Department of

CIVIL AND ENVIRONMENTAL ENGINEERING

CEE213L

Surveying & Introduction to GIS Lab

SURVEYING LABORATORY

NORTH SOUTH UNIVERSITY

Center of Excellence in Higher Education

The First Private University in Bangladesh

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North South University
Department of Civil and Environmental Engineering

CEE213L: SURVEYING AND INTRODUCTION TO GIS LAB

Field Works No.	Name of the Field Works
1	A small plot is to be surveyed by chain surveying.
2	A small area is to be surveyed by plane table surveying.
3	Elevation of different points on the ground is to be calculated to draw a Contour map.
4	A small area is to be surveyed by Tacheometry.
5	Height of a building/tower is to be measured by trigonometric leveling.
6	A small plot bounded by a polygon is to be surveyed by theodolite traversing.
7	A simple circular curve is to be set in the field.
8	House Setting
9	Global Positioning System (GPS)
10	Total Station

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CEE 213L SURVEYING & INTRODUCTION TO GIS LAB
WORKBOOKS FOR LABORATORY PRACTICE

FIELD WORK NO: 01
A SMALL PLOT IS TO BE SURVEYED BY CHAIN SURVEYING

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

FIELD WORK NO: 01

A SMALL PLOT IS TO BE SURVEYED BY CHAIN SURVEYING

THEORY:

Chain surveying is the type of surveying in which only linear measurements are made in the field. The main principle of chain surveying or chain triangulation is to provide a framework consist of number of well-conditioned triangles or nearly equilateral triangles. Chain survey is suitable in the following cases:
(i) Area to be surveyed is comparatively small (ii) Ground is fairly level (iii) Area is open and (iv) Details to be filled up are simple and less.

In chain surveying only linear measurements are made i.e. no angular measurements are made.

PROBLEM DESCRIPTION:

After selecting proper stations, the students will divide the area into a number of triangles. They should use base line, tie line and at least one check line. The students will measure the lines, take offsets of different objects in the field and enter the data in the field book. Using the record on the field book, the students will plot the area with adjacent details in a drawing sheet.

INSTRUMENTS:

a) Chain b) Tape c) Ranging rod d) Arrow e) Optical square f) Wooden hammer g) Field book h) Trough compass

PROCEDURE:

- Form a triangle in the field. Every station should be located with respect to three permanent objects.

- Measure the bearing of one side of the triangle.

- Measure the survey lines using chain or tape. Chaining should be started from base line.

- Take offsets on the both sides of the survey lines and keep record on the field book (including tie line and check line).

- Plotting of the area-
  - Select a suitable scale to fit the surveyed area on your drawing paper.
  - Plot the triangle from its known sides.
  - Draw tie and check line to check the accuracy of field work.
  - Draw offsets like trees, posts etc one by one from field book record.

SUBMISSION:

- Plot the surveyed area on a drawing sheet showing interior details. (Individual Submission)
- Field book Pages.

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WORKBOOKS FOR LABORATORY PRACTICE

FIELD WORK NO: 02
A SMALL AREA IS TO BE SURVEYED BY PLANE TABLE SURVEYING

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

FIELD WORK NO: 02

A SMALL AREA IS TO BE SURVEYED BY 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. 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.

PROBLEM DESCRIPTION:

The students will use the same area surveyed before by chain surveying. The area should be covered by at least two plane table stations. The details of the field are to be plotted by intersection method.

INSTRUMENTS:

a) Plane table (drawing board) b) Tripod c) Alidade d) Plumbing fork e) plum bob f) Spirit level g) Trough compass h) Tape I) Drawing sheet

PROCEDURE:

- Select the plane table stations (Let, P and Q).
- Measure the base line PQ connecting two stations.
- Attach drawing sheet on the plane table and place the table over the first station, p.
- Using a plumbing fork and plumb bob, station P can be centered on the drawing sheet in such a way that the marked point on the drawing sheet P is vertically above the station P on the ground.
- Level the table using a spirit level.
- Place a trough compass at one corner of the drawing sheet. Move/Rotate the table in such a way that the needle marking north direction point towards the top of the drawing sheet.

