CE331A: PROJECT REPORT

Project Duration	29-Sep-22 to 10-Nov-22 (6 working weeks)	
Submission Date	14-Nov-22	
Course Code	CE331A	
Course Title	Geo-Informatics	
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Student Group Number and batch	Group 3 (Thursday Batch)	
Evaluation Remarks	CRITERIA	MARKS
	Overall comprehension	
	Content	
	Correctness	
	Completeness	
	Writing skills	
Evaluators Name		

ABSTRACT

Group 3 participants mapped the region in and around **the IME Building and DOAA canteen** as part of the lab project. During the six-week period, the group established control points, measured internal angles for the closed traverse, determined elevation for the established control points, used GNSS to determine global coordinates of the control points, and mapped features of the area to create a full-fledged map of the entire area allotted using the QGIS software.

OBJECTIVES

The basic objectives of this exercise include:

- To establish a close traverse by establishing the control points such that $(i-1)^{th}$ and $(i+1)^{th}$ control points are visible from the i^{th} control point.
- To measure the side length and interior angles of the close traverse after its establishment.
- To carry out levelling process of our region using the Auto Level.
- To find the global coordinates of our stations using GNSS.
- To map features like trees, buildings, fire hydrants, lamps, etc. around our control points.
- To finally prepare the map of the area using QGIS Software after adjusting the traverse using Bowditch's Rule.

INTRODUCTION

Concepts used and related terminology

Reconnaissance

Reconnaissance is the first and most important step in the surveying process. Only after a careful and detailed reconnaissance of the area can the surveyor decide upon the techniques and instrumentation required to complete the work economically and meet the accuracy specifications.

Traversing

Traversing is one of the simplest and most popular methods of establishing control networks in engineering surveying. Using the technique of traversing, the relative position of the control points is fixed by measuring the horizontal angle at each point, between the adjacent stations, and the horizontal distance between consecutive pairs of stations. Traverse networks have many advantages, including:

- Less reconnaissance and organization needed
- While in other systems, which may require the survey to be performed along a rigid polygon shape, the traverse can change to any shape and thus can accommodate a great deal of different terrains.
- Only a few observations need to be taken at each station, whereas in other survey networks a great deal of angular and linear observations need to be made and considered.
- Traverse networks are free of the strength of figure considerations that happen in triangular systems.
- Scale error does not add up as the traverse is performed. Azimuth swing errors can also be reduced by increasing the distance between stations.

Levelling Process

Levelling involves the measurement of vertical distance relative to a horizontal line of sight. Hence it requires a graduated staff for the vertical measurements and an instrument that will provide a horizontal line of sight. Errors in levelling are of following types:

1. Instrumental Errors
2. Personal Errors
3. Errors due to natural causes

Closing error (e) can be distributed to each station by this expression

$$C= -e* \frac{d}{D}$$

Where,

d= distance of station from BM

D= total distance travelled

Total Station

When these two instruments are integrated into a single instrument it is called a ‘total station’. Total stations contain algorithms that calculate and display the horizontal distance and vertical height. This latter facility has resulted in trigonometrical levelling being used for a wide variety of heighting procedures, including contouring.

Systems of Bearing

- **Whole circle Bearing**: The system used to define a direction is called the *whole circle bearing system* (WCB). A WCB is the direction measured clockwise from 0 ◦ full circle to 360 ◦ . It is therefore always positive and never greater than 360 ◦ .
- **Quadrant Bearing**: In this method, both north or south can be used as a reference direction. Moreover, the direction of angle measurement can be taken in both clockwise or anti-clockwise sense. The reference direction or measurement sense flexibility is due to the fact that the measured angles must lie between 0º to 90º.

Quadrant in which bearing lies	*Conversion relation*
NE	$\alpha = \theta$
SE	$\alpha = 180° - \theta$
SW	$\alpha = \theta - 180°$
NW	$\alpha = 360° - \theta$

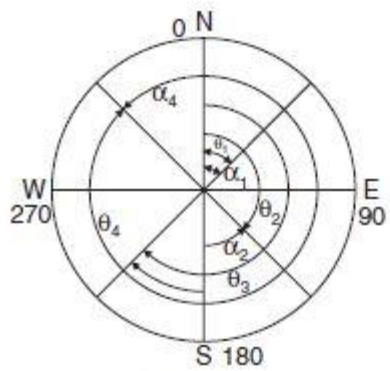

Fig. 13.4

Figure 1: WCB and Quadrant Bearing Conversion formulae

Global Navigation Satellite System (GNSS)

GNSS stands for Global Navigation Satellite System and is the standard generic term for satellite navigation systems that provide geospatial position with global coverage. The entire system is basically a constellation of 24 satellites orbiting the earth, out of which minimum 4 are needed for positioning.

