Tribhuwan University
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A Report on
Survey Camp -2074

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Submitted To:
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ABSTRACT

Surveying is the process of determining the relative position of points on, above or under the surface of the earth, and is the most important part of Geomatics Engineering. The results of surveys are used to map the earth, prepare navigational charts, establish property boundaries, develop data of land used and natural resource information etc. Further survey maintains highways, railroads, buildings, bridges, tunnels, canals, dams and many more. Thus, the objective of survey camp was to make us gain the experience in this field by performing topographic survey in a large area, learning to propose road alignment and select suitable site for bridge axis. The report reflects the methodology, observations and calculations made by the students in the Camp with the corresponding drawings. The large portion of the course covered with elements of topographic surveying, and then those of road alignment and bridge site survey follow it. The main objective of the Survey Camp organized for us is to take an opportunity to consolidate and update our practical and theoretical knowledge in engineering surveying in the actual field condition. In this survey camp we have to prepare a topographic map of the given area, road and bridge site survey fulfilling all technical requirements. In this regard, we are required to carry out the necessary field works in our sub-group so that we will get ample opportunity to the decision on planning and execution of field works for the preparation of topographic map and detail road and bridge site survey. This survey camp helps us to build in our confidence to conduct engineering survey on required accuracy.

ACKNOWLEDGEMENT

The two-week SURVEY CAMP at Kirtipur acquainted us with Practical as well as theoretical knowledge for surveying in field. It also helped us to develop the co-operative feelings among ourselves regarding the practical aspects of the study because it stimulated group discussion, Co-operation, curiosity and motivation during the fieldwork.

We would like to thank Department of Civil Engineering, "Survey Instruction Committee", Pulchowk Campus for initiating and facilitating this survey camp to further enhance our knowledge of surveying and its applications.

Out sincere appreciation goes to the teachers namely: Mr. Narayan Basnet, Mr. Bharat Bahadur Dhakal, Mr. Chandra Lal Gurung, Mr. Abhimanyu Lal Singh, Mr. Pradip Koirala, Mr. Bishnu Prasad Sharma, Mr Jayaram Maharjan. We would like to thank all teaching and non-teaching staffs for their kind co-operation with their friendly behavior and guidance during the whole survey work including fieldwork instructions, calculations, plotting and report preparation. We are also thankful to all our friends and colleagues for their support and help.

Lastly we would like to thank everyone who helped us directly or indirectly in the duration of survey camp and in the preparation of this report. Their effort and sincerity on the field are always memorable to us.

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ABSTRACT

This report is the outcome of two weeks Survey Camp 2076 (Kirtipur) organized by The Survey Instruction Committee, Department of Civil Engineering, IOE, Pulchowk Campus for the students of 074BCE Batch as per the Syllabus of BCE. The camp was held inside the Kathmandu Valley, in TU, Kirtipur from 18th Kartik to 27th Kartik, 2076 B.S.

The report reflects the methodology, observations, and calculations made by the students in the Camp with the corresponding drawings. The large portion is of course covered with elements of topographic surveying, and then those of road alignment and bridge site survey follow it.

Surveying is the science and art of determining the relative positions of above, on, or beneath the surface of earth, and is the most important part of Civil Engineering. The results of surveys are used to map the earth, prepare navigational charts, establish property boundaries, develop data of land used and natural resource information etc. Further survey maintains highways, railroads, buildings, bridges, tunnels, canals, dams and many more. Thus, the objective of survey camp was to make us gain the experience in this field by performing topographic survey in a large area, learning to propose road alignment and select suitable site for bridge axis.

The report is prepared with great efforts and dedications of the students who have devoted their immense from the very first time of fieldwork till today. The students are always learning for knowledge and promotions. Therefore, we feel that this report deserves the excuses and tolerances from the readers for any errors or blunders present, despite the best efforts.

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1 INTRODUCTION

Surveying is an art and science of determining the relative position of point on above or beneath the surface of the earth by means of angular and linear measurements. It is the most important subject matter 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 main objectives of surveying courses allocated for civil engineering students is to promote them the basic knowledge of different surveying techniques relevant to civil engineering works in their professional practice. The completion of all surveying courses including ten days survey camp work organized by the Department of Civil Engineering, **"*Survey Instruction Committee*"** of Pulchowk campus, IOE will give better enhancement to students to use all surveying technique covered in lecture classes**.**

Students of civil Engineering studying in third year were on survey camp 2076 in two shifts the first shift was from 18th Kartik to 27th Kartik, 2076 B.S. at TU Kirtipur, Kathmandu. The survey camp is the part of course of third-year, first part (III/I) civil engineering study.

This is a detail report of the works, which were performed by group no. 6, having five members, during the camp period. It briefly explains the working procedures and technique used by this group during that camp period. In addition, it also 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 is presented in a concise form.

1.1 OBJECTIVES OF SURVEY CAMP

The main objectives of the survey camp are as follows:

- To become familiar with the surveying problems that are arise during the field works.
- To became familiar with the parts of the instruments, their functions and handling the surveying instruments for its use in surveying.
- To become familiar with the spirit and importance of teamwork, as surveying is not a single person work.
- To complete the given project in scheduled time and thus knows the value of time.
- To collect required data in the field in systematic ways.
- To compute and manipulate the observed data in the required accuracy and present it in diagrammatic and tabular form in order to understand by other engineers and related personnel easily.
- To tackle the mistake and incomplete data from the field while in office work.
- To know the complete method of report preparation.

1.2 LOCATION MAP

Figure 1

1.3 PROJECT AREA

Tribhuvan University, Kirtipur, Kathmandu.

1.4 LOCATION AND ACCESSIBILITY

Kirtipur is about 12km southern west part from Kathmandu. IswariRajmarg and Viswa Vidhyalayamarg links Kirtipur with Kathmandu. Kirtipur was also called Padma Kshetrapuri at ancient time. Kirtipur is assumed to be earth quake resistant area. The area to be surveyed is area under Tribhuvan University. The journey from Kathmandu to Kirtipur takes about 20minutes by bus.

- Country : Nepal
- Province : Bagmati
- District : Kathmandu
- Municipality : Kritipur
- Ward No. : 3
- Location : Tribhuvan University, Kirtipur Campus

1.5 TOPOGRAPHY AND GEOLOGY

Before starting our job, we should study about the existing position of the project area related to the natural grid line so that we can relate our result into the natural grid.

The latitude and longitude of Kirtipur are as follows:

Latitude : 29° 22’ 06” N

Longitude : 84° 55’ 00” E

Kirtipur is situated southern western part of Kathmandu valley and just below the Chandragiri Mountain. The average height of Kirtipur is 1414m above the mean sea level; area of Kirtipur is about 1400 hectors.

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. Geologically Nepal is divided into five zones from south to north, which are extending towards east west direction and are separated by several geological structures called thrust. For our concern, the job site falls in “Lesser Himalaya Zone”.

Stratigraphically the central region of Nepal is divided into two major complexes, out of which one is Kathmandu Complex and another one is Nawakot complex. The Kathmandu valley and thus of course the survey camp site lies in Kathmandu complex which is separated from Nawakot complex by Mahabharat Thrust (M.T.).

