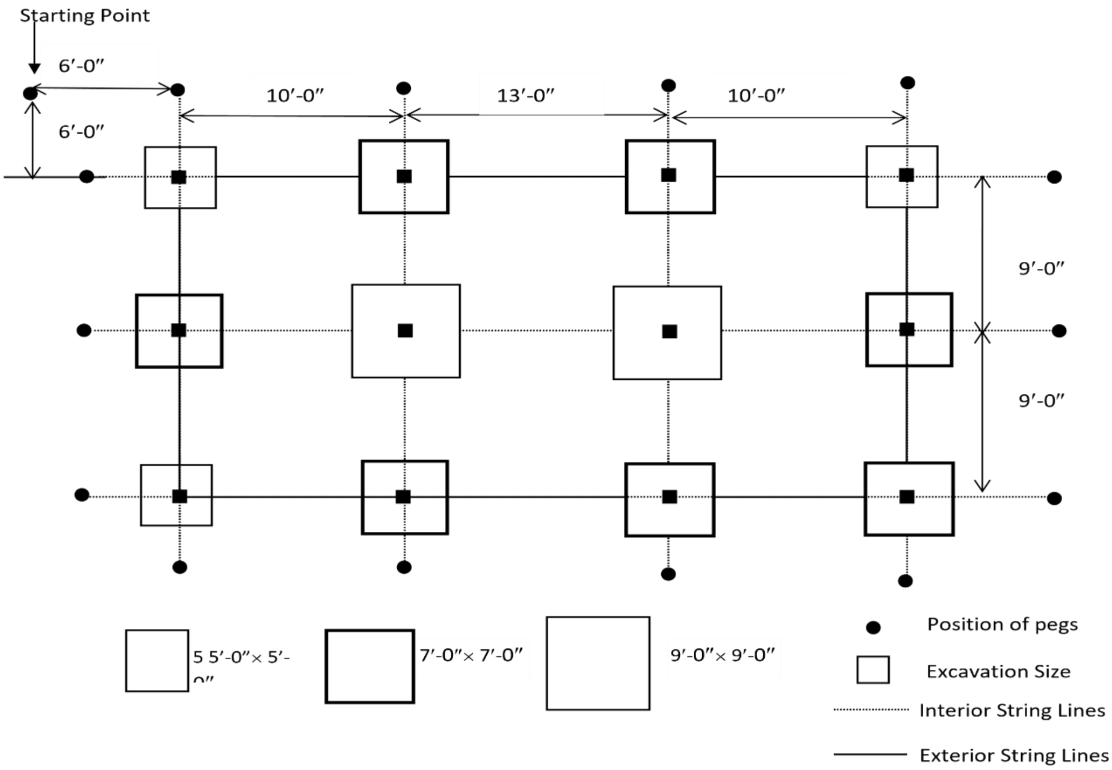
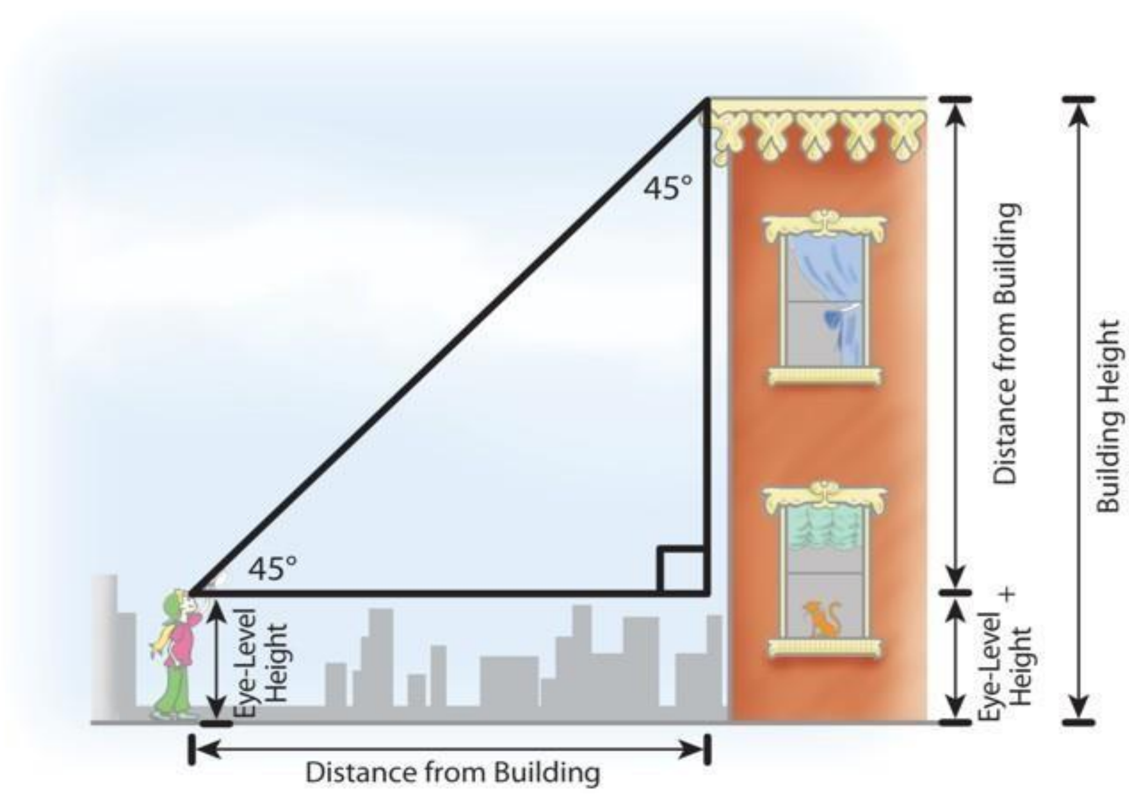