Bowditch Rule

The Bowditch Rule is :

$$\delta E_i = \frac{\Delta' E}{\sum_{i=1}^{n} L_i} \times L_i = K_1 \times L_i$$

and

$$\delta N_i = \frac{\Delta' N}{\sum_{i=1}^{n} L_i} \times L_i = K_2 \times L_i$$

Where,

$\Delta' E$, $\Delta' n$ = the coordinate misclosure (constant)

δE_i, δN_i = the coordinate corrections

ΣL_i = the sum of the lengths of the traverse (constant)

L_i = the horizontal length of the i^{th} traverse leg

K_1, K_2 = the resultant constants

Similarity Transformation

The similarity transformation scales, rotates, and translates the data. It will not independently scale the axes, nor will it introduce any skew. It maintains the aspect ratio of the features transformed, which is important if you want to maintain the relative shape of features. The similarity transform function is

x’ = Ax + By + Cy’ = -Bx + Ay + F

where

A = s * cos t

B = s * sin t

C = translation in x direction

F = translation in y direction

and

s = scale change (same in x and y directions)

t = rotation angle, measured counter clockwise from the x-axis

A similarity transformation requires a minimum of two displacement links. However, three or more links are needed to produce a root mean square (RMS) error.

EQUIPMENT/TOOLS/SOFTWARE USED

- Total Station
- Retroreflector
- GNSS Receiver
- Auto Level
- Levelling Staff
- Paint
- QGIS Software
- Ms-Excel for calculations
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METHODOLOGY/EXPERIMENT

Week 1
Performed Reconnaissance Survey of the allotted area to create a close network by establishing a total of seven control points for the entire area creating a close traverse and marked the points using paint for future references.

Week 2
Total Station was used to measure the distance between the already defined control stations (close traverse side lengths) and interior angles between the sides. Found out the local coordinates of the control points and adjusted them using Bowditch Rule.

Week 3
Used Auto-level for carrying out the levelling process in the allotted area by using the GI lab elevation as a Bench Mark.

Week 4
Used GNSS receiver (R10) to obtain the global coordinates of the 4 out of the total 7 control points set up and used Similarity transformation for calculating the adjusted global coordinates of the points.

Week 5
Using Total Station, we mapped features like trees, buildings, lamp posts, fire hydrants, manhole, etc. and took contour points.

Week 6
Exported data from Total Station into csv format and added the data points as layer in QGIS. Provided different colors and symbols for different features according to Survey of Indian standards. Exported the map in print composer of QGIS.

CALCULATIONS/MEASUREMENTS

- **Balancing the angles**

Measurements of side lengths and included angles was taken from each of the control points, established in Figure 2, using the Total Station.

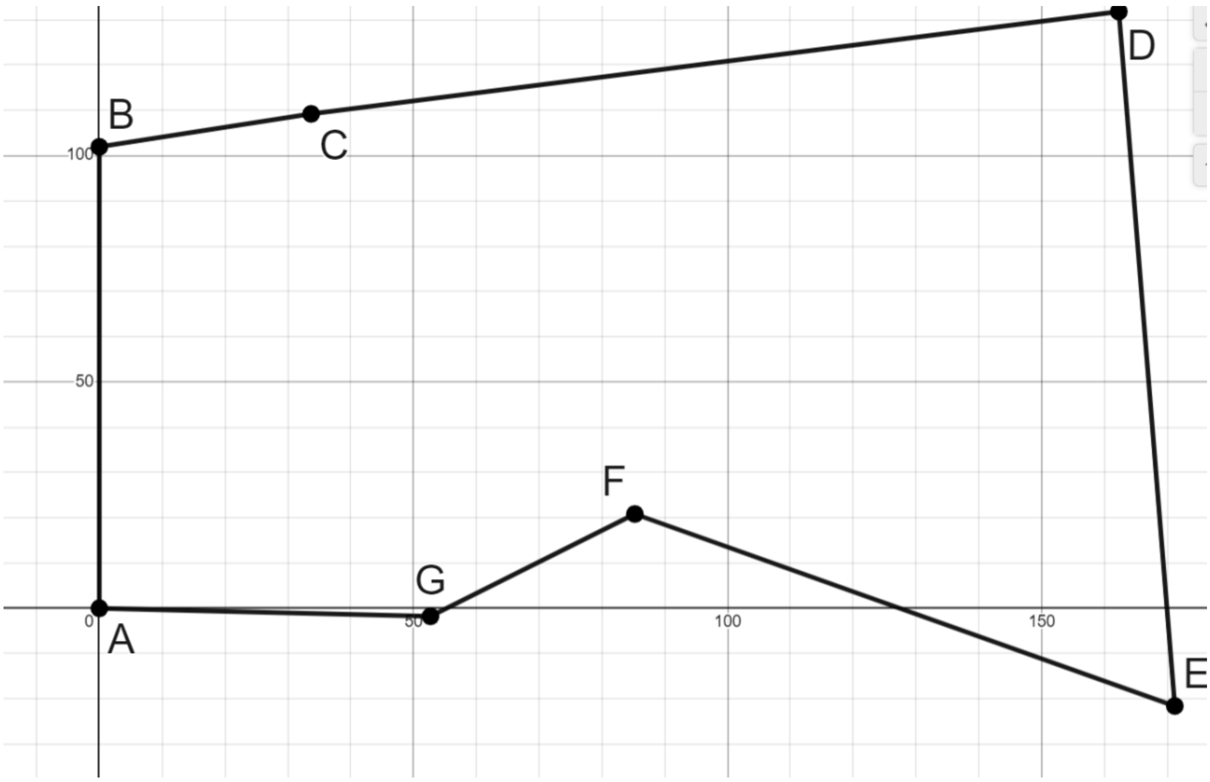


Figure 2: Established Control Network

Side	Length
AB	101.922
BC	34.486
CD	130.550
DE	112.479
EF	95.865
FG	39.609
GA	52.739

Balancing angles in the polygon			
Name of the angle	**Measured Value [θi]**	**Correction**	**Corrected Angle [θi']**
∠A_B_C	102° 12' 18''	0° 00' 9''	102° 12' 9''
∠B_C_D	177° 46' 12''	0° 00' 16''	177° 45' 56''
∠C_D_E	89° 25' 22''	0° 00' 8''	89° 25' 14''
∠D_E_F	69° 50' 27''	0° 00' 6''	69° 50' 21''
∠E_F_G	241° 1' 24''	0° 00' 21''	241° 1' 3''
∠F_G_A	127° 50' 56''	0° 00' 11''	127° 50' 45''
∠G_A_B	91° 54' 40''	0° 00' 8''	91° 54' 32''
$\Sigma\theta_i$	900° 1' 19''	$\Sigma\theta'_i$	900° 00' 00''
Sum of angles in the polygon theoritically	900° 00' 00''		
Misclosure [δ]	0° 01' 19''		

- **Adjusting heights**
  The heights were adjusted using the following Bowditch's Rule:

$$C = -e\frac{d}{D}$$

Where,
C = correction to each RL value
e = closing error
d= distance of station from BM
D= total distance travelled

An interactive excel has been attached in the mail showing all the data

	1.519	1.452	1.389	13		
					1.448	1.334
	1.485	1.378	1.269	21.6		
CP1					1.4	1.373
	1.77	1.42	1.301	46.9		
CP2					1.595	1.438
	1.44	1.352	1.263	17.7		
					1.482	1.398
	1.498	1.384	1.27	22.8		
					1.233	1.15

Misclosure (M) = Last RL – First RL = 128.409 – 128.409 = 0.00 m = 00 mm

- **Finding out the Whole Circle Bearings**
  Line A_B was assumed to coincide with the North direction. Whole circle bearing of all lines joining the established control points in the traverse were then calculated. The same is tabulated below.

Side	WCB
AB	00° 00' 00''
BC	77° 47' 42''
CD	80° 1' 30''
DE	170° 46' 8''
EF	280° 46' 35''
FG	219° 45' 11''
GA	271° 54' 32''

- **Calculation of local co-ordinates**

Local co-ordinates of all established control points were calculated using the Latitudes and Departures obtained previously. CP2 was taken as origin (0,0) and line 2_3 was taken as y-axis.

Point	X	Y
A	0	0
B	0	101.922
C	33.706	109.212
D	162.282	131.826
E	171.213	-21.598
F	85.245	20.823
G	52.704	-1.759

- **Transformation of co-ordinate system using Similarity Transformation**

Following equations were used for similarity transformation from local to UTM co-ordinates:

$$E = aX - bY + T_E$$
$$N = aY + bX + T_N$$

Where,
E: Easting of the point in UTM co-ordinates
N: Northing of the point in UTM co-ordinates
a, b, T_E, T_N: constants of transformation
The value of constants of transformation was determined by solving the above equations for two control points, the global coordinates of which were known, which reduced our problem to 4 equations and 4 unknowns

The results obtained were as follows:

a=0.9963992072
b=0.0766272247

T_E=2932774.461

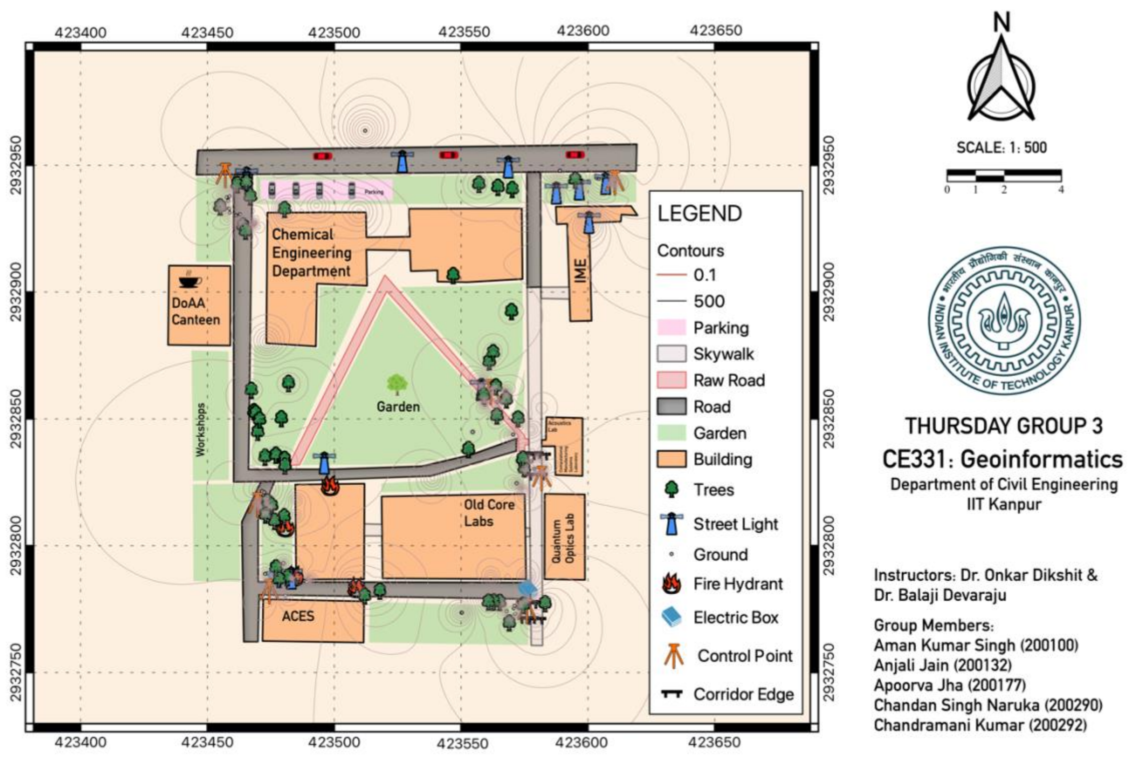
T_N=423575.89

After transformation, Global co-ordinates that were calculated are tabulated below:

Point	Northing(L)	Easting(L)	Northing(G)	Easting(G)
A	0	0	2932774.461	423575.89
B	0	101.922	2932782.271	423474.335
C	33.706	109.212	2932816.414	423469.654
D	162.282	131.826	2932946.26	423456.9739
E	171.213	-21.598	2932943.403	423610.5298
F	85.245	20.823	2932860.995	423561.6741
G	52.704	-1.759	2932826.84	423581.6812

RESULTS

Various measurements were collaborated to form a map.



CONCLUSION

- Acquired proficiency in all surveying and mapping fundamentals.
- Acquired the knowledge of establishing control points. We developed a control network with minimal control points that encompassed the entire region.
- Acquired knowledge on how to use GNSS, Total Station, and Auto Level.
- The map was made with the help of the QGIS software.