CE673: Instrumentation Laboratory & Field Practices in Geoinformatics

Report

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CE673: Instrumentation Laboratory & Field Practices in Geoinformatics

SURVEY CAMP REPORT

- **Introduction**

Spatial data, or spatial information, has become indispensable in our daily lives, facilitating data-driven and informed decision-making in the field of geoinformatics. Surveying and mapping form the foundation for generating, managing, and manipulating spatial data, which is subsequently utilized by policymakers and planners for various purposes. As part of our master's coursework, the CE673 course, titled "Instrumentation Laboratory & Field Practices in Geoinformatics" at IIT Kanpur, played a pivotal role in providing us with hands-on experience in understanding how data is generated, analysed, and utilized to create maps based on local surveys.

The CE673 course comprised a 9-day survey camp held in Aaroghadham, Chitrakoot, Madhya Pradesh – 485334, from November 27 to December 6, 2023. Situated approximately 5 hours away from the IIT Kanpur campus, this camp aimed to bridge the gap between academic knowledge and practical hands-on experience by immersing us in on-field activities.

Under the guidance and mentorship of Dr. Onkar Dikshit, along with lab staff including Dheetla sir, Hari Babu, and Vipul sir, as well as the assistance of three teaching assistants, Mr. Aranab Laha, Mr. Ratnesh, and Mrs. Rashmi, the survey camp provided valuable learning opportunities. Throughout the camp, we engaged in various activities to GNSS survey, feature mapping, City survey using Juno which help us to gain practical insights into surveying techniques and instrumentation, enhancing our understanding of surveying and geoinformatics principles.

In the survey camp a topographic map was been made for the area of Ras Shala till the hospital and from cottages to the DRI canteen. For establishing the seven control points we use the GNSS R10 receiver, for transferring the levels from the petrol pump we carried out the auto level survey and for feature mapping we used the Total station. We also carried out a city survey using the Juno hand held GNSS receiver. As well as a cross section and the longitudinal road profile survey was carried out. The aim of this report is to give an in-depth explanation and the methodology followed in the survey camp.

- **Objective**

Primary objective of the CE 673 A course and survey camp is to provide practical understanding and on- hand experience on various survey in instruments. Surveying serves a fundamental purpose in the field of geoinformatics. Various objectives of this exercise survey camp are stated below.

  - To understands the basics principals of surveying and mapping.
  - Exploring and understanding the importance of reconnaissance activity to establish optimal control points such that the control points should be minimal and the area cover should be maximum.
  - Establishing control points in an area using GNSS for getting the horizontal datum information.
  - Gain practical application of various surveying equipment's like Total station, Auto level, R10 receiver, tape, etc an there limitations as well.
  - Understanding levelling process to transfer the RL to various control points.

- Learn to make a topographic map of an area and the basic of setting scale of map.
- Conduct the city survey using the Juno handled device and collect the spatial data.
- Carrying out the road profile activity and understand the longitudinal and cross-sectional profile of each station.

3. Overview of methodology, schedule of activities, specification and features of equipment used.

Overview of methodology.

The end goal of this surveying camp was to make a topographic map, a city map and longitudinal and cross section profile of road. The over-view of all these activities in the form of flow chat is given below.

- Topographic map overview.

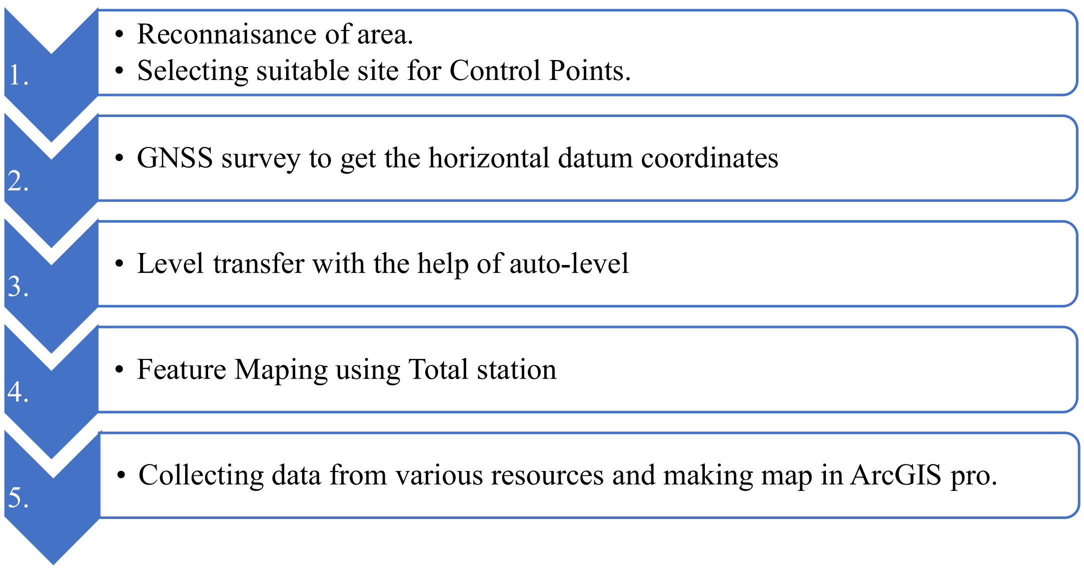

Figure 1: Flow chart of methodology of Topographic map

- Juno Map Overview

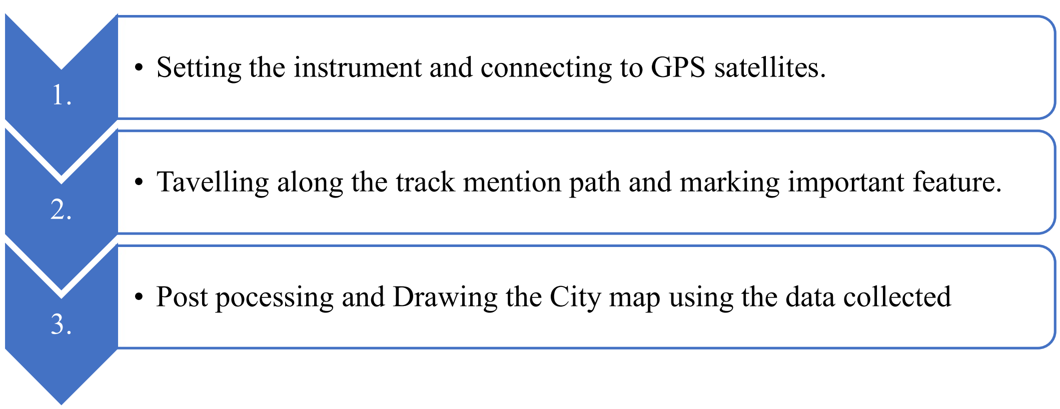

Figure 2: Methodology of Juno Map

- Road survey overview.

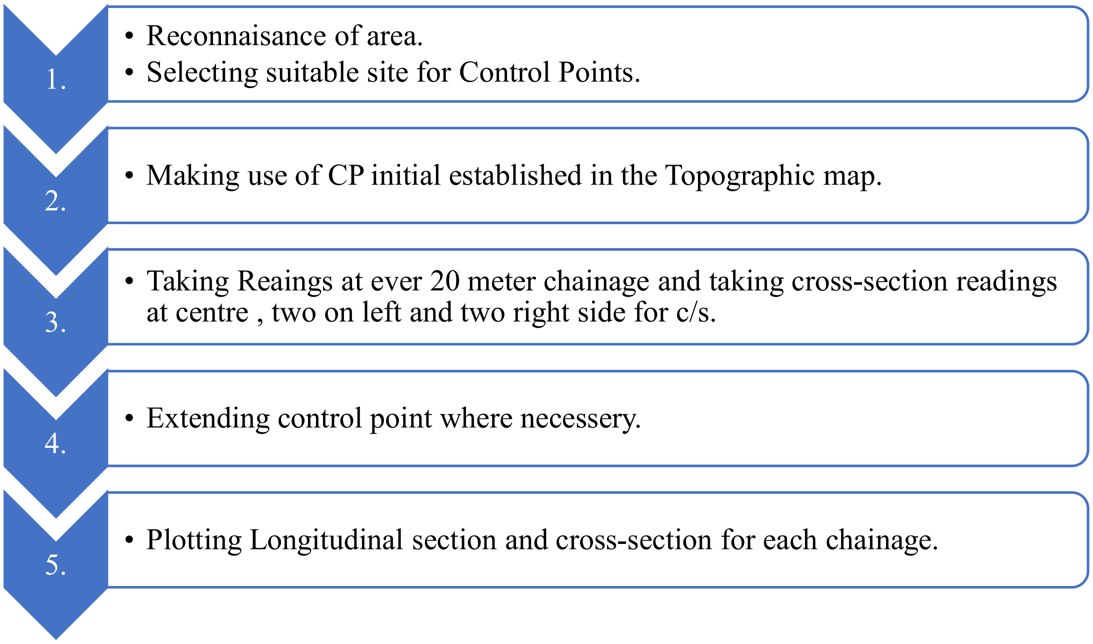

Figure 3: Methodology of Road Survey

Schedule of activities.

Various tasks were performed on different days of survey camp according to the instrument's availability the schedule of activities of our group is given below.

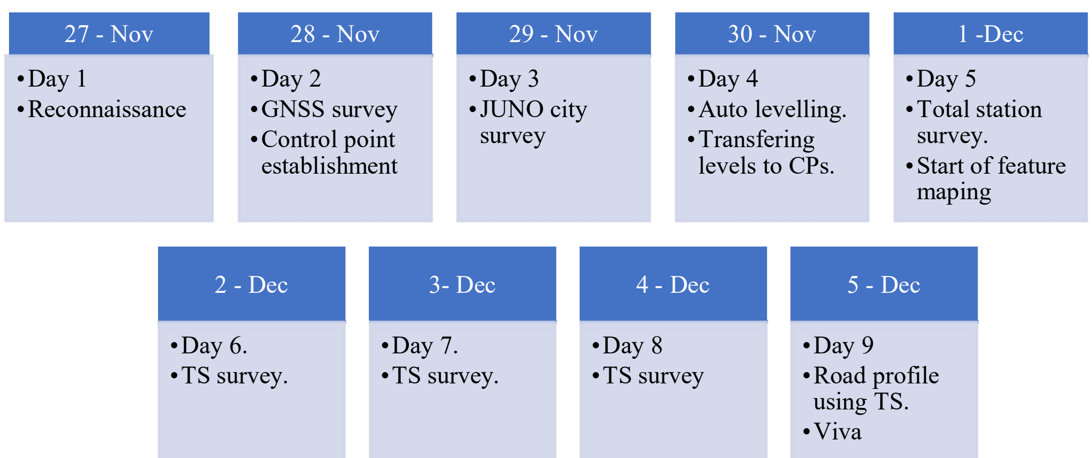

Figure 4: Schedule of activities

Features and specification of Instruments and equipment's

In this survey camp we were exposed to various equipment's the list of all the instruments is given in the table below.

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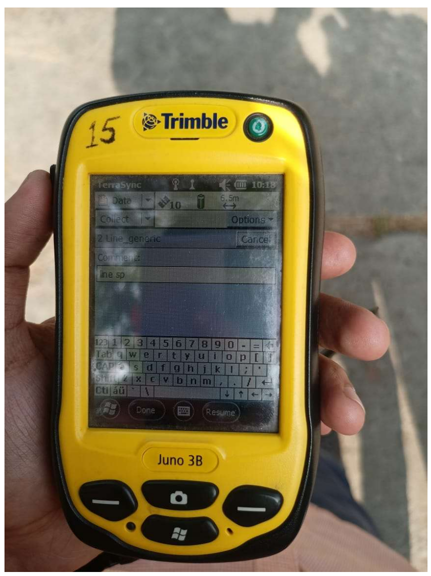
Sr No	Instrument	Specifications (if any)
1.	GNSS R10 receiver 	• Dual frequency receiver • Multi-constellation support. GNSS systems: 1. GPS: L1C/A, L1C, L2C, L2E, L5 2. GLONASS: L1C/A, L1P, L2C/A, L2P, L3 3. SBAS: L1C/A, L5 4. Galileo: E1, E5a, E5B 5. Bidou: B1, B2 • 440- channels support. • Precision: 3 to 5 mm depending upon the conditions.
2.	Auto-level 	Nikon AC-2S Level • Magnification Typically 20x to 32x • Levelling Accuracy ±0.5 to ±2.0 mm per kilometre double-run levelling • Working Range Usually up to 100 meters (330 feet) • Sensitivity Typically 0.2" to 1" (arcseconds) • Compensator Setting Accuracy Typically ±0.3" to ±0.5" • Deviation from Line of Sight Typically within ±0.2" • Environmental Conditions Typically works within -20°C to 50°C (-4°F to 122°F)
3.	Total station 	• Angular accuracy: 1” • Distance Measurement Prism: up to 5000m and non-prism: up to 600m • Telescope Magnification: 30x • Battery life: up to 6 hrs. • Operational temperature: -20°C to 50°C (-4°F to 122°F) • Weight: 5Kg • Communication Interface: Bluetooth, USB, Serial. • Memory Capacity: 1GB

4	Tripod 	Use to mount the Auto-level and Total station providing a firm base for them. • Can be of Wood, aluminium or stainless steel.
5.	Prism 	Single Reflector prism was used in survey camp. Survey prisms, also known as targets, reflect signals from Total Stations, aiding precise distance and angle calculations in surveying, minimizing signal scatter.
6.	Bipod 	Bipod has 2-legged frame used as platform to support the weight. If was used with the GNSS mounted road to provide support and helps to level it.