Figure 5.1: Foundation Trench Plan

WEEK 09-10

Fieldwork No. 5

HEIGHT MEASUREMENT



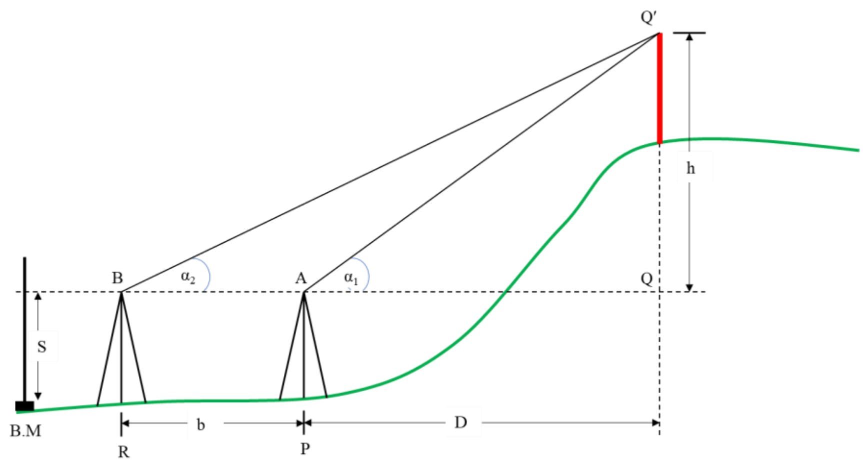
Objective: To determine the height of a tower by Trigonometric Leveling.

Instrument:

1. Theodolite
2. Staff
3. Measuring Tape
4. Arrow/ peg
5. Ranging rod

Base of the object inaccessible: Instrument stations in the same vertical plane as the elevated object

If the horizontal distance between the instrument and the object can be measured due to obstacles etc., two Instrument stations are used so that they are in the same vertical plane as the elevated object.