1.6 TEMPERATURE, CLIMATE AND VARIATION

Kirtipur has very pleasant climate. The annual rainfall is about 3000mm. Major Crops grown in Kirtipur are maize, wheat, millet, paddy etc.

The altitude of Kirtipur is 1331.52 m from the sea level. Therefore, it has medium rainfall and temperate climate. Kirtipur lies in mid-hill region of Nepal hence the climate is pleasant. The variation of temperature in summer and winter at Kritipur are as follows:

Season	Max. Temperature °C	Min. Temperature °C	Rain Fall
Summer	34	16	90 mm
Winter	17	2	5 mm

Table 1-Temperature variation

The soil of Kritipur area seemed to be very vegetative. We saw a no. of fertile lands, dense vegetation and deciduous forest where oak, sal, bamboo trees are abundantly found.

1.7 OTHERS

Kirtipur is an ancient city with its unique history and pleasant environment. It has a number of places which are important from viewpoint of history, mythology and tourism. The places of mythological importance include Bagh Bhairab Temple, Uma Maheswor Temple and Adhinath Temple. Kirtipur is one of Municipality City of Kathmandu district. The city is at a height more than the surrounding places so a beautiful view of Chobhar, Dharahara, Swoyambhu and lalitpur can be seen from here. Kirtipur is gateway of Kathmandu valley. Kirtipur is important for its religious aspects. Kirtipur is famous for religious places as Bagh Bhairav Temple, Uma Maheswor Temple, Adinath Temple and antiquities archeology as Tribhuvan University, international cricket ground, Thai Bihar, Chiloncho Bihar etc. The main tribes of people are Newar about 90% people are newar rest of tribes is Brahman, Chhetri, Gurung, and Magar etc.

Tribhuvan University area lies at the center of the Kirtipur Municipality. It is oldest university of Nepal and biggest one from all campuses of Nepal. The campus is also important because it carries international cricket ground in it's premises. The project area was divided into different parts for individual group. The main area of traversing includes almost all types of the land features like sloppy, dense forest, hedges, plain areas etc.

The whole area was sub-divided into various parts where the almost area covers educational buildings. The main buildings are Faculty of Education, Faculty of Humanities, Gandhi Bhawan, Library, CEDA building, Student's Club, Physical Science, Chemistry, Earth Science, Botany, Mathematics etc. and Coronation Park.

2 TOPOGRAPHIC SURVEY

2.1 OBJECTIVES

The main objective of the topographic survey is to prepare the topographic map of the given area with horizontal and vertical control at required accuracy. By topographical survey we can determine the positions both on plan and elevation, of the natural and artificial features of a locality for the purpose of delineating them by means of conventional sign upon a topographic Map.

2.2 BRIEF DESCRIPTION OF AREA

The area to be surveyed was a small part of Trihbuvan University, Kirtipur. Since the area over which the campus was situated was very large, the major traverse was run only to cover the small area, about one fifth area of the Tribhuvan University. Our objective was to prepare a topographic Map of the given small area, which is a part of the University. So, we are asked to prepare detail topographical map of the area which includes the following buildings and special ground features:

- ✓ Central Library
- ✓ Department of Economics
- ✓ Department of Management
- ✓ Administrative building (Clock Tower)
- ✓ Gandhi Bhawan
- ✓ CEDA
- ✓ TU Press
- ✓ Department of Education
- ✓ And other nearby small buildings and garden

These buildings and the important ground features are included between the minor traverse provided with one link traverse and four legs of major traverse.

2.3 TECHNICAL SPECIFICATION (Norms)

- Conduct reconnaissance survey of the given area. Form a close traverse (major and minor) around the perimeter of the area by making traverse station. In the selection of the traverse station maintain the ratio of maximum traverse leg to minimum traverse leg less than **2:1** for major and less than **3:1** for minor.
- Measure the traverse legs in the forward and reverse directions by means of a tape calibrated against the standard length provided in the field, note that discrepancy between forward and backward measurements should be better than **1:2000.**
- Measure traverse angle on two sets of reading by Total Station. The difference between face left and face right readings should be within 20". Note that difference between the mean angles of two sets reading should be within **1'.**
- Determine the R.L. of traverse stations by fly leveling from the given P.B.M. Perform two-peg test before the start of fly leveling. Note that collimation error should be less than **1:10000**. Maintain equal foresight and back sight distances to eliminate collimation error. The Permissible error for fly leveling is **($\pm 24\sqrt{K}$) mm**.
- Balance the traverse. The permissible angular error for the sum of interior angles of the traverse should be less than **$\pm\sqrt{n} \times 30''$** for Major Traverse and **$\pm\sqrt{n} \times 1'$** for Minor Traverse (n = no of traverse station). For major and minor traverse, the relative closing error should be less than **1: 5000** and **1: 3000** respectively.
- Plot the traverse stations by coordinate method in appropriate scale, i.e. **1:1000** for major traverse and **1:500** for minor traverses.
- Carry out the detail survey of the given area by tachometric method with reference to the major and minor traverse stations, which have been already plotted. Use conventional symbols for plotting.

2.4 EQUIPMENT AND ACCESSORIES

From our batch (072) the syllabus of the course study is changed. New course of study is designed to address the new change in surveying field practice. So, the study about total station is focused in this syllabus rather the theodolite as in earlier batches. The followings are the main equipment's required and used during the field work:

- Total station
- Theodolite
- Leveling staffs (5m)
- Ranging Rods
- Measuring Tapes (30m & 5m)
- Leveling instrument
- Hammer
- Nails & pegs
- Plumb bob
- Compass
- Prism
- Prism holder
- Umbrella

2.5 METHODOLOGY

The methodology of surveying is based on the principle of surveying. They are as follows:

I. Working from whole to a part.
II. Independent check.
III. Consistency of work.
IV. Accuracy required

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

2.5.1 Traversing

Traversing is that 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 lake, 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:

I. Angle between the successive lines or bearing of each line.
II. The length of each line.

The direction and the length of the survey lines are measured with the help of angle measuring instrument, theodolite and tape. If the coordinate of first station and bearing of first line are known, the coordinates of all successive points can be computed.

It eliminates the accumulation of errors which may happen when the scale and the protractor is used, as we can find out the coordinate of each station.

Traverse is of three types:

2.5.1.1 Close traverse (loop traverse)

2.5.1.2 Open traverse

2.3.1.3 Link traverse

2.5.1.1 Close traverse

If a traverse starts from a point, runs and ends on the same starting point then such traverse is called closed traverse. These types of traverse are run for a closed field survey. In this type of traverse, independent check is possible and adjustment can be done very easily.

2.5.1.2 Open traverse

If a traverse starts from a point, runs and ends at the point other than starting point is called open traverse. This type of traverse is run during the route survey like road, railway, canal, tunnel etc. In these types of traverse the error calculation and balancing is very difficult.

2.5.1.3 Link traverse

These are geometrically open but mathematically closed traverse. This type of traverse starts from a known point and ends at another known point. Also in this type of traverse the calculation and balancing of error can be done easily.

