2/16/2081

SURVEY CAMP REPORT-2081

Group-H



**TRIBHUVAN UNIVERSITY**

**Institute Of Engineering**

**PURWANCHAL ENGINEERING CAMPUS**

DHARAN-8, SUNSARI

**A REPORT ON**

**SURVEY CAMP 2081**

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# ACKNOWLEDGEMENT

This compiled report of Survey Camp 2081 has been prepared as per the syllabus of B.E. Civil Engineering, fifth semester for the partial fulfillment of Bachelor Degree in Civil Engineering, offered by Tribhuvan University.

The purpose of this fieldwork was to make each student capable to handle equipments and carry out the survey work in real field along with the development of team work coordination.

We would like to express our sincere gratitude towards the Department of Civil Engineering, Purwanchal Campus and the Survey Instruction Committee for initiating and facilitating the survey camp to enhance our knowledge of surveying and its applications. We express our high words of acknowledgement to **Er. Kaji Ram Karki**, Campus chief IOE Purwanchal Campus and **Er. Bhisan Bhujel**, acting HOD, Department of Civil Engineering for their kind help and assistance.

We are also indebted to our Co-Ordinator of Survey Instruction **Er.Tularam Bhandari** and **Er.Janap Ghimire, Mr.Tara Kant Chaudhary,** for assisting, suggesting, motivating and supervising in every aspects of our study and support while doing a field work, calculation as well as to prepare this complete report. Without their help, this study would probably be impossible. We also express our deep sense of gratitude towards **Mr. Gopal Shrestha and Mr.Driver dai**for their tremendous effort on helping us in the survey camp by providing all the help and support while doing a field work.

We are also grateful to IOE Purwanchal Campus arranging and maintaining of safe and comfortable environment to conduct our work smoothly in spite of current critical condition. We express our vote of thanks to our friends for their support and help. Finally, we would also like to thank all those seen and unseen faces who had helped us directly or indirectly in the duration of our survey camp and preparation of this report.

**Group-H**

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# ABSTRACT

The survey camp focused on imparting the experience of different surveying techniques relevant to civil engineering works by executing topographic survey in a large area, learning to propose a viable engineering works by executing topographic survey for bridge axis. The report reflects the methodology, road alignment and selection of a suitable site for bridge axis, with the corresponding observations, and empirical calculations made by the students in the Camp with our practical and theoretical drawings. The principal purpose of the Survey Camp is to enhance our practical and theoretical knowledge of engineering surveying in actual field conditions.

The B.E. Survey Camp 2080, organized by the Survey Instruction Committee, IOE Purwanchal Campus, Dharan is a part of the four-year Bachelor's degree in Civil Engineering course, third year first semester, carrying a total of 100 marks. The Topographic survey was carried out at **the premises of IOE Purwanchal Campus** while Bridge Site Survey and Road Alignment Survey at **Sardu River** located at Dharan-17.

This is a detail report of the work, performed by Group H, throughout the camp period. It briefly explains the working procedure and technique used by this group during the camp period. In addition, it contains observations, calculations, methods of adjustment of error, main problem faced during work and their solution, results of all calculations and their assessments with some comments presented in a concise form.

In this survey camp, we prepare topographic map of the given area, road and bridge site fulfilling all technical requirements. In this regard, we are required to carry out the necessary field works in our sub-group with proper planning and execution of field works for the preparation of topographic map, road alignment and bridge site survey. This survey camp helps us to boost our confidence to conduct engineering survey with the consideration of provided timeframe with required accuracy.

Time schedule:

6:30 AM to 7:30 AM: Discussion class

7:30 AM to 11:00 AM: Survey work  
11:00 AM to 12:00 PM: Lunch

12:00 PM to 5:00 PM: Survey work

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**LIST OF ABBREVIATIONS**

AP -Apex Point

BC-Beginning of Curve

BM-Bench Mark

BS-Back Sight

CP-Common Point

D M S-Degree Minute Second

D/S-Down Stream

EC-End of Curve

EDM-Electronic Distance Measurement

FL-Face Left

FR-Face Right

FS-Fore Sight

GP-Ground Point

HI-Height of Instrument

IS-Intermediate Sight

IP-Intersection Point

IS-Intermediate Sight

Recce-Reconnaissance

RL-Reduced Level

TBM-Temporary Bench Mark

T M B-Top Middle Bottom

TP-Turning Point

U/S-Up Stream

VCR-Vertical Circle Reading

HCR- Horizontal Circle Reading

TL-Tangent Length

LC-Length of Curve

BC-Beginning of Curve

MC-Middle of Curve

EC-End of Curve

GP-Ground Point

BL-Bank Level

HFL-High Flood Level

BR-Bridge

CL-Centre Line

R-Road

GW-Gabin Wall

TR-Tree B-Building

To-Toilet

W-Wall

Fe-Fence

GT-Gate

LB- Left Bank

RB- Right Bank

WORKING SCHEDULE

|  |  |  |
| --- | --- | --- |
| S.N | Day | Survey Field Work |
| 1. | 17th Baisakh | * Reconnaissance surveying for major traverse * Marking major station * Angle measurement of major and minor stations * Two-way linear measurement(EDM) |
| 2. | 18th Baisakh | * Angle Measurement * Two-Peg Test * RL Transfer from TBM to CP1 |
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| 10. | 26th Baisakh | * Profile and Cross section leveling 25 m on each side of road |

**SALIENT FEATURES**

**Name of the Project**: **Survey Camp 2081**

**(A)Description of the Project**:

**Location**:

* + - Province: Koshi
    - District: Sunsari
    - Municipality: Dharan

Latitude:28.6˚N

Departure:87.28˚E

**Site**: **Campus Area** for detailed surveying, **Shardu River** for bridge and road alignment surveying.

**Geographical features**:

* + - Terrain: Plain and rolling
    - Climate: Mild temperature
    - Geology: Plain region with small undulations composed of gravels, boulders etc
    - Vegetation: Good

**(B)Description of works**:

**(a)Traversing:**

* No. Of Major Traverse stations: 13 (including CP1 and CP2)
  + - * No. Of minor loops: 1
      * No. Of Minor traverse stations: 6
      * Perimeter: 1324.976
      * Longest leg length: 139.508(H3-H4)
      * Shortest leg length: 74.401(H8-H9)

Details of the data taken are in the observation sheet.

**Scale:**

* + - Topographic map: 1:500
    - Contour interval:0.5m for topographical survey and 1m for road and bridge traverse

**Detailing:**

Area: The major traverse contains Campus area, staff block, Park and trees etc.

**(b)Road Alignment:**

* Road Type: Village Road
* Surface: Gravel
* Length of the road: 720m
* No. Of intersection points: 6
* Cross section: 25m left and 25m right on both sides from the centerline.
* Longitudinal section: In every 20m of the length for road alignment survey.

Details of the data taken are in the observation sheet.

**Scale:**

* Topographic map: 1:500
* Contour interval: 0.5 m

**(c)Bridge Site Survey:**

i) Bridge Span

ii) Cross section: 300m on upstream and 200m on downstream

Details of data taken are in the observation sheet.

**Scale:**

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**CHAPTER:1**

## 1.1 INTRODUCTION

Surveying is an art and science of determining the relative positions of point on above or beneath the surface of the earth by means of angular and linear measurements. The main objective of surveying is to prepare plans and maps of areas. Thus, the subject emerges out to be the most important before and during all engineering works like civil engineering works such as designing and construction of highways, water supply systems, irrigation projects, buildings etc.

The process of surveying consists of fieldwork of taking measurements and office work of continuing and drawing necessary to the purpose of survey. The fieldwork is the vital part for any kind of survey. As a surveyor, he/she must have sound knowledge, instrument handling skills, personal traits of friendship, sociability by rational and logical, be able to lead and command, etc.

The B.E. Survey Camp 2081 organized by the Department of Civil Engineering, I.O.E., Purwanchal Campus is a part of the four-year Bachelor's degree in Civil Engineering course, third year first semester, carrying a total of 100 marks. The total duration of our survey camp was 10 days, from 17th of Baisakh to 26th of Baisakh, 2081. This is a detailed report of the works performed by group H during the camp period. It briefly explains the working procedures and technique along with the observations, calculations, and methods of adjustment of error. In addition, it also contains the main problem faced during work and their solution, results of all calculations.

The work done during the camp duration can be categorized into:

1. Topographical survey

2. Bridge site survey

3. Road alignment survey

**1.1 Principle of Surveying**

The fundamental principles of surveying are:

1. **Working from whole to part**: It is very essential to establish first a system of control points with higher precision. For horizontal control, the points are established by triangulation or by precise traversing. To do this triangulation, the area to be surveyed is divided into large triangles which are surveyed with the greatest accuracy. They are further divided into small triangles which are surveyed with less accuracy. The objective of this system of working is to prevent the accumulation of error and to control the localize minor errors.
2. **Location of a point by measurement from two control points:** The relative position of points to be surveyed should be located by the measurement from at least two (preferably three) points of reference, the position of which have already been fixed.
3. **Consistency of work:** Keeping consistency in method, instrument and observer, the survey work of desired level of accuracy can be obtained.
4. **Independent check:** Every measurement taken in the field must be checked by some independent field observation so that the mistake is not passed unnoticeably.
5. **Accuracy required:** Proper method and proper instrument should be used depending upon the amount of accuracy required. Accuracy of angular and linear values should be compatible.

**1.2 Objectives of Survey Camp:**

The main objective of the survey camp is to provide a basic knowledge of practical implementation of different surveying works. It helps to build up the self-confidence level by implementing different surveying works.

Other objectives of the camp can be further listed as follows:

* Horizontal control and vertical control survey practices and produces topographic map in coordinate system.
* Linear segment survey practice through Road Alignment Survey.
* Practices of horizontal control and vertical control survey surrounding the river through bridge site survey.

## 1.4 Project Area:

IOE PURWANCHAL CAMPUS DHARAN FOR TOPOGRAPHICAL SURVEY.

SARDU KHOLA AREA FOR BRIDGE AND ROAD SITE SURVEY.

**1.4.1 Location and Accessibility**:

Dharan is situated on the foothills of the Mahabharat Range in the north with its southern tip touching the edge of the Terai region at an altitude of 1148 ft (349m). Dharan bazaar grew up near Phusre where the old walking route to Dhankuta and a large part of the Eastern hills left the plains with the ascent of Sanghuri Danda. The area to be surveyed for topographic survey is area under IOE Purwanchal Campus. Being the college premises, our project area was quite suitable and easily accessible.

Similarly, Sardu Khola, famous for the Weekly shramdaan in Dharan lead by Harka Sampang, is located in west of Dharan. This is the torrential stream which cause disaster in the downstream during rainy season. Campus has made bus available for travel to and from site. Thus, our project area was quite suitable and easily accessible. The journey from Kathmandu to Sardu Khola takes about 30 minutes by bus.

* Country: Nepal
* Province no.: 01
* Province Name: Koshi
* District: Sunsari
* Municipality: Dharan
* Ward No.: 15 ➢ Ward No.: 16
* Location: IOE Purwanchal Campus ➢Location: Sardu Khola

**1.4.2Topography and Geology:**

IOE Purwanchal Campus occupies areas of 34-13-11.75 Bigahas in convenient unit, which is equivalent to about 234,870.53 square meters. It is adjacent to Charkose Jhadi (densely forest) in the north and located at entrance gate by bus of Dharan Sub-metropolitan city. The average height of Campus area is 1148 ft (349m) above the mean sea level. Dharan has gently steep topography. The area contains ground features ranging from step slopes to almost flat grounds.

For conducting any type of work, we should know about the geology of that area. Geology plays a vital role for the construction maintenance and rehabilitation of any type of structure.

As Dharan is underlain by Tertiary sediments (Siwalik) in the north and Quaternary sediments (Terai Plain) in the south. For our concern, the Topographic survey site falls in “Siwalik Zone” and Bridge site falls in “Terai Zone”.

**1.4.3 Temperature, Climate and Vegetation**:

According to Central Bureau of Statistics, Dharan has a tropical monsoon climate with maximum temperature of 35 to 36 Degree Celsius in April and minimum of 10 to 12 Degree Celsius in January.

Average temperature: 28˚C in summer

17˚C in winter

Major Crops grown: Paddy, wheat, maize etc.

Types of vegetation found: Herbs, Shrubs and tall trees, *Peepal*, *Sirish*, Bamboo.

The temperature during the camp period was about 32˚C. The days were hotter whereas in the evening, wind blew throughout the camp period making the evening pleasant.

**1.4.4 Others**:

Dharan is one of beautiful cities of Nepal, beautiful roads, remarkable homes and natural beauty. It embraces cleanliness, openness, friendly hill people and their smiles. A famous hill station called Bhedetar (19 KM from Dharan) lies in the north and it has remained the place of relief for the people of Dharan during the summer as the heat begins to rise. In the autumn when the sky becomes clear, one can witness the breathtaking range of mountains. The distinct view of Makalu can be seen from this area. Many fine lodges and the restaurants are now opened up for the tourists and the people coming for the cool and fresh air. The tower named Charle’s tower situated on the top of the hill is one of the exciting spots indeed from where one who can see excellent views of Hile-Dhankuta, Kanchenjunga Himal in the north and a really large valley with Sapta Koshi river along with Dharan Bazaar very close but really down. Dharan grew after British setup the ‘Gurkha Recruitment Center’ in 1953. Two ethnic groups namely Rais and Limbus used to constitute the major portion of the Gurkha soldiers and these groups came from the eastern region of Nepal for their training. Pindeshwar, Dantakali, Budha Subba, Panchkanya Temples are all located in historically and archeologically important Bijaypur hill. A famous Barahchatra temple at Chatara is very near to Dharan. Koshi Tappu Wildlife Reserve is the only refuge for wild buffalo and is home for more than 300 species of birds. Dharan is also the gateway for the many north/east hill regions and starting point for the trekkers to the Kanchenjunga, Solu Khumbu and the Arun Valley. Dharan enjoys many fine lodges and the elegant restaurants which serves the good meals but is short of star hotels. The shopping mall named Bhatbhateni and Gorkha Shopping Complex is also at Dharan. Dharan is also remaining an educational center for the eastern Nepal; boosts some of the fine colleges, schools and the medical college. B.P. Koirala Institute of Health Science is not only a major medical institute of Nepal but also serves high quality health care services to eastern Nepal and north parts of India. Besides IOE/ Purwanchal Campus, Central Campus of Technology (Food and Beverages Technology) Hatisar, Mahendra Multiple Campus are constituent campuses of TU and Pindeswor Bidyapitha (Sanskrit) are the major institution of Dharan.

**CHAPTER:2**

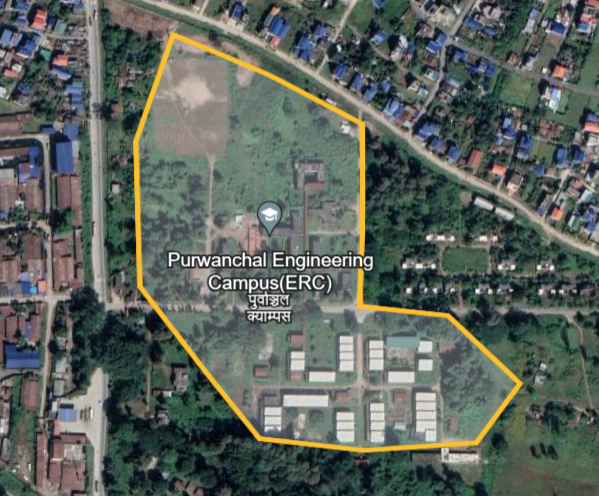
## TOPOGRAPHICAL SURVEY

## Introduction

Topographic surveying is the process of determining the positions, both on the plan and elevation, of the natural and artificial features of a locality for the purpose of delineating them by means of conventional signs upon a topographic map. Topography defines the shape or configuration of the earth’s surface. The basic purpose of a topographic map is to indicate the three-dimensional relationships for the terrain of any given area of land. Thus, on a topographic map, the relative positions of the points are represented both horizontally as well as vertically.

## **2.1 Brief Description of the Area**:

The area through which the major traverse was run was a small portion of the whole IOE Purwanchal Campus premises. Along with the preparation of the topographical map of the major traverse, detailed topographical map of the small area with contours was also prepared. The area on which detailed topographical survey was performed includes: Administration, all departments, canteen, football ground and both boys and girls hostels.



## Fig: Traversing of IOE Purwanchal campus

## 2.2 Objective

The main objective of the topographic survey undertaken here is to prepare the topographic map of the given IOE Purwanchal campus, with horizontal as well as vertical controls within pre-determined accuracy. Apart from this, some of the other objectives are summed-up as follows:

* + - To use and become familiar with different kinds of surveying instruments.
    - To select and use appropriate methods to undertake the topographic survey.
    - To fix Major traverse to cover the maximum area to be surveyed.
    - To fix Minor traverse for comfort and control in detailing.

## 2.3 Norms (Technical Specifications)

1. **Reconnaissance survey of the area to be surveyed.** Form a closed traverse (major and minor) around the premises of the area by fixing or marking appropriate no. of stations (13-15). In the selection of the traverse stations the leg ratio, i.e. the ratio of length of the longest traverse leg to the length of the smallest leg, should be less than or equal to **1:2** for major traverse and **1:3** for the minor traverse.
2. **Two-way measurement of the traverse legs by means of a Total Station.** Accuracy of two way measurement in the case of major traverse is **1:5000** and minor traverse. (Two way measurement, i.e. measurement of the traverse leg in the forward as well as in the backward direction.)
3. **Two sets of angle measurement making use of a Total Station.** Measure two sets of horizontal circle reading of major traverse stations either by Total Station or Theodolite. The difference between face left and face right readings should be within **30”**. Note the difference between the mean angles of two sets reading should be within **1’**.
4. **Determination of RL of traverse stations by fly leveling from the given BM.**Perform two peg test. Collimation error in the case of two peg test should be better than **1:10000**. Balancing of back sight and fore sight is necessary for the elimination of different types of errors including collimation error. The permissible error of fly leveling is **± 25√K** mm, where **K** is the distance of the leveling passed in kilometer.
5. **Adjustment of traverse or balancing the traverse.** The permissible angular error or the angular misclosure for the sum of interior angles of the traverse should be within **C√N**, where **N** denotes the no. of traverse leg or traverse stations and, **C=10’’** for major traverse and **C=1’** for minor traverse. For major traverse the relative error of closure should be less than **1:3000** and that for minor should be less than **1:2000.**
6. **Plotting of the traverse stations by co-ordinate method**. An appropriate scale is selected, i.e. **1:500** for the major traverse and for the minor traverse.
7. **Detailing or the detail survey of the plot by Tachometric surveying.** References are drawn from the major and minor traverses. The details are extracted from a self-recording Total station. Conventional symbols are used to denote the detailing along with the contours of **0.5 m** contour interval in the same scale in topographic survey and 1m contour interval for road alignment and bridge survey.

## 2.4 Equipments

The equipments used for the topographic survey are listed as follows

1. Total Station with tripod
2. Auto level with tripod
3. Compass with tripod
4. Staffs
5. Target prisms with stands and leveling bubble provided
6. Ranging rods
7. Plumb bob
8. Tapes
9. Plane table
10. Alidade
11. Spirit level
12. Arrows
13. Hammer
14. Pegs
15. Enamel paints and marker

## 2.5 Methodology

The different methodologies were used in surveying to solve the problems arise in the field. These methodologies are as follows:

### 2.5.1 Reconnaissance:

Reconnaissance (Recce) means the preliminary inspection of the area before commencing the actual detail survey, for the purpose of fixing the survey stations and forming a general plan for the network of the chain lines. This helps to make the necessary observations regarding the total area, type of land, topography, vegetation, climate, geology and intervisibility conditions that helped in fetailed planning. For this purpose the detailed inspection of the given area was carried out by reconnaissance survey. During reconnaissance, the major and minor traverse control points to form a closed traverse around the perimeter of the area was found out.

While selecting the major and minor control points, the following points should be considered:

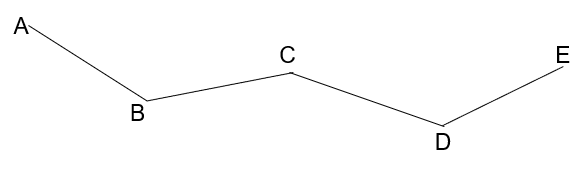
* Location should be such that the basic principle of surveying i.e. working from whole to the part gets implemented.
* Number of stations should be minimum as far as possible but the possible figures joining the stations should be well conditioned.
* Length of the traverse lines better be as long as possible to reduce the effect of centering error.
* The indivisibility among stations and at least between adjoining stations is required.
* Stations should be positioned on firm and level ground.
* While selection of stations the leg ratio should be maintained its consecutive legs and in overall leg distance 1:2 or 1:3.

### 2.5.2 Traversing

Traversing is the type of surveying in which a number of connected survey lines form the frame work, which is used for housing, factory sides, determination of perimeter of lakes, setting out and detailing of many engineering works. The main purpose of traversing is to find control points. When there is large extend of chaining triangulation, generally traversing is used. It is the method of control survey. The survey consists of the measurement of angle between the successive lines or bearing of each line and the length of each line. These are done with the help of angle measuring instrument, theodolite or tape. If the coordinate of first station and bearing of first line are known, then the coordinates of all successive points can be computed. Traversing is of two types:

1. **Open Traverse**

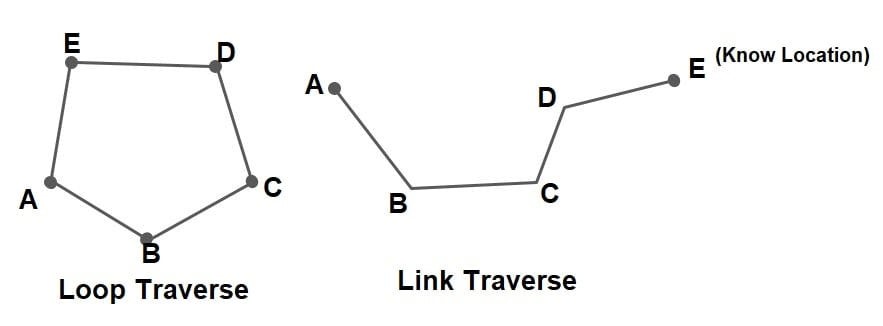
A traverse is said to be open traverse when the traverse starts at one point and terminates at another point as shown in the figure. Open traverse is also called as unclosed traverse. It is suitable for surveying of roads, coastal lines, etc

.

*Fig1:open traverse*

1. **Close Traverse**

A traverse is said to be closed traverse when the traverse formed a closed circuit as shown in the figure. In this case, both starting and terminating points of the traverse coincide with each other. It is suitable for the survey of boundaries of ponds, sports grounds, forests, etc. It is further divided into two types: Closed loop closed traverse and open loop closed traverse (Link traverse).

****

*Fig 2 : Closed Traverse*

### 2.5.2.1 Major Traverse

The skeleton of lines joining those control points, which covers the whole entire area, is called Major Traverse. Two-set of readings are taken for Major Traverse as the work done on major traverse need to be precise. For convenience, the readings are taken by setting the total station at 00˚00’00” for one set and 90˚00’00” for another.

The major traverse had 13 control stations including two given control points. The control stations were named as H1, H2, ….,H11 and two control points as CP1 and CP2 respectively. The leg ratio of maximum traverse leg to minimum traverse leg was maintained within 2:1. The precision in length between the forward measurements and the backward measurements of all the traverse legs was within 1:5000 when measured through total station. The difference between the mean angles of two sets of readings was within a minute for all the angles whereas for two face reading was within 30’’ for all the measured angles.

**Computation of Co-ordinates:**

The length of the traverse is measured by total station. The traverse angles are measured with a total station by setting up the instrument at each station. The bearing of the any one of the traverse leg measured and the entire traverse angle measured, the bearing of all the legs can be calculated by:

Bearing of a line = (bearing of previous line + included angle) ± (180˚ ) or (540˚)

If θ is the bearing of line (C.P, A say), and l be the length of the line and provided that co-ordinate of the control point (C.P) is known then the coordinate of the point ‘A’ can be calculated as follows:

Independent X-coordinate of A = x-coordinate of control point (c.p) +L\*sinθ

Independent Y-coordinate of A = y-coordinate of control point (c.p) + L\*cosθ

Where, L\* sinθ and L\*cosθ denote the **consective coordinates** of the line

R.L or z-coordinate of A = R.L of point (c.p) + H.I ± V - Height of signal

Where, H.I = Height of instrument V = Vertical distance

**Closing Error**

In a closed traverse, the algebraic sum of the latitudes and departures must be zero if linear as well as angular measurements of the traverse along with their computations are correct. If not, the distance between the starting station & point or position of the same station obtained by the calculation is known as closing error. The value of closing error is obtained by the following formula.

**D**

**C**

**A**

*L*2  *D*2

**A’**

Error=

**B**

**A**

*Fig:Closing Error*

### 2.5.2.2 Minor traverse:

For the detailed topographical survey, the detail points may not be sufficiently obtained from the control stations of the major traverse. For this minor traverse need to be laid. Minor traverse is that one which runs through the area to make detailing easy. Minor Traverse covers only small area. Less precise work than that of major traverse is acceptable so that single set reading is sufficient. The minor traverse had 6 control stations. The stations were named as h1, h2…., h6. The leg ratio of maximum traverse leg to minimum traverse leg was maintained within **3:1**. The precision in length between the forward measurements and the backward measurements of all the traverse legs was within **1:2000**.

### 2.5.2.3 Balancing the traverse

The process of adjusting the consecutive co-ordinates by applying the correction to the latitudes & departures of each of the traverse legs such that their algebraic sum is equal to zero is called balancing the traverse or balancing the consecutive co- ordinates.

A closed traverse can be balanced by any one of the following methods.

1. Bowditch’s method
2. Transit rule
3. Graphical method
4. Axis method
5. **Bowditch’s Method**

The method is based on the assumption that errors in the linear measurement are proportional to √L and the errors in the angular measurements are inversely proportional to √L where ‘L’ is the length of a line. The method is applicable when both the linear as well as angular measurements are of equal precision.

The Bowditch rule is:

Correction to latitude (or departure) of any side=

=*Total error in latitude or departure* x

*Clat*   *Lat*   *Cdep*   *Dep* 

Where, CLat = Correction to latitude of that side

CDep = Correction to departure of that side

ΣLat = Total error in latitude

ΣDep = Total error in departure

ΣL = Total perimeter of traverse

L = Length of that side

**ii. Transit Method**

The method is most applicable when angular measurements are of more precision than linear measurement. According to this rule, the total error in latitude and in departure is distributed in proportion to the latitude and departure of the sides. The angles are less affected by the corrections applied by this method than by the Bowditch method.

The Transit rule is:

Correction in Latitude (or Departure) of any side

= 𝑇𝑜𝑡𝑎𝑙 𝐸𝑟𝑟𝑜𝑟 𝑖𝑛 𝐿𝑎𝑡𝑖𝑡𝑢𝑑𝑒 𝑜𝑟 𝐷𝑒𝑝𝑎𝑟𝑡𝑢𝑟𝑒 x

CL=ΣL\* CD=ΣD\*

Where, CL= Correction to latitude of any side

CD = Correction to departure of any side

L = Latitude of any line

D = Departure of any line

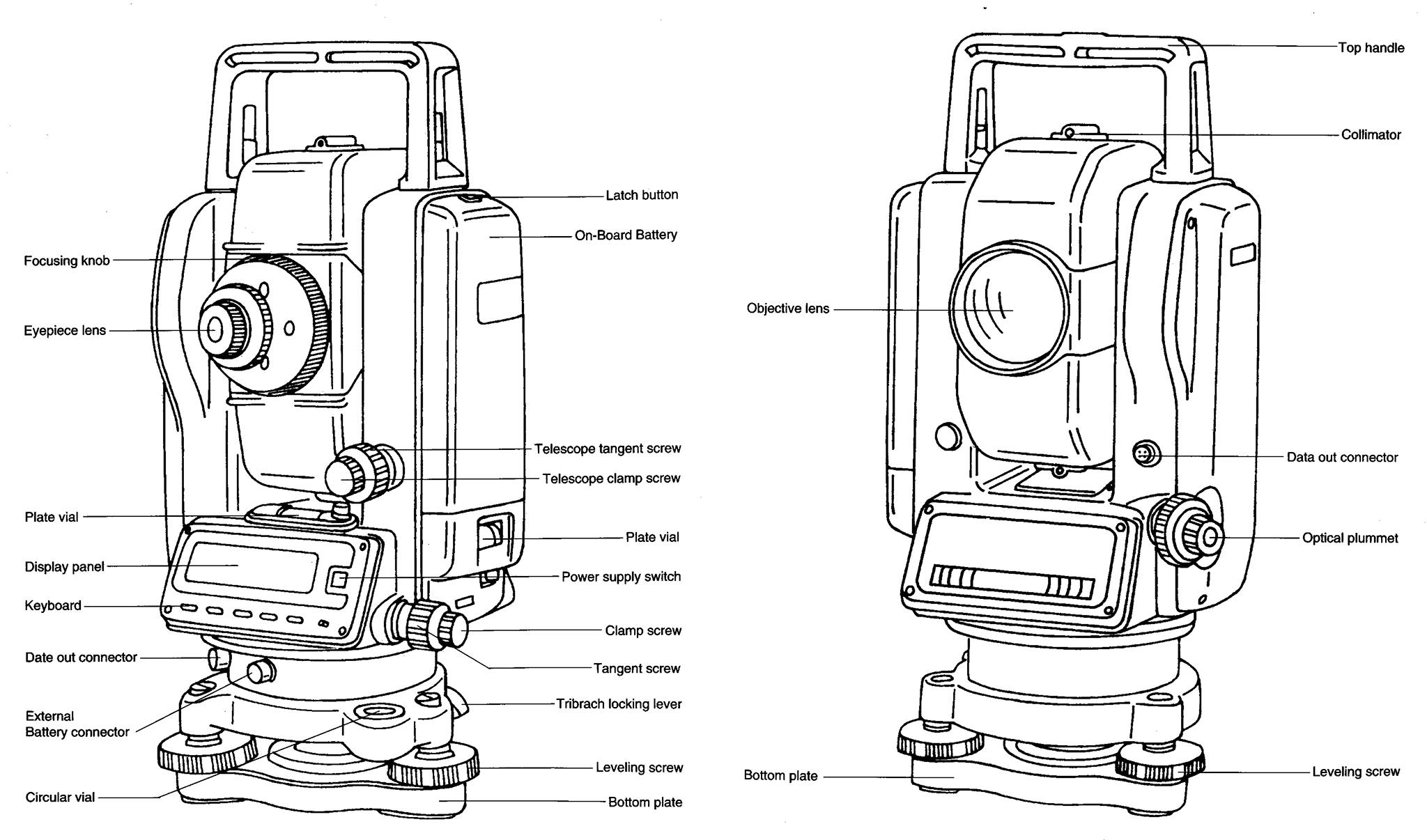
LT = Arithmetic sum of latitudes

DT = Arithmetic sum of departures

## 2.5.3 Detailing

Detailing means locating and plotting relief in a topographic map. Detailing can be done by either plane table surveying or tachometric surveying or by total station. We performed detailing by total station, detailing by tachometry and tangential method while taking details during the camp.

### Total Station

A total station is an electronic/optical instrument in modern surveying and building construction that uses electronic transit theodolite in conjunction with electronic distance meter (EDM). It is also integrated with microprocessor, electronic data collector and storage system. 

*Fig 3: Total Station and its parts*

The instrument is used to measure sloping distance of object to the instrument, horizontal angles and vertical angles. This Microprocessor unit enables for computation of data collected to further calculate the horizontal distance, coordinates of a point and reduced level of point. Data collected from total station can be downloaded into computer/laptops for further processing of information. Total stations are mainly used by land surveyors and civil engineers, either to record features as in topographic surveying or to set out features (such as roads, houses or boundaries). They are also used by archaeologists to record excavations and by police, crime scene investigators, private accident Reconstructionist and insurance companies to take measurements of scenes.

**Types of Total Station**

Usually, these three types are used in the total stations given in the chart and their operations.

|  |  |  |  |
| --- | --- | --- | --- |
| Types | Vertical Angle | Horizontal Angle | Slope distance |
| Manual | manually | manually | electronically |
| Semi-automatic | digitally | manually | electronically |
| Automatic | electronically | electronically | Co-ordinate system |

Besides, there are many other types of total stations as well. The total handheld station is the most popular form which uses an internal or external antenna for photogrammetric processing. The mobile total station gives us mobility attached to a motorized platform. The fixed station provides services from a stationary point. Scanning Total Stations, Robotic Total Stations, autolock Total Stations, prism total stations, and Total Mechanical Stationary are also kinds of total stations.

1. **Tacheometry:**

It is the branch of surveying in which both the horizontal and vertical distances between stations are determined by making instrumental observations. Tacheometry is used in the preparation of contour maps and they also provides a good check on distances measured with tape or chain.

**Principle of tacheometry:**

In isosceles triangles, the ratio of the perpendiculars from the vertex on their bases is constant.

The formula for the horizontal distance is

**H=k∗s Cos2𝜃**

The formula for the vertical distance is

**V = (k∗s Sin2θ)/2 )**

Where, **s** = staff intercept ;

**θ** = Vertical Angle

Thus knowing the value of **V**, reduced level (R.L.) of instrument station, Height of instrument (**H.I.)** and central wire reading (**R**), the R.L. of any point under observation can be calculated as:

**R.L.of point = R.L. of instrument station + H.I. ± V - R**

1. **Detailing by trigonometric leveling:**

In this method we have to take two middle staff reading, with 2 different vert. angle along with horizontal angle with any traverse leg.

We use the formula:

S=difference in staff reading

H=S / (tan(90-θ1)-tan(90-θ2))

V=H tan(90- θ2)

where,θ1 is smaller zenithal angle and θ2 is bigger zenithal angle.

## Levelling

Leveling is an art of determining relative altitudes of points on the surface of the earth or beneath the surface of the earth. It is used to find the elevation of given points with respect to a given or assumed datum and to establish points at a given elevation or at different elevations with respect to a given or assumed datum. Leveling deals with measurements in a vertical plane. Finding out elevation is necessary to enable the work and establishing points are necessary in the setting out of works. The different methods of leveling are explained as follows:

1. **Simple Leveling:**

The operation of leveling for determining the difference in elevation, if not too great, between two points visible from a single position of the level, is known as simple leveling.

1. **Differential Leveling:**

The method of leveling for determining the difference in elevation of two points either too far or obstructed by an intervening ground, is known as differential leveling. The level is set up at number of points and the difference in elevation of successive points, is determined in this method.

1. **Check Leveling:**

After the completion of fly leveling, level lines are run to check the accuracy of the bench marks previously fixed which is called check leveling.

1. **Profile Leveling:**

The operation of leveling carried out to determine the elevations of the points at known distances apart, and also salient features, along a given straight line is called profile leveling. It is also known as longitudinal leveling.

1. **Cross-section leveling:**

The operation of leveling which is carried out to provide levels on either side of the main line at right angles, in order to determine the vertical section of the earth surface on the ground is called cross section leveling.

1. **Reciprocal leveling:**

When the level is not possible to be set up between two points due to an intervening obstruction as large water bodies, reciprocal leveling is carried out. The two sets of reciprocal leveling is done to find out the difference in elevation between two points accurately.

**Temporary adjustments of Level:**

The temporary adjustments for a level consist of the following:

1. **Setting up the level:**

The operation of setting up includes fixing the instrument on the stand and leveling the instrument approximately.

1. **Leveling up:**

Accurate leveling is done with the help of foot screws and with reference to the plate levels. The purpose of leveling is to make the vertical axis truly vertical and horizontal line of sight truly horizontal. It is done by adjusting the screws.

1. **Removal of parallax**

Parallax is a condition when the image formed by the objective is not in the plane of the cross hairs. Parallax is eliminated by focusing the eye-piece for distinct vision of the cross hairs and by focusing the objective to bring the image of the object in the plane of cross hairs.

### 2.5.5 Permanent adjustments of Level (Two peg test):

To check for the collimation error of level two-peg test should be performed. Two staffs were placed at A and B of known length. First the instrument was setup on the middle point of A and B and staff readings (Top, Middle and Bottom) on A and B were taken. Second the instrument was setup behind A and again staff readings were taken on A and B. The was done in order to check whether the adjustment was within the required accuracy or not. The error obtained was within the given permissible error. So, the permanent adjustment was not required.

**A**

**B**

**C**

**10mm**

**10mm**

**D**

**B**

**A**

**5m**

**20m**

*Fig :Two-peg test*

### Booking of reducing levels:

There are two methods of booking and reducing the elevation of points from the observed staff reading:

1. **Height of the Instrument method**

Arithmetic Check: B.S. – F.S. = Last R.L. – First R.L.

1. **Rise and Fall method**

Arithmetic Check: B.S. – F.S. = Rise –Fall = Last R.L. – First R.L.

Among the two methods, Rise and Fall method was widely used.

**Fly Leveling:**

The fly leveling was carried out between TBM 2 and TBM 3 and check leveling was performed to check the results.

**Level transfer to the major and minor traverse stations**:

The R. L of the temporary benchmark was then transferred to the control stations of the major and minor traverse. The closing error was found to be within the permissible limits. The misclosure was adjusted in each leg of the leveling path by using the following formula:

Permissible error = ±25√k mm.

Where k is the total perimeter in Km

Actual Error (e) = ∑BS – ∑F.S. = Last R.L. – First R.L.

Correction i th leg=-(e \* (L1 + L2 +…. + Li)/P

*Where L1, L2, Li Length of 1st 2nd, …... i th leg and P is perimeter. Relative Precision= 1/(p/e)*

### Contouring

A contour is an imaginary line of constant elevation on the ground surface. It is the line in which the surface of the ground is intersected by the level surface.

**2.5.6.1Contour interval and Horizontal Equivalent**

The vertical distance between any two consecutive contours is called the contour interval. The contour interval is kept constant for a contour plan or the topographic map; otherwise the general appearance of the map will be misleading. The horizontal distance between two points on two consecutive contours is known as horizontal equivalent and it depends upon the steepness of the ground. The choice of the proper contour interval depends upon the following considerations:

* + - * + The nature of the ground
        + The scale of the map
        + The purpose and the extent of the survey
        + Time and expense of field and the office work

**2.5.6.2Characteristics of Contours**

The characteristic features of the contour which are used while plotting and reading a contour map or the topographic map are summed up as follows:

1. Two contour lines of different elevations cannot cross each other. They can cross each other only in the case of overhanging cliff.
2. Two contour lines of different elevations cannot unite to form a single. If they do, it is only in the case of vertical cliff.
3. Closely spaced contour lines represent a steep slope. BCanally spaced contour lines represent a gentle slope. Equally spaced contour lines represent a uniform slope. A series of straight, parallel and equally space contours represent a plane surface.
4. A contour line cannot split into two or more contour lines.
5. A series of closed contour lines with higher value of contour i.e. with contour having higher value of elevation inside represent a hill where as a series of closed contour lines with lower value of contour inside represent a pond or the depressed land.
6. A contour line must close upon itself, though not necessary within the limits of the map.
7. Contour lines cross a watershed or the ridge line at right angles. They form curves of U-shaped round it with the concave side of the curve towards the higher ground.
8. Contour lines cross a valley line at right angles. They form sharp curves of V- shaped across it with the convex side of the curve towards the higher ground.
9. The same contour appears on the either side of a ridge or valley, for the highest horizontal plane that intersects the ridge line must cut it on the both the sides. The same is true of the lower horizontal plane that cuts a valley.
   * + 1. **Methods of Locating Contours**

The location of a point in topographic survey involves both horizontal as well as vertical control. The methods of locating contours, therefore, depend upon the instruments used.

1. The direct method
2. The indirect method

In the **direct method**, the contour to be plotted is actually traced on the ground. Only those points are surveyed which needs to be plotted. After having surveyed those points, they are plotted and the contours are drawn through them. The method is slow and tedious and is used for the small areas where great accuracy is required.

In the **indirect method**, some suitable guide points are selected and surveyed; the guide points need not necessarily be on the contours. These guide points, having been plotted, serve as basis for the interpolation of contours. This is the method most commonly used in engineering surveys.

* + - 1. **Interpolation of the Contour lines**

Interpolation of the contour is the process of spacing the contours proportionately between the plotted ground points established by indirect methods. The method of interpolation is based on the assumption that the slope of the ground between the two points, which are surveyed, is uniform. There are different methods of interpolation of contours. They are as follows:

1. Estimation
2. Arithmetic calculations
3. Graphical method
4. Estimation

This method is extremely rough and is used for small scale work only. The position of the contour points between the guides points are located by estimation.

1. Arithmetic Calculations

The method, though accurate, is time consuming. The position of contour points between the guides points are located by arithmetic calculation.

Where, X= Horizontal distance of the point to be located H= Horizontal distance between two guide points V= Vertical distance between two guide points

Y= Vertical distance between the point to be located and lower elevation point

1. Graphical Method

In the graphical method, the interpolation is done with the help of a tracing paper or a tracing cloth.

## 2.6 Comments and Conclusion:

The site for the survey camp was suitable for us to practice the theoretically acquired knowledge in the field. Laying control stations, carrying out level works and angular measurement became difficult while laying stations on bushes side. The obstructions due to trees created problem. The work was slowed down as some of the instruments provided were with errors. Also, during fly leveling from TBM1 to cp1, we faced difficulties due to traffic disturbances. However, the given topography survey camp was finished within the given span of time. The subject survey needs practice as much as possible. For surveying, theory can only take as the introduction but if there is practice, there will be much gain of knowledge about the techniques of surveying. Thus, this camp helps us by practicing the survey work to gain the much essential knowledge as far as possible. It is better to say that it provides us a confidence to perform survey and apply the techniques at any type of problem facing during the actual work in the future career.

**CHAPTER:3**

# BRIDGE SITE SURVEY

Bridges are the structures that are constructed with the purpose of connecting two places separated by deep valleys or gorges or rivers and streams. Bridges are usually the cross drainage and hence a part of roads making them shorter and hence economical. In countries like Nepal, where there are a lot of uneven lands and plenty of rivers. Thus, bridges are the most economic and efficient way to join two places by road in a very convenient way.

## 3.1 Objectives:

The main objective of the bridge site survey is to give the students the preliminary knowledge on selection and planning of possible bridge site and axis for the future construction of the bridge. The purposes of the bridge site survey are:

* To select the possible bridge site and axis for the construction of bridge.
* To collect the preliminary data i.e. normal water flow level, high flood level.
* To study about the geological features of the ground.
* To carry out surveying for topographical mapping, longitudinal and cross sections at both upstream and downstream sides of the river.

### 3.2 Brief description of the site:

Bridge site survey was conducted over Sardu Khola. The Khola being seasonal, there is no water during the survey time but highflood level extends to larger width. The bridge site was surrounded by trees and bushes. The ground was sandy with numerous boulders and rocks. The hill slopes on both sides were very steep and are thus geologically unstable. Below axis of bridge, there is landslide prone area where old traces of landslide are visible.

### Hydrology, Geology & Soil:

The site is surrounded with steep hill, which is covered with densely planted shrubs. The soil was sandy as the basin is the fan base of river. The width of stream is not so big but high flood level covers large area. Water scoured marks on the sideshow that the highest flood level is quite high sometimes.

### Technical Specifications (Norms):

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

* Carry out reconnaissance survey of the bridge site area. Establish necessary triangulation stations to determine Bridge Axis length, as well as horizontal and vertical control of the area. Well condition triangles should be formed while selecting the triangulation stations
* 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 angles of the triangle were greater than 120° or less than 30°.
* Maintain free board distance at least 4m in between invert of proposed bridge and high flood level mark.
* In triangulation, distance of Base Line must be measured in an accuracy of 1:2000.
* Observe two sets of horizontal circle reading by the theodolite to measure the angle of triangles. Note that the difference between the mean angles of two sets of readings had to be within a minute. Angular misclosure for base triangle should be ±30"N.
* Compute the length of proposed bridge axis by triangulation survey from two adjacent base triangles by using sine law and determine the length of bridge axis by taking average length.
* Conduct fly leveling to transfer the R.L. from given B.M. to the nearest triangulation station of the bridge axis and make circuit close for checking error of closure
* Carry out reciprocal leveling to transfer level from one bank to other bank of the river within a precision of ±24 k mm. Determine the RL of the other triangulation stations by fly leveling from the end point of bridge axis.
* Plot a topographic map indicating contour lines at suitable interval (contour interval = 1m). The scale for plotting the topographical map had to be 1:500.
* In order to plot the longitudinal section of the river, data had to be taken along the riverbed 300 m upstream and at least 200 m downstream. Draw cross section at 20m interval from topographic map and one at the bridge axis. The plot for the longitudinal section along the flow line had to be done in a scale of 1:500 for vertical and 1:500 for horizontal, for cross-section V=H=1:200.
  1. **Equipment & Accessories:**

The equipment used in the survey during the preparation of topographic map in bridge site are as follows:

* Total station
* Theodolite
* Leveling staffs
* Ranging rods
* Measuring tapes
* Tripod stand
* Hammer
* Plumb bob
* Nails and pegs
* Marking pen
* Compass
* Prism
* Prism holder
  1. **Methodology:**

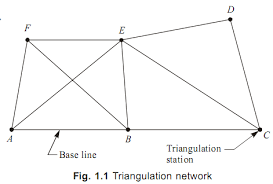
The various methods performed during the bridge site survey were site selection, triangulation, leveling (fly leveling and reciprocal leveling), detailing by total station, cross section, and L section. The brief descriptions of these methodologies are given below:

**3.6.1 Site Selection:**

Site selection is the first and foremost step for the construction of bridge. Several governing factors are there for the site selection of the bridge. Geological condition, socio-economic and ecological aspect etc. guides the way of selection of bridge site. Therefore, the site was chosen such that it is laid on the very stable rocks at the bed of river as far as possible and not affect the ecological balance of the flora and fauna of the site area. The location of the bridge was selected in such a way that the heights of the roads joined by the proposed bridge were almost the same. This prevented a lot of cutting and filling to maintain a gentle gradient. The bridge site was chosen in such a way that the bridge axis was perpendicular to the flow direction and was also shorter in span so as to make the construction economical. The starting point of bridge axis was not laid on the curve of the road.

**Triangulation**

Triangulation was performed for the determination of the approximate span of the bridge axis. The triangulation stations can be taken as the control points for detailing. Two points on either bank of the river were fixed as control points and one of the sides of the triangle was taken as the bridge axis. The two triangles from each bank were fixed.



*Fig : Triangulation network*

The base line was measured accurately by two way taping as well as tachometry and interior angles were measured by taking two sets of reading by theodolite. The accurate span of bridge was computed by applying sine rule. To minimize the plotting error well-conditioned triangles were constructed i.e. the angles greater than 30 degrees, less than 120 degrees and nearer to 60 degrees. The best triangle is equilateral triangle.

**3.6.2 Topographic Survey**:

For the topographic survey of bridge site, triangulation was done. Triangulation is the process of measuring the angles of a chain or a network. The main purpose of the triangulation was to determine the length of the bridge axis. The triangulation also serves the control points for detailing. The bridge axis was set and horizontal control stations were fixed on either side. Distances between stations on the same sides of river i.e. base lines were measured with tape precisely. Then the interconnecting triangles were formed and angles were measured with the theodolite with two sets of observations. The bridge axis length or span was calculated by solving the triangles using the sine rule. For vertical control, the level was transferred from the arbitrary benchmark and RL was transferred to the stations on the next bank by reciprocal leveling while direct level transfer method was used or the same bank.

**3.6.3 L-Section & Cross Section:**

For gaining an idea about bed slope, nature of the riverbed, and the variation in the elevations of the different points along the length of the river, L-section is carried out. Keeping the instrument at the control (traverse) stations on the river banks, the staff readings were taken at different points along the center line of the river up to 150 meters upstream and 50 m downstream. The RLs of the traverse stations being known previously, the levels of the different points on the river were calculated. Then the L-Section of the riverbed was plotted on a graph paper on scale for vertical and horizontal.

Cross-section of a river at a particular point is the profile of the lateral sides from the centerline of the river cut transverse to the L-Section at that point. The cross section can be used to calculate the volume and discharge of water at the particular section if the velocity at the cross section is known. Cross sections were taken at an interval of about 20 m extending 300 m upstream and 200 m downstream of the river. Staff readings of points along a line perpendicular to the flow of river were taken from the stations points and the elevations of the points were calculated using tachometric methods.

**3.6.4 Leveling:**

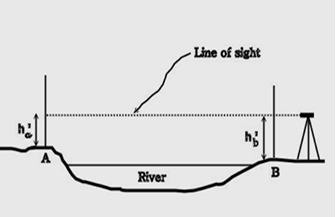
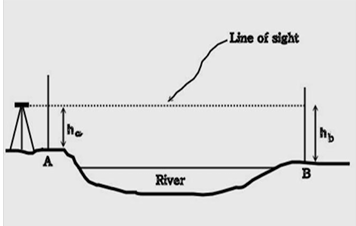
Transferring R.L. from B.M. to control points: The R.L. of benchmark TBM was given and was transferred to the triangular station from the B.M. by fly leveling by taking the back sight-reading to the bench mark which should be within the given accuracy. The R.L. was transferred to the opposite bank of the river by reciprocal leveling.

### Reciprocal Leveling:

This method is applicable when taping is obstructed but not the vision. For transferring the RL across the bridge reciprocal leveling was performed. This method eliminates the error due to focusing, collimation, earth’s curvature and refraction of atmosphere etc.

True difference in elevation between A and B = H = ha- (hb-e)

Also the true difference in elevation = H = (ha'- e) – hb'



*Fig:Reciprocal Levelling*

Taking the average of the two differences we get the difference in elevation between A and B i.e.

### 3.6.5 Detailing:

Total station was used for detailing of the entire bridge site. The reading was taken from the different station set up. The detailing was done with respect to the skeleton formed by triangulation. The vertices of triangles serve as a control point. The details were booked, up to 150m upstream and 50m downstream. The data and the calculations have been tabulated in a systematic way.

### 3.6.6 Computation & Plotting:

The use of total station makes the detailing process easy and fast. The total station gives the direct vales of the horizontal distances and vertical height difference between the station point and the detailing point. The RLs of the points can be calculated by using following formula.

RL of detail = RL of station + HI ± V-Target Height

The following tacheometric formulae were used for the calculation of the horizontal distance and R.L. of different points:

Horizontal distance of any point from the traverse station,

**H = 100 \* S \* cos2θ**

where, S = Staff intercept

θ = Vertical angle

And R.L. of any required point is

**R.L. = R.L. of station + HI + H\*tanθ - Mid wire reading**

The topographic map, the longitudinal section and the cross section were plotted on the respective scales after the completion of calculations. By taking an A1 grid sheet, control stations were plotted accurately. Then all hard details as well as contours were plotted with reference to the control stations by the method of angle and distances.

### 3.7 Comments and Conclusion:

As a civil engineer, we should design the bridge with the view point of economic and its durability. The bridge axis should be designed such that the span length should be minimum and the location is safe. The bridge axis should not be below the highest flood level. No springs and streams are added in the river to the surveyed area. Also, the drainage and sewage have been discharged into the river. The cross-section was taken at middle of the river to get the profile of the flowing river. Also, we marked the high flood level.

# CHAPTER:4

# ROAD ALIGNMENT

A road is an identifiable route, way or path between two or more places. Roads are typically smoothed, paved, or otherwise prepared to allow easy travel; though they need not be, and historically many roads were simply recognizable routes without any formal construction or maintenance. The road needs to pass through positive obligatory points. Positive obligatory points include cities, schools, markets and negative obligatory points include temples, national parks and wild life conservation areas. Road must not pass through such negative obligatory points.

Before the construction of the road, preliminary survey is done. Road alignment is the preliminary stage of road construction. Selection of Intersection Points (IP) is the foundation of construction of the road. After that cross section, longitudinal section and formation level are required.

## 4.1 Objectives

The main objectives of the road survey are as follows:

* To design the alignment of road in the actual field by fixing IPs.
* To take the details of the land features of the surrounding area of the planned road.
* To prepare the Longitudinal section and cross section of the road at certain required chainage so that nature of terrain can truly represented in graphs.
* To calculate the amount of cutting and filling and estimate the cost of work.

### 4.2 Brief description of the project area:

Road alignment survey is conducted on the river on which bridge is proposed. As, we are concerned about taking skills and knowledge, the terrain of river provides a lot of undulation. This specific job is essential for an engineer combating with the mountainous topography of Nepal. Road alignment survey was conducted assuming the axis of the bridge as initial ip.

### Geology, Hydrology & Soil:

The road had to go along a route of stream that was much undulated. There were number of large boulders or rocks of any kind along the proposed site. The soil is uniform throughout the whole length of the road. The road alignment has certain up and downs. Because of gentle slope, the vertical curve was not required. Sandy soil was found along the road course.

### Technical Specifications (Norms):

Reconnaissance of alignment selection was carried out of the road corridor considering permissible gradient, obligatory points, bridge site and geometry of tentative horizontal and vertical curves. The road setting horizontal curve, cross sectional detail in 20m interval and longitudinal profile were prepared.

The topographic map (scale 1:500) of road corridor was prepared. Geometric curves, crossings and other details were shown in the map.

While performing the road alignment survey, the following norms were strictly followed:

* Carry out reconnaissance survey and alignment selection of a road corridor about 700m or more.
* If the external deflection angle at the I.P. of the road is less than 3°, curves need not be fitted.
* Simple horizontal curves had to be laid out where the road changed its direction, determining and pegging three points on the curve - the beginning of the curve, the middle point of the curve and the end of the curve along the centerline of the road.
* The radius of the curve had to be chosen such that it was convenient and safe. The radius of the curve should not be less than 15m. The radius must be within the multiple of 5 or 10.
* Point of commencement (T1) and point of tangency (T2) must not be located within the bridge axis. Start and finish of curves must be totally outside the bridge axis end points.
* Subsequent reverse as well as compound curves in road alignment should be avoided.
* The deflection angle should not be greater than 90˚.
* Two successive curves must not be overlapped.
* Carry out leveling survey for longitudinal section along the centre line at 20m interval, at abrupt change point and at all the curve point BC, MC and EC. Close the leveling survey and check the RL at job site immediately. Permissible error of closure for leveling must not be greater than ±25 √k mm.
* Cross sections had to be taken at 15 m intervals and at the beginning, middle and end of the curve, along the centerline of the road - observations being taken for at least 10 m on either side of the centerline.
* Plan of the road had to be prepared on a scale of 1:500.
* L-Section of the road had to be plotted on a scale of 1:1000 horizontally and 1:100 vertically.
* The cross section of the road had to be plotted on a scale of 1:100 (both vertical and horizontal). The amount of cutting and filling required for the road construction had to be determined from the L-Section and the cross sections. However, the volume of cutting had to be roughly equal to the volume of filling.

### Equipment & Accessories:

The following are the instruments used during the road alignment survey in the field:

* + Total station
  + Theodolite
  + Leveling staffs (5m)
  + Ranging rods
  + Measuring tapes (30m and 5m)
  + Leveling instrument
  + Tripod stand
  + Nails and pegs
  + Marking pen
  + Plumb bob
  + Arrows

**4**.6 Methodology:

The alignment of road includes several ways and procedures that need to be carried out. Following are the listed methodology:

**4.6.1** Reconnaissance:

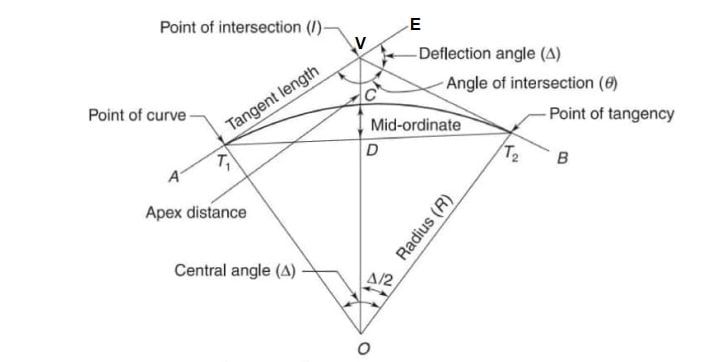
The reconnaissance survey was performed along the given route. Tentative estimation was done for the intersection points, where the direction had to be changed. While returning back the route, the IPs was fixed. For this the inter-visibility of the stations was checked. Meanwhile the pegs with IP no. were driven at these points.