- Draw a line along the longer edge of the trough compass and put an arrow at the north end. Thus the table will be oriented with respect to magnetic meridian.

- From point p on the drawing sheet, draw rays along the line of sight for different objects; say 4, B, C and D by the alidade.
- Move the table to station Q. Repeat the same procedure of centering, leveling and orientation as done before for station P. The table at station Q should also be oriented with respect to PQ.

- From point q, draw rays along the line of sight for object A, B, C and D using the alidade.

- The position of the objects A, B, C and D will be obtained on the drawing sheet as a, b, c and d respectively, when the rays from q will cut the corresponding rays from p.

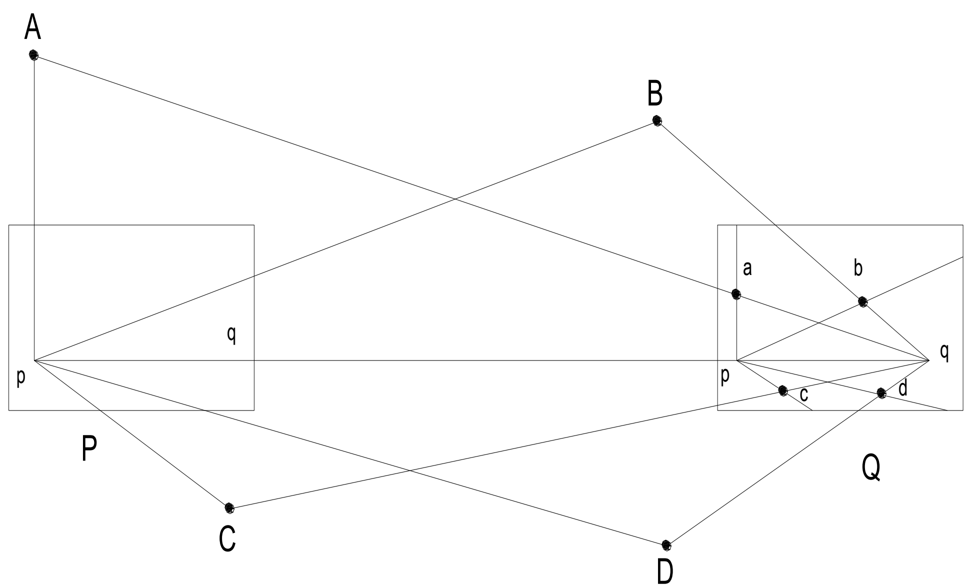

Figure: Plane Table surveying by Intersection Method

SUBMISSION:

- Attached a drawing sheet on the plane table. (A1 Paper)
- Group Submission.

DRAWING PAPER OUTLINE:

All submission/drawing/map/plan must have the following items:

0.5 inch border

N-S Line

Scale

Group & Student No.: [For group submission , Include all active group members ID]	Course Code: Title of Surveying: Date of Performance: Date of Submission:	Title of the Legends:

0.5 inch border

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WORKBOOKS FOR LABORATORY PRACTICE

FIELD WORK NO: 03
ELEVATION OF DIFFERENT POINTS ON THE GROUND IS TO BE CALCULATED TO DRAW A CONTOUR MAP

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

FIELD WORK NO: 03

ELEVATION OF DIFFERENT POINTS ON THE GROUND IS TO BE CALCULATED TO DRAW A CONTOUR MAP

THEORY:

Contour An imaginary line on the ground surface joining the points of equal elevation is known as contour. It facilitates depiction of the relief of terrain in a two dimensional plan or map. In other words, contour is a line in which the ground surface is intersected by a level surface obtained by joining points of equal elevation. This line on the map represents a contour and is called contour line. Contouring is the science of representing the vertical dimension of the terrain on a two dimensional map.