8.	Staff 	Staff was use in levelling activity. Least count: 10mm Length of staff: 5m Material: Aluminium Collapsable.
9	JUNO 	Juno-3B was used in the city survey activity. Constellations: Only GPS. Horizontal Accuracy: up to 10 meters. Vertical accuracy: 5-10 meters

5. Reconnaissance:

Reconnaissance Survey Report

Reconnaissance is the most under-rated activity but still most important activity that has to be before planning or carryout any kind of survey in the field. It involves thorough exploration to optimally establish local control points, maximizing coverage within time constraints. These points serve as reference markers, guiding accurate mapping and streamlining surveying processes, forming the foundation for efficient data collection and project success.

Points to be consider while making out control points.

I. Covering maximum area with minimum number of points.
II. As we will use GNSS for finding the coordinates so no canopy should be there to reduce the DOP value.

III. Control Points should be inter-visible.

IV. Choosing point which is accessible as well as do not disturb the flow of people/ traffic as well.

a. Description of Equipment Used: During the reconnaissance survey, minimal equipment was utilized due to the enclosed and limited nature of the area. The following tools were employed:

- **Paint:** Used for marking control points.
- **Peg and Hammer:** Utilized for marking ground control points.
- **Field Book and Pen:** Used to record the number and locations of points.
- **Online Tools (Google Earth and Maps):** Assisted in accessing inaccessible areas and marking features.

b. Methodology:

1. **Performing Recce:** Taking a look around the surroundings near the Canteen, Gaushala, Health Centre, and Cottages at Aarogyadham. Identify potential station locations while noting features for documentation. Identify all the features which we have to cover to create a feature map of that area.
2. **Preliminary Mapping:** Drafted a preliminary rough map to identify potential control points, focusing on maximum coverage and accuracy. These control points are strategically selected through on-site exploration to facilitate topographic surveying.

   After a preliminary observation, collect data from diverse sources such as maps, plans, and aerial photos what commonly referred to as 'paper survey.' Use online tools like Google Earth to assess potential sites for GNSS receiver placement and control point establishment. Create a preliminary sketch, marking proposed control point locations based on gathered information.

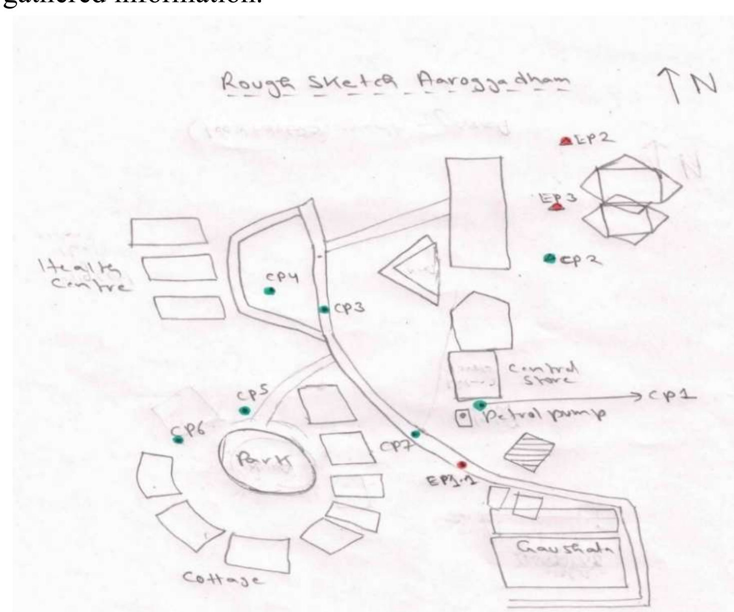


Figure 5: Rough sketch of reconnaissance survey

Figure 6: Control point establishment after reconnaissance.

3. **Final CP Determination:** From all the combination of control points selecting the optimal number of control points. Finalized control points with guidance from lab staff, marking them using appropriate methods. If any of the CPs are on terrain use peg to establish the control and if the CPs points are on firm surface like road, paved block etc use paint to mark the control point.

c. Justification for Control Points: According to our understanding and after performing the dead reconning we finalize points 1 to 7 such that they were able to cover the whole cottage office area and canteen area as well. While selecting the points a care full consideration was given that we do not block any road for disturb any flow of traffic or peoples. According to our group understanding what ever point we have selected we optimal and where ever needed the extra points we extended like for the case of Ras Shala and back-site of canteen extra points were extended from the Control point to cover the other features as well, as consulted with the lab staff. The final connection of CP can be seen in the figure below.

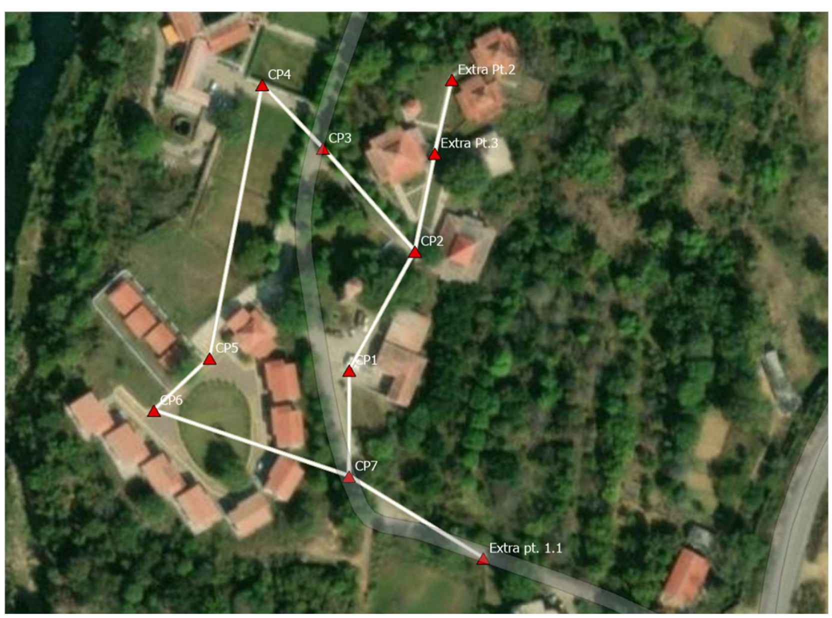


Figure 7: Closing loop of control point.

As well as by selecting only seven CP we felt that that were the optimal number of control points that we to be setup and can cover whole are as per our understanding.

As we can see form figure CP1points covers the whole office zone , CP2 point covers the whole canteen zone, CP3 point covers whole main road of Aroghyadham, CP4 point covers the hospital are which was the boundary for our map, CP5 and & CP6 covers the whole cottage area. As initially instructed by the staff these points were selected such that they were inter visible to carry out the traversing work. So, all our CPs were interring visible as well.

6. Juno Map: A Geographic Information System (GIS) based informative map needs to be prepared for the proposed area.

a) **Instrument Used:**
   JUNO-3B
b) **Methodology:**

1. **Equipment Setup:**

- Utilize two JUNO 3B receivers, designated for specific data collection tasks:
  - One receiver for capturing line-generic features (the path being followed).
  - Another receiver for gathering point-generic features along the route.
  - Ensure at-least four satellites are connected every time.

2. **Data Collection Process:**

- Begin by following the designated path.
- Activate the JUNO 3B receiver responsible for capturing line-generic features.
- Ensure adequate reception of satellite signals before initiating data logging.
- Record the path data continuously as a line feature.

3. **Point Feature Collection:**

- Simultaneously, record point-generic features along the path:
  - Identify and mark prominent locations such as ATMs, police stations, post offices, restaurants, schools, etc.
  - Log these point features as data points along the route.

4. **Pausing and Resuming Data Collection:**

  - When needing to capture point features or halt momentarily:
  - Pause the line-generic mode.
  - Utilize the same instrument to collect point-generic features.
  - Resume the line-generic mode from the same location upon completion.

Post-Processing:

1. **Data Processing:**

  - Perform post-processing on collected data to refine and enhance precision.

2. **Exporting Data:**

  - Export collected data in shapefile format (.kmz or .kml).

3. **Visualization on Google Earth:**

- Open the exported .kmz or .kml file using
- Google Earth.Overlay the collected data onto the Google Earth platform for visualization.

4. **Accuracy Assessment:**
   - Evaluate the accuracy of the collected data.
   - Make comments or observations regarding data precision and reliability.

5. **GIS Software Integration:**
   - Integrate the shapefiles into GIS software applications such as QGIS or ArcGIS.
   - Utilize GIS tools to create of ArcGIS to create a city map for effective visualization.

c) Results:

Below figure show the KML output of the raw data projected on google earth.

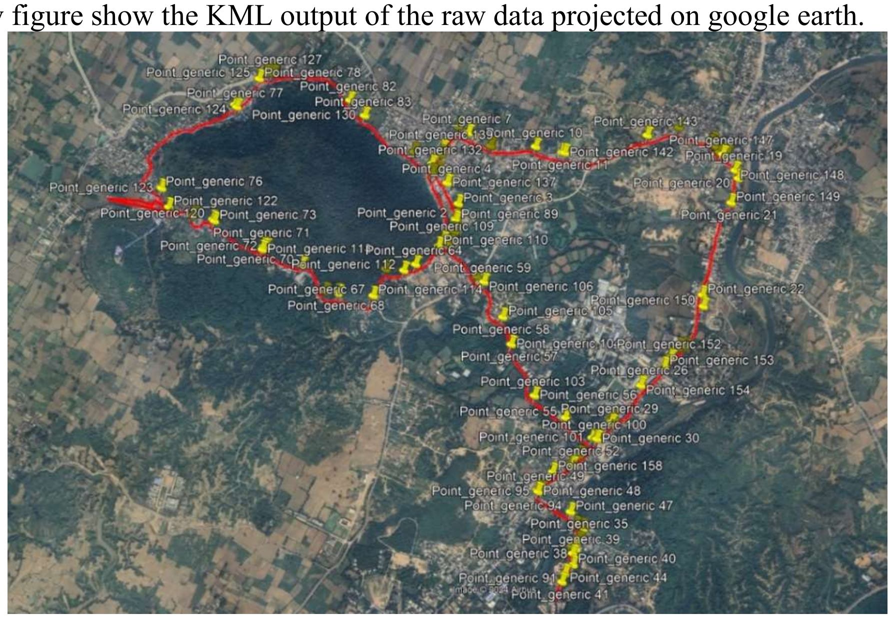


Figure 8: Juno Raw data projected on google Earth.

The lab staff has provided with the merged file form both the Juno devices. First, we clear out the duplicate point and then a layout of city map was created in ArcGIS pro software.

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City Map: CHITRAKOOT , MADHYA PRADESH (SHEET NO. S7)

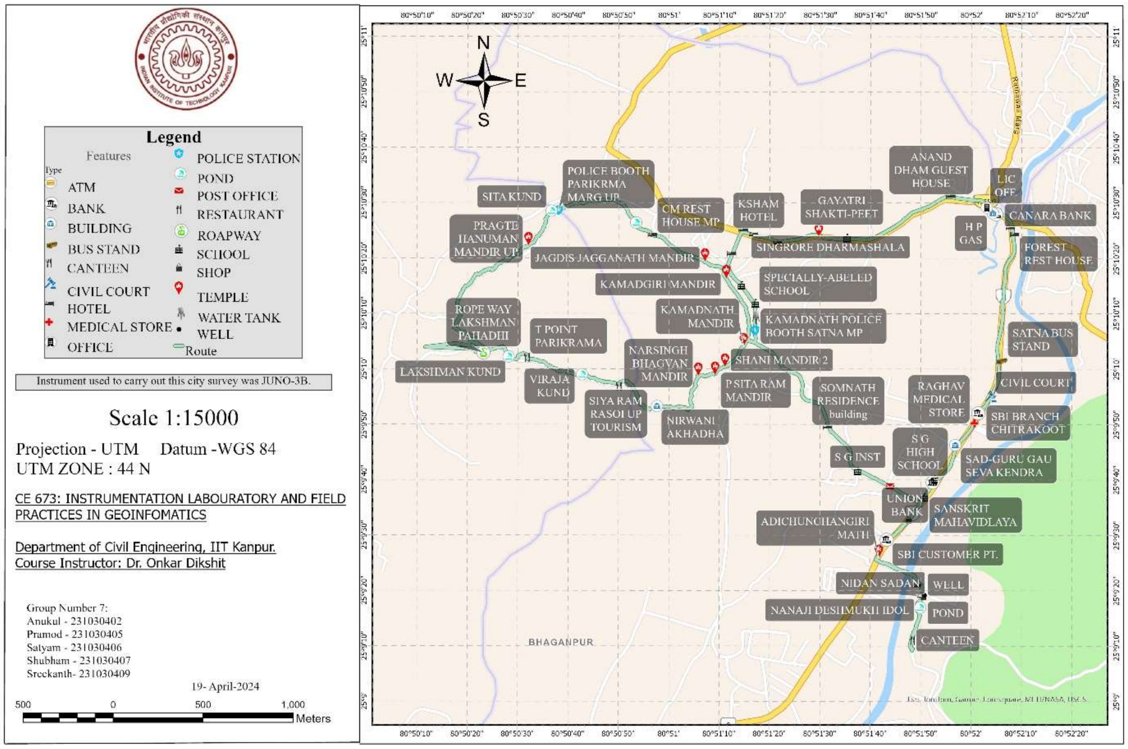


Figure 9: Layout of City Map

7. Topographic mapping:

As a part of survey work, we have assigned the task to make a topographic map the overall methodology is as mentioned above in this section we will delve into the details of each section that was perform to create a successful topographic map. So, the logical sequence for the topographic map is GNSS survey > Auto-level > TS survey > Feature map preparation. Below each section explains the sequence in detail and the results we obtain how each activity is dependent of other is discussed in detail in the independent section below.

a. Auto level:

The auto level is a precise instrument utilized in surveying and construction to accurately measure height and elevation. Comprising a telescope mounted on a tripod, it features a built-in compensator ensuring automatic levelling, maintaining a horizontal line of sight despite minor tilts. Crucial for tasks like establishing reference points and determining land slope, it aids in precise construction measurements. In topographic mapping, auto levelling is vital. For Total Station (TS) feature marking, control point coordinates including Northing and Easting are determined via GNSS, providing ellipsoidal height. To obtain accurate orthometric height for feature marking, auto levelling is necessary. To create

Instrument and Software used:

- Auto- Level

  The Nikon AC-2S Level is an automatic level used for levelling surveys. It comes with various accessories including a carrying case, lens cap, plumb bob, adjustment tool, and vinyl dust cover. Its compact and lightweight design makes it easy to handle in the field.

