CHAPTER 3:

TACHEOMETRIC SURVEYING

Contents

1. INTRODUCTION

1.1. Background

Topographical survey is the branch of survey which determines the horizontal and vertical location of the certain points by the linear and angular measurement by an instrument called tacheometer and is made to determine the nature of the given terrain i.e. river, stream, hills,

town, canals, roads and etc. With the data information collected from the survey, the topographical map is prepared (Agor, 2018) .

Topographic map is the graphical representation of topographical feature, to some scale of the given terrain in the plane sheet of paper. It is used for detailing works of the area. Topographic map helps to know the Topography of the given terrain and also useful in the design of highways, railways, canals, sewers, etc. Topographic map is also useful for laying out construction project. This method is useful when speed is more important than accuracy. Within this method, optical instrument is used to determine the horizontal distance and height difference.

In this project, Tacheometry method was adopted to make detailing of area around premises of Kathmandu University. The main purpose of his project was to prepare a topographic map. Moreover, it helped us to improve our skill in instrument handling, collaboration among colleagues and understanding about counter, detailing and features representation.

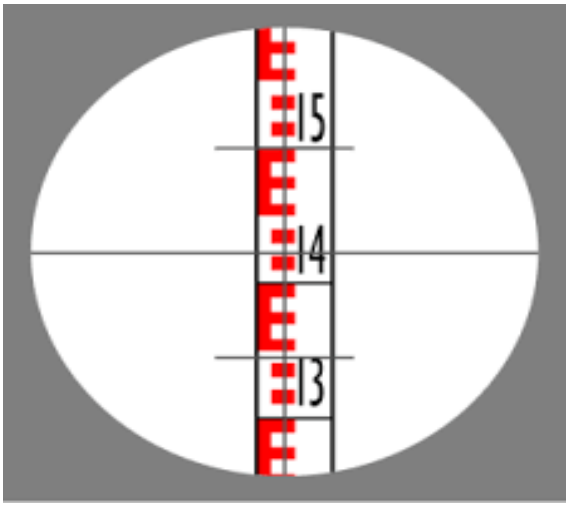

Figure 1. Stadia Diaphragm

1.2. Objectives

The primary objective of tacheometric surveying was:

- To prepare the topographic map of Kathmandu University premesis.

The secondary objective of tacheometric surveying are given below:

- Determining quantitative characteristics of the topographical and features of site (i.e. x,y,z values or angles and distances) with respect to the control points set.
- Determination of RL using the values of staff reading, zenithal angle and RL of the station.

1.3. Scope

This project deals with the scope of map preparation to show the topography of the site. The prepared map will show elevation change using contour lines. Also the map would include the features of the site such as electric poles, buildings, road etc. The map prepared is mono- colored and use of symbols is done to represent various features. Preparation of multi-colored map is not under the scope of our project.

2. METHODOLOGY

2.1 Theorotical Framework

The principle of tacheometry is based on the principle that the ratio of the perpendicular to the base is constant in similar isosceles triangles.

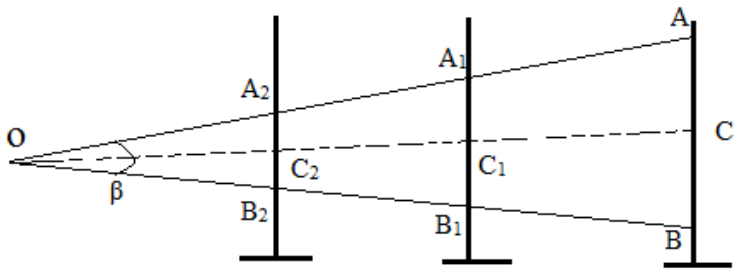

Figure 2. Principle of Tacheometry

Let A_2B_2, A_1B_1 and AB be the staff intercepts and the two rays OA and OB be equally inclined to the central ray OC then,

$OC_2/A_2B_2 = OC_1/A_1B_1 = OC/AB$ = constant k= $\frac{1}{2}\ cot\frac{\beta}{2}$

The constant k depends upon the magnitude of the angle β. If β is made equal to 34'22".64, the constant k = $\frac{1}{2}$ cot 17'11".32 = 100. In this case, the distance between the staff and the point O will be 100 times the staff intercept (Punmia et al., 2005).

Methods of Tacheometric Surveying:

i) Stadia Hair Method: In this method theodolite with the stadia diaphragm is used to find out the staff intercept between the lower and upper hairs and also the central hair reading is noted.

Principle of Stadia hair method is that the ratio of the length of perpendicular to the base is constant in case of similar triangles.