Figure[1] 7.1: Instrument axes at the same level

Procedure:

Procedure:

1. Set up the theodolite at P and level it accurately with respect to the altitude bubble.

2. Direct the telescope towards Q′ and bisect it accurately. Clamp both the plates. Read the vertical angle α_1

3. Transit the telescope so that the line of sight is reversed. Mark the second instrument station R on the ground. Measure the distance RP accurately. Repeat steps (2) and (3) for both face observations. The mean values should be adopted.

4. With the vertical vernier set to zero reading, and the altitude bubble in the centre of its run, take the reading on the staff kept at the nearby B.M.

5. Shift the instrument to R and set up the theodolite there. Measure the vertical angle $\alpha 2$ to Q′ with both face observations.

6. With the vertical vernier set to zero reading, and the altitude bubble in the centre of its run, take the reading on the staff kept at the nearby B.M.

In order to calculate the R.L of Q′, there can be three cases:

(a) When the instrument axes at A and B are at the same level.

(b) When they are at different levels but the difference is small,

(c) When they are at very different levels.

Case (a); i.e., Instrument axes at the same level (Fig. 7.1)

Let h = QQ′

α_1= Angle of elevation from A to Q′

α_2 = Angle of elevation from B to Q′

S =staff reading on B.M., taken from both A and B, the reading being the same in both the cases.

b = horizontal distance between the instrument stations.

D = horizontal distance between P and Q

From triangle AQQ′, $h= D \tan \alpha_1$ …………….(9.1)

From triangle BQQ′, $h= (b + D) \tan \alpha_2$………..(9.2)

Equating (9.1) and (9.2) $\Rightarrow D \tan \alpha_1 = (b + D) \tan \alpha_2$

$\Rightarrow D = b \tan \alpha_2/(\tan \alpha_1 - \tan \alpha_2)$

$\therefore h = D \tan \alpha_1 = b \tan \alpha_1 \tan \alpha_2/(\tan \alpha_1 - \tan \alpha_2)$

R.L. of Q′ = R.L. of B.M. + S + h

Case (b); i.e., Instrument axes at the different level (Fig. 7.2)