The instrument features a magnetic dampened automatic compensator that ensures the line of sight remains level, along with high-quality Nikon optics for clear and detailed images. The horizontal tangent knobs have an unlimited range, allowing for precise pointing and angular measurement.

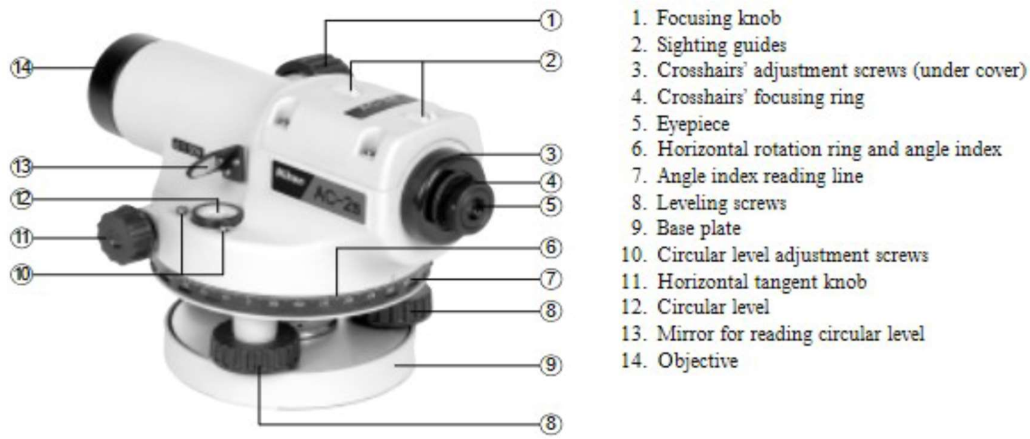


Figure 10: Auto Level.

- Levelling Staff.

The levelling staff used with auto levels typically features adjustable sections for convenient storage and transport. Made of aluminium or wood, it may have imperial or metric graduations. Some staffs are telescopic, while others fold or slide for versatility. They provide precise height measurements for accurate levelling surveys. The staff given to us in this exercise was fitted it bubble also to centre it and it was made of aluminium. It was a 5-meter levelling staff with 1 cm or 10 mm as the least count. A sample picture is given below.

Figure 11: Staff used in the levelling operation

- ArcGIS Software.

Methodology

As GNSS does not give us the Reduce level or the orthometric height directly we have to array out the procedure of transfer the Reduce level using Auto level by the process of levelling. For the survey camp the RL was set to 100m near the petrol pump we have to carry out the loop to transfer the level from the permanent benchmark to the different control point. The step-by-step methodology followed is given below right from taking readings till the adjustment of error and comparing error with error tolerance for levelling is discussed below.

Step 1: Do reconnaissance survey and find a feasible way to start from BM and end the survey to the bench mark to close the traverse. In case of survey camp, we use the Control point establish by the GNSS survey.

Step 2: It was instructed to take the Benchmark near the petrol station as 100 meters and carry out the level transfer.

Step 3: Take Backsight and Foresight readings at every point by setting the instrument at the at approximately half of the distance between the back sight and fore sight readings. Make sure the you level the instrument and hold the staff properly with bubble in the centre while taking the readings. Take the upper colimitation and lower colimitation readings as well. These readings will we use to calculate the distance or the perimeter of traverse to later distribute the error if any.

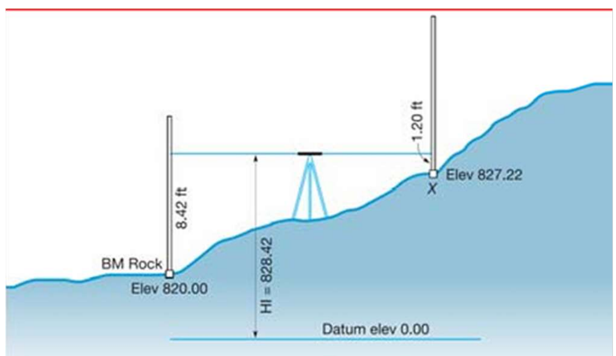


Figure 12: Line diagram of levelling

Step 4: Continue this process start from BM and again end on BM by covering all the Control points in a sequence. Try to have as less change points as possible, also try that the distance between the station and the staff should not exceed greater than 50m at any point of time. Store the data in the field book, to record the observations.

Step 5: Height of Instrument / Height of collimation method was used to calculate the RL of every control point as well as apply respective checks.

Step 6: Perform arithmetic checks. It is mandatory to that this check should satisfy.

Step8: Now, we have calculated the total error present in our reading by applying arithmetic checks and followed the approach2 (Correction applied as a function of number of change/turning points) for closing of loop.

$$\text{Correction} = -\frac{e}{n}$$

Were,

e is total error

n = (No. of change points + Closing point) = (n_1 + 1)

Step 7: Now, we applied the correction to the elevation of each change point and the closing point whose elevation is known to get the adjusted reduced level.

Step 8: Applied the arithmetic checks:

Arithmetic check for Line of Collimation method:

- Difference of sum of all the backsight (BS) readings and sum of all the foresight (FS) readings should be equal to zero.

$$\Sigma BS - \Sigma FS = 0$$

- Difference of last reduced level (RL) and first reduced level should be equal to zero.

Last RL – First RL = 0

Step 9: Determined the quality of survey work.

First, we have to calculate the C value and based on the section II of appendix 1, quality of the survey work can be determined.

$$C = \frac{E}{\sqrt{K}}$$

Were,

E = Error in mm

K = in km

Work	Purpose	C
Highest quality	Geodetic leveling and surveys for special purpose	1
Precise leveling	Geodetic leveling and benchmarks of widely distributed points	4 (5)
Accurate	Principal benchmarks and extensive surveys	12 (10)
Ordinary	Location and construction survey	24 (25)
Rough	Reconnaissance and preliminary surveys	100 (100)

Figure 13: Accuracy Standards

Based on the C value given in above table, quality of survey work can be determined.

Following all this step we get the RL or the orthometric height for the control stations, which we can use to in total station for caring out the feature mapping to create a topographic map of the area.

Observation table generated by this able is given below.

Sr No.	Location	B.S(m)	I.S	F.S(m)	H.I(m)	R.L(m)	L.S(m)	U.S(m)	Length(m)	Remarks
1	Bench Mark	0.998			100.998	100.000	0.888	1.106	21.80	
2	CP 1			1.463		99.535	1.405	1.519	11.40	RHS road edge
3	CI 1	0.422			99.957		0.315	0.530	21.50	
4	CI 1			2.799		97.158	2.710	2.885	17.50	
5	CI 2	0.753			97.911		0.569	0.947	37.80	
6	CP 2			2.760		95.151	2.490	3.030	54.00	Behind fountain
7	CI 3	1.931			97.082		1.849	2.020	17.10	
8	CP 3			1.220		95.862	1.151	1.291	14.00	Corner of resort entance
9	CI 4	1.269			97.131		1.182	1.355	17.30	
10	CP 4			3.530		93.601	3.360	3.700	34.00	Hospital road
11	CI 5	0.450			94.051		0.322	0.580	25.80	
12	CP 5			2.522		91.529	2.370	2.680	31.00	Start of valley
13	CI 6	2.080			93.609		1.965	2.199	23.40	
14	CI 6			0.219		93.390	0.151	0.285	13.40	
15	CI 7	2.451			95.841		2.339	2.509	17.00	
16	CI 7			0.667		95.174	0.628	0.705	7.70	
17	CI 8	2.889			98.063		2.829	2.948	11.90	
18	CI 8			0.503		97.560	0.465	0.543	7.80	
19	CI 9	2.251			99.811		2.219	2.284	6.50	
20	CP 6			0.791		99.020	0.744	0.839	9.50	Canteen Gate
21	CI 10	1.330			100.350		1.200	1.461	26.10	
22	CP 7			1.089		99.261	0.955	1.220	26.50	Frount of Pertol pump
23	CI 11	1.449			100.710		1.423	1.478	5.50	
24	BM			0.712		99.998	Total Length		458.50	Permenant Benchmark
	SUM	18.273		18.275						

Checks	Σ BS - Σ FS	-0.002	m	
	Last RL -First RL	-0.002	m	
Closing Error		-2	mm	
	Number of CP	7		
	Correction	0.000285714	m	
	E= C sqrt(K)	C = E / sqrt(K)	2.95366	Precise Levelling

Note: As the correction at forth decimal place it will not impact the RL measurments much so correction was not carried out.

Figure 14: Whole Levelling table

Sample calculation:

H.I = R.L + B.S = 100+ 0.998 = 100.998 m

R.L of CP1 = H.I – F.S = 99.957 m.

H.I at CI-1 = 99.535 + 0.422 = 99.957 m. and so on.

Length = (U.S – L.S) *100 = (1.106 – 0.888) *100 = 21.80 meters.

Closing error,

Σ Back sight – Σ Fore sight = 18.273 – 18.275 = -0.002 meter = 2 mm.

Arithmetic check,

Arithmetic check can be performed using any of the method mentioned below.

Checks for Line of Collimation method:

Σ Back sight – Σ Fore sight = Last R.L – First R.L

Checks for Rise and Fall method:

Σ Back sight – Σ Fore sight = Rise – Σ Fall = Last R.L – First R.L

For the survey camp we followed the Height of Instrument method so we use Line of Collimation check.

Quality of the survey work, (referring to section II of appendix 1),

The levelling network is classified based on the formula,

$$\mathbf{E = C}\ \sqrt{\boldsymbol{K}}$$

Where, E = Error Tolerance (mm)

C = constat chosen depending on the type of purpose of work.

K = Total length of level loop in km.

In this lab we calculate the distance as:

Distance = (Upper collimation reading – Lower collimation reading) * Cr

Where is Cr is constant of instrument. Generally taken as 100.From this we get the distance in meters. Do the summation of all the distance to get total length K. For our network the total distance came as 458.50 meters i.e. 0.45850 km. The closing error was -0.002m i.e. -2 mm by reverse solving this formula we can get the values of C.

$$C = \frac{E}{\sqrt{K}} = \frac{2}{\sqrt{0.4585}} = 2.95336 < 4.$$

So, our work falls in **'Precise levelling work'** category as per the Elevation measurement document.

Adjusted results.

As the error is 2 mm and the number of control points are 7 so if we divide this equally in all CPs, we get 0.000285 which is in fourth decimal place. That correction will not make any sense as the Total station has least count has 1 mm. So, for this exercise we didn't apply any correction but we can apply correction as function of number of control points.

By doing this now we have vertical datum information for each control points which can we use as an input information to create a total station to create a topographic map or feature map. As for drawing contours we require the orthometric height precisely which we get by doing the auto-level survey.

Gslobal Navigation Satellite System (GNSS) survey:

Introduction:

GNSS surveying, facilitated by instruments like the Trimble R10, establishes crucial control points with exceptional precision. Utilizing advanced receiver technology supporting multiple GNSS constellations, it enables accurate positioning for diverse applications. Methodologies involve meticulous static mode measurements and precise baseline processing, ensuring reliable control point establishment essential for various surveying endeavours.

Instrument used:

The Trimble R10 utilizes powerful Trimble 360 receiver technology to support signals from all current and planned GNSS constellations and augmentation systems. With 672 GNSS channels, it ensures future-proofing of investments. Enhanced interference protection suppresses various sources of interference and spoofing for optimal performance. The rugged and lightweight design integrates GNSS antenna, receiver, internal radio, and battery, suitable for RTK rover or base station setups. LEDs provide status monitoring, while Bluetooth technology enables cable-free communication with the controller. The R10's dual-frequency receiver antenna is embedded within the unit, mounted on a bipod, and operates on carrier phase frequency principles, offering accuracy between 3mm to 5mm depending on data acquisition mode. It utilizes Windows-based devices and Trimble Access software for data management and control.

