Kathmandu University

School of Engineering

Department of Civil Engineering

Surveying Field Camp Report 2023

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1. Introduction

The process of surveying entails locating the locations of man-made and natural features on or beneath the surface of the earth, presenting this information graphically in the form of plans or numerically in the form of tables, and laying out measurements on the surface of the planet. Typically, it entails precise location determination, plan creation, calculations, and measurement.

Engineers, physicists, engineers, metrologists, programmers, lawyers, and students of geometry, trigonometry, regression analysis, and more all have applications to surveying. They employ tools like robotic total stations, GS receivers, retroreflectors, radios, handheld tablets, digital levels, subsurface locators, drones, GIS, and surveying software.

Since the earliest known records, surveying has played a role in the evolution of the human enviroment .
Surveying has been an element in the development of the human environment since the beginning of recorded history. The planning and execution of most forms of construction requireit. It is also used in transport, communications, mapping, and the definition of legal boundaries for land ownership. It is an important tool for research in many other scientific disciplines.

The main objectives of surveying courses allocated for civil engineering students is to promote them the basic knowledge of different surveying techniques relevant to engineering works in their professional practice. The completion of all surveying courses including 16 days' survey camp work organized by the **Department of Civil Engineering, Kathmandu University, Dhulikhel** has directed students to use all surveying technique covered in lecture classes.

Primary division of Surveying:

Depending on the size of the area of land to be surveyed, surveying can be broadly classified as either planar or geodetic.

In a plane survey, the average surface of the earth is assumed to be a plane, the spheroidal shape is disregarded, all formed triangles are assumed to be plane triangles, level lines are assumed to be straight, and plumb lines are assumed to be parallel. It is appropriate for a region of less than 250 square kilometers.

The form of the earth is taken into consideration during geodetic surveying. It incorporates spherical trigonometry since all lines are curved and all triangles are spherical. The goal of a geodetic survey is to pinpoint the exact location of a system of widely separated points that serves as the control station to.

1.1 Principle of Surveying:

The fundamental principles of plane surveying are:

1.1.1 Working from whole to part:

Working from whole to part means at first, a large area is covered in surveying to establish control points with a higher degree of precision and after that surveying is carried out within this area. Working from whole to part minimises the occurrence of error.

1.1.2 Location of point by measurement from two points of reference:

The location of a point by measurement from two points of reference is the fundamental principle of surveying. The relative position of a point to be surveyed should be located by measurement from at least two points of reference, the positions of which have already been fixed.

Consistency in work:

The survey work should be performed by keeping consistency in method, instrument, observer etc. to get desired level of accuracy.

1.1.3 Independent Check:

An independent check should be applied on data when possible. For e.g. measuring all three angles of triangle, even though third angle measurement is redundant.

1.1.4 Accuracy required:

Depending on the level of precision desired, the appropriate procedure and equipment should be employed. The accuracy of angular and linear values should be comparable.

According to the requirements of the course CIEG-210, we completed our 14-day "Surveying Field Camp 2023" based on the aforementioned concepts, methodologies, and instrument usage.

1.2 Accuracy and Errors:

Precision

Precision is the degree of perfection of measuring instruments, the methods and the observations. It is the degree to which the repeated observations under same condition shows the same result.

Accuracy:

As a result of observation, accuracy is the level of perfection attained. The level of observational closeness to the actual value is what determines this. The use of precise tools, methods, and well-thought-out planning are all necessary for accuracy.

Differences between two measured values of the same quantity are called discrepancies; such differences are not errors.

1.3 Sources of error

Error may arise from three sources:

1.3.1 Natural errors

These are the error that arise due to variation in natural phenomenon such as temperature, refraction, magnetic declination etc.

1.3.2 Instrumental errors

These are the errors that arise due to imperfection or faulty adjustment of the instrument with which measurement is being taken. E.g., a tape too short

1.3.3 Personal errors

These are the errors that arise due to want of perfection of human sight in observing and of touch in manipulating instrument. E.g., error in taking level reading.

1.4 Type of error:

Error may be classified as:

1.4.1 Mistakes

These are the errors that may arise due to lack of attention, experience and due to carelessness and confusion in the mind of observer. If these kinds of errors are undetected, it may produce serious effect. Hence, every measurement to be recorded in the field must be checked by independent check.

1.4.2 Systematic error

These errors cause the result to be too large or too small and are therefore treated as positive or negative errors because, under the same conditions, they will always be the same size and sign.

1.4.3 Accidental error

These are the types of error which remain after mistake and systematic error have been eliminated and caused by a combination of reason beyond the ability of observer to control. They tend some times in one direction and sometimes in other. Accidental error represented the limit of precision in the determination of value.

1.5 Permissible Error

It is the absolute maximum that a measurement can deviate from its true value or from a value that has already been accepted as correct. In a random instance, its size depends on the scope, purpose of the investigation, instruments available, type of work, etc.

1.6 Name of the project:

Surveying Field Camp 2023

1.7 Description of the project:

Location:

MARS Engineering Survey Camp, Bungmati,Lalitpur.

Sites:

For Topographic Survey : MARS Engineering Survey Camp
For Bridge Survey : Bungamati, Lalitpur
For Road Survey :Bungamati, Lalitpur

Geographical Features:

Terrain : Hilly
Weather : Sunny, Partly Cloudy
Google Earth Location:MARS Nepal Survey Camp.

Figure 1: MARS Nepal Survey Camp

1.8 Objectives:

The main objective of survey camp was to develop our practical engineering skills through applying our theoretical background of Engineering Survey from Survey Volume I and Survey Volume I as well as to develop confidence and mutual co-ordination in students while working in a group of random members. It also focused on training students in such a way that they could work independently for any civil engineering project. In this regard following main works were highlighted:

- To prepare geographical map of an area showing details, contours, etc.
- To use resection and intersection methods to find co-ordinates of unknown station with the help of known stations.
- To learn about the use of Total station.
- To layout building design using Total station and also using 3-4-5 method to set out perpendicular.
- To choose proper road alignment and prepare plan, longitudinal and cross section of road alignment.
- To select appropriate location of bridge axis and prepare longitudinal and cross section as well as topographical map of bridge site.
- To become familiar with the surveying problems that may arise during and after the field works in future.