**4.6.2** Horizontal Alignment:

Horizontal alignment is done for fixing the road direction in horizontal plane. For this, the bearing of initial line connecting two initial stations was measured using compass. The interior angles were observed using theodolite at each IP and then deflection angles were calculated.

**Deflection angle = 180˚- observed angle**

If the deflection angle is positive the deflection is towards right and if the deflection angle is negative the deflection is towards the left. The radius was assumed according to the deflection angle. Then the tangent length, Beginning of the Curve (BC), End of the Curve (EC), apex distance along with their chainage were found by using the following formulae,



Tangent length (T) = R\*tan(∆/2)

Length of curve (L.C) = Π \* R \* ∆ /180

Apex distance = R \*(sec( ∆/2)-1)

Chainage of BC = Chainage of IP – T

Chainage of MC = Chainage of BC +LC/2

Chainage of EC = Chainage of MC + LC/2 = Chainage of BC + LC

The BC and EC points were located along the line by measuring the tangent length from the apex and the points were marked distinctly. The radius was chosen such that the tangent does not overlap. The apex was fixed at the length of apex distance from IP along the line bisecting the interior angle.

### 4.6.3 Vertical Alignment:

Vertical profile of the Road alignment is known by the vertical alignment. In the L-section of the Road alignment, vertical alignment was plotted. According to Nepal Road Standard, Gradient of the Road cannot be taken more than 12 %. In the vertical alignment, we set the vertical curve with proper design. Vertical curve may be either summit curve or valley curve. While setting the vertical alignment, it should keep in mind whether cutting and filling were balanced or not.

### 4.6.4 Leveling:

The method of fly leveling was applied in transferring the level from the given B.M. to all the I.Ps, beginnings, mid points and ends of the curves as well as to the points along the center line of the road where the cross sections were taken. After completing the work of one-way fly leveling on the entire length of the road, check leveling was continued back to the B.M. making a closed loop for check and adjustment. The difference in the R.L. of the B.M. before and after forming the loops should be less than 25√ k mm, where k is the loop distance in km.

### 4.6.5 L-section & Cross Section:

Nature of the ground, the variation in the elevations of the different points along the length of road need to be known for the construction of the road. For this L-Section of the road is required. In order to obtain the data for L-Section, staff readings were taken at points at 20m intervals along the centerline of the road with the help of a level by the method of fly leveling. Thus, after performing the necessary calculations, the level was transferred to all those points with respect to the R.L. of the given B.M. Then finally the L-Section of the road was plotted on a graph paper on a vertical scale of 1:100 and a horizontal scale of **1:1000**. The staff readings at BC, EC and apex were also taken. The RL of each point was calculated.

Cross sections at different points are drawn perpendicular to the longitudinal section of the road on either side of its centerline in order to present the lateral outline of the ground. Cross sections are also equally useful in determining the amount of cut and fill required for the road construction. Cross sections were taken at 20m intervals along the centerline of the road and at points where there was a sharp change in the elevation. While doing so, the horizontal distances of the different points from the centerline were measured with the help of a tape and the vertical heights with a measuring staff. The R.L. was transferred to all the points by performing the necessary calculations and finally, the cross sections at different sections were plotted on a graph paper on a scale of **both vertical and 1:100 – horizontal.**

### Curve Setting:

A regular curved path followed by highway or railway alignment is curve. It is introduced wherever it is necessary to change the direction of motion due to the nature of terrain. A curve may be circular, parabola or spiral and is always tangential to two straight directions.

There may be different types of curves:

Simple curve, Compound curve, Reverse curve, Transition curve.

Simple Circular Curve:

A simple circular curve is the curve, which consists of a single arc of a circle. It is tangential to both the straight lines.

Setting Out of Simple Circular Curves:

1. Linear method: - In this method, only a chain or tape is used. Linear methods are used when a high degree of accuracy is not required and the curve is short.

E.g: Offsets from Long Chord

Offsets form Tangents

Successive bisection of Chords

Offsets from Chords produced

2.Angular method: - In this method, an instrument like theodolite is used with or without chain or tape. E.g.: Rankine’s Method of Tangential Deflection Angles,Two Theodolite Method

Offset from Long Cord Method:

Mid-ordinate can be determined by the relation

Oo = R - [R2 – (L/2)2] T

he Ordinate at a distance ‘x’ is given by,

Ox = [ ( R2 – X2) – ( R - Oo ) ]

Where, Oo = mid-ordinate

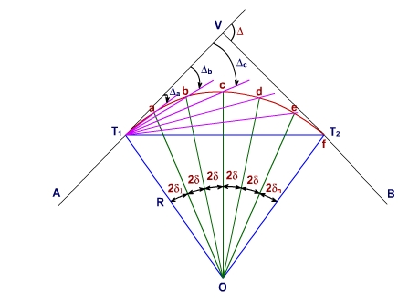
Ox = ordinate at distance x from the mid point of the chord

L = length of the long chord

R = Radius of the curve

### Rankine’s Method:

In Rankine’s method, it’s assumed that the length of the curve and the chord length are equal (case for larger radius). The deflection angle to any point on the curve is an angle at the point of contact between the back tangent and the chord joining the point of contact and that point.



Here:

∠T1Oa = 2 δ1

Chord T1a~ Arc T1a

∠T1Oa / *l*1 = 360◦/(2πR)

2δ1 = 360◦/ (2π R)

δ1 = (360◦× *l*1) / (2 × 2πR) degrees

δ1 = (360◦×60× *l*1) / (2 × 2πR) minutes

δ1 = (1718.9 × l1) / R minutes

Similarly, δ2 = (1718.9 × *l*2) /R minutes

δ3 = (1718.9 × /R minutes and so on.

Finally: δn = (1718.9 × ln) /R minutes

Also, ∆a= δ1

∆b= δ1 + δ2

∆c= δ1 + δ2 + δ3 and so on.  
 ∆n= δ1 + δ2 + δ3 … … … + δn

Arithmetical check: ∆n= ∆/𝟐

### Field Procedure:

1. Locate the tangent points (T1 and T2) and find out their changes. From these changes, calculate the lengths of first and last sub-chords and the total deflection angles for all points on the curve as described above.
2. Set up and level the theodolite at the first tangent point (T1).
3. Set the vernier A of the horizontal circle to zero and direct the telescope to the ranging rod at the intersection point B and bisect it.
4. Loosen the vernier plate and set the vernier A to the first deflection angle Δ1, the telescope is thus directed along T1D. Then along this line, measure T1D equal in length to the first sub-chord, thus fixing the first point D on the curve.
5. Loosen the upper clamp and set the vernier A to the second deflection angle Δ2, the line of sight is now directed along T1E. Hold the zero end of the chain at D and swing the other end until the arrow held at that end is bisected by the line of sight, thus fixing the second point (E) on the curve.
6. Continue the process until the end of the curve is reached. The end point thus located must coincide with the previously located point (T2).

### 4.8 Comments and Conclusion:

Survey of the road alignment is done to make safe, easy, short and economical road. Geological stability and soil stability are also taken into account. Vertical and horizontal curves are set according to Road Design Standards for comfort and other factors. While setting the road alignment, it should be kept in mind that the minimum IP points should be taken as far as possible and deflection angles should be minimal as far as possible. The task was challengeable and difficult due to the muddy and slippery terrain at some places.

# CHAPTER 5

# CONCLUSION

With the helpful regard of teacher and cooperative behavior of all friends, all the work is complete as scheduled in routine time assigned to us although we faced minor difficulties during our orientation. The management team had arranged the required instruments and accessories for our daily field work. This had made our work easy, reliable; less time consuming and competitive. All the results we obtained were within the limits given to us. This camp really helped us with the practical parts of survey fieldwork as we were working in conditions we will surely have to face in the future. It increased our confidence in handling instruments as well as completing projects within given deadlines.

We think I.O.E should organize such field works frequently and for all possible subjects, as practical knowledge is better. In these field works, we gain first hand concept of the subject matter that makes it easier for us to grasp the concept. At last, this entire camp was very informative, effective and enjoyable.

Any suggestion and comment are heartily acceptable. During report preparation all the confusions are cleared by teachers whom we are very grateful.