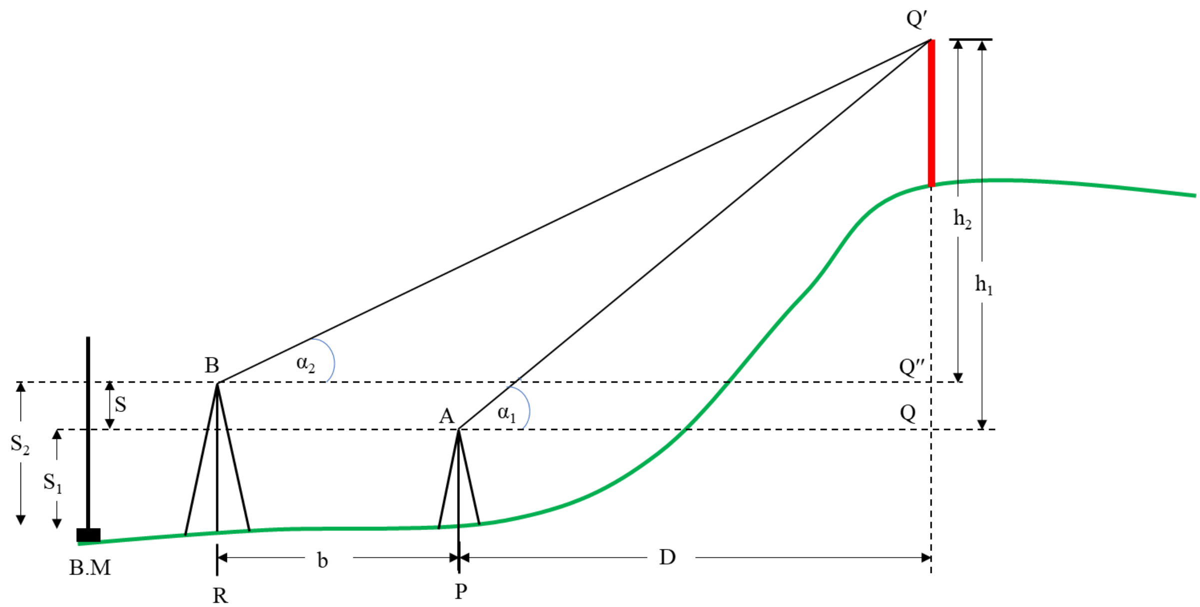


Figure 7.2: Instrument axes at the different levels

Let h_1 = QQ′
α_1= Angle of elevation from A to Q′
α_2 = Angle of elevation from B to Q′
S = Difference of staff readings on B.M., taken from both A and B
b = horizontal distance between the instrument stations.
D = horizontal distance between P and Q

D= $\boldsymbol{s+b\ tan\alpha 2/tan\alpha 1-tan\alpha 2}$

$h1 = D\ \boldsymbol{tan1}$

∴ $\boldsymbol{h1 = s\ tan\alpha 1 + b\ tan\alpha 1 tan\alpha 2/tan\alpha 1 - tan\alpha 2}$

R.L. of Q′ = R.L. of B.M. + S_1 + h_1

Data Sheet:

Reduced level of bench mark: 0.00 m

Sl. No	Parameters	Value
01		
02		
03		
04		
05		
06		

Assignments:

1. Height of the building.
2. Height of the flagpole.
3. Compare your result with the actual values.
4. Write some benefits of this method

UNIVERSITY OF GLOBAL VILLAGE

WEEK 11-12

Fieldwork No. 6

HIGHWAY CURVE SETTING

Objective: Setting out a simple circular curve in the field by a linear method and checking it by an angular method.

Theory:
Curves are generally used on highways and railways where it is necessary to change the direction of motion. A curve may be circular, parabolic or spiral and is always tangential to the two straight directions. There are three types of circular curves:
(i) Simple Curve, (ii) Compound Curve and (iii) Reverse Curve.

Simple Curve: A simple curve is the one that consists of a single arc of a circle.

T_1 = Point of Curve (P.C.)

T_2 = Point of Tangency (P.T.)

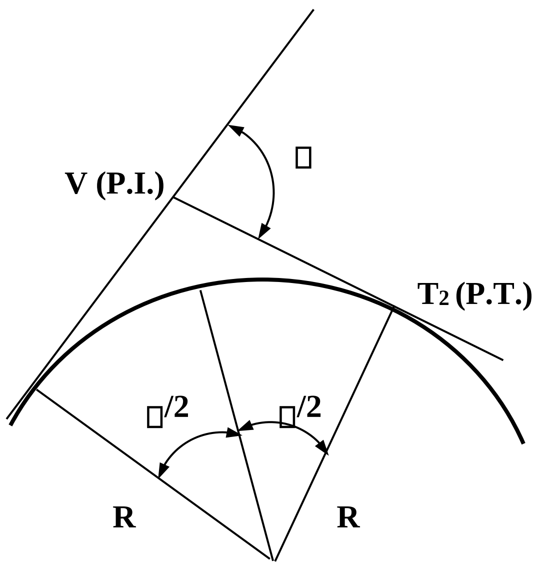
V = Point of Intersection (P.I.)

Δ = Deflection Angle

D = Degree of Curvature

Radius of Curvature, R ≅ 5730/D

Length of Curve, *l* = 100 Δ/D



T1 (P.C.)