2. Project Area

2.1 Location and Accessibility

The survey camp was conducted inside MARS Nepal Engineering Survey Camp.The survey camp was carried out with the motive of conducting the survey inside the closed premises for civil engineering students as per the syllabus of course CIEG 210.

The site is expanded over sufficient area of land and is a dedicated survey camp site for civil engineering students so as to enlighten their practical knowledge and experience in fully natural and undulated environment.

The site is accessible by graveled road from the main road locally available at the area.

2.2 Topography and Geology

Lying along the stepped hill topography of MARS Nepal Engineering Survey Camp, with residential housings scattered all over the area and lots of vegetation and crops cultivated over the undulated terrain.

2.3 1.3 Rainfall and Climatic condition

The climatic characteristics are of site are as follows:

- Temperature: 30°C to 16°C in summer
- Max. 17°C to Min.2°C in winter
- Rainfall: 935 mm average annual rainfall.
- Major Crops grown: Paddy, wheat, maize, etc.
- Types of vegetation found: Herbs, shrubs and trees.

- The temperature during the camp period was about 25^{o}C on average

2.4 1.4 Others

MARS Nepal Engineering Survey Camp Pvt. Ltd is located at Lalitpur Metropolitan City, Ward No 22, Bugmati. It's about 35km south east from Kathmandu University, Dhulikhel and 6km far from Ekantakuna Chakrapath Chowk of Lalitpur (followed by Nakhu, Bhaisepati and Bugamati).

Figure 2: Google image of survey camp site.

3. Topographical Survey

A topographical survey, also known as a land survey or topographical land survey also known as contours. Topographical survey measures and identifies the exact location and specifications of natural and human made features within an area of land. The survey is then drawn up into an appropriate and detailed plan which includes human-made features such as boundaries, neighbouring buildings, walkways etc. The topographical survey also picks up natural features such as trees, ponds and ground contours. This survey aims primarily to gather data on the characteristics of the land and its altitude. The result, usually a two- dimensional map of the property, depicts the relative elevation and position of man-made and natural features in a landscape.

3.1 Objectives

The objectives of carrying out Topographical Survey are as follows:

- To prepare the topographical map of the area
- To construct the major traverse, check for errors and adjust them
- To perform detailing of various ground points and details such as trees, roads and the buildings
- To find out the reduced level of various points in order to make contour of the map

3.2 Brief description of area

The area of survey camp lies within MARS Nepal Engineering Survey Camp, which is sloppy in nature with decreasing elevation on southern side with undulation,water bodies and lots of vegetation. Detail within survey areas are residential housing, road alignment footpath ways, lots of vegetation, water bodies and shed.

3.3 Norms (Technical specification)

All the students at the camp had to work under some norms provided by survey instruction committee. The norms are listed as follows:

- The given work had to be completed within 14 days giving days each for road site and bridge site.
- The proper handling and care of the instrument was the responsibility of the entire group.
- The major traverse had to be fixed in such a way that these points were to be followed:

  i. At least two consecutive stations should be visible from a station.

  ii. Two-way measurement for one traverse leg should be done. The discrepancy should be greater than 1:10000 for major traverse.

  iii. The number of traverse stations should be minimized.

  iv. Two sets of horizontal angles should be taken in major traverse. The difference between the mean angles of two set reading should be within the least count of the theodolite.

  v. The leg ratio of the traverse stations should not be less than 1:2 for major traverse (where the ratio is the ratio of longest length : shortest length)

  vi. All the available checks should be applied to the traverse and adjusted using appropriate method. The angular error must lie within the limit defined by the formula$\mp(LC\sqrt{N})$.

  vii. After the completion of the field work, the plotting of the traverse along with details and the contour lines has to be done thus preparing the topographical map of the worked area.

  viii. Plotting should be done by independent co-ordinate.

  ix. Fly leveling should be done to transfer RL from the BM. The permissible error in the levelling should not be greater than $\pm 25K\sqrt{N}$ mm, where k is the distance in km. All three hair readings should be taken in these cases.

3.4 Equipment

Instruments required during the topographical surveying were:

3.4.1 For reconnaissance

- Ranging rods (3)
- Measuring Tape (1)
- Wooden Pegs (16)
- Hammer (1)
- Marker (1)
- Iron Nail (16)

3.4.2 For Horizontal distance measurement

- Total station (1)
- Tripod (1)
- Prism (2)
- Prism Holder (2)
- Prism Stand (2)
- Measuring Tape (1)

3.4.3 For leveling

- Auto Level and its stand -1
- Leveling staff-1
- Measuring tape-1
- Marker-1

3.4.4 For tacheometer traversing

- Tacheometer with stand -1
- Staff-1
- Ranging rods-2
- Measuring tape -1
- Plumb bob-1
- Compass-1

3.4.5 Detailing with tacheometer

- Tacheometer-1
- Staff-2
- Tape-1
- Calculator-1

3.5 Methodology

3.5.1 Reconnaissance

Reconnaissance or Recce refers to the initial and preliminary phase of a surveying project where surveyors gather essential information about the area to be surveyed. This phase is crucial for planning and determining the scope of the survey. Its purpose is to eliminate those routes or sites that are impractical or infeasible and to identify the better routes of traversing. The visualideal is taken of the terrain and the feature are noted.

3.5.2 Major Traverse

Traversing is a type of surveying in which a number of connected survey lines form the framework. It is also a method of control surveying. The survey consists of the measurement of

- Angle between successive line and bearing of each line,
- The length of each line.

The direction and the length of the survey line are measured with the help of an angle measuring instrument such as theodolite and a tape. If the co-ordinate of the first station and the bearing of the first line are known, the co-ordinate of all successive point can be computed as follows:

$$\boldsymbol{X_B = X_A + L\,cos}(\emptyset)$$

$$\boldsymbol{Y_B = Y_A + L\,sin}(\emptyset)$$

Where, L = Length of traverse leg

$(\emptyset)$ *= Bearing of AB*

3.6.2.1 Open Traverse

An open traverse, also known as an "unclosed traverse," is a surveying technique used to measure distances and angles between a series of survey points to determine the relative positions of those points. Unlike a closed traverse, which forms a closed loop where the last point connects back to the first point, an open traverse does not return to its starting point. Instead, it involves a series of interconnected straight-line segments with known distances and included angles.

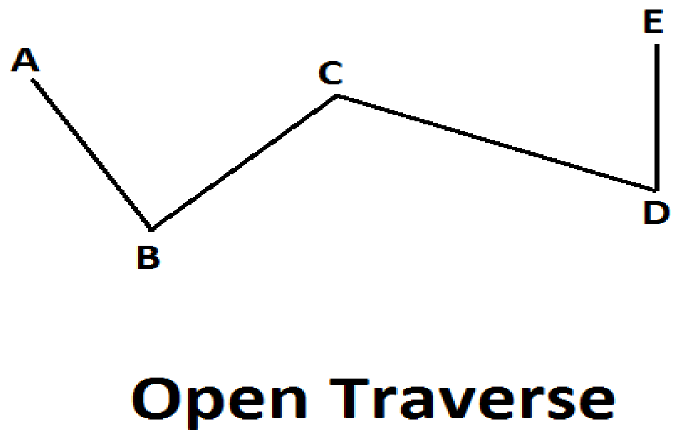

Figure 3: Open Traverse

3.6.2.2 Closed Traverse

A closed traverse is a surveying technique used to measure and establish the positions of a series of survey points, forming a closed geometric shape or loop. In a closed traverse, the first point is connected to the last point, creating a continuous path. The primary purpose of a closed traverse is to ensure the accuracy of the survey measurements by providing a self-checking mechanism for errors.

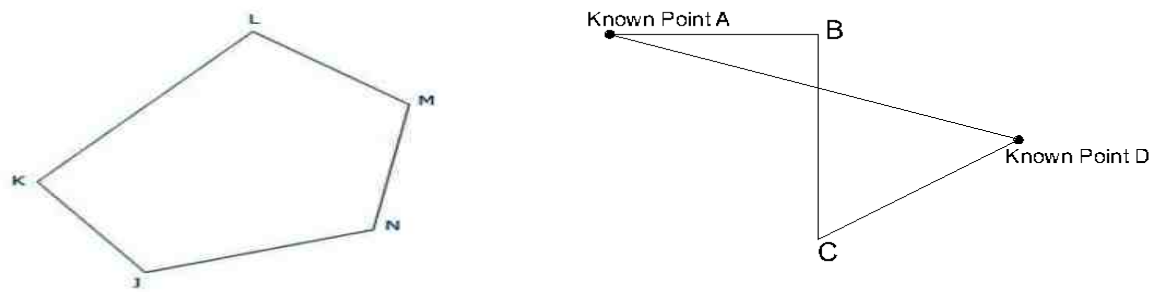

Figure 4: Closed Traverse

The skeleton of lines joining those control points, which covers the whole entire area, is called major traverse. Work on major traverse must be precise. So, two set of reading should be taken for Major Traverse. For convenience, the reading is taken by setting the total station at 0°0’0” for the second.

The major traverse having x control station including two given control points (CP1 and CP2). The control stations are named as XMY where X is the group number and Y is the traverse station number.

The distance of each traverse leg was measured in two ways. The accuracy required was to be greater than 1:10000 with the permissible angular error given by LC√N, where n is the no of traverse station and LC is the least count of the instrument used.

3.5.3 Minor Traverse

It is not sufficient to detail the area by enclosing with the help of major traverse. Minor traverse is the traverse which runs through the area to make detailing easier. Minor traverse covers only a small area. Less precise work than that of major traverse is acceptable so single set reading is sufficient for minor traverses. For the setting out of minor traverse, it should be noted that any one of the major traverse stations should be included with minor stations.

3.5.4 Detailing

Detailing is the process of locating all the required detail point on the ground for the preparation of the topographic map or plan with both horizontal and vertical controls. This was carried out in the field with the help of theodolite.

3.5.5 Leveling

Leveling in surveying is a fundamental technique used to measure and establish the height or elevation of points on the Earth's surface relative to a reference point or benchmark. The primary objective of leveling in surveying is to accurately determine the vertical position of various points within a survey area. This vertical control is essential for a wide range of applications in land surveying, construction, engineering, and mapping. A benchmark some distance away from the survey area was established by a GPS and its reduced level was recorded. The RL of a temporary bench mark (TBM) inside the survey area was determined by method of ordinary/fly leveling from the benchmark. The precision of the work was checked as per the requirement. Then theRL of the temporary benchmark was transferred to the control station of the major traverse. The closing errors was found to be within the permissible limits. The misclosure was adjusted in each leg of the leveling path by using the following formula.

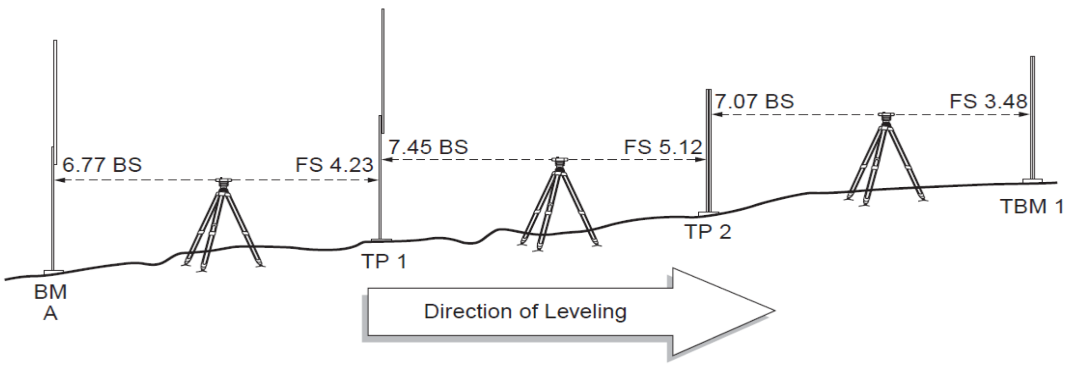

Figure 5: Levelling

$$\boldsymbol{Permissible\ error = \pm 25\ x\ \sqrt{k}\ mm}$$

where, k is perimeter in Km

$$\boldsymbol{Actual\ Error(e) = \sum BS - \sum FS = Rise - Fall = Last\ R.L - First\ R.L}$$

$$\boldsymbol{Correction\ for\ i^{th}\ leg = Error\ x \frac{L_1 + L_2 + \cdots + L_i}{p}}$$

$$\boldsymbol{Relative\ precision = \frac{1}{\frac{p}{error}}}$$

where, L_1, L_2..., L_i is length of legs and p is perimeter

3.5.6 Computation and plotting

The Traverse was plotted in the scale of 1:500

3.5.7 Comments and conclusion

Major stations were set up over the area on which the survey is based on and coordinates and bearing of the traverse stations and traverse legs respectively were calculated and necessary correction was applied. Minor Traverse stations were not used in our work. Detailing was done after the traverse computation was verified by our instructor. After than contouring was done simultaneously. Topographic map was drawn through the measured data.