- Fixed Hairs Methods: In this method, the vertical spacing between the upper stadia hair and the lower stadia, called stadia interval is fixed. This spacing is not change during the measurement.

- Movable Hairs Method: In this method, the vertical spacing between the stadia hairs (stadia interval) can be varied by moving the stadia hairs vertically by micrometer screws.

ii) Tangential Method: In this method, the stadia hairs are not required.

Terms used in Tacheometry:

The technical terms used in tacheometric surveying are:

- Tacheometer: It is the theodolite fitted with the stadia diaphragm. It is generally used for tacheometric survey.
- Stadia diaphragm: It consists of three horizontal cross hairs, one on middle and other two on top bottom.
- Anallactic Lens: It is an additional convex lens generally provided in the external focusing tacheometer between object glass and eyepiece.
- Multiplying Constant: It is the ratio of focal length of the lens to stadia intercept. The value of multiplying constant is generally 100.
- Additive constant: It is the sum of focal length of lens and horizontal distance between instrument axis to optical center of lens. The value of additive constant varies from 0.15 to 0.60m.
- Contouring: Contouring is the process of representing the features of ground on plan i.e. it gives the three dimensional view (topographical view) of the ground on map. The imaginary lines joining the points of equal elevation on the ground are called contour lines.
- Contour Interval: The vertical distance between any two consecutive contours is called contour interval. It is kept constant in a map.
- Horizontal Equivalent: It is the horizontal distance between two points on two consecutive contours. It depends upon the steepness of the ground.
- Staff Intercept: It is the difference between top and bottom hair of the diaphragm.

2.2 Study Area

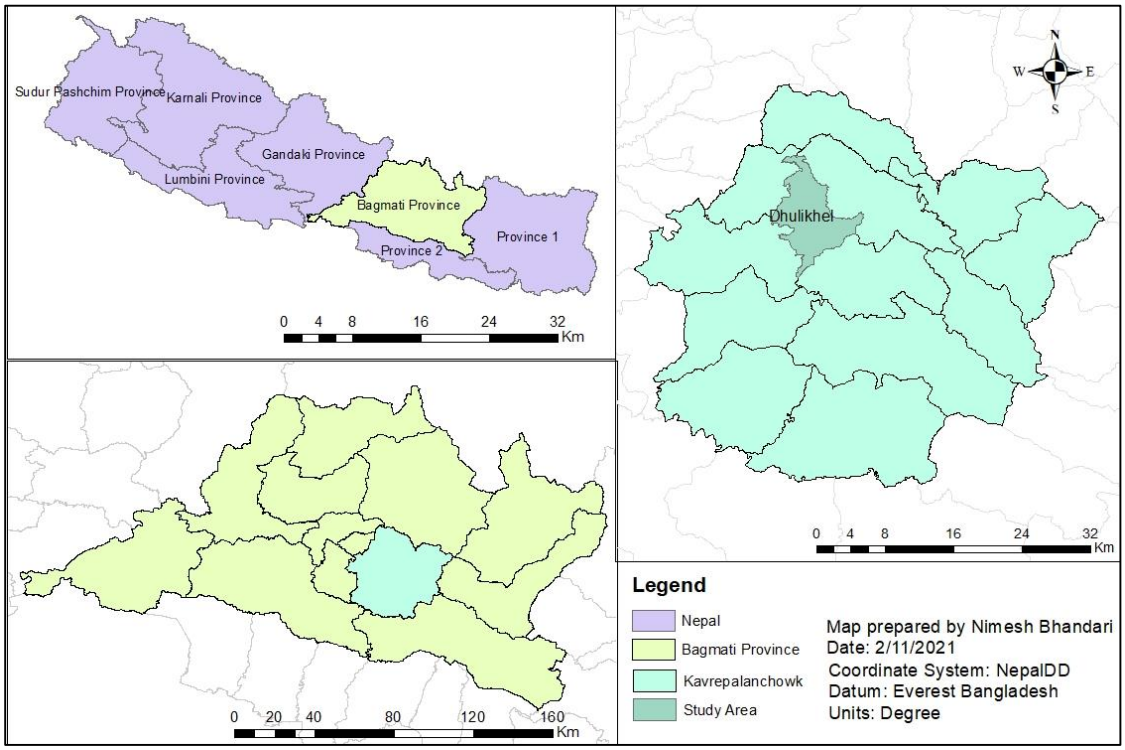

Figure 3. Study Area of Tacheometric Surveying

2.3 Specifications

The specifications of the project are listed below:

Order of work	Fourth order
Purpose	Preparation of contoured map
Unit of measurement	Linear measurement (meters), Angular measurement (degrees, minutes, seconds)
Method and instrument	Angular measurement, Theodolite
Choice of Theodolite	Theodolite with stadia hairs (Tacheometer)
Staff	Telescopic
Minimum staff reading	0.3 meters
Maximum staff reading	2.7meters
Observation Time	Whole Day

2.4 Study Method

A) Planning and Reconnaissance

After establishment of traverse station, it was planned to apply the method of Tacheometry for detailing of the site. In planning various kinds of things were for taken in considerations. Human resource, instrument to be used, availability of transport, and other infrastructures used during surveying were considered. During reconnaissance, whole area to be detailed was investigated and the features to be taken in concerned were detected and rough sketch was drawn. The places to throw the offsets were also determined.

B) Observation

Observation was done by Tacheometry method. Within the Tacheometry, first RO was set preceding station, the feature of site were observed in clockwise direction and circle was completed and return to RO and the error should not exceed 30cc. During observation, horizontal angle, cross-hair reading and zenithal angle were observed. If any features were missed to be observed then first clockwise circle was completed then missing, features were again observed in clockwise direction. For those house corners of building and structure where erected staff was not possible, staff was placed at same horizontal distance from instrument, staff reading were observed and horizontal angle was observed on the corners. For uniformly and continuously changing terrain, staff readings were observed at extremities and mid area were of same slope so they were estimated. For sudden height changing area, sufficient readings were taken in zig-zag line. For flat area, few spot heights were taken to show the elevation change. Offsets were taken for those features which were inaccessible by traverse stations.

C) Data collection and computation

After observation, the data were recorded and following terms were computed from the data observed by using the formula:

1. Horizontal distance = $100*(t-b)\sin^2 Z$
2. $\Delta h = 100*(t-b)*\sin Z*\cos Z$
3. Reduced level(R.L) of detail= RL(station) $+\Delta h+h-m$

   Where,

   t= top reading of stadia wire, m=middle wire reading, b=bottom reading of stadia wire

Z= Zenithal angle, Δh= Vertical intercept

D) Plotting

After the computation of data and their adjustment, the paper work was done by plotting the data. In this stage the data were firstly plotted on tracing paper. Traverse stations were plotted on tracing paper at the scale of 1:1000. For that, Average of extreme Easting and Northing was computed to prick the center point on tracing paper and its co-ordinates was computed. From that, stations were plotted on the tracing paper. Those traverse station were connected by lines called traverse leg. Taking reference of the traverse legs, other detailing of the feature with their respective horizontal angle and horizontal distance were done in the same scale I tracing paper. Physical feature was plotted using first and contour lines at contour interval 1m were plotted. Plotting was done in the office using compass, scale, pencil and eraser.

E) Map Preparation

After tracing the all the points and features on the tracing paper, next step was preparation of map. Map was traced on permatrace of size 75*60. The points and the features of the tracing paper were pricked on working face (50*50) of the permatrace paper. Every fifth contour line was considered as index contour line made bold and dense compare to intermediate contour line. Legends were provided to indicate the specific features like buildings, roads, boundary walls and others. Title of the map was provided on the top of the paper and the authors on the bottom of the permatrace paper. Also the graphical scale was prepared below the working face.

2.5 Methods Adopted for Achieving Accuracy in Tacheometric Surveying

To achieve higher accuracy following things were kept on consideration:

- RO was set to preceding station and checked continuously after 25 to 30 reading and if angular error was greater than 30cc then whole process was repeated.
- While taking detailing, it was done in clockwise direction and if any feature was missed to be observed then that feature was again observed clock-wise direction from RO.
- Staff reading was taken between 2.7m and 0.3m as far as possible.
- At least three corner of the building and house were taken so they could be plotted accurately on suitable scale.

3. RESULT

Following above mentioned methodology, we got about points for detailing the site. With the help of those points, we prepared Topographical map with the contour interval of 1 m as a result. The field-book containing detailing points and the topographic map is attached with the report.

4. CONCLUSION

For the preparation topographical map, it is necessary to do detailing of the site. For that purpose, method of Tacheometry was adopted. It is very rapid method for detailing. Hence, the topographic map of the given site was prepared by tachometric survey. The tachometric project was done within given period of time. We achieved the practical knowledge of drawing contour and detail picking which we lagged in previous semester project. Thus, from this project, we felt that we have upgraded one level in surveying and as we are geomatics engineering students, so we are in great benefit from this project.

5. RERERENCES

Agor, R. (2018). *Surveying and Levelling* (Twelveth).

Punmia, B. C., Jain, A. K., & Jain, A. K. (2005). *Surveying: Vol. I* (Seventeenth). Laxmi Publications (P) Ltd.