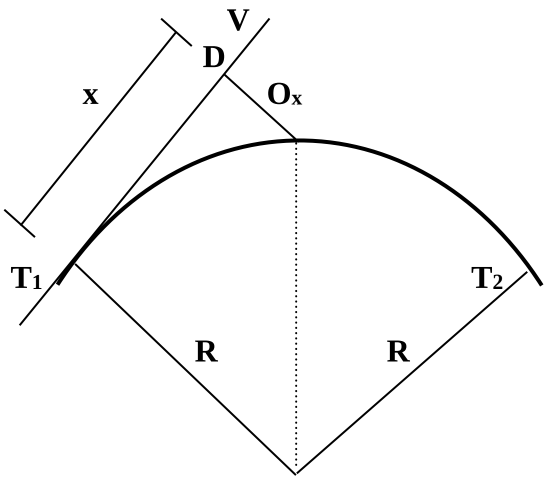
O

Figure 6.1: Elements of Simple Circular Curve

Depending on the instruments used, there are two main methods for setting out of Simple Curves; i.e., (i) Linear methods and (ii) Angular methods.

Super-Elevation, e = B (s – f)/(1+ s f)
where s = v2/gR, f = Friction Factor,
v = Maximum speed of vehicle,
g = Acceleration due to gravity

One of the linear methods is by **Perpendicular Offsets from Tangents**



Perpendicular Offset, Ox = R–√(R2–x2)

x = Distance along the tangent from P.C.

R = Radius of Curvature

$T_1V = R \tan(\Delta/2)$

$T_1T_2 = 2R \sin(\Delta/2)$

Figure 6.2: Linear Method by Perpendicular Offsets from Tangents

One of the angular methods is **Rankine's Method of Tangential (or Deflection) Angle**.

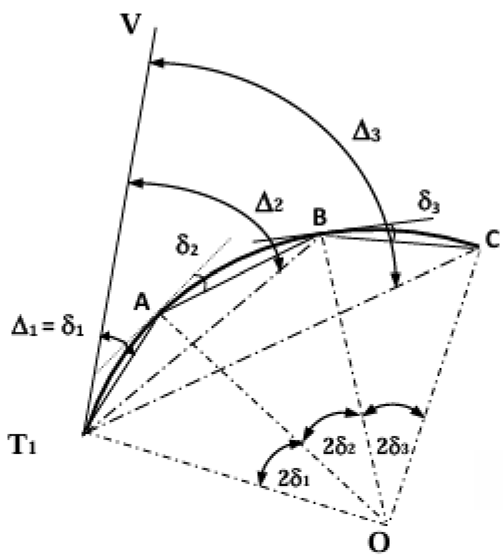


Figure 6.3: Angular (Rankine's)

T1V = Rear Tangent
δ1, δ2, δ3…..= The Deflection angles or the angles which each of the successive cords T1A, AB, BC…..make with the respective tangents to curve at T1, A, B, C…...
Δ1, Δ2, Δ3…. = Total tangential angles or the deflection angles to points A, B, C…...
C1, C2, C3 …= Lengths of the cord T1A, AB, BC..…..

δ1 = 1718.9 C1/R (mins), δ2 = 1718.9 C2/R (mins), δ3 = 1718.9 C3/R (mins) …...

Δ1= δ1, Δ2= Δ1 + δ2, Δ3= Δ2 + δ3 ………………….. Δn= Δn-1 + δn

Significance:

After participating in this fieldwork, students will learn how to mark areas of the ground and in what proportions for setting out circular curve using data from 2 intersecting straight portions of different roads. Students will set the curve and check it following engineering principles. In particular they will set the curve using Perpendicular Offset Method and check for accuracy of points set using Rankine's Method.

Instruments:

Theodolite, Rope, Pegs (e.g., bamboo, steel), Tape.

Procedure:

Method of Perpendicular Offsets from Tangents
(i) Measure distances x1, x2, x3 …..…… from the first tangent point T1 along the tangent
(ii) Set perpendicular offsets Ox at the corresponding point.
(iii) Set the Super-elevation along the road width.
Check by Rankine's Method of Tangential Angle
(iv) Set the theodolite at T1 along the back tangent VT1

(v) Rotate it to the pegs at A, B, C……, measure the successive cord distances C1, C2, C3 ……… and deflection angles Δ1, Δ2, Δ3 ……..

(vi) Compare the deflection angles with the calculated deflection angles.

Data:

Deflection angle, Degree of curvature, Cord interval for circular curve, Super-elevation, Road width, Maximum speed of vehicle.

Submission:

Detailed calculation for necessary data and drawing using
(i) Perpendicular offsets from tangents, (ii) Rankine's Method

WEEK 13-14
Fieldwork No. 7
CONTOURING

Objective: To draw a contour map

Methodology: Square or Grid System

Instruments:

1. Level
2. Leveling Staff
3. Arrows
4. Tape

Definitions:

(a) Contours: Contours are imaginary lines joining points of equal altitudes upon the earth's surface with reference to a fixed datum.

(b) Contouring: The process by which a contour map is prepared is known as contouring.

(c) Contour map/topographic map: The map showing the altitudes of all these points is called contour map or topographic map.

Procedure:

(a) Select any suitable place for setting up the instrument. Place the instrument and try to adjust it. Adjustment procedure should be consist of the followings,
(i) Setting up the level (ii) Leveling up (iii) Elimination of parallax

(b) Mark an area of 100 m2; i.e., length 10 m and width 10m.

(c) Take staff reading at every station at an interval of 2.5 m. (e.g. 2.5 m × 2.5 m grid). The grid points are determined using tape, and marked using arrows.

(d) Take the elevation of top left corner as 7.00 m (A-1) which may be considered as bench mark.

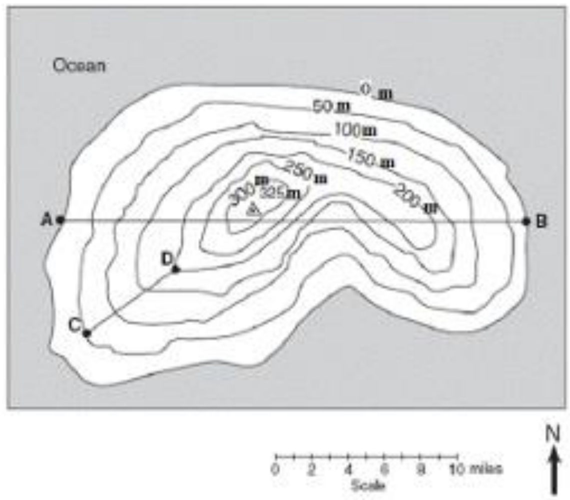


Figure 9.1: Typical Contour Diagram

Significance:

Contouring helps in studying the general character of the tract of the country without visiting the ground. With the knowledge of characteristics of contours, it is easy to visualize whether country is flat, undulating or mountainous. Contouring can assist in deciding the sites for engineering works such as reservoirs, canals, roads and railways etc. on the basis of the economy. Contouring is used to determine the catchment area of the drainage basin and hence capacity of the proposed reservoir. It is useful in computing the earth work required for filling or cutting along the linear alignment of the projects such as canals, roads, etc. In addition the height of earth retaining structures (e.g. retaining walls) can be easily estimated. Contouring is also used to find out the inter-visibility of the points and to trace out a contour gradient for road alignments. Besides, we can draw longitudinal and cross- sections to ascertain nature of the ground. Through this fieldwork students will learn about procedures of collecting data for contour maps, using level and tape. Students will also learn about the procedures to draw contour maps.

Data Sheet:

Station	Distance (m)	Staff Reading at station			H. I.	Difference		Reduced Level (m)	Remarks
		Back (m)	Inter (m)	Fore (m)		Rise (m)	Fall (m)		
A1									B.M.
A2									
A3									
A4									
A5									
B1									
B2									
B3									
B4									
B5									
C1									
C2									
C3									
C4									
C5									
D1									
D2									
D3									
D4									
D5									
E1									
E2									
E3									
E4									
E5									

Contour Map:

WEEK 15-16

DOUBT SOLVING

WEEK 17

FINAL ASSESSMENT