Figure 15: R10 receiver with controller

Methodology

Initially the coordinates of four control points and four extra points were measured using R10 receiver in static mode. Then these eight points were use for base line processing using Trimble Business Centre (TBC) software to find the horizontal and vertical precision. So, this section has two parts first part has step by step procedure followed to take observation on R10 receiver. Then second part has step by step procedure for baseline processing using Trimble business centre software.

Methodology for R10 coordinates in static mode.

Step 1: Open Trimble access software. Create a new project.

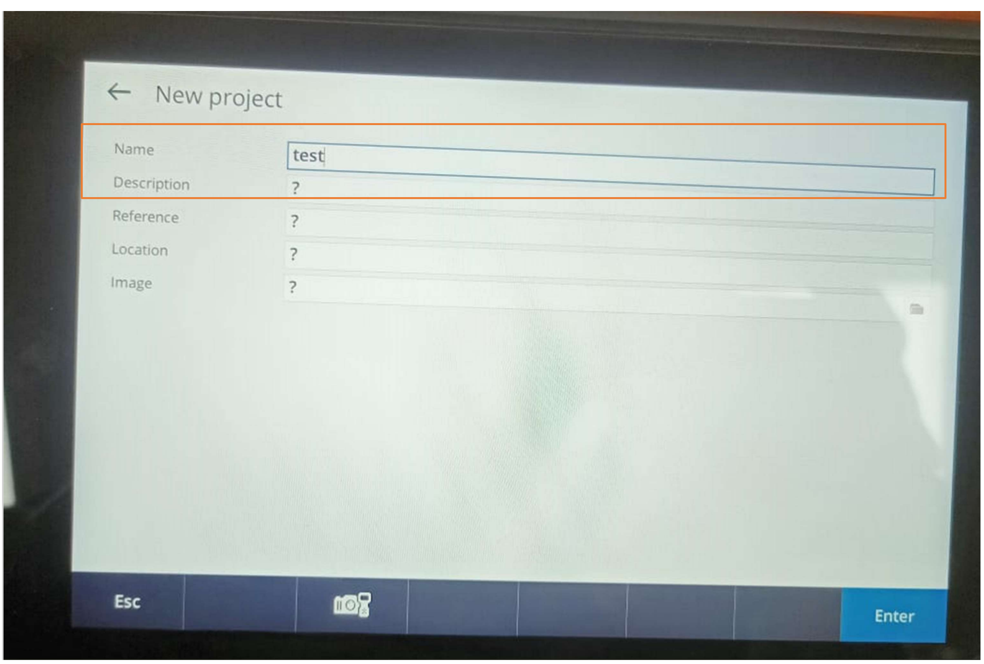


Figure 16: New project creation

Step 2: Give Job name and select coordinate system.

- World Wide UTM.
- Zone: 44 N.
- Local datum: WGS84 (7P).
- Project Height: 0.000

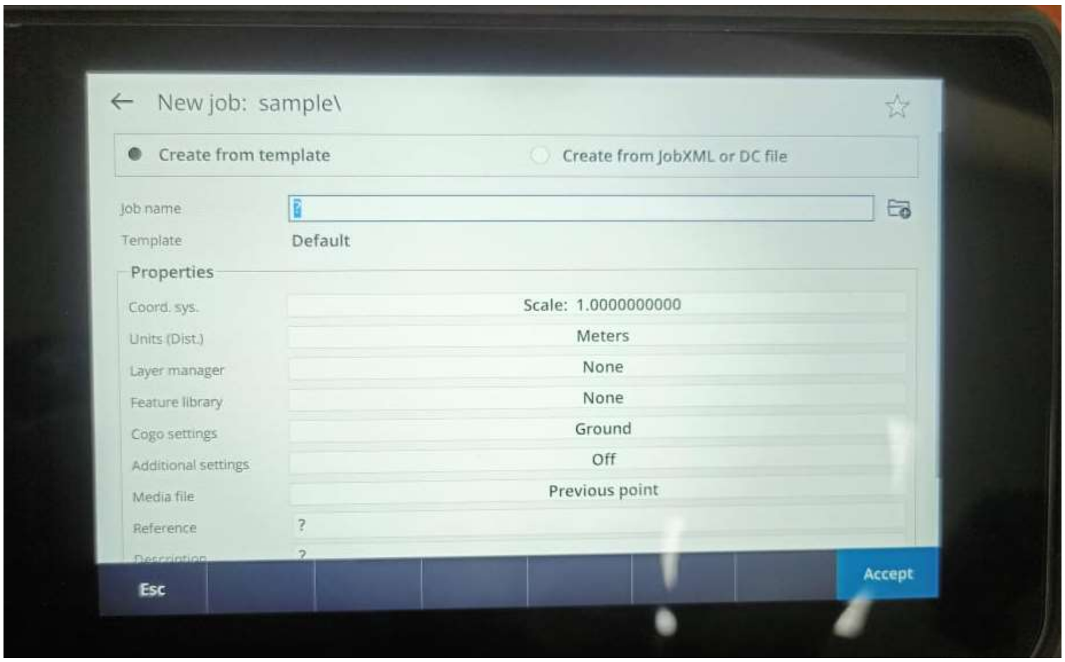


Figure 17: After opening new created project

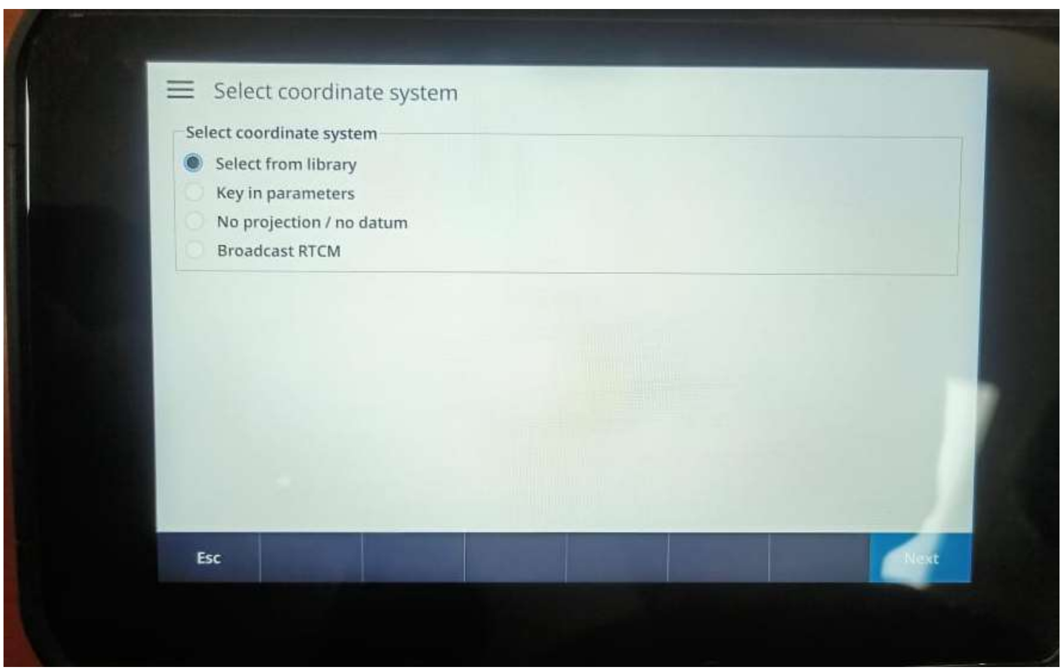


Figure 18: Selecting coordinate system from library

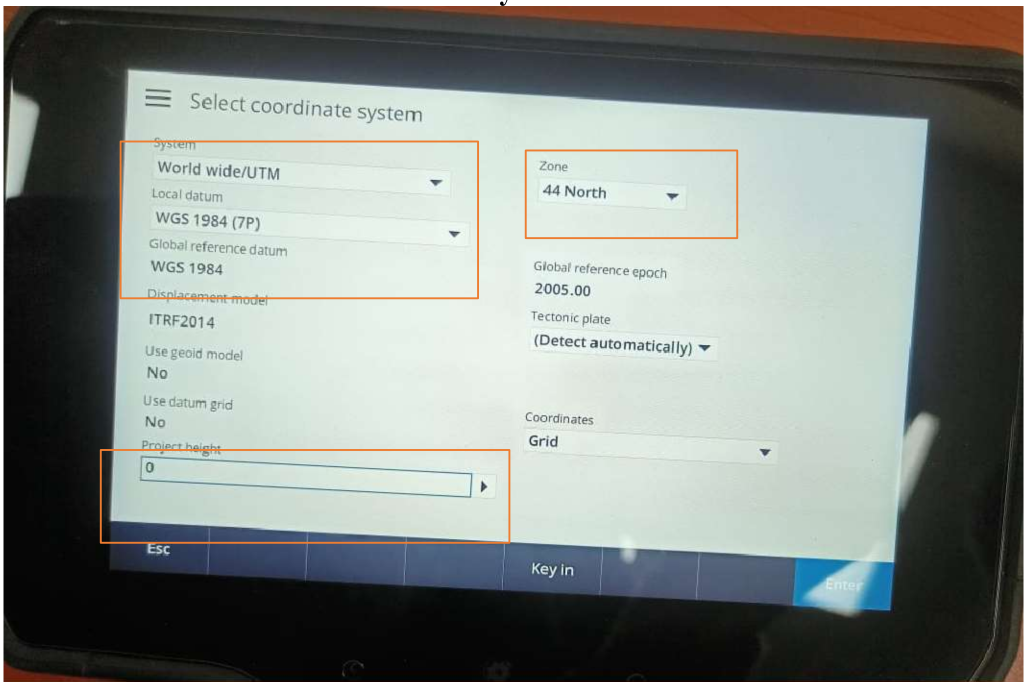


Figure 19: Specifying coordinate system.

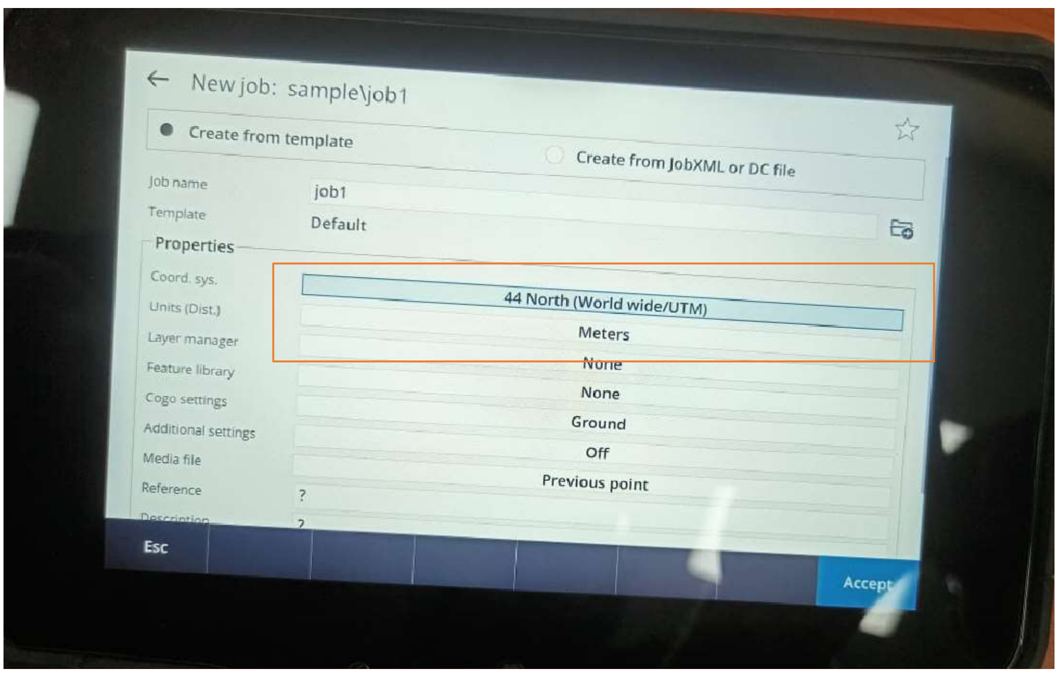


Figure 20: After selecting coordinate system.

Following this specification accept the settings. Job will be successfully created.

Step 3: Click of setting to select the survey style. We have three options here PPK, RTK and static. We have done the survey by using static mode.