Depending upon the instrument used in determining the relative directions of the traverse lines, there are several methods of traversing such as:

1. Chain traversing
2. Chain and compass traversing
3. Transit tape traversing
4. Plane table traversing
5. Theodolite traversing

2.5.2 Balancing of Traverse

There are two methods of balancing of traverse: -

II.3.2.1 Bowditch's method
II.3.2.2 Transit method

2.5.2.1 Bowditch's method

In this method, the total error in the latitude and departure is distributed in proportion to the lengths of the sides. It is mostly used to balance a traverse where linear and angular measurements are of equal precision. This rule says:

Correction to latitude (or departure) of any side

$$= \frac{\text{Total error in latitude (or departure) * length of that side}}{\text{Perimeter of traverse}}$$

2.5.2.2 Transit method

In this method, the total error in latitude & departure is distributed in proportion to the latitude & departure of its side. This rule is adopted when angular measurements are precise rather than linear measurements. This role provides correction to latitude & departure of any side.

Correction in Latitude (or Departure) of any side

$$= \frac{\text{Total error in latitude or departure * latitude (or departure) of that line}}{\text{Arithmetic sum of latitude (or departure)}}$$

2.5.2.3 Tachometry

Tachometry is the branch of angular surveying in which the horizontal and vertical distances of points are obtained by optical means as opposed to the ordinary slower process of measurements by tape or chain. This method is very rapid and convenient.

The primary objective of Tachometry is to prepare the contoured map or plans requiring both horizontal as well as vertical control. It also provides the check on distance measure with a tape of required. It is more suitable in the obstacles such as steep and broken ground, deep ravines, stretches of water or swamp and so on.

The formula for horizontal distances is:

$H = k * s * Cos^2\theta + C * Cos\ \theta$

The formula for vertical distance is:

$V = (k * s * Sin2\theta)/2 + C * Sin\ \theta$

Where,

k= multiplying constant (=100)

C=additive constant (=0, for analectic lens)

s=staff intercept = Top reading – Bottom reading (T-B)

θ=angle of (elevation/depression)

2.5.2.4 Leveling

Leveling is a branch of surveying the object of which is

- To find the elevation of given points with respect to a given or assumed datum.

- ❖ To establish points at a given elevation or at different elevations with respect to a given or assumed datum.

The first operation is required to enable the works to be designed while the second operation is required in the setting out of all kinds of engineering works. Leveling deals with measurements in a vertical plane

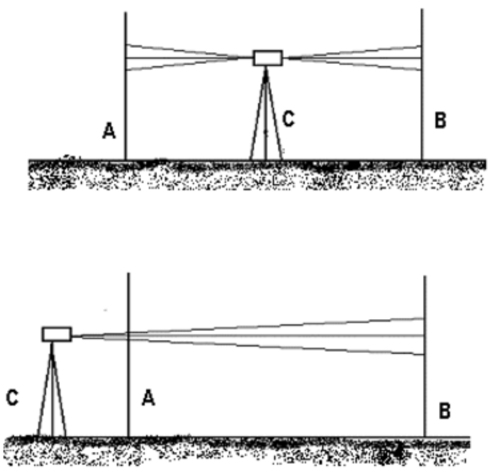
Temporary adjustments of Level:

The temporary adjustments for a level consist of the following:

a. Setting up the level: The operation of setting up includes fixing the instrument on the stand and leveling the instrument approximately.
b. 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. It is done by adjusting the screws.
c. 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.

Permanent adjustments of Level:

To check for the permanent adjustments of level two-peg test method should be performed. Two staffs were placed at A and B of known length (about 60 m). First the instrument was setup on the line near B and both staff readings (Top, Middle, and Bottom) were taken. Then, the instrument was setup at the middle C on the line and again both staff readings on A and B was taken. Then computation was done in order to check whether the adjustment was within the required accuracy or not. No permanent adjustment was required since the error was within the permissible value.



Two peg test arrangement

Two staffs were placed at A and B of known length (about 60m). First the instrument was setup at the middle point C and both staff readings (Top, Middle and Bottom) were taken. Then, the instrument was setup at D near the A on the line AB and again both staff readings were taken. Then computation was done in order to check whether the adjustment was required or not.

Booking and 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:

   $$\sum B.S. - \sum F.S. = \text{Last R.L.} - \text{First R.L.}$$

2. Rise and Fall method

Arithmetic Check:

$$\sum B.S. - \sum F.S. = \sum Rise - \sum Fall = \text{Last R.L.} - \text{First R.L.}$$

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

Fly Leveling

The RL of Given TBM1 point was found by transferring the level from Known BM located at Lab School by the process of fly leveling. In this method auto level was used and the level was transferred directly by taking BS and FS at every Turning Point.

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 = $\pm 24\sqrt{k}$ mm.

Where k is perimeter in Km

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

Correction i^{th} leg=-(e x ($L_1 + L_2 + \ldots + L_i$)/P

Where L_1, L_2, L_iLength of 1^{st} 2^{nd}, ….i^{th} leg.

P is perimeter

Relative Precision= 1/(p/e)

2.5.2.5 Contouring

Contour is the imaginary line joining the equal elevation, with reference to given or assumed datum, on the natural ground surface. The branch of surveying that deals with development of contour line is called contouring. Every fifth contour is made darker than other is called index contour. The elevation difference between two consecutive contours is called the contour interval. The contour interval is the important parameter to be considered during the surveying field work. The large contour interval is suitable for the steep hilly areas while small contour interval is suitable for the plain areas. The least horizontal distance between two consecutive contours is called the horizontal equivalent.

2.5.2.5.1 Methods of contouring

There are two ways of contouring. They are namely:

2.5.2.5.1.1 The Direct method

2.5.2.5.1.1 The Indirect method

2.5.2.5.1.2 The Direct method

In this direct method, the contour to be plotted is actually traced on the ground. Only those points are surveyed which happen to be plotted.

2.5.2.5.1.3 The indirect method

In this 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 the basis for the interpolation of contours. There are some of the indirect methods of locating the ground points:

a. By squares
b. By cross-sections
c. By tachometric method
d.

2.5.2.5.2 Contour Interpolation

The process of drawing contours proportionately between the plotted ground points or in between the plotted contours is called interpolation of the contours. Interpolation of contours between points is done assuming that the slope of ground between two points is uniform. It may be done by anyone of following methods:

* Estimation
* Arithmetic calculation
* Graphical method

2.5.2.5.3 Contour Characteristics

- Two contours of different elevations do not cross each other except in the case of an overhanging cliff.
- Contours of different elevations do not unite to form one contour except in the case of a vertical cliff.
- Contours drawn closer depict a steep slope and if drawn apart, represent a gentle slope.
- Contours equally spaced depict a uniform slope. When contours are parallel, equidistant and straight, these represent an inclined plane surface.
- Contour at any point is perpendicular to the line of the steepest slope at the point.

- A contour line must close itself but need not be necessarily within the limits of the map itself.
- A set ring contours with higher values inside depict a hill whereas a set of ring contours with lower values inside depict a pond or a depression without an outlet.
- When contours cross a ridge or V-shaped valley, they form sharp V-shapes across them. Contours represent a ridge line, if the concavity of higher value contour lies towards the next lower value contour and on the other hand these represent a valley if the concavity of the lower value contour, lies toward the higher value contours.
- The same contour must appear on both the sides of a ridge or a valley.
- Contours do not have sharp turnings.

2.5.2.6 Electronic Distance Measurement (EDM)

These are the instruments used to measure the distance between any two points. This system consists of the emitter and the reflectors. The emitter produces the electronic waves which travels to the reflector and then reflects back. The measured time interval between emission and receiving back the distance can be calculated easily. The emitter instruments emits the electromagnetic waves like radio wave, light wave etc.

Distance = (Velocity of EMW*time interval)/2

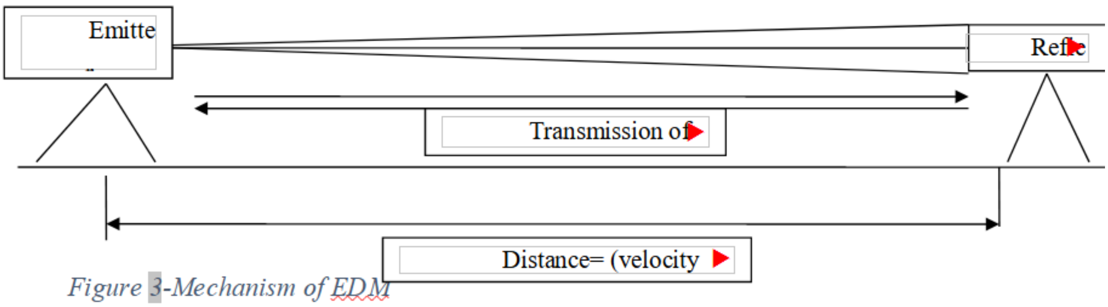


Figure 3-Mechanism of EDM

2.6 RECONNAISSANCE

Recce means the exploration or scouting of an area. To prepare a good topographic map of any area, it is necessary to know about the area in proper way so that we can plan our work and complete it in systematic order and in short span of time with less effort. For this purpose, the detail inspection of the given area of Tribhuvan University was carried out by reconnaissance survey.

While doing reconnaissance we find out the major and minor traverse control points to form a closed traverse around the perimeter of the area. While selecting the major and minor control points following points should be taken into account:

i. The adjacent stations should be clearly inter-visible and cover the whole area with least number of stations as far as possible. The traverse station should maintain the ratio of maximum traverse leg to minimum traverse leg less than 2:1.
ii. The steep slopes and badly broken ground should be avoided as for as possible, which may cause inaccuracy in tapping.
iii. The stations should provide minimum level surface required to set up the tripod of the instrument.
iv. The traverse line of sight should not be near the ground level to avoid the refraction.
v. If possible, well-conditioned triangles should be formed to give good graphical intersection during plotting.

Walking around at least three times inspected the whole area and major ground features were noted. The possible location of major and minor control points was decided by inspecting the indivisibility of the stations. After sketching rough outlines of the area and possible station distances of legs were estimated to make them within specific range i.e. 1:2 ratios. For minor traverse, all the detail available was noted. After checking the requirements for a good station, the points were fixed for major and minor stations by driving wooden pegs on the ground and it was name by a marker. The measurements of each station from reference points such as permanent objects near it were taken. Hence, the recce survey was completed after fixing all the control points.

2.7 MAJOR 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 readings are taken by setting the total station at 0°0’0” for one set and 90°00’00” for the second.

In the Kirtipur Survey Camp, two traverses - major and minor had to be established. The major traverse had 19 control stations including two given control points. The control stations were named as M1, M2,…., M17 along with CP1 and CP2 (the two given control points) .The leg ratio of maximum traverse leg to minimum traverse leg was maintained within 1:2. The discrepancy in length between the forward measurements and the backward measurements of all the traverse legs was within 1:5000. Two sets of theodolite readings were taken for measuring the horizontal traverse angles. The difference between the mean angles of two sets of readings was within a minute for all the angles.

The distances between the adjacent control points were measured accurately as far as possible for the accuracy of the whole traverse. To attain the accuracy required i.e. 1:5000 ratio, a two-way EDM measurement was done independently so that the length from each measurement was found within specified range.

2.7.1 Computation of Co-ordinates

According to the accuracy aimed and the nature of the ground, the lengths of traverse legs are measured directly on the ground either by chaining or taping. The traverse angles are measured with a theodolite by setting up the instrument at each station in turn and the vertical angle at each station measured will help to find the tachometric distance and reduce level of that point. And the bearing of the any one of the traverse legs 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) $\pm$ (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 co-ordinate of the point 'A' can be calculated as follow-:

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

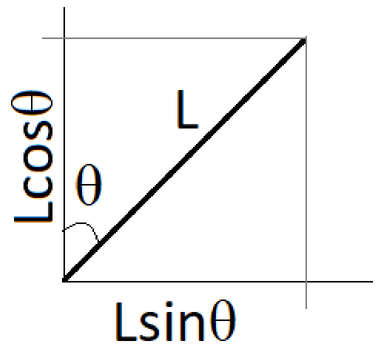
Y-coordinate of A=y-coordinate of control point (c.p) +L*cosθLsinθ

R.L or z-coordinate of A=R.L of point (c.p) +H.I $\pm$ H*Tanθ-Height of signal.

Where,

H.I = Height of instrument

H = horizontal distance = Lcosθ



2.8 MINOR TRAVERSE

It is not sufficient to detail the area by enclosing with the help of major traverse. 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 7 control stations and enclosed the CNAS building and management building as the major details. The control stations were named as 1M5, 1M6 and so on along with the seven control stations common for both the major and the minor traverses. The leg ratio of maximum traverse leg to minimum traverse leg was maintained within 1:3. The discrepancy in length between the forward measurements and the backward measurements of all the traverse legs was within 1:1000. Measurement of Horizontal and Vertical

Two set of horizontal angles was measured at each station and one set of vertical angle. And it was done in the following way-:

i) One the face left temporary adjustment was done.
ii) After setting zero to the first station the second station was sighted by unclamping the upper screw.
iii) For better accuracy and exact bisection horizontal angle was measured at the bottom of the arrow.
iv) And on the same setting or same face vertical angle at both the station was taken.
v) Now again changing the face the horizontal angle was taken and vertical angle too.
vi) Now setting the reading to ninety at the first station again one set of horizontal angles was taken but the vertical angle is enough, taken earlier.
vii) Before shifting the instrument to the next station, the height of instrument was taken.
viii) Similarly, the instrument was shifted to other station and in each station one set of vertical angles and two set of horizontal angle and height of instrument was measured.

For comparison of the tape distance and the Tachometric distance the stadia reading (top, mid, bottom) was taken at each station and for the calculation of the reduce level of each station we need to read mid reading which can be compared with the level transferred using auto level.

2.9 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 use total station while taking details during the camp. This takes less time and computation work.

2.10 Total Station

2.10.1 Introduction

A total station is an optical instrument used a lot in modern surveying and archaeology and, in a minor way, as well as by police, crime scene investigators, private accident reconstructionist and insurance companies to take measurements of scenes. It is a combination of an electronic theodolite (transit), an electronic distance meter (EDM) and software running on an external computer known as a data collector

With a total station one may determine angles and distances from the instrument to points to be surveyed. With the aid of trigonometry and triangulation, the angles and distances may be used to calculate the coordinates of actual positions (X, Y, and Z or northing, easting and elevation) of surveyed points, or the position of the instrument from known points, in absolute terms.

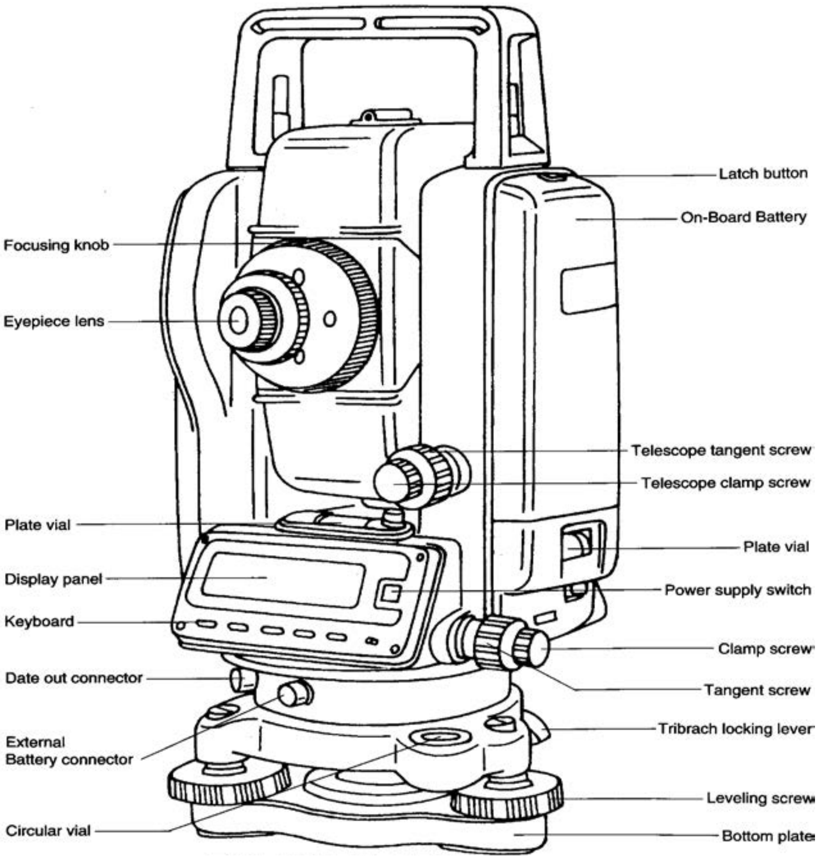


Figure 3-Totalstation

Some total stations also have a GPS interface which combines these two technologies to make use of the advantages of both (GPS - line of sight not required between measured points; Traditional Total Station - high precision measurement especially in the vertical axis compared with GPS) and reduce the consequences of each technology's disadvantages (GPS - poor accuracy in the vertical axis and lower accuracy without long occupation periods; Total Station - requires line of sight observations and must be set up over a known point or within line of sight of 2 or more known points).

Most modern total station instruments measure angles by means of electro-optical scanning of extremely precise digital bar-codes etched on rotating glass cylinders or discs within the instrument. The best quality total stations are capable of measuring angles down to 0.5 arc-second. Inexpensive **"construction grade"** total stations can generally measure angles to 5 or 10 arc-seconds.

Measurement of distance is accomplished with a modulated microwave or infrared carrier signal, generated by a small solid-state emitter within the instrument's optical path, and bounced off of the object to be measured. The modulation pattern in the returning signal is read and interpreted by the onboard computer in the total station. The distance is determined by emitting and receiving multiple frequencies, and determining the integer number of wavelengths to the target for each frequency. Most total stations use a purpose-built glass Porro prism as the reflector for the EDM signal, and can measure distances out to a few kilometers, but some instruments are **"reflectorless"**, and can measure distances to any object that is reasonably light in color, out to a few hundred meters. The typical Total Station EDM can measure distances accurate to about 3 millimeters or 1/100th of a foot.

Some modern total stations are **'robotic'** allowing the operator to control the instrument from a distance via remote control. This eliminates the need for an assistant staff member to hold the reflector prism over the point to be measured. The operator holds the reflector him/herself and controls the total station instrument from the observed point.

The basic principle of Total Station is that the distance between any two points can be known once the time light takes to travel the distance and back and the velocity of light is known. Then the following relation, which is already programmed in the memory of the instrument along with other correction factors, calculates the required horizontal distance and is displayed on the LCD screen.

Distance = (velocity of EMW*time taken)/2

2.10.2 Setup

1. Place tripod approximately over a known point locking legs at a convenient height so machine will be at or lower than eye level and the legs are at equal distances from each other. Eyeball the head of the tripod so it is as close to level as possible.
   * Be sure the legs of the tripod are firmly planted into the ground.
   * For smooth surfaces (such as concrete, asphalt, or tile), use folding metal tripod footing to secure the legs.
2. Remove instrument carefully from casing with both hands. Place on top (supporting with top handle) of tripod and tighten centering screw below platform into instrument, aligning the three corners of machine and platform. Use sight tangent screw on back side of LCD display to center the instrument over the exact known point to be surveyed.

2.10.3 Power and preparation

1. Attach one of the batteries to the side of instrument with the clamp side up. Press any one of the five buttons below the display to turn on machine. It shall beep and the display should indicate the instrument is not level and must be leveled and indexed (precisely level internal components).
   * To switch power off, hold ESC button and press indicated button that corresponds to OFF on the display.
   * If the battery is at a low level, the following will be displayed, "**Battery is low!**"-switch batteries and charge the drained one using provided jack.
   * Prior to storing the instrument for its next use, check the status of both provided batteries. If either is only ENTIRELY drained, charge overnight using given equipment.
2. Locate the horizontal level bubble above the LCD display. Rotate instrument by loosening the horizontal clamp and align the display with any two of the leveling screws. Tighten or loosen the left screw so bubble is in center. Rotate instrument clockwise to the next two screws and again use the left one to center bubble. Rotate to the final two pair of screws and center bubble. Check stationary leveling bubble to see if it is center. If not, repeat previous leveling process.
   * If the error message "**Tilt out of range**" is displayed, it is indicating the instrument is off-level. Relevel the instrument.

3. To index the vertical circles, loosen the vertical clamp, and manually rotate the telescope either way twice. The beep should be heard and the zenith angle (**ZA**vertical angle) will appear on the LCD display.
4. Loosen the horizontal clamp and rotate the instrument clockwise twice to index the horizontal circles. The beep is heard again and the horizontal angle (**HAR**) is displayed.
   * Vertical and horizontal indexing has now been completed.
5. Note the menus displayed. Each option shown on the home page (reached by pressing ESC) opens a section which contains several (up to 3) pages. To scroll through these pages to reach other options, press button left of the yellow ESC button that reads →PX.
6. Set the target and instrument height by pressing **Ht**. in **S-O** mode. Measure the target height by reading the measurement on the reflector pole at the clamp (set at any arbitrary height suitable for job). Measure the instrument height by taping the distance from the black point on side of instrument (level with center of telescope) to the known point on ground.
   * Be sure to note the units used (currently default set at feet and decimal fractions of feet; see manual to change to metric units) and height of instrument and target in the field book.
   * When using two reflecting poles, be sure to set each at same height.

2.10.4 Angle measurement

1. Sight the first point (focus with eye piece and align center hairs with center of reflector) using the horizontal clamp and the fine motion screw. Set the angle to zero by pressing **0SET** in **THEO** mode. Sight the second target and read the **HAR** on the display.
   * If you wish to read the angle by rotating the instrument to the left, press **R/L** in **THEO** mode (display will read **HAL** or **HAR** for left or right respectively).
2. For higher accuracy, the average of a number of readings can be taken using repetition. Sight the first target and press **REP** in **THEO** mode. Press **BS** (back sight) then sight the second target. Press **FS** (fore sight) and the angle between the two will be displayed. Sight the first target again, presses **BS**, and site the second target again and press **FS**. The average of the two readings will be displayed. Repeat up to 10 times for higher accuracy.
3. The slope of the line being shot can be displayed as a percentage by pressing **ZA%** in **THEO** mode. This is read as **VA** and gives the percentage grade of the line. Press it again to return to the **ZA** reading.
   * **VA%** will be displayed when the parameter is set to “Horizontal 0” instead of “Zenith 0” but performs the same function.

2.10.5 Distance and angle measurement

This is the most useful and suggested method. The working procedure is described as follow:

1. Sight target and select for slope, horizontal, or height (**SHV**) measurement. Press **Sdist**to start the measurement and **STOP** to end. The distance, vertical, and horizontal angle are displayed. Press **SHV** to view the other measurements (Horizontal distance or Height difference).
2. To measure the horizontal distance several times and display the average, sight the target and press **Hdist**in **THEO** mode. Three measurements are taken and the average (**H-A**) is displayed after a few seconds.
    * The most recently taken data can be recalled and displayed by pressing **RCL** in the **EDM** mode.

2.10.6 Coordinate measurement

This is not much more useful. So, co-ordinate measurement is not suggested for use.

1. In order to begin the coordinate measure, set the initial coordinates of the station. This is done by pressing the **S-O** button at the main menu. Then press the **Stn-P** button on the second page of the **S-O** menu. Choose the **Input** button, then set the initial coordinates and press **ENTER**.
2. Sight the target and press **COORD** in **S-O** mode, then press **STOP** to end the measurement. The coordinates of the target are given with respect to the initial starting position (0,0,0) and designated direction to be North.

2.10.7 Measuring the distance between two points

1. Sight the first position and press either **Sdist**, **Hdist**, or **Vdist**in **EDM** mode to start the measurement. Stop the measurement by pressing the **STOP** and sight the next point. Press **MLM** on the same page to start the measurement, the press **STOP** to stop the measurement. The slope, horizontal, and height difference between the two points is displayed. This can be repeated as many times as necessary.
2. The slope may be read as a percentage by pressing **S%** in the same mode after the missing line measurement has finished. This displays the percent grade between the two points.

2.10.8 Distance setting-out measurement

1. To find the direction and distance of a point set out a wanted distance from the instrument station, sight the reference direction and press **0SET** in **THEO** mode to set the **HAR** at 0. Turn theodolite until the required angle is displayed and locks the horizontal movement.
2. Press ESC to go to basic mode and go to **S-O** mode. Go to **S-O_D** for the data and input the desired distance to set out. Set the reflecting prism in the sighting line and press **SO_Hd**to start the distance measurement. The difference between the desired distance and the measured distance is displayed on the 1st line.
3. Move the reflecting prism towards or away from the Instrument until **H** distance becomes 0m to determine the point at the desired distance.
   * If there is negative (-) data: Move prism away from Instr.
   * If positive (+) data: Move prism towards Instr.
   * Press **STOP** to end the measurement.

2.10.9 Coordinates setting-out measurement

1. Set the station coordinates and initial azimuth angle. Press **S-O_P** in **S-O** mode and input the desired coordinates for N and E and press **YES** to store the data. Press **SO_HA** in **S-O** mode to start the angle measurement. The setting-out horizontal angle, **dHA**is displayed. Use the horizontal clamp and fine motion screw to turn theodolite until **dHA**reads 0° 00’ 00” and lock the clamp.
2. Sight the reflecting prism on the sighting line and press **SO_HD** and move reflecting prism until **H** reads 0m as in part 3 of the distance setting-out measurement.

2.11 Computation and plotting

For the calculations as well as plotting, we applied the coordinate method (latitude and departure method). In this method, two terms latitude and departure are used for calculation. Latitude of a survey line may be defined as its coordinate lengths measured parallel to an assumed meridian direction. The latitude (L) of a line is positive when measured towards north, and termed Northing and it is negative when measured towards south, and termed Southing. The departure (D) of a line is positive when measured towards east, and termed Easting and it is negative when measured towards south, and termed Westing. The latitude and departures of each control station can be calculated using the relation:

Latitude = L Cosθ

Departure = L Sinθ

Where, L=distance of the traverse legs

θ=Reduced bearing

If a closed traverse is plotted according to the field measurements, the end of the traverse will not coincide exactly with the starting point. Such and error is known as closing error.

Mathematically,

Closing error (e) = $\sqrt{\{(\Sigma L)^2 + (\Sigma D)^2\}}$

The relative error of closure = e / p

The error (e) in a closed traverse due to bearing may be determined by comparing the two bearings of the last line as observed at the first and last stations of traverse.

Plotting of Major and Minor traverse

After computing the co-ordinate of each of the control points, they were plotted in A1 size grid paper. Both major and minor traverses were plotted to **1:1000** scales. The plotted traverse was made at the center of the sheet with the help of least co-ordinates and highest co-ordinates. Minor Traverse was plotted in similar way to scale **1:500** over which later detailing by tachometry was done.

2.12 RESECTION

Resection is the determination of the observer's position by means of observations taken to previously fixed points. There are several methods of resection and they include:

- Observing horizontal angles from the unknown point to three known points.
- Observing horizontal angles from two unknown points to two known points.
- Observing horizontal angles from one unknown point to two known points when the Azimuth of one of them is known.

2.13 Comments and Conclusion

The site for survey camping was the campus area of TU, Kirtipur. The pattern was very suitable because all the facilities for engineering work were available with the good environment of doing work.

The arrangements of the survey instruments were appreciable although there were some faulty instruments that made the fieldwork time consuming. Some instruments like theodolite, levels etc. do not given the accurate reading. We hope that there will be sufficient number of instruments for next survey camp. The stationary accessories should be managed inside the campus area because it is difficult to take all the stationery goods from Kathmandu and there is no such stationery shop near the campus.

Some other problems during the field works were during fly leveling during transferring the R.L. from given benchmark to the T.B.M. due to the disturbance by traffics.

The given Topography survey camp work was finished satisfactorily 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. 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.

All the groups prepared their topographic map of the given area of the TU campus areas in the same scale. The whole area was divided in such a way that area allocated for one group contains some part of the area allocated for another group. One traverse leg is also common to all groups and hence the combination of all groups' effort will provide a perfect and complete topographic map of TU after combining it.

3 BRIDGE SITE SURVEY

This part of the Survey Camp dealt with the bridge site survey at Kirtipur. 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 the ground is undulated and where there are plenty of rivers, bridges are the most economic and efficient way to join two places. It is a very convenient way. That is why the task of bridge site surveying has been included in the curriculum of Bachelor's degree in Civil Engineering at Pulchowk Campus, IOE.

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 purpose of the bridge site survey was not only to prepare plan and layout of the bridge site but also from the engineering point of view, the purpose is to collect the preliminary data about the site such as normal water flow level, high flood level, geological features of the ground for planning and designing of the bridge from the details taken during the surveying. Moreover, bridge construction is an important aspect in the development of transportation network. Surveying is required for topographical mapping, knowledge of longitudinal sections of the river and cross sections at both the upstream and in downstream side of the river for the construction of a bridge.

3.2 BRIEF DESCRIPTION OF THE SITE

Bridge site survey was conducted over a small rain spring on the T.U. facility. The spring collects water etc. coming from the departments and flows through a ravine formed by two hill slopes. Our site was between the physics and chemistry departments and the coronation garden. The site was mossy and swampy. No huge boulders are to be found near the site. It was damp and hilly.

Hydrology, Geology & Soil

The site is surrounded with steep hill, which is covered with densely planted shrubs. 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.

3.3 TECHNICAL SPECIFICATIONS (NORMS)

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

1. 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°.
2. The triangulation angle had to be measured on two sets of readings by Theodolite and the difference between the mean angles of two sets of readings had to be within a minute.
3. Transferring the level from one bank to another bank had to be done by the method of reciprocal leveling.
4. The scale for plotting the topographical map was given to be 1:500
5. In order to plot the longitudinal section of the river, data had to be taken along the riverbed 150 m upstream and at least 50 m downstream. The plot for the longitudinal section along the flow line had to be done in a scale of 1:50 for vertical and 1:500 for horizontal, for cross-section v=H=1:200.
6. For the cross-section profile, data had to be taken at 25 m intervals both upstream and downstream, and one at the bridge axis. Observation had to cover minimally 20 m beyond the bank of river on either side.

3.4 EQUIPMENT & ACCESSORIES

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

1. Total Station
2. Ranging Rods
3. Measuring Tapes
4. Leveling Staffs
5. Plumb Bob
6. Pegs & Arrows
7. Marker Pen
8. Compass
9. Prism & Prism Holder

3.5 METHODOLOGY

The various methods performed during the bridge site survey were triangulation, leveling, tachometry, cross section, and L-section. The brief descriptions of these methodologies are given below:

3.5.1 Site Selection

There are various factors for the selection of bridge site such as geological condition, socio-economic and ecological aspect etc. Therefore, the sites were chosen such that it should be 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 bridge axis should be so located that it should be fairly perpendicular to the flow direction and at the same time, the river width should be narrow from the economical point of view and the free board should be at least 5m. The starting point of bridge axis should not in any way lie or touch the curve of the road.

The site selected for the bridge axis was near the curve of the river with no community but with the temples and the shed house nearby. For the purpose of the shortest span, the stations were set perpendicular to the river flow direction. The riverbanks were not eroded and were suitable for bridge construction. The chance of change of direction of river on the selected axis line was nominal.

3.5.2 Topographic Survey

For the topographic survey of bridge site, triangulation was done. The main purpose of the triangulation was to determine the length of the bridge axis. The triangulation also serves the control points for detailing. First, 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 a 1" total station with two sets. The bridge axis length or span was calculated by solving the triangles using the sine rule. Thus, the horizontal control 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.

3.5.3 L Section & Cross Section

The L-Section of the river is required to give an idea about the bed slope, nature of the riverbed, and the variation in the elevations of the different points along the length of the river. 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 R.Ls 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 25 m extending 150 m upstream and 50 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. At some places, the "danda and tape" method was also applied. With all the calculations done and the required data in hand, the cross section was plotted on a graph paper on required scale.

3.5.4 Leveling

3.5.4.1 Transferring R.L. from B.M. to control points

The benchmark was on the stone near the chautara near the existing bridge. R.L. 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.

3.5.4.2 Reciprocal Leveling

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.

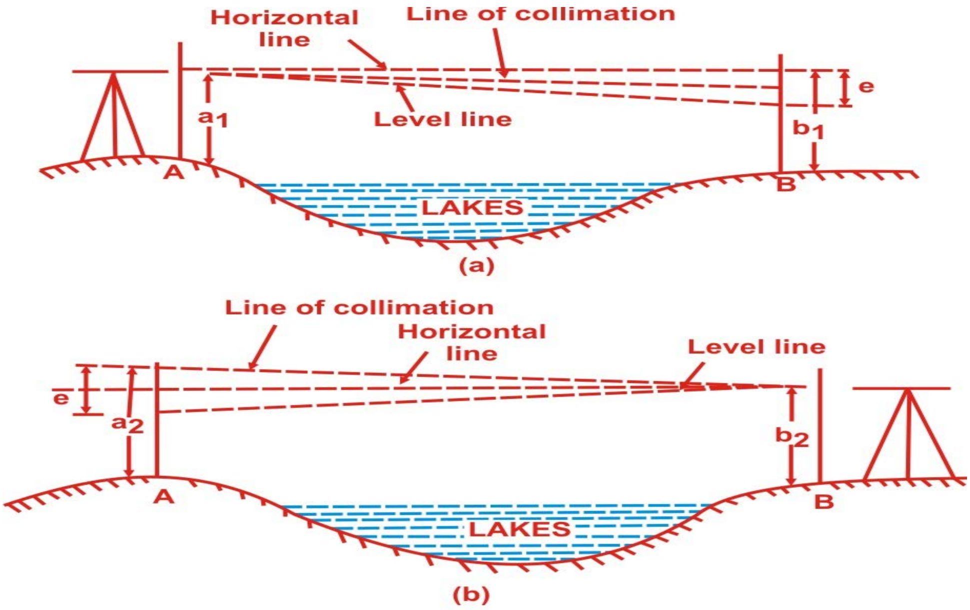


Figure 4-Reciprocal Leveling

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

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

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

3.5.5 Detailing

Detailing of the entire bridge site was done by total station and tachometric method, the readings being taken with a theodolite stationed at the different traverse stations. The detailing was done with respect to the skeleton formed by triangulation. The vertices of triangles serve as a control point. With the help of tachometer, the details were booked, up to 100m upstream and 50m downstream. The important details not included in the cross-section data, were taken. Trigonometric Leveling was also done to find out the RL of the inaccessible points. The data and the calculations have been tabulated in a systematic way.

3.5.6 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 tachometric formulas were used for the calculation of the horizontal distance and R.L. of different points:

Horizontal distance of any point from the traverse station,

$H = 100 \times S \times \cos^2\theta$

Where, S = Staff intercept = Top - Bottom Stadia Reading

θ = Vertical Angle

And R.L. of any required Point is

$R.L._{(point)} = R.L.$ of Station + H.I + H x Tan θ – 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.

3.5.7 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 design such that the span length should be minimum and in safe location. That means the bridge axis should not be below the flood level so that during course of monsoon it is affected by floods. From the geological and topographic and economic point of view, bridge span is found to be 71……. No springs and streams are added in the river up to the surveyed area, also the drainage and sewage have not been discharged into the river. At the axis, the river width, the river width is about 10m and water flow is normal. The cross-section was taken at the banks of river and at the middle of the river to get the profile of the flowing river. Also, we marked the high flood level and low flood level.

There is a very little change due to the erosion of bank. The watermarks are at the level below the existing Foot track. Due to the low discharge the channel of river is not changing.

The instruments provided for the bridge site survey were not so precise than that of topographic survey performed at T.U. However, we managed to complete our job on the specified time.

4 ROAD ALIGNMENT &GEOMETRIC DESIGN

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.

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 BRIEF DESCRIPTION OF THE PROJECT AREA

Road alignment is an important aspect in the development of the transportation network of the country. Road alignment is important part of the survey. Road alignment and bridge site survey goes side by side to run a road between two terminals and to carry a survey for the bridge construction along the route. This specific job is essential for an engineer combating with the mountainous topography of Nepal.

4.2 Geology, Hydrology & Soil

The road had to go along a damp route that was much undulated. The place was damp. There were no large boulders or rocks of any kind along the proposed site. There are several places where culvert or cause way can exist. The soil is uniform throughout the whole length of the road. Although the road alignment has certain up and downs. Finally, the starting and ending point of the road has not significant level differences.

If along the potential slip surface in the soil the stress produced by gravity exceeds the shear strength of the soil along the potential failure surface, the slope will become unstable. Obviously, the shear strength of soil is largely depending upon the type of soil. Cohesive soil has more shear strength than others do. The hard and dense soil is best for slopes. We found soft clayey soil that was very damp. Other kinds of soils were not found along our proposed route.

4.3 Technical Specifications (Norms)

Reece 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 15m interval and longitudinal profile were prepared.

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

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

- 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 gradient of the road had to be maintained below 8 %.
- 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.

4.4 Equipment's& Accessories

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

- Total Station
- Prism & Prism Holder
- Plumb Bob
- Leveling Instrument
- Leveling Staffs
- Ranging Rods
- Measuring Tape
- Pegs and Arrows
- Marker Pen

4.5 Methodology

4.5.1 Reconnaissance

The reconnaissance survey was performed along the given route. Then guess works were done for 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 and gradient between the two IPs was adjusted such that it does not exceed 12%, using the abney level. Meanwhile the pegs with IP no. were driven at these points.

4.5.2 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 1" Total station at each IP and then deflection angles were calculated.

Deflection angle = (360^0 or 180^0) - observed angle

If +ve, the survey line deflects right (clockwise) with the prolongation of preceding line and deflects left if –ve (anti-clockwise). The radius was assumed according to the deflection angle. Then the tangent length, EC, BC, apex distance along with their chainage were found by using following formulae,

Tangent length (T L) = R x Tan (Δ/2)

Length of curve (L.C) = 3.142 x R x Δ/180

Apex distance = R x 1/(Cos (Δ/2)-1)

Chainage of BC = Chainage of IP – TL

Chainage of MC = Chainage of BC +LC/2

Chainage of EC = Chainage of MC + LC/2

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.

4.5.3 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 with maximum gradient of 12 %. 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.

4.5.4 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 leveling on the entire length of the road, fly 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 $24\sqrt{k}$ mm, where k is the total distance in km.

4.5.5 L-section & Cross Section

The L-Section of the road is required to give the road engineer an idea about the nature of the ground and the variation in the elevations of the different points along the length of the road and also to determine the amount of cutting and filling required at the road site for maintaining a gentle slope. In order to obtain the data for L-Section, staff readings were taken at points at 15m 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 were 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 15m 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.**

4.6 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.

4.6.1 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.

4.6.1.1 Setting Out OF Simple Circular Curves

4.6.1.1.1 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

4.6.1.1.2 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

$$O_o = R - \sqrt{[R2 - (L/2)^2]}$$

The Ordinate at a distance 'x' is given by,

$$O_x = \sqrt{[(R^2 - X^2) - (R - O_o)]}$$

Where,

$O_o =$ mid-ordinate

$O_x =$ ordinate at distance x from the midpoint 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.

The angle subtended by first sub-chord is given by,

$\delta_1 = 1718.9\ C_1/R$ minutes

The angle subtended by each normal chord is given by the formula,

$\delta = 1718.9\ C/R$ minutes

If δ_1, δ_2..., δ_n are the tangential angles made by successive chords with their tangents and $\Delta_1, \Delta_2 \ldots\ldots \Delta_n$ are the total deflection angles, then

$\Delta_1 = \delta_1$

$\Delta_2 = \Delta_1 + \delta_1 = \delta_1 + \delta_2$

……………………

……………………………

Similarly,

$\Delta_n = \Delta_{n-1} + \delta_n = \delta_1 + \delta_2 + \delta_3 + \ldots\ldots\ldots + \delta_n = \Delta/2$

Field Procedure

1. The instrument is set at T_1 and zero is set along P.I..
2. Then the theodolite is set to read an angle of $\delta_1 (=\Delta_1)$.
3. With T_1 as center and C_1 as radius, the tape is swung and arrow was marked at intersection of the tape with crosshairs.
4. Then angle Δ_2 was set on the theodolite and with length of normal chord as radius, the next point on the curve was marked at the pt of intersection.

   This procedure is continued till the point of tangency is located.

4.7 Comments and Conclusion

Survey of the road alignment is done to make most economical, comfortable, and durable. Extra case is taken to avoid any soil erosion and any other ecological damage. 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 tough due to the route high altitude.

5 CONCLUDING REMARKS

With the helpful regard of teacher and cooperative behavior of all friends all the work is completed as scheduled in routine time assigned to us although we faced minor difficulties during our orientation. The management team had arranged the total station instrument for our daily field work. This had made our work easy, reliable; less time consuming and competitive as total station is the instrument which is widely used in the surveying works nowadays. Use of Total Station had allowed the camp organizer to shorten the fieldwork duration from 14 days to 10 days. All 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. This trip also offered us relief from the monotony of performing all survey practical within the college compound. It was also a chance to get to know our friends from other sections, work closely, and interact with them. This trip is a good experience in dealing with locals and other people who were interested in our work. We also learned to explain what we were doing to laymen in simple terms. We think I.O.E should organize such trips frequently and for all possible subjects, as practical knowledge is better. In these trips, we gain first hand concept of the subject matter that makes it easier for us to grasp the concept. All in this entire trip was very informative, effective and enjoyable.

Any suggestion and comment are heartily acceptable. During report preparation all confusion are cleared by teacher whom we are very grateful.