PROBLEM DESCRIPTION:

The students will select a suitable plot (15m x 15 m) in the field. They will have to represent the contour map by grid system. In each direction there should be minimum 5 grid lines. The side of the grid should not exceed 5 m. The contour interval should be taken in such a way that at least 5 contour lines could be drawn in the map.

INSTRUMENTS:

a) Level b) Tripod c) Leveling staff d) Tape e) Arrow f) Rope

PROCEDURE:

- Select any suitable position for setting up the level. Place the level and try to adjust it.
- Complete centering and leveling of the level.
- Set the grid system using rope and arrow.
- Start the leveling from a Bench Mark specified by your teacher.
- Take staff readings at every station and record them simultaneously in a level book.
- Find out the reduced levels of all the stations by the line of collimation and rise and fall method.
- Select a suitable contour interval so that minimum 5 contour lines can be drawn within the area.
- Draw contour lines.

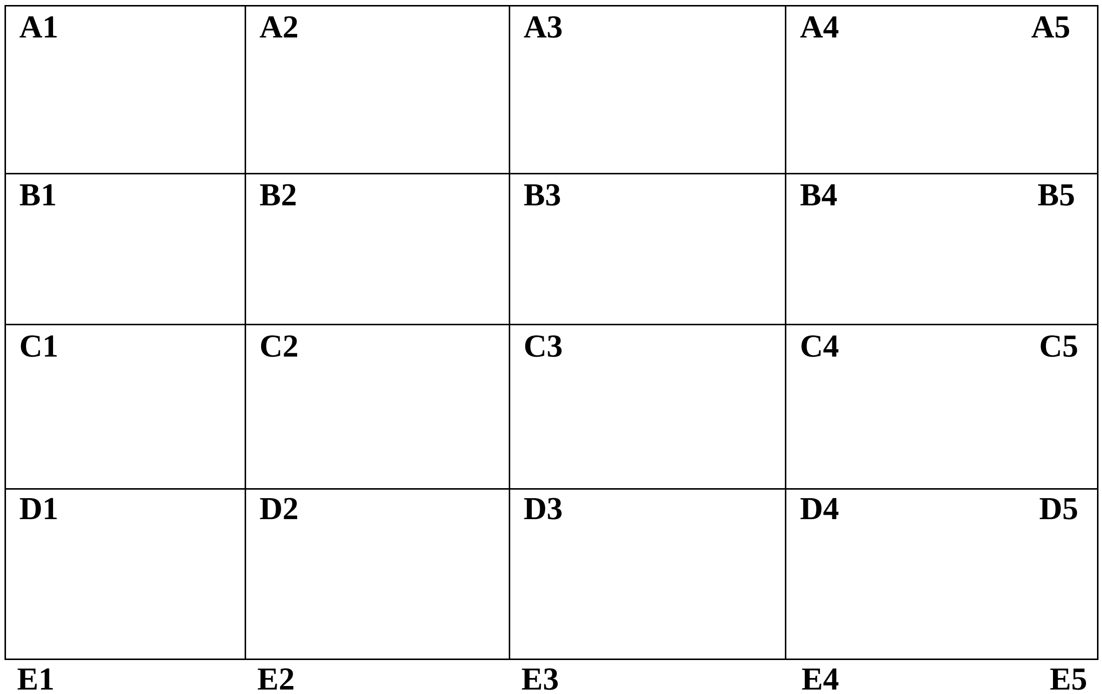

Figure: Grid System

SUBMISSION:

- Calculate the reduced levels and complete the data sheet. (Individual Submission)
- Prepare a contour map on a drawing sheet. (Individual submission)

DATA SHEET:

Station	Staff Reading (cm)			HI	RL (m)	Rise	Fall	RL (m)	Remarks
	BR	IR	FR						
Given Data								0.5	BM
A1									
A2									
A3									
A4									
A5									
B1									
B2									
B3									
B4									
B5									
C1									
C2									
C3									
C4									
C5									
D1									
D2									
D3									
D4									

D5									
E1									
E2									
E3									
E4									
E5									

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FIELD WORK NO: 04
A SMALL AREA IS TO BE SURVEYED BY TACHEOMETRY

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

FIELD WORK NO: 04

A SMALL AREA IS TO BE SURVEYED BY TACHEOMETRY

THEORY:

Tacheometry is the type of surveying in which vertical and horizontal distances are computed from stadia readings without using chain or tape. This is done by the help of a special type of transit theodolite known as tacheometer and a staff known as stadia rod. The stadia diaphragm essentially consists of one stadia hair above and the other an equal distance below the horizontal cross-hair, the stadia hairs being mounted in the ring and on the same vertical plane as the horizontal and vertical cross-hairs.

PROBLEM DESCRIPTION:

The students will use theodolite/level as a tacheometer. They will first find out the tacheometric constants of the theodolite/level and will learn how to calculate distance and elevation of any point from the theodolite/level without direct measurement. Finally, they will prepare a map of the surveyed area with the help of tacheometer without using chain or tape.

INSTRUMENTS:

a) Level/Theodolite b) Tripod c) Leveling Staff d) Tape e) Arrow f) Trough compass g) Wooden hammer

PROCEDURE:

- Select any suitable position for setting up the level. Place the level and try to adjust it.
- Complete centering and leveling of the level.
- Measure the tacheometric constants-

- Take two points on the level ground. And measure the horizontal distances D_1 and D_2 from the level station. If the corresponding staff intercepts are S_1 and S_2, tacheometric constants can be calculated using the following equations –

$$\frac{f}{i} = \frac{D_1 - D_2}{S_1 - S_2} \quad \& \quad f + d = \frac{D_2 S_1 - D_1 S_2}{S_1 - S_2}$$

- Take stadia readings at different stations and calculate horizontal distance and elevation by using the following equation, if the line of sight is horizontal.

$$\boldsymbol{D} = \boldsymbol{S} \times \frac{\boldsymbol{f}}{\boldsymbol{i}} + (\boldsymbol{f} + \boldsymbol{d})$$

SUBMISSION:

- Detailed calculation of tacheometric constants and horizontal distances of different stations. (Individual Submission)

- Plotting of the area on a drawing paper. (Individual Submission)

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FIELD WORK NO: 05
HEIGHT OF A BUILDING/TOWER IS TO BE MEASURED BY TRIGONOMETRIC LEVELING

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

FIELD WORK NO: 05

HEIGHT OF A BUILDING/TOWER IS TO BE MEASURED BY TRIGONOMETRIC LEVELING

THEORY:

Trigonometric levelling is the process of determining the differences of elevations of stations from observed vertical angles and known distances. The vertical angles are measured by means of theodolite

PROBLEM DESCRIPTION:

The students will calculate the height of an object. That object can be a multi-storied building or a tower. Height can be determined from observed vertical angles and known horizontal distances using trigonometry.

INSTRUMENTS:

a) Theodolite b) Tripod c) Leveling Staff d) Tape

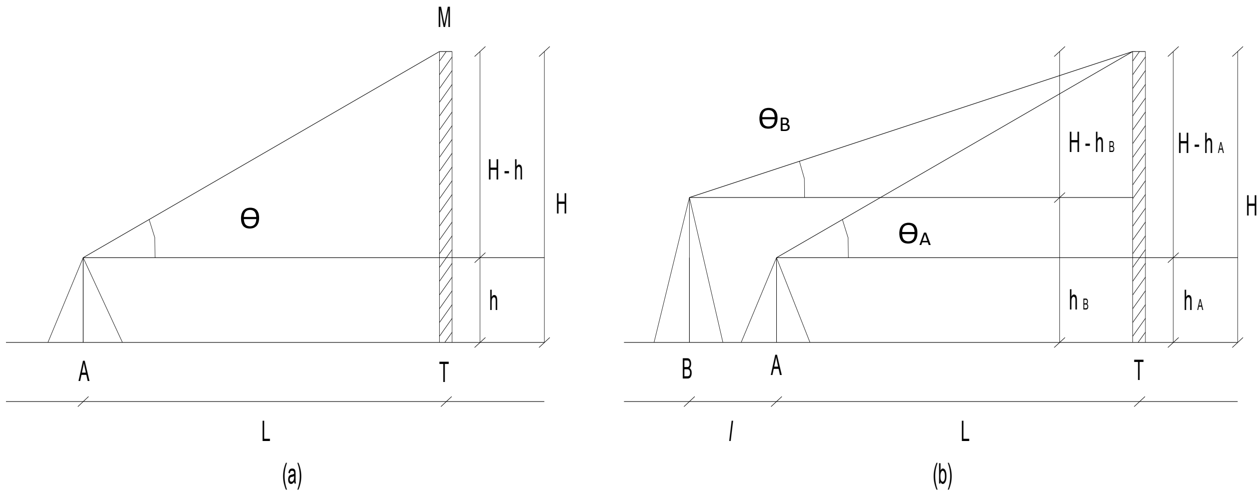
PROCEDURE:

- Place the theodolite at station A.
- After centering and leveling, measure vertical angle Θ.
- If foot of the tower is accessible, as per figure (a) measure horizontal distance L, Between the instruments station A and the foot of the tower T. Take staff reading h above the BM.
- Then height of the tower will be, $H = h + L \tan\Theta$
- If foot of the tower is inaccessible, choose two stations A and B as per figure (b) at a known distance l apart so that A, B and T are on the same line.
- Place the theodolite at A and B, measure the vertical angles Θ_A and Θ_B.
- Take the staff readings h_A and h_B.

- As per figure (b),

$$tan\theta_A = \frac{H-h_A}{L} \quad \text{and} \quad tan\theta_B = \frac{H-h_B}{L+l}$$

- From known h_A, h_B, l, Θ_A and Θ_B determine H & L by solving the above two equations simultaneously.



SUBMISSION:

- Detailed calculation of height of the building/tower in A4 paper. (Group Submission)

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FIELD WORK NO: 06
A SMALL PLOT BOUNDED BY A POLYGON IS TO BE SURVEYED BY THEODOLITE TRAVERSING

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

FIELD WORK NO: 06

A SMALL PLOT BOUNDED BY A POLYGON IS TO BE SURVEYED BY THEODOLITE TRAVERSING

THEORY:

Traversing is a type of survey where the framework is formed by a number of connected survey lines. The directions of the survey lines are measured by a direction-measuring instrument (like theodolite), while the lengths are measured by a tape (or chain).

Bearing: The Bearing of a line is its direction relative to a given meridian and always measured in the clockwise direction.

Backward Bearing (B.B.): If the bearing of a line AB is measured from B toward A, it is known as Backward Bearing or Back Bearing.

Forward Bearing (F.B.): If the bearing of a line AB is measured from A toward B, it is known as Forward Bearing or Fore Bearing.

PROBLEM DESCRIPTION:

The students will select a suitable plot and form a polygon. For uniformity among the groups, it is recommended to cover the area by a pentagon. The students will measure the included angles and sides of the polygon. The bearing of any of the sides is to be noted. The students will take angular measurements of at least two objects in the field. Finally they will plot the area (polygon) with adjacent details in a drawing sheet.

INSTRUMENTS:

a)Theodolite b) Tripod c) Ranging rod d) Tape e) Arrow f) Rope g) Trough compass h) Wooden hammer

PROCEDURE:

- Form a polygon in the field. Measure the sides of the polygon.
- Place the theodolite at the first station. After centering and leveling, measure included angle.
- Center and level theodolite at every station.
- Take bearing and linear measurement of each line.
- Take angular measurements of at least two objects in the field.

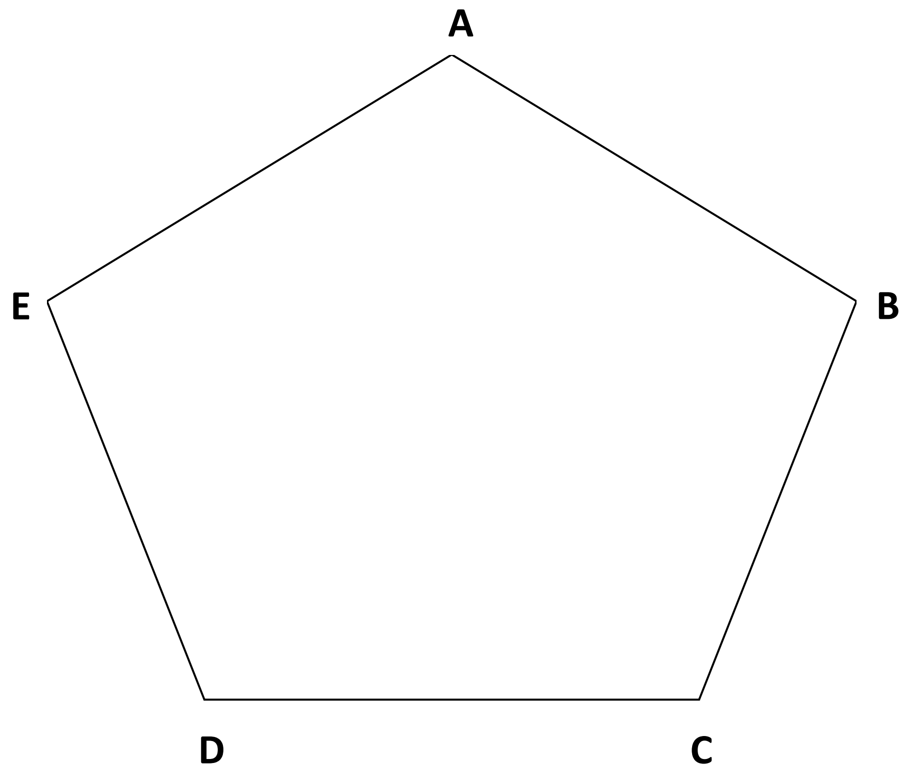

Figure: Pentagon

SUBMISSION:

- Plot the polygon showing objects on a drawing sheet. (Individual submission)
- Adjust the closing error by graphical method if required.

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FIELD WORK NO: 07
A SIMPLE CIRCULAR CURVE IS TO BE SET IN THE FIELD

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

FIELD WORK NO: 07

A SIMPLE CIRCULAR CURVE IS TO BE SET IN THE FIELD

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. 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.

PROBLEM DESCRIPTION:

The students will set a simple circular curve in the field by using one of the linear methods. The necessary data will be supplied in the field. The students will have to show the layout of the curve by using arrow and ropes.

INSTRUMENTS:

a) Tape b) Optical square c) Ranging rod d) Arrow e) Rope f) Wooden hammer

PROCEDURE:

- Collect required data from your teacher.
- For curve ranging use the linear method of "Perpendicular offsets from tangents"
- $\boldsymbol{O_x = R - \sqrt{R^2 - x^2}}$, is the offset perpendicular to the tangent at a distance x along the tangent.
- Calculate necessary data in a paper for setting the curve.
- From first tangent point T_1, measure different distances x along the tangent.
- Set perpendicular offsets O_x at the corresponding point and mark the location of the curve using arrow.
- Half of the curve will be set from the first tangent. The other half can be set from the second tangent.

- Connect the located points of the curve using rope.

SUBMISSION:

- Detailed calculation for necessary data in A4 paper. (Group Submission)
- Verification of the layout in the field by the teacher. (Group Submission)

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CEE 213L SURVEYING & INTRODUCTION TO GIS LAB WORKBOOKS FOR LABORATORY PRACTICE

FIELD WORK NO: 08

HOUSE SETTING

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

FIELD WORK NO: 08
HOUSE SETTING

PROBLEM DESCRIPTION:

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.

INSTRUMENTS:

a) Tape b) Lime powder c) Wooden Pegs d) Arrow e) Rope f) Wooden hammer

PROCEDURE:

- First locate any back corner on the ground of the plan.
- 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.
- Fixed other two exterior lines.
- Check the diagonals after fixing the perimeter of the building.
- All the pegs lie on the column line are driven at equal distances
- Intersection of rope indicates the position of the column.
- Mark the excavation lines on the ground with the help of lime powder.
- Check the diagonals of all grids and adjust if necessary.
- Mark the plinth level.
- From the plinth level fixed the depth of the footings by using water level at two points.

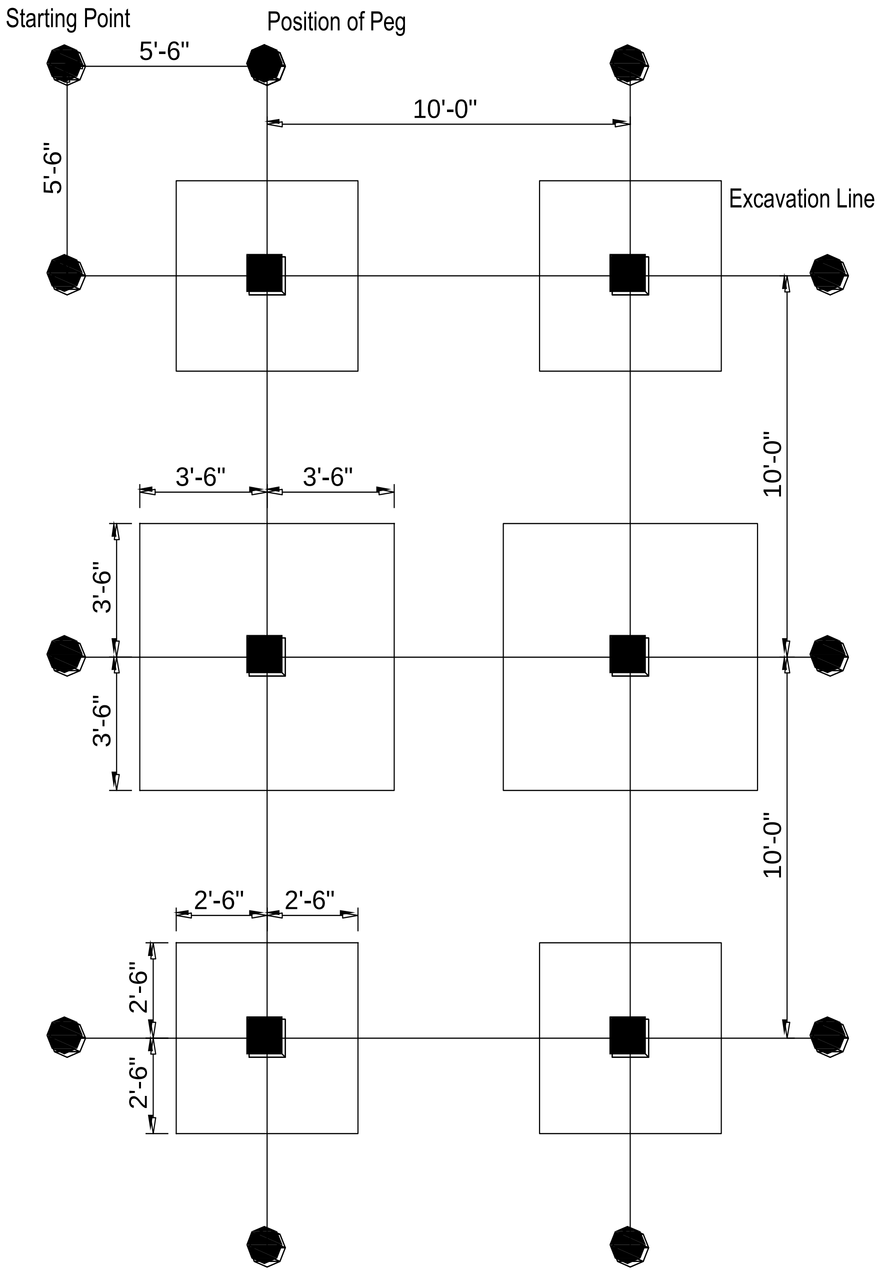

Figure: Foundation Trench Plan

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FIELD WORK NO: 09
GLOBAL POSITIONING SYSTEM (GPS)

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

FIELD WORK NO: 09
GLOBAL POSITIONING SYSTEM (GPS)

THEORY:

The Global Positioning System (GPS) is a satellite-based navigation and surveying system for determination of precise position and time, using radio signals from the satellites, in real time or in post-processing mode. The NAVSTAR Global Positioning System is a satellite based navigation system being developed and maintained by the DoD since 1972, for providing extremely accurate 3-D position fixes and UTC information to properly equipped users anywhere on or near the Earth, at any time, regardless of weather conditions. The system consists of three segments: Space Segment, Control Segment and User Segment. The satellites continuously transmit dual frequency navigation signals consisting of information of satellites position with time tag, along with other data, which is periodically uploaded in satellite memory from the Control Segment. The User Segment receives navigation signals from at least 4 satellites, available any time globally, allowing the user to simultaneously solve 4 independent range-difference equations to yield his position - latitude, longitude and height and also the time.

PROBLEM DESCRIPTION:

To plot a small area using GPS measurements.

INSTRUMENTS:

a) GPS device b) Tape c) Station log sheets d) Station descriptions e) Rope
f) Arrow

PROCEDURE:

Follow the field instructions.

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CEE 213L SURVEYING & INTRODUCTION TO GIS LAB WORKBOOKS FOR LABORATORY PRACTICE

FIELD WORK NO: 10
TOTAL STATION

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

FIELD WORK NO: 10
TOTAL STATION

THEORY:

Total station is a surveying equipment combination of Electromagnetic Distance Measuring Instrument and electronic theodolite. It is also integrated with microprocessor, electronic data collector and storage system. The instrument can be used to measure horizontal and vertical angles as well as sloping distance of object to the instrument.

Important Operations of Total Station:

- Distance Measurement: Electronic distance measuring (EDM) instrument is a major part of total station. Its range varies from 2.8 km to 4.2 km. The accuracy of measurement varies from 5 mm to 10 mm per km measurement. They are used with automatic target recognizer. The distance measured is always sloping distance from instrument to the object.
- Angle Measurements: The electronic theodolite part of total station is used for measuring vertical and horizontal angle. For measurement of horizontal angles any convenient direction may be taken as reference direction. For vertical angle measurement vertical upward (zenith) direction is taken as reference direction. The accuracy of angle measurement varies from 2 to 6 seconds.
- Data Processing: The instrument is provided with an inbuilt microprocessor. The microprocessor averages multiple observations. With the help of slope distance and vertical and horizontal angles measured, when height of axis of instrument and targets are supplied, the microprocessor computes the horizontal distance and X, Y, Z coordinates. The processor is capable of applying temperature and pressure corrections to the measurements, if atmospheric temperature and pressures are supplied.

PROBLEM DESCRIPTION:

To plot a small area using measurements taken from a Total Station

INSTRUMENTS:

a) Total Station b) Tripods c) Prisms d) Prism Poles

PROCEDURE:

Follow the field instructions.