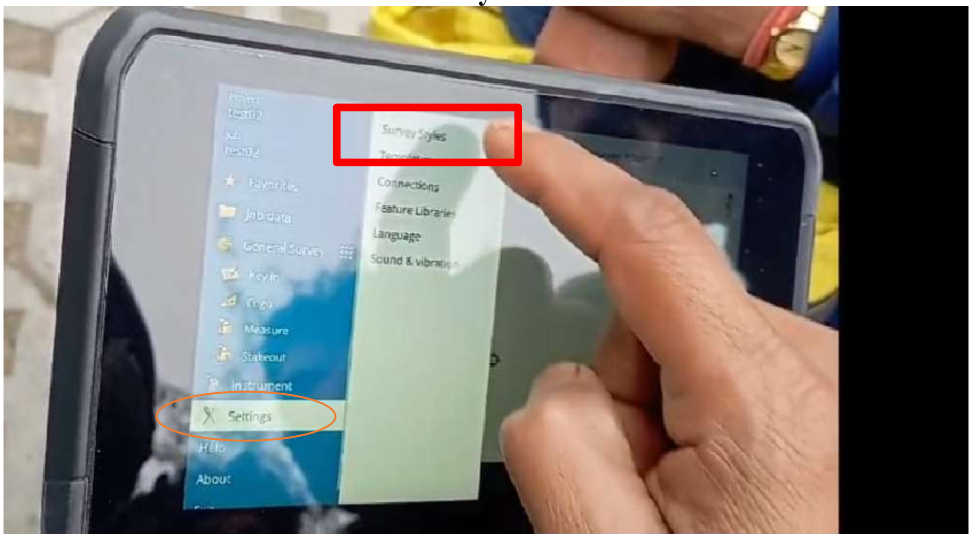


Figure 21: Selection of Survey Style

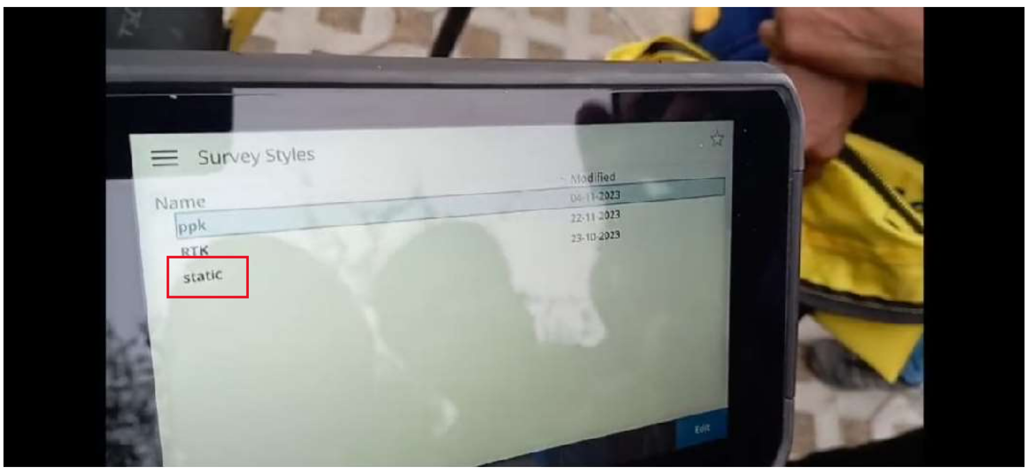


Figure 22: Selection between Static, RTK and PPK mode.

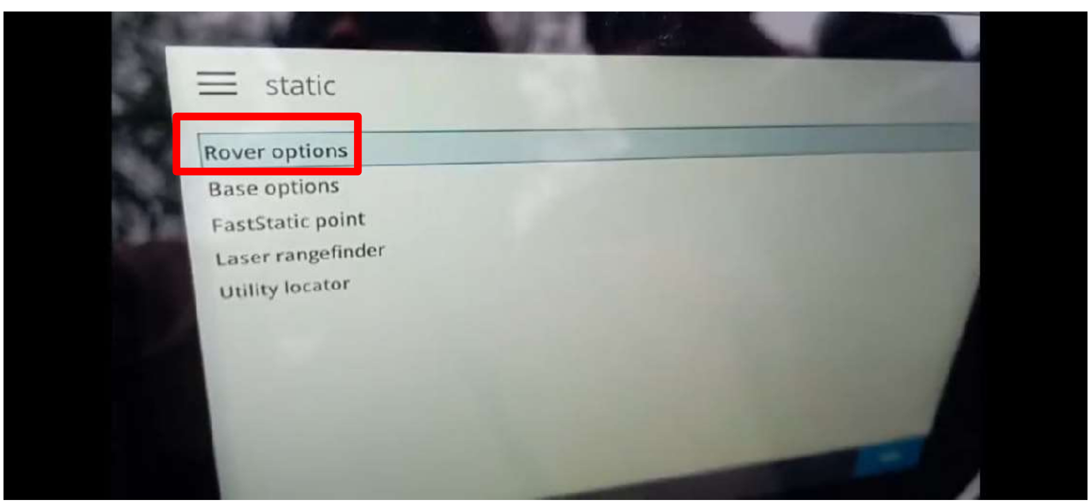


Figure 23: Selecting Rover options

Step 4: Do the Rover options settings as per your personal preference.

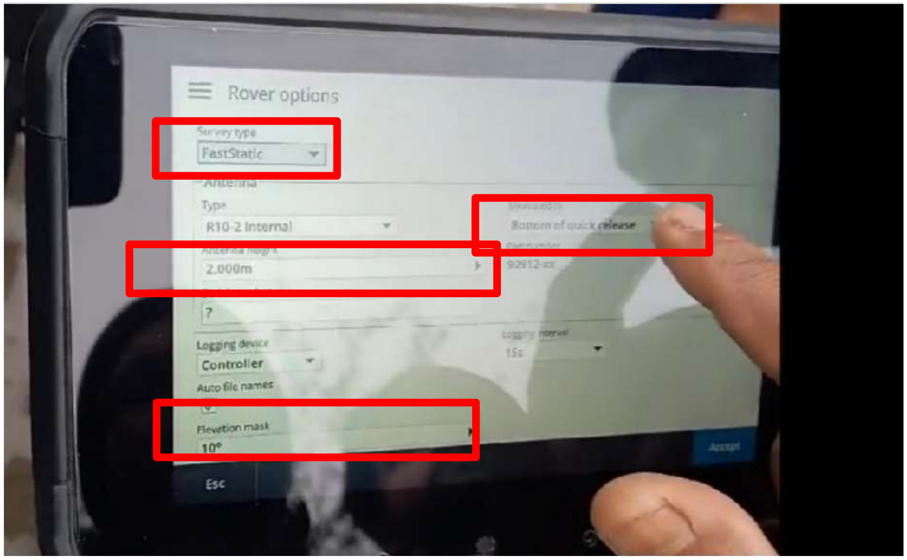


Figure 24: Rover settings.

The below are the settings followed in this lab.

- Survey type: Fast static
- Antenna height: 2.000m
- Measurement: From Bottom of quick release.
- Serial Number of Antenna.
- Elevation mast 10^0 was selected.
- Select from different GNSS constellation by selecting check box. For this lab all constellations were used.

After doing all the necessary settings accept the settings and then store the settings.

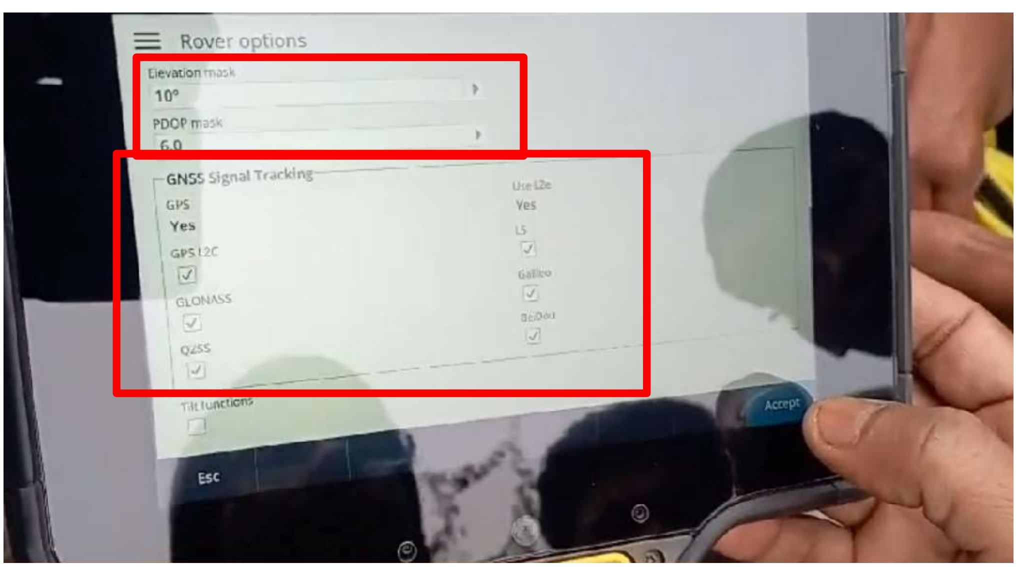


Figure 24: Rover settings

Step 5: Go to instrument. Then GNSS function.

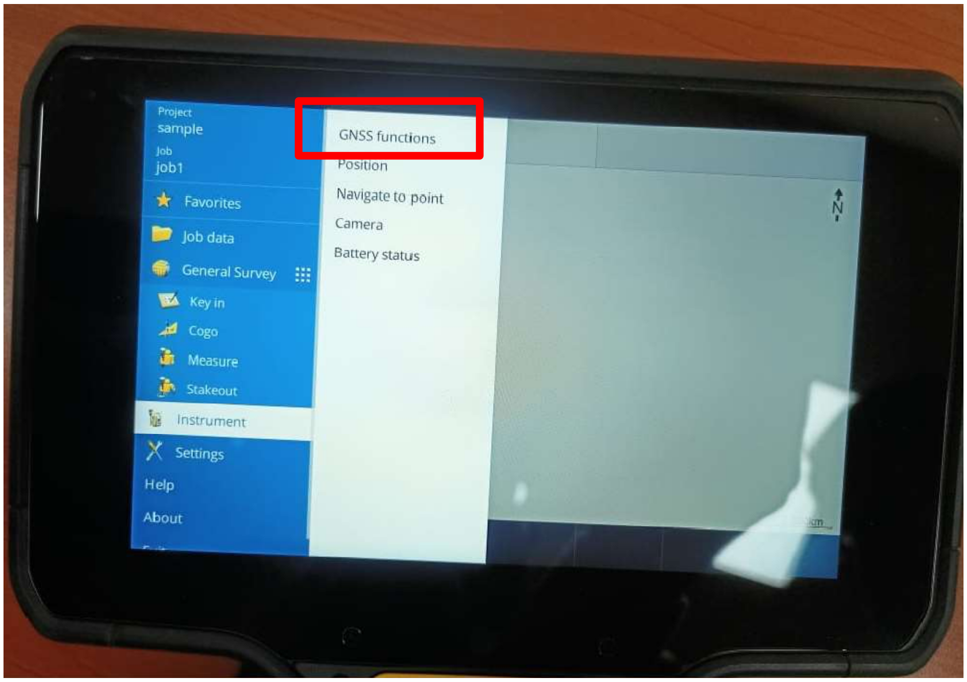


Figure 25: GNSS functions.

Step 6: Select rover mode. Then settings for rover mode was done.

- Connect to GNSS rover: R10-26016F00469 Trimble.
- Connect to GNSS base: None. As we are not doing RTK survey.

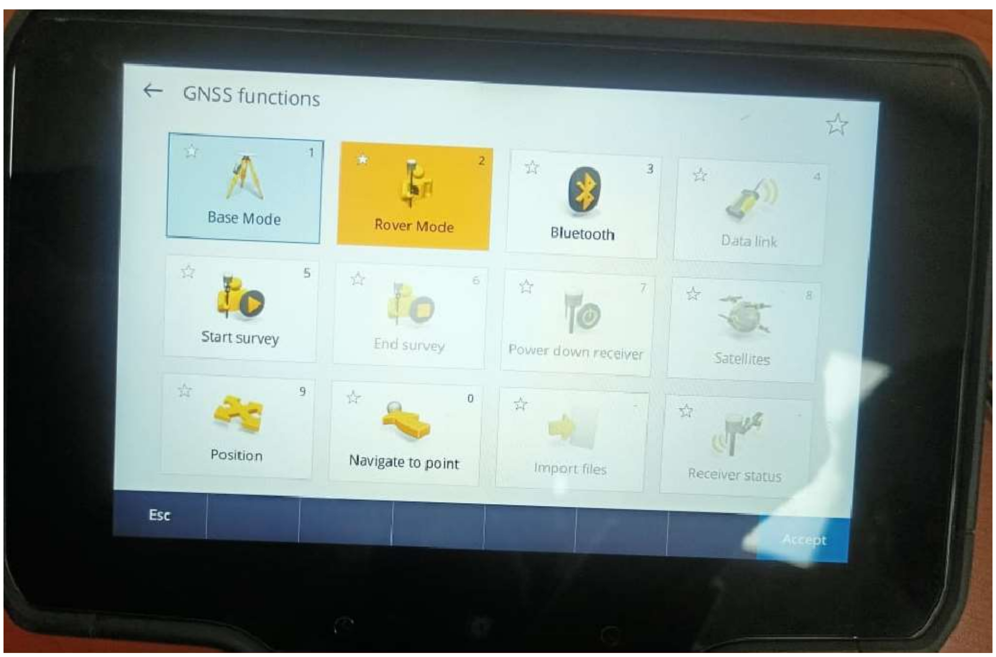


Figure 26: Selecting Rover mode.