4. Total Station

4.1 Description

A total station or total station theodolite is an electronic as well as optical instrument used for surveying and building construction. It's a modern surveying instrument that integrates an electronic theodolite with an electronic distance meter. A theodolite uses movable telescope to measure angles in both horizontal and vertical plane.

The total station we learned to use on field was TOTAL STATION SPECTRA FOCUS 2.

Total station can measure distances up to an accuracy of 1mm and angle up to an accuracy of 1 second. Using total station, we can measure any length to a maximum of 5 km distance. Microprocessor unit in total station processes the data collected to compute the following data:

- Average of multiple angles measured
- Average of multiple distance measured
- Horizontal distance
- Distance between any two points. Elevation of objects and all the three coordinates of the observed points.

4.2 Advantages of total station

- Field work can be carried out very fast.
- Accuracy of measurement is high.
- Manual errors involved in reading and recording are eliminated.

- Calculation of coordinates is very fast and accurate.

4.3 Task performed during the camp

4.3.1 Finding out the unknown coordinates

- Co-ordinates of two known station was to be provided.
- Coordinates of the station where total station is set up is entered in the total station.
- Co-ordinates of the backward station is set to total station as reference.
- Finally, co-ordinates of unknown stations are determined.

4.3.2 Stake out

- Place the total station in the spot from which you want to stake out points after you have finished entering the coordinates of two unknown stations for the area into the total station's internal memory. Make sure that the total station is level and on secure, even ground before continuing.
- Press the "Power" button to turn on the instrument if it isn't already on. When you see the home screen, press the "S-O" button and use the navigation arrows to move down to the "Stake Out" menu option. Press the "Select" button to enter the stake out menu.
- Select the method that you want to use to stake out the point. Select "XYZ" to stake out by coordinates which will be the most common method.
- Press the "Yes" button to continue the process using the coordinates on the screen for your total station. If the coordinates are incorrect, press the "No" button to try again. In the next screen, use the keypad to enter the coordinates or distances and press the "OK" button to measure. The results will be displayed on the following screen.
- Position the reflector in the point of interest and turn the total station until the horizontal circle reads zero.
- After the horizontal angle readings is aligned, Sight the prism and press measure, then the total station directs whether the point lies in or out of the current point. The prism reflector is moves as necessary and a peg is fixed when the total station verifies the point.

4.4 Conclusion

After the completion of this work we learnt how to find out unknown coordinates of a point in an area and also to locate the point with known co-ordinates in the ground using stake out.

5. Analytical Intersection and Resection

5.1 Intersection

This method is suitable for locating inaccessible points by the intersection of the rays drawn from two instrument stations.

5.1.1 Procedure*:*

Suppose A and B are two stations and P is an object (e.g. tower) on the far bank of a river. Now, it is required to fix the position of the sheet by the intersection of rays, drawn from A and B.

Intersection is resorted to when the distance between the point and the instrument station is either too large or cannot be measured accurately due to some field conditions. The location of an object is determined by sighting at the object from two stations and drawing the rays. The intersection of these rays will give the position of the object. It is therefore very essential to have at least two instrument stations to locate any point. The line joining the two instrument stations isknown as the base line. No linear measurement other than that of the base line is made. The pointof intersection of the two rays from the vertex of a triangle having the two rays as two sides and the base line as the third line of the triangle. Due to this reason, intersection is also sometimes known as graphic triangulation.

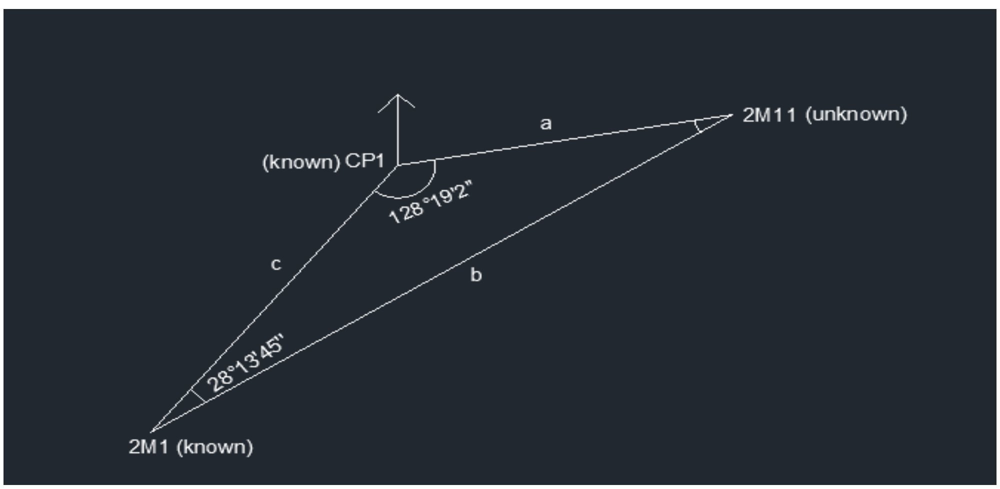

Figure 7:Intersection method of determining co-ordinates of an unknown station

5.1.2 Calculation with Data Acquired on Field

We have,

			D	M	S	M	S	
Inst at CP1	2M11	L	0	0	0			128º19’2’’
		R	179	59	58	59	59	
	2M1	L	128	19	01			
		R	308	19	01	19	01	

			D	M	S	M	S	
Inst at 2M1	CP1	L	0	0	0	0	2	28º*13’45’’*
		R	180	0	4			
	2M11	L	28	13	45	13	47	
		R	208	13	45			

∡2M11= 180º-128º19’2’’-28º13’45’’

=23º27’13’’

Co-ordinate of CP1 = (3055749mN, 331855mE)

Co-ordinate of CP1 = (3055733.665mN,331816.095mE)

Distance (CP1-2M1) = $\sqrt{(-15.3350)^2+(-38.905)^2}$

= 41.818m

Bearing of (CP1-2M1) = $\tan^{-1}$ (-38.905/-15.335)=68º29’14.51”

= 248º 29’14.5’’

Bearing of (CP1-2M11) = 248º29’14.5’’-128º19’2’’

=120º10’12.5’’

Now,

Using sine law,

$$\frac{41.818}{\sin(23^\circ 27' 13'')} = \frac{a}{\sin(28^\circ 13' 45'')}$$

a = 49.697

Latitude = lcosɵ = 49.697cos(120º10’12.51’’)

= -24.976

Departure = lsinɵ =42.964

Co-ordinate of 2M11 = (3055724.024mN,331897.964mE)

Again,

Using sine law,

$$\frac{41.818}{\sin(23^{o}27'13'')} = \frac{b}{\sin(128^{o}19'2'')}$$

b=82.436

Bearing of (2M1-CP1) = $\tan^{-1}\frac{(38.905)}{(15.335)}$

= 68º29'14.5''

Bearing of (2M1-2M11) = 68º29'14.51''+ 28º13'45''

= 96º42'59.5''

Latitude = 82.436cos96º42'59.51''

= -9.641

Departure = 81.870

Co-ordinate of 2M11 = (3055724.024,331897.965)

On average

Co-ordinate of 2M11 = (3055724.024,331897.964)

Calculating RL ,

RL OF 2M11= RL of CP1 +HI +DTanɵ -PH

= 1272.5912 + 1.486 +49.697Tan(0º50'27'') -2.15

=1272.656571

Again,

RL pf 2M11 = RL of 2M1 +HI + DTanɵ -PH

= 1267.810 +1.605

= 1272.709

On average,

RL of 2M11 = $\frac{(1272.6561+1272.709)}{2}$

= 1272.682

5.2 Resection (Three-Point)

The method of resection is used to determine the coordinates of an unknown station from three known stations. The known stations should be selected such that they all lie opposite side to the unknown station. Ranging rods, each of height r, are placed on the known stations.

5.2.1 Steps of Analytical Resection

1. The reduced bearing of traverse leg BA is calculated as, RB (AB) $= \frac{X1 - X2}{Y1 - Y2}$ and the reduced bearing of traverse leg B-C is calculated as, RB (BC) $= \frac{X3 - X2}{Y3 - Y2}$
2. Then, angle z = WCB of BA – WCB of BC
3. With instrument at P, the horizontal angle α, the zenithal angle between stations P and A, V_{PA}, the zenithal angle between stations P and B, $V_{PB,}$ the horizontal angle β, and the zenithal angle between stations P and C, $V_{PC,}$ are measured setting 0º0’0’’ at A and B respectively.
4. The height of instrument at P, $HI_{P,}$ is measured.
5. In quadrilateral PABC, α + β + x + y + z = 360º

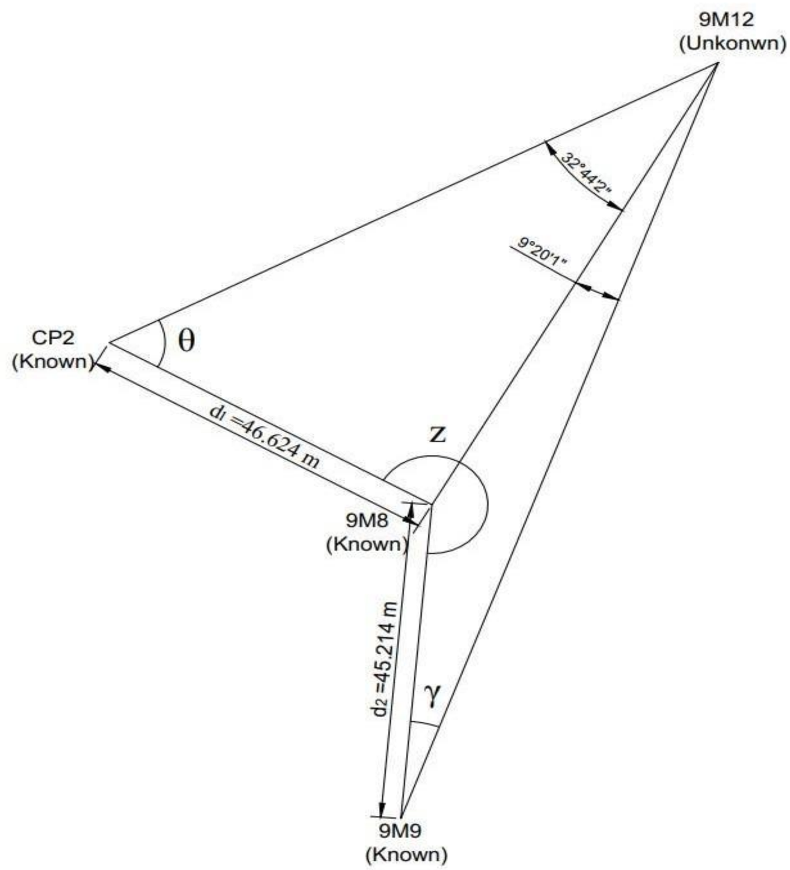

Figure 8: Resection

6.

Or, $x + y = 360^{o} - \alpha - \beta - z = \phi$.................................... (1)

7. The distance AB is calculated as AB = $\sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2}$ and the distance BC is calculated as BC = $\sqrt{(X_3 - X_2)^2 + (Y_3 - Y_2)^2}$.

8. In Δ PAB and in Δ PBC,

$\frac{BP}{\text{Sin x}} = \frac{AB}{\text{Sin }\alpha}$ …….. (2) and $\frac{BP}{\text{Sin y}} = \frac{BC}{\text{Sin }\beta}$ ………(3)

Or, $\frac{\text{Sin x}}{\text{Sin }(\phi - X)} = \frac{BC * \text{Sin }\alpha}{AB * \text{Sin }\beta}$

Or, x=………..
From (1), y = ………..

9. Using sine law, the distances AP, BP and CP are calculated.
10. WCB of AP = WCB of line AB + x; WCB of CP = WCB of CB –y
11. WCB of PB =WCB of AP + α ± 180º
12. From A, the (X, Y) coordinates of P = [X_1 + AP*Sin (WCB of AP), Y_1 +AP*Cos(WCB of AP)]
13. From B, the (X, Y) coordinates of P = [X_2 + BP*Sin (WCB of BP)), Y_2 + BP*Cos(WCB of BP)]
14. From C, the coordinates of P = [X_3 + CP*Sin (WCB of CP)), Y_3 + CP*Cos(WCB of CP))]
15. From A, the Z-coordinate of P = Z_1 + r ± AP*tan(90º - V_{PA}) – HI_P [- if $V_{PA} < 90º$]
16. From B, the Z-coordinate of P = Z_2 + r ± BP*tan(90º - V_{PB}) – HI_P [- if $V_{PB} < 90º$]
17. From C, the Z-coordinate of P = Z_3 + r ± CP*tan(90º - V_{PC}) – HI_P [- if $V_{PC} < 90º$]
18. The coordinates of P(X_4, Y_4, Z_4) are average of the coordinates of P from A, B and C.

5.2.2 Calculation with Data Acquired on Field

We have,

Co-ordinate of 2M1 = (3055733.665,331816.095)

Co-ordinate of 2 M11 = (3055723.753,331897.592)

Co-ordinate of CP1 = (3055749,331855)

Now,

$$\text{Bearing of CP1-2M11} = \tan^{-1}\frac{(331897.592-331855)}{(3055723.753 - 3055749)}$$

$$= 59º\,20'\,31.45''$$

$$= 120º39'28.55''$$

$$\text{Bearing of CP1-2M11} = \tan^{-1}\frac{(331816.095-331897.592)}{(3055733.665-3055723.153)}$$

$$= 08º\,29'14.57'' + 180º$$

$$= 248º\,29'14.57''$$

$$\text{Angle CP1} = 248º\,29'14.57'' - 120º39'28.55''$$

$$= 127º49'46.02''$$

Now,

$x + y + 117^o13'36'' + 70^o48'29.5'' + 127^o49'46.02'' = 360^o$

$x + y = 44^o8'8.48''$

Using sine law ,

$$\frac{\text{Sin}(117^o13'36'')}{41.8} = \frac{\sin (x)}{D} \quad \text{---------------------(1)}$$

$$\frac{\text{Sin}(70^o48'29.5'')}{49.508} = \frac{\sin (y)}{D} \quad \text{-------------------(2)}$$

Now,

$x = 44^o8'8.48'' - y$

Using x in eq^n (1)

$$\frac{\text{Sin}(117^o13'36'')}{41.8} = \frac{\sin(y)}{\sin(44^o8'4.8' - y) \times 41.8}$$

$$\frac{\text{Sin}(y)}{\sin(44^o8'8.48'' - y)} = 0.897$$

$$\frac{1}{(0.897)} = \frac{0.696 \cos y + 0.718(-\sin y)/}{\sin(y)}$$

On solving ,

$y = 20^o48'24.69''$

$x = 23^o19'43.79''$

Again,

$$\frac{41.8}{\sin(117^o13'36'')} \times \sin 23^o 20'37.14'' = D$$

D = 18.615m

Now,

$\measuredangle a = 180^o - 117^o13'36'' - 23^o 19'43.79''$

$= 39^o 26'40.21''$

$\measuredangle b = 127^o 49'46.02'' - 39^o 26'40.21''$

$= 88^o 23'5.81''$

Back bearing of CP1-2M1= $68^o 29'14.5''$

Bearing of 2M1 -Peg = $91^o 48'58.36''$

Using sine law ,

$$\frac{41.8}{\sin(117^o13'36'')} = \frac{\text{Dis.between 2M1-peg}}{\sin(39^o26'40.21'')}$$

Dis. bet^{n} 2M1- peg = 29.865

Latitude = 29.865cos91º48’58.36’’

= -0.946m

Departure = 29.865sin91º48’58.36’’

= 29.849m

Co-ordinate of peg = (3055732.719mN, 331845.944mE)

Again,

Bearing of CP1-2M11 = 120º39’ 28.55”

Bearing of CP1-PEG = 120º 39’28.55’’+ 88º 23’5.81’’

= 209º 2’ 34.36’’

Distance = 18.615

Latitude = -16.274

Departure = -9.0369

Co-ordinate of PEG = (3055732.726mN,331845.963mE)

Again,

Bearing of 2M11-PEG = 360º - 59º20’31,45’’ - 20º48’24.69’’

= 279º 51’3.86’’

Distance between 2M11- PEG = 49.508 × sin(88º23’5.81’’)

sin (70º48’29.5’’)

= 52.401

Latitude = 52.401 cos (279º51’3.86’’)

= 8.965

Departure = -51.628

Co-ordinate of PEG = (3055732.718mN , 331845.964mE)

On average, Co-ordinate of PEG = (3055732.721 mN , 331845.957mE)

Again,

Calculation of RL,

RL of PEG = RL of 2M1 + PH +Dtanɵ - HI

= 1267.81 + 2.15 +29.865 tan (0º 6’59’’)

=1268.596m

Again,

RL of PEG = RL of 2M11 + PH - Dtanɵ - HI

= 1272.69 + 2.15 - 54.401 tan (5º5’30’’) -1,424

= 1268.568m

RL of PEG = RL of CP1 + PH - D tanɵ - HI

$= 1272.591 + 2.15 - 18.615 \tan(14^{\circ}15'45'') - 1.424$

$= 1268.585$

On average ,

RL = 1268.583m

6. Layout of Building

The process of laying out (or setting out) a building or a structure is an important part of surveying, as it enables the works to proceed on site exactly according to prepared designs. Building layout was done by two methods:

i. Using Total station
ii. Using tape

6.1 Brief Description of Layout

Building layout is set according to foundation plan drawings and specifications provided as per the engineering drawing. The purpose of setting out is to transfer the plan, length and width of its foundation on the ground so that the foundation can be excavated for construction of purposed building as per drawing. The provided plan of building to be laid out was 18'*26'3''.

6.2 Norms

- Laying out should be started with the longest side first.
- Minimum of 2.5 feet lengths should be left out on each side of the rectangular plan.
- 3-4-5 method should be used to lay out perpendiculars to any line.
- While using total station stake-out is to be done to locate the points on the ground directly using co-ordinates of two known points.
- The center-to-center distances between the proposed walls should be marked

- The diagonals of the layout should be measured to cross-check for the errors.

6.3 Location and Site Plan

The site for building layout was located on the plain area of under construction road outside the premises of MARS Nepal Survey Camp. The layout was carried out on avery gently sloped ground. A drawing of building was provided to us whose layout was to be drawn.

6.4 Equipment

- Pegs
- Masonry rope
- Measuring tape
- Nails
- Hammer

6.5 Methodology

- A base line was set out first by choosing the longer side of the outer wall.
- By leaving 5ft offset on both sides from the center of column pegs were fixed and masonry rope was tied tightly on the nails at the top of pegs.
- Using 3-4-5 method a perpendicular offset from the base line was set out and pegs were fixed at necessary distance.
- The theoretical and practical hypotenuse length were compared to check the accuracy of the perpendicular offset and repeated until its free from errors.
- Similarly outer rectangular plan was first plotted on the ground and then the inner rectangles were plotted and check simultaneously to check the accuracy of work.
- In this way the plan of the building layout was plotted on the ground.

6.5.1 Site Selection

Ground with stable mass, intact soil and fairly levelled was selected.

Figure 9: Building layout

6.5.2 Topographical Survey

The site for laying out the building was selected, was fairly levelled.

6.5.3 Determination of Area

The theoretical area occupied by the building was already known from the map of the plan. Also, the area at the site was found out by measuring the actual dimensions and it was made sure that the area was equal to the theoretical area.

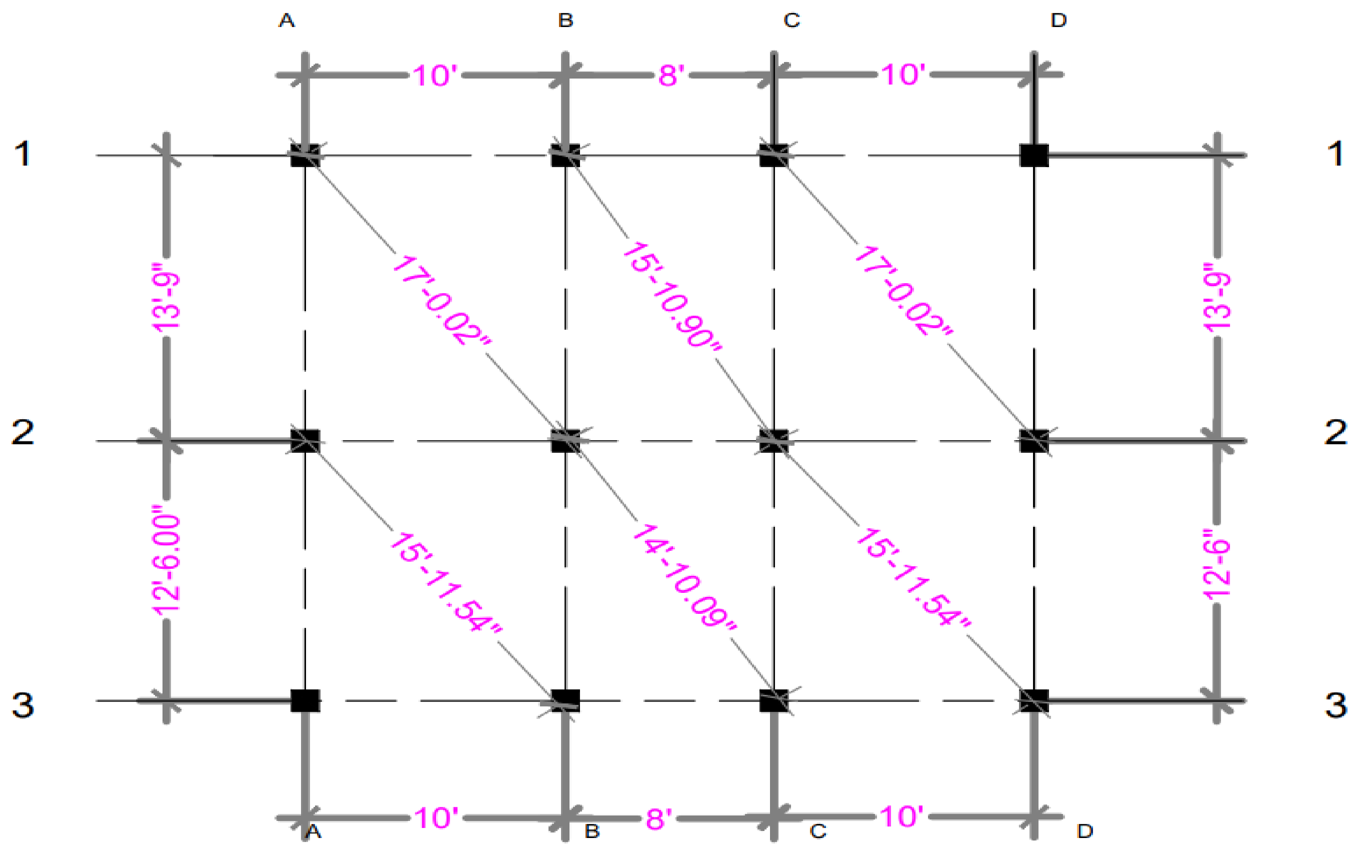

Figure 10:Plan of building layout

6.5.4 Steps of Layout

The following procedure was followed in order to make the layout of the building:

❖ Using Tape

- A peg was hammered into the ground to mark one of the edges of the area.
- The various dimensions were measured and pegs were inserted into the ground starting from the external edges of the ground.
- Nail was hammered on the top and center of the peg.
- Thread was tied on the nail of the hammer and the pegs were tied by the same thread thereby giving the exact layout of the building.
- 3 4 5 method was applied to create perpendicular line and corners.

❖ Using Total station

- Total station was set up on a station with known co-ordinates.
- From the station another known station having known co-ordinates was back-sighted.

- Co-ordinates of these two known stations were entered in data of total station.
- Independent coordinates of all the columns were calculated and every point was located on the ground using stake-out.

6.6 Comments and Conclusion

The excavation and cutting-filling process can be carried out in the proposed site with the help of building layout.

7. Bridge site survey

Bridges are the structured that are constructed with the purpose of connecting two places separated by deep valleys or gorges or rivers and streams. Bridges are usually a part of road making them shorter and hence economical. In countries like Nepal, where the land is undulated and where there are plenty of rivers, bridges are the most economical and efficient way to join two places.

The aim of bridge site survey is to obtain preliminary knowledge of selection and planning of possible bridge site and its axis.

Points that should be taken under consideration while selecting bridges axis are: -

- Narrow and stable banks
- Straight channel
- Longitudinal gradient of river
- Stable downstream and upstream site and
- Perpendicular to flow direction

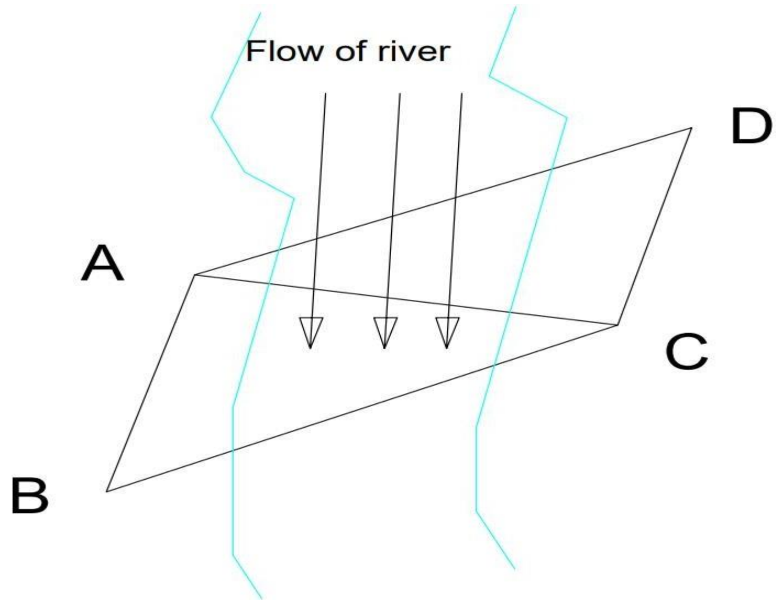

Figure 11: Using Triangulation method to determine length of bridge axis.

7.1 Objectives

i. To select suitable location for the construction of bridge.
ii. To determine the span of the bridge by triangulation.
iii. Perform Survey both upstream and downstream of the proposed bridge axis.
iv. To plot the contour map around that location.

7.2 Brief description of the area

Bridge site survey was carried out over the gorge situated near the survey camp location. The area was covered with lots of vegetation, trees, shrubs. It was a gorge between two hills with local catchment and having runoff only in rainy season. The flow direction seemed to be from northeast to southwest. The depth of gorge ranged from 3-5m between the proposed bridge abutments. During our survey we couldn’t see any marks lefts by high water level and only a small canal was running from upstream towards downstream.

7.3 Hydrology, geology and soil

The site is surrounded with sloppy ground and with no road accessible but foot trails connecting two sides. The area is covered with dense vegetation and the width of gorge was about 50 meters. There was no presence of water marks on the rocks. The average annual precipitation is 935mm.

7.4 Norms (Technical Specification)

The following norms were followed while performing the bridge site survey in the field:

- Control point fixing as well as determining the length of the bridge axis had to be done by the method of triangulation. While forming triangles, proper care had to be taken such that the triangles were well conditioned i.e., none of the angle of the triangle were greater than 120^o or less than 30^o.
- Computed mean length of bridge axis from base triangle should be greater than 1:2000.
- Transforming the level from one bank to another bank had to be done by the method of reciprocal leveling.

7.5 Equipment

- Theodolite
- Total station
- Auto Level
- Tripod stand
- Leveling staff
- Ranging rod
- Pegs and Hammer
- Tape

7.6Methodology

7.6.1 Site selection

Following things were considered while selecting the bridge site: -

- The site was determined to be suitable after the rock abutments were examined to ensure that they were strong enough to support the bridge and the dead as well as live loads.
- The river should be thin from an economic standpoint and the bridge axis should be positioned such that it is roughly perpendicular to the direction of flow.
- The location of the bridge was selected in such a way that the height of the roads joined by the proposed bridge were almost the same. This prevented a lotof cutting and filling to maintain a gentle gradient.

- The high flood level of the river was studied and hence the height of the bridge above the river was designed taking into consideration the occasional flooding.
- The bridge was chosen at such a place that it was very convenient for the local use. And the bridge doesn't deviate from the currently used pathway. Hence itsuse is predicted to be huge thus providing service to a large number of the localpeople.

7.6.2 Topographical Survey

Topographic survey is simply the recording of coordinates and height data for a particular survey area. This data can be used to create spot height maps, contour maps, or more complex terrain models of the surveyed area. To understand the form, level, shape and geographic position both of the natural and in unnatural landfeatures, topographic survey is crucial, whether it is a small garden, a highway, a farm, or even a national park. The topographical surveys can probably be the most popular application in establishing the limits of land or property. This survey aims primarily to gather data on the characteristics of the land and its altitude. The result,usually a two-dimensional map of the property, depicts the relative elevation and position of man-made and natural features in a landscape.

During our project, the triangulations and its angle measurement were done by using total station. The obtained length of bridge axis from triangulation was compared from both triangles.

The detailing of points to create the contour, cross-section and L section were taken using total station.

7.6.3 Longitudinal section and cross section.

An L-section is a graphical representation of the longitudinal or vertical profile of the ground along a specific linear path, typically a proposed road, railway, pipeline, or any linear infrastructure. It provides a side view of the land, showing the existing ground level, the proposed design level, and any changes in elevation over the length of the survey line. L-sections help engineers and planners visualize how the land's contours will need to be adjusted to accommodate the construction of the infrastructure.

To create an L-section, surveyors measure elevations at various points along the survey line and then plot these points on a graph, typically with distance along the x-axis and elevation on the y-axis. Connecting the points produces the L-shaped profile that represents the land's longitudinal section.

A cross-section is a graphical representation of the horizontal and vertical profile of the land perpendicular to the survey line. It provides a view of the land's features and elevation changes across a specific width or width interval. Cross-sections are crucial for understanding the terrain's shape and any variations in elevation or slopes.

To create a cross-section, surveyors measure elevations at various points across the survey line's width and then plot these points on a graph. The x-axis represents the width or distance perpendicular to the survey line, and the y-axis represents elevation. Connecting these points generates a profile that shows how the land's surface changes across the selected width.