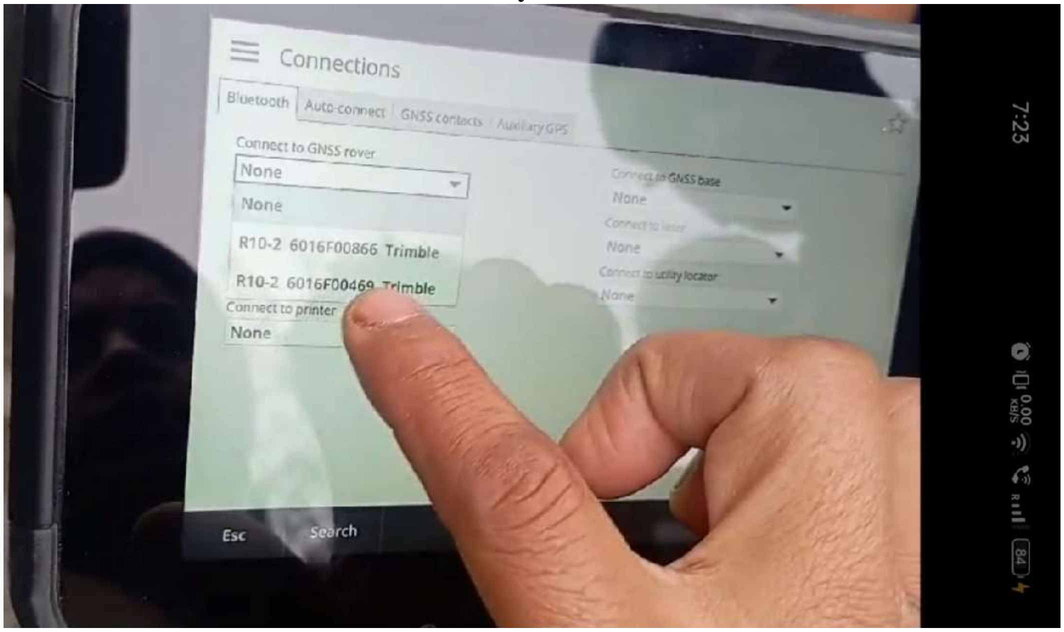


Figure 27: Rover settings.

Step 7: After accepting the rover settings go to Measure-Static-measure points.

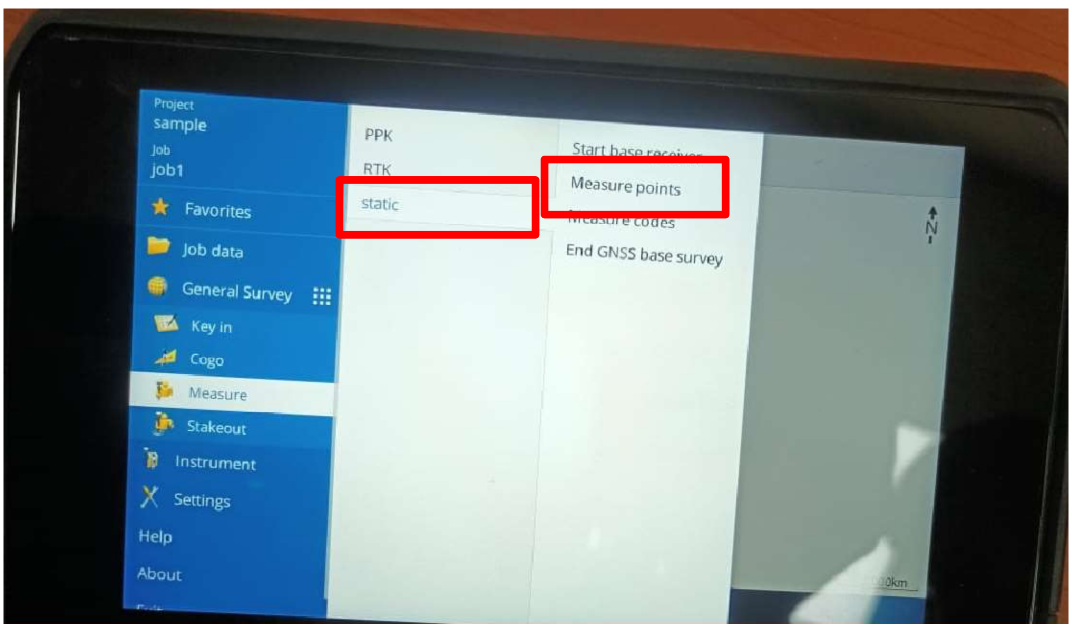


Figure 28: Measure-Static-Measure points.

Steps 8: Now in the next screen define point name, point code antenna height. Go to options to select the timings for period for which we have to take measurements. For this lab we have taken 15 minutes as time to take coordinates of base station.

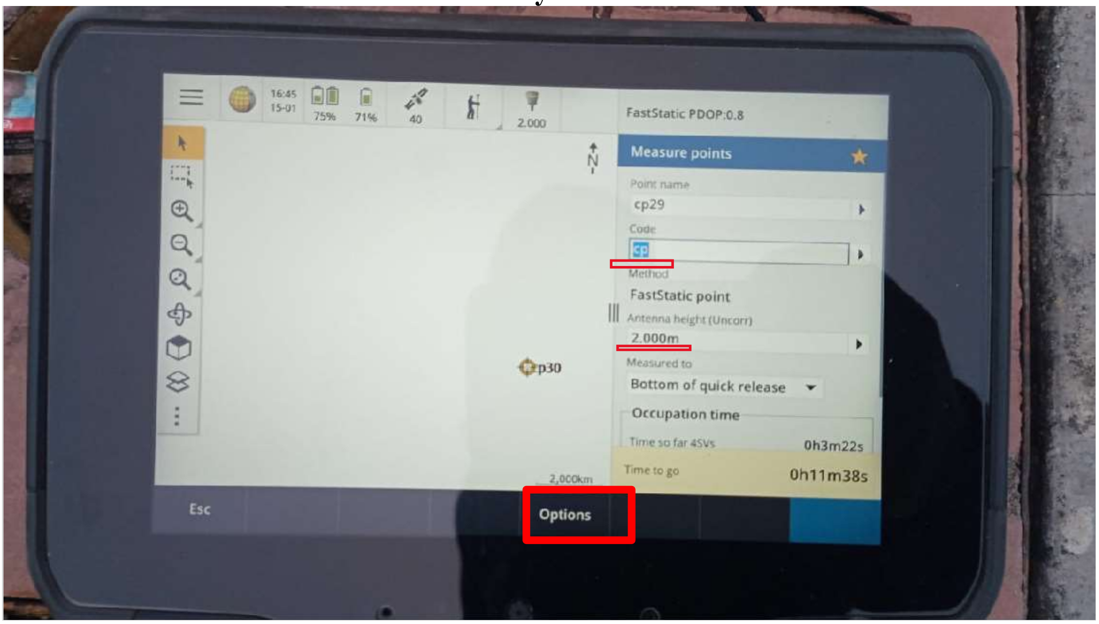


Figure 29: Point settings.

Figure 30: Settings time to 15 minutes.

After doing all this just level the instrument and press measure to take readings and weight for 15 minutes. Take reading at all the control points and close the survey. Export the data for base line processing on TBC software. In survey camp the lab staff them self-carry out the processing on the TBC software. The correction was applied using the base station set-up at near the fountain of cottage which was operating 24 X7.

Results of GNSS

The various tables below show the data after the post processing carried in TBC software. Table below shows the control point with the three easting and northing values with their ellipsoidal height.

Point List

ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	Feature Code
Base1	486196.680	2781803.096	86.476	
IITK	423495.479	2933660.080	70.242	22317M001
p1	486247.572	2781780.464	90.166	control point
p1.1	486247.586	2781780.468	90.175	control point1.1
p2	486172.050	2781805.955	85.781	control point2
p3	486193.595	2781826.191	86.500	control point3
p4	486256.771	2782034.917	79.764	control point4
p5	486305.123	2782116.889	77.321	control point5
p6	486213.978	2781932.148	82.154	control point6
p7	486235.271	2781916.333	88.494	control point7
p7.2	486237.472	2781907.557	84.043	control point7.2
p8	486273.066	2781867.617	89.661	control point8
p9	486247.664	2781821.501	89.900	control point9

Table 2: Control Points

Below Figure shows the Baseline processing summery report where we can see the Horizontal and Vertical precision for various stations and control points.

Project file data		Coordinate System	
Name:		Name:	World wide/UTM
Size:		Zone:	44 North
Modified:		Datum:	WGS 1984
Time zone:		Global reference datum:	WGS 1984
Reference number:		Global reference epoch:	
Description:		Geoid:	
Comment 1:		Vertical datum:	
Comment 2:		Calibrated site:	
Comment 3:			

Baseline Processing Report

Processing Summary

Observation	From	To	Solution	H. Prec.	V. Prec.	Geodetic	Ellipsoid	ΔHeight
IITK --- Base1 (B1)	IITK	Base1	Fixed	0.005	0.016	157°13'39"	164353.31	16.234
Base1 --- p1 (B12)	Base1	p1	Fixed	0.005	0.010	113°54'59"	55.719	3.690
Base1 --- p2 (B13)	Base1	p2	Fixed	0.002	0.004	276°33'47"	24.805	-0.694
Base1 --- p3 (B14)	Base1	p3	Fixed	0.003	0.005	352°19'56"	23.310	0.025
Base1 --- p4 (B15)	Base1	p4	Fixed	0.003	0.006	14°28'25"	239.579	-6.712
Base1 --- p5 (B16)	Base1	p5	Fixed	0.016	0.030	19°00'23"	332.135	-9.154
Base1 --- p6 (B17)	Base1	p6	Fixed	0.002	0.005	7°34'33"	130.259	-4.321
Base1 --- p7.2	Base1	p7.2	Fixed	0.009	0.018	21°16'21"	112.188	-2.432
Base1 --- p8 (B20)	Base1	p8	Fixed	0.009	0.012	49°45'18"	100.029	3.185
Base1 --- p9 (B21)	Base1	p9	Fixed	0.002	0.004	70°05'33"	54.226	3.425
Base1 --- p1.1	Base1	p1.1	Fixed	0.006	0.012	113°54'25"	55.730	3.699

Figure 31: Table after post processing

Below is the snip where we can see the A posteriori variance covariance matrix results after carrying out the base line processing. As well as the standard errors given in the report.

Variance covariance matrices corresponding to each control point.

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000035114		
Y	0.0000064218	0.0000591320	
Z	0.0000036179	0.0000234720	0.0000137712

Figure 32: Variance covariance (Base 1 (B1))

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000045969		
Y	0.0000024338	0.0000193776	
Z	0.0000016931	0.0000091466	0.0000086646

Figure 33: Variance covariance (Base 1: P1)

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000009291		
Y	0.0000003547	0.0000034741	
Z	0.0000002014	0.0000013958	0.0000013820

Figure 34: Variance covariance (Base 1: P2)

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000012918		
Y	0.0000001090	0.0000053337	
Z	0.0000001204	0.0000023189	0.0000023165

Figure 35: Variance covariance (Base 1: P3)

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000014379		
Y	0.0000001630	0.0000089816	
Z	0.0000002762	0.0000033676	0.0000027769

Figure 36: Variance covariance (Base 1: P4)

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000167734		
Y	0.0000018379	0.0002434269	
Z	0.0000025124	0.0000355640	0.0000250283

Figure 37: Variance covariance (Base 1: P5)

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000008608		
Y	0.0000003069	0.0000051111	
Z	0.0000002014	0.0000019480	0.0000017137

Figure 38: Variance covariance (Base 1: P6)

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000143531		
Y	0.0000098365	0.0000691369	
Z	0.0000058263	0.0000282205	0.0000250593

Figure 39: Variance covariance (Base 1: P7)

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000128023		
Y	0.0000068717	0.0000295421	
Z	-0.0000011297	0.0000106424	0.0000121475

Figure 40: Variance covariance (Base 1: P8)

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000005534		
Y	0.0000002673	0.0000033459	
Z	0.0000001062	0.0000013612	0.0000013742

Figure 41: Variance covariance (Base 1: P9)

Aposteriori Covariance Matrix (Meter²)

	X	Y	Z
X	0.0000045169		
Y	0.0000038618	0.0000309231	
Z	0.0000016331	0.0000150852	0.0000146698

Figure 42: Variance covariance (Base 1: P1.1)

So, after doing the GNSS survey now we have the Easting and Northing values of with their respective precision which will serve as a horizontal datum for Total Station readings.

c. Topographical map: A detailed topographical map (with different layers, such as buildings, roads, contours, etc.) of the proposed area in Aarogyadham referring to the guidelines and proper sign conventions.

- Use tables and neat figures to explain the methodology as per requirement, use proper headings for figures and tables, how multi-date data was aggregated into suitable files and imported into ArcGIS/QGIS SW in different layers (buildings, roads, contours, etc.) and converted into final map, choice of coordinate systems, scale and contour interval, precautions and bottlenecks (if any). **Instrument used**
    - Total Station (Trimble S5 Total Station)
    - Prism (Retroreflector)
    - Trimble Traversing Target, Tiltable
    - Trimble Tripod
    - Trimble Bipod
    - Peg
    - Measuring Tape

Figure 43: Total Station

A total station is a cutting-edge surveying tool that accurately measures angles and distances, displaying real-time data on its built-in computer. It swiftly calculates horizontal and vertical distances, and with inputted station coordinates, determines observed point coordinates. Vital for various fields, it aids in comprehensive data collection and analysis.

Methodology

This lab is divided into two parts in first part we have to create a large-scale feature map using Total Station and in second part we have to create a local geoid model of the area. The step-by-step methodology for both the sections is mentioned below.

Methodology for feature mapping using Total Station

Step 1: First do levelling and centring of instrument. This is an iterative process we have to first level the instrument and then centre it repeat this till your bubble is also levelled and optical plumet is exactly over the control point. This is done so that TS represent the exact control point and levelling is done to get the direction of gravity/ vertical axis perpendicular to line of culmination. For this lab we have set the instrument at control point 12.1. On the instrument and now set the electronic level.

Step 2: On the instrument and create a new job, set the coordinate system 44 North World Wide UTM. Also put all the necessary input data necessary.

Step 3: Key In the coordinates (northing and easting) and orthometric height of all the control points from the GNSS results and the Auto level results. Measure the height of instrument and input it as well.

Step 4: Go to Measure> VX & S settings > Station Set-up. Select the Control point on which we have placed the TS. Then select another control station which you want to sight. Set the prism height in meters (1.5 m) second CP which is to be sighed. Now take the readings this will show the misclosure between the coordinates you have entered and the measurement TS is calculating. If misclosure is inacceptable range accept the data or redo the setup. Station steps up is completed here. This step helps to orient the TS to UTM zone.

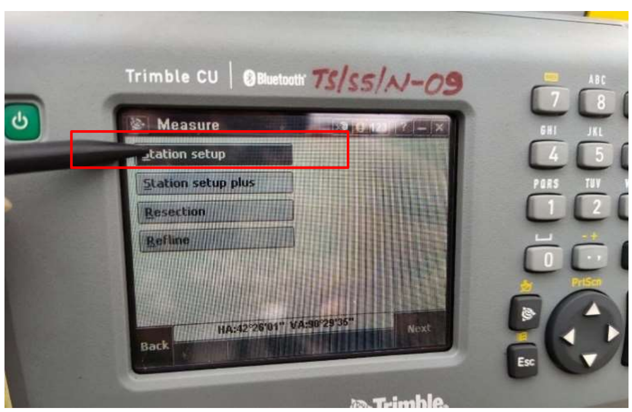


Figure 44: Station Setup

Figure 45: Misclosure

Step 5: Then go to Measure > Measure Topo > Set the Code for feature and set the prism height and now start moving the prism to different features and take the readings. Don't forget to store the readings (Don't forget to listen Observation stored). If you are not interested in height details use laser to point and just take the reading this will give you the coordinate of that feature.

Figure 46: Measure Topo

Step 6: Complete all the features using different codes and complete the survey. After completing don't forget to end the conventional survey to close the survey successfully.

Step 7: Export data is .csv format with all fields. Here the work of TS is over.

Step 8: Map is created using the exported data from TS. Make a new project in ArcGIS pro and define the location of file to store the project. After that select the coordinate system.

- World Wide UTM.
- WGS 1984 Datum

- ZONE 44N

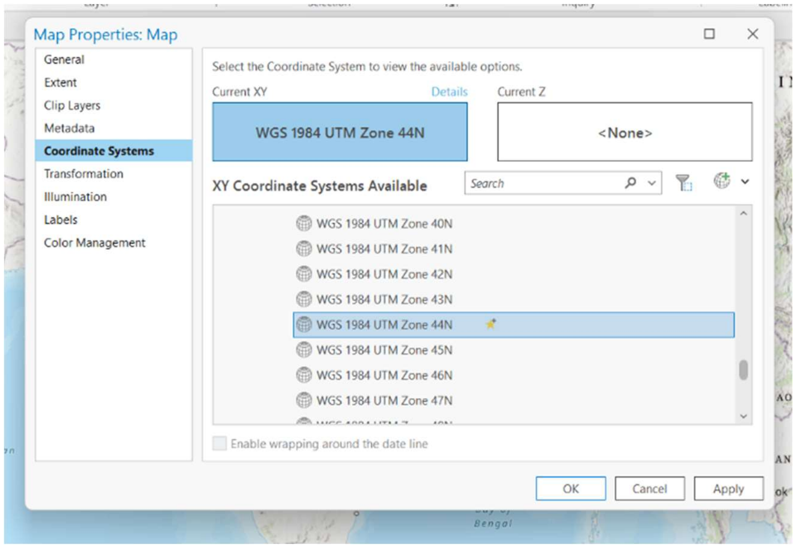


Figure 47: Selecting Coordinate system

Step 9: Import the .csv file your project. Use split feature using Code this split all the feature using according to the code assign to them directly in separate shape file. Project this point in on the map. Go to view tab and open catalog pane. Open folders in which you want to store the data set of files. Create the feature data base and add feature data set as point, line and polygon.

Step 10: Add feature class according the feature you mapped on ground while surveying. Classify the feature and add them in point, line and polygon respectively.

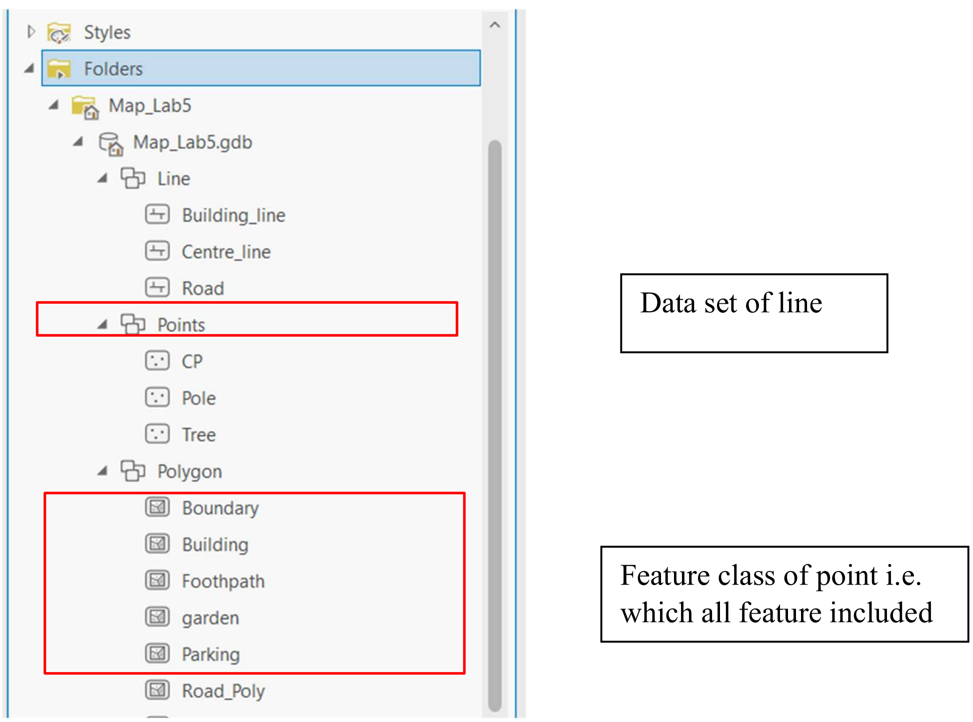


Figure 48: Data set and feature class creation

Step 11: Go to create and now start creating the features with their respective feature class.

Figure 49: Raw point data of different layers

Step 12: After creating all the features. Edit the feature attribute like colour, symbol, label etc.

Selection of Contour Interval:

According to the M3-3 Elevation measurements- Contouring provided by Dr. Onkar Dikshit. The contour interval should be selected according to the table below.

English System		Metric System	
Scale (ft/in.)	Contour Interval (ft)	Scale	Contour Interval (m)
50	1	1:500	0.5
100	2	1:1000	1
200	5	1:2000	2
500	10	1:5000	5
1000	20	1:10,000	10

Figure 50: Reference table for contour

According to this table the contour interval depends upon the Scale of map. So, for our case the as the scale of map is 1:1000 so the contour interval according to this table should be 1m.

So, we created contour in ArcGIS pro with contour intervals of 1meter.

Step 13: Creating Contour.

Select the point of contour > Use project raster to convert this vector point to raster format > Use contour tool in geoprocessing tab > Select rater layer > Select contour interval > select appropriate Z values > Run. This will generate contour of required interval edit them according to you requirements.

Step 14: Go to insert > new layout > layout size. And set the map with help of ruler, add scale, legend, title and other information as required. Export it in required format (preferably pdf).

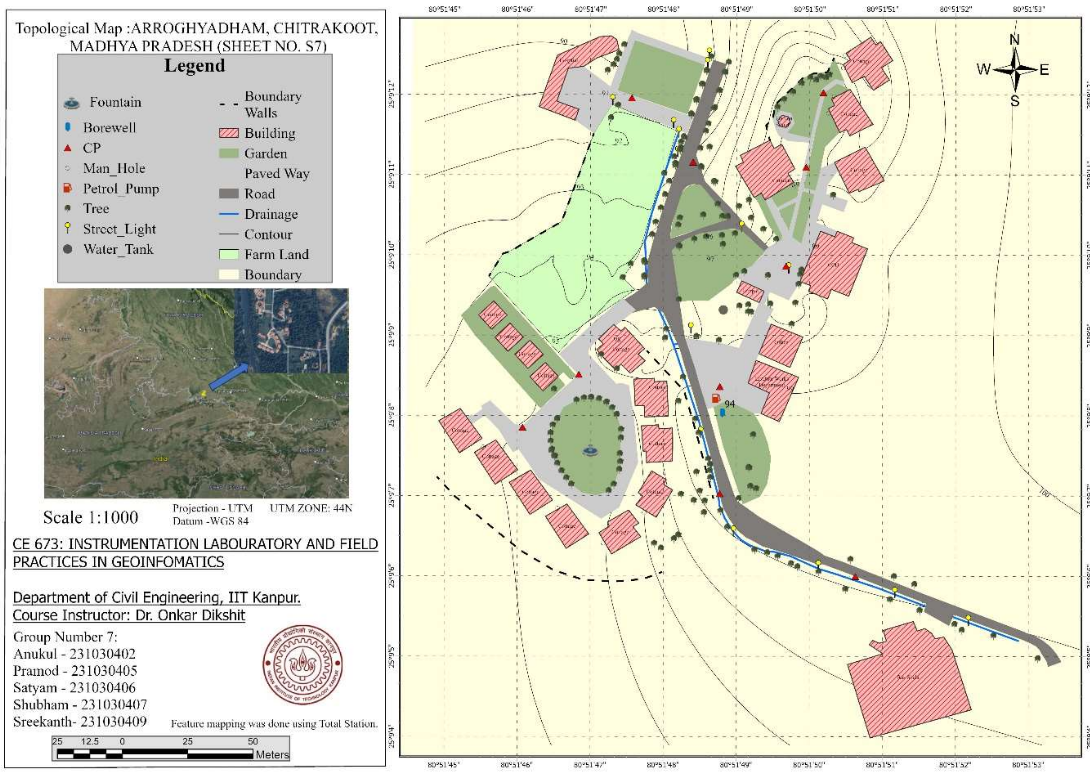


Figure 51: Reference table for contour

8. Road profile: In the survey camp we were also instructed to map a road profile and create a longitudinal profile and c/s of road at each chainage. First, we divided the road in the segments of 20 meters starting from the entrance of the cottage and end at the main gate of Aroghyabham. Then each chainage was further divided into five parts. One at centre, two at left and two at right side of centre point.

Instrument used:

- Total station.
- Prism.
- Tape.

Methodology.

1. **Equipment Setup**: Begin by setting up the total station at a stable location along the road. We ensure that it is placed on a firm and level surface and adjust the tripod legs for stability. We make sure that total station is properly levelled and calibrated.

2. **Establish Benchmark**: Identify a benchmark point with a known elevation of RL 100.00m near the starting point of the road. This benchmark had served as a reference for all subsequent elevation measurements.

3. **Instrument Calibration**: Calibrated the total station according to the manual's instructions. This includes setting the instrument's height and orientation accurately.

4. **Backsight Setup**: Used the total station to take a backsight reading on the benchmark point. This involves aiming the total station at the benchmark and recording the horizontal and vertical angles, as well as the slope distance.

5. **Set Up Intermediate Points**: Along the road, set up intermediate points at regular intervals where elevation measurements will be taken. Ensure that these points are easily identifiable and accessible.

6. **Take Fore-sight Readings**: Move the total station to each intermediate point and take fore-sight readings on the benchmark point. This involves aiming the total station at the benchmark and recording the horizontal and vertical angles, as well as the slope distance.

7. **Readings**: We have taken readings at every 20m in longitudinal direction and 5 readings which includes centre point and 2 pints on both LHS and RHS side, so total 5 readings.

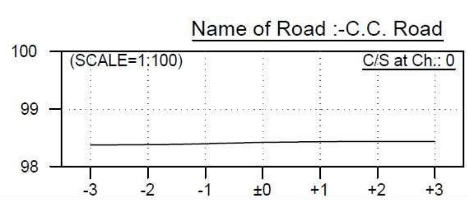
8. **Calculate Elevations**: TS automatically records elevation of each intermediate point relative to the benchmark. This can be done using trigonometric calculations or by inputting the data into surveying software in built.

9. **Mark Elevations**: Once the elevations are calculated, mark them on the road surface at each intermediate point using a levelling rod or other suitable marking tool. Ensured that the marks are clearly visible and accurately represent the elevation of the road surface at each point.

10. **Profile Plotting**: Plot the elevations on a profile graph or drawing to visualize the road profile. This will provide a clear representation of the elevation changes along the length of the road and cross section.

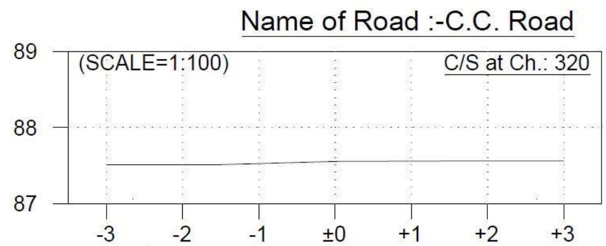
Results

Below are the figures showing the longitudinal and cross section at different chainages. One can also see the attachments as well for the more clarification.



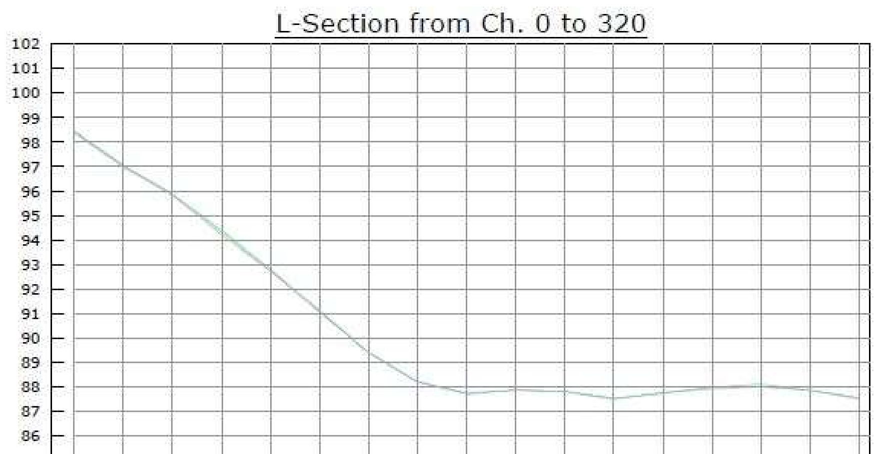
OGL	98.375	98.385	98.420	98.435	98.435
Distances	3.000	1.500	0.000	1.500	3.000

Figure 52: C/S at Chainage 0



OGL	87.510	87.510	87.550	87.560	87.560
Distances	3.000	1.500	0.000	1.500	3.000

Figure 53: C/S at Chainage 320



Ch.	L.H.S.	R.T.L.	R.H.S.
0	98.375	98.420	98.435
20	96.960	97.030	97.035
40	95.830	95.830	95.880
60	94.215	94.325	94.405
80	92.705	92.750	92.805
100	91.125	91.090	91.050
120	89.395	89.395	89.400
140	88.185	88.215	88.200
160	87.695	87.735	87.730
180	87.865	87.875	87.850
200	87.795	87.810	87.790
220	87.500	87.535	87.550
240	87.755	87.750	87.735
260	87.980	87.960	87.910
280	88.120	88.040	87.990
300	87.855	87.860	87.845
320	87.510	87.550	87.560

Slope (Ch.)	
0–100	1:13.65(-)
100–200	1:30.48(-)
200–320	1:462.43(-)

Ht.

Figure 54: Longitudinal C/S of Road

9.Conclusions:

The survey camp, an integral part of the CE673 course, proved invaluable for gaining a comprehensive understanding of surveying basics. Hands-on experiences laid a strong foundation, enabling us to delve into topography mapping, city mapping with Juno, GNSS control point establishment, and auto level-based level transferring.

This immersive learning opportunity equipped us with practical skills and insights that textbooks alone cannot provide. From mastering the intricacies of surveying techniques to honing teamwork and leadership qualities, the camp fostered holistic development crucial in professional life.

In conclusion, the survey camp emerges as a pivotal educational experience, bridging the gap between theoretical knowledge and practical application. I would like to express my sincere gratitude to Prof. Onkar Dikshit for granting me this enriching opportunity. The unwavering support and guidance from Mr. R. K Maurya, Mr. Sheetla Tripathi, Mr. Hari Babu and our TA's Mr. Arnab Laha, Mrs. Rashmi Malik, Mr. Ratnesh Kushwah, the supportive staff, and my fellow batchmates were instrumental in making the camp a resounding success. I wholeheartedly recommend this camp to future students, recognizing its profound impact on professional growth and skill development.

Suggestions:

According to me the three labs can also be done there it-self as we were having all the resources as well. I know Batchelors student don't have these three labs but still the three labs can be done by the master's students there itself only the report work can be done later for masters within one month of survey camp.

CE673: Instrumentation Laboratory & Field Practices in Geoinformatics

Name: Pramod B Gandugade Roll No: 231030405

Laboratory Exercise -I Report

Introduction

Chain survey, an ancient technique for mapping terrain features, is characterized by its simplicity and relatively low accuracy compared to contemporary methods. It relies on a chain to measure distances and rudimentary tools to establish angles. Despite its limitations, chain survey played a pivotal role in early cartography, laying the foundation for more precise mapping techniques.

Objective

The objective of this lab is to learn to use chain to prepare a feature map of old convo ground IIT Kanpur.

Instrumentation

1. **Surveyor's Compass:** Compass is used to measure angles and determine the bearing of base lines. The least count is 1o for the surveyor's compass.

Figure 1: Surveyors compass

2. **Chain or Tape:** Chain or tape is use to measure distances between various point on the group and well as setting up a precise base line. They are also use to measure the distances from the features as offset. That is measuring the perpendicular off set from the base line.

Figure 2: Tape

3. **Ranging Rod:** Ranging rod are use for ranging to set up a straight base-line. They are typically made of wood or metal and have red and white markings. Ranging roads are position vertically to align the base line in a straight line.

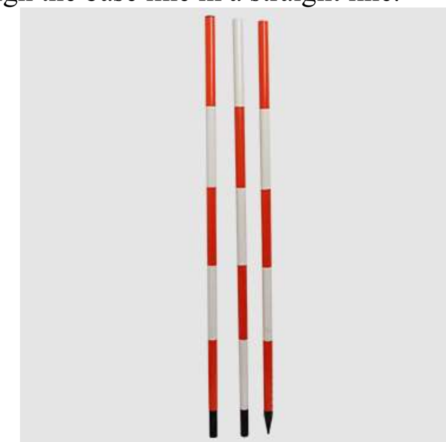


Figure 3: Ranging Rod

4. **Pegs and Hammer:** Wooden or Metal pegs, are use to establish the control points, reference point. Hammer is use to drive the peg in the ground to establish a firm control point.

Methodology

The methodology followed to create a feature map using the chain surveying is given below.

1. **Setup Control points:** We started with selecting three prominent points in the area from which we can cover the maximum number of features, and which serve as control points for our survey. This point is selected such that they form the vertex of triangle and these points are easily identifiable and accessible.
2. **Placing Ranging Road:** Placing the ranging road at two control point and third in approximate centre such that all of them are in straight line. By doing so we can establish base line that will be use to calculate the distance and measure the offset of the feature from the baseline.
3. **Measure Distances:** Using chain and tape measure the distance between the feature and the baseline. This distance is an offset which is the shortest distance between the base line and the baseline.
4. **Record Bearing:** Using surveyor's compass measure the bearing of each baseline. Forbearing and Back bearing of each baseline to be measured using surveyors compass and recorded.
5. **Check for closure error:** This is the post processing work in which closure error is found out and of there is any error in the closure the correction is carried out. Ideally, this the difference between fore-bearing and back-bearing is equal to $\pm\ 180^0$.
6. **Adjusting the bearing:** If there is any error in closure adjust it accordingly, at each station.
7. **Prepare Topographic map:** Using the adjusted bearing data assume suitable scale and create a feature map using the offset distances.

Results and Discussion

Following the methodology we successfully create a feature map of old convo ground.

The data for the fore- bearing and back-bearing and the base line length is mentioned in the table below.

Line	FB (degrees)	BB (degrees)	FB – BB (degrees)	Distance(meters)
AB	308^0	127^0	181^0	57.29
BC	80^0	260^0	-180^0	45.8
CA	182^0	3^0	179^0	43.04

The correction was carried out in the bearing which are given below.

Thus, the difference of FB and BB of line BC is exactly 180^o.

Therefore, station B and C are having no local attraction.

BB of AB is correct 127^0.

Correct FB of AB = $127^0 + 180^0 = 307^0$.

But, measured FB of AB = 308^0.

Error in FB of AB = Measured – Corrected

$= 308^0 - 307^0$

$= 1^0$

There for the corrections applied in the FB is AB = -1^0

Correction of – 1 o is applied to measured BB of CA

Correct BB of CA = $3^0 - 1^0 = 2^0$

Base-line map is given below:

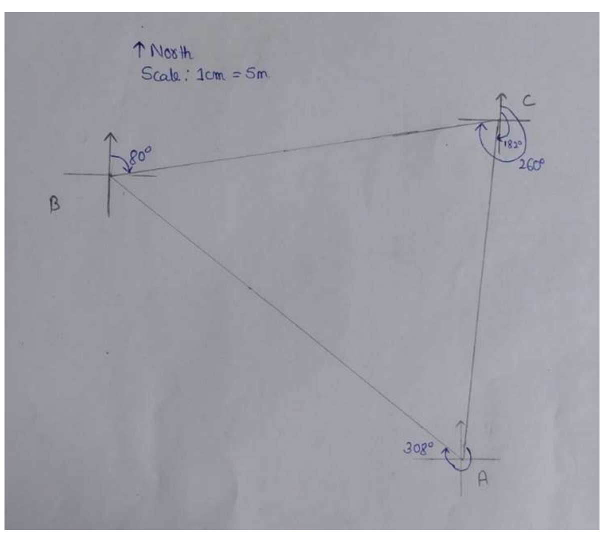


Figure 4: Base line formation

The feature map after caring out the chain survey is also given below.

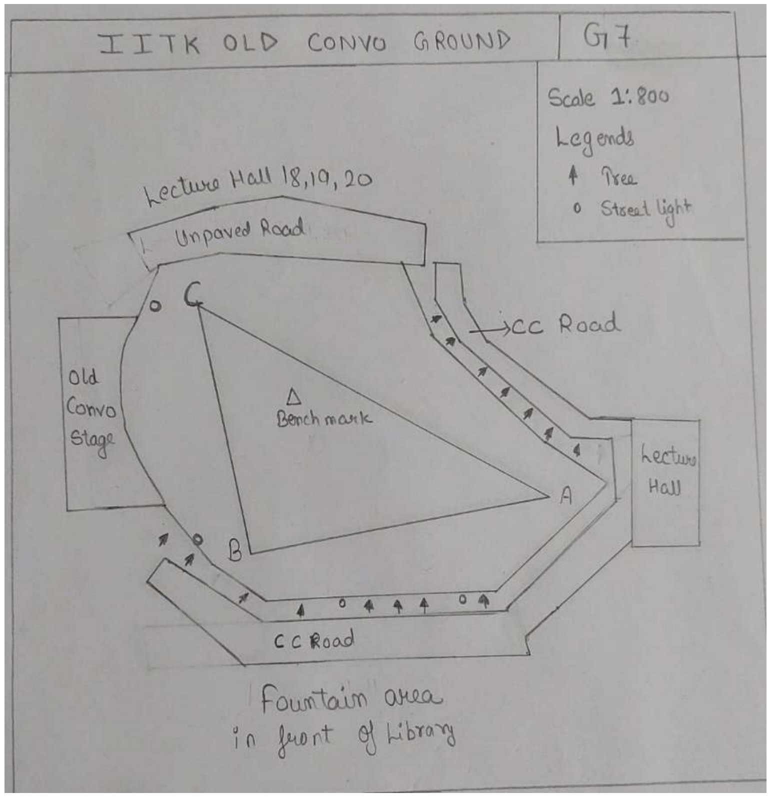


Figure 5: Feature Mapping

Corrected Readings after applying corrections.

Line	FB (degrees)	BB (degrees)	FB – BB (degrees)	Distance(meters)
AB	307^0	127^0	180^0	57.29
BC	80^0	260^0	-180^0	45.8
CA	182^0	20	180^0	43.04

Conclusions and Future Work

Through the chain survey exercise, we've grasped the fundamentals of surveying, particularly in creating rough feature maps. Despite its simplicity, chain surveying offers valuable insights into terrain mapping. Mastering basic tools like chains and compasses empowers us to produce rudimentary yet informative maps, laying a strong foundation for future surveying knowledge.

CE673: Instrumentation Laboratory & Field Practices in Geoinformatics

Name: Pramod B Gandugade Roll No: 231030405

Laboratory Exercise -2 Report

Introduction

The Electronic Distance Measurement Instrument (EDMI) is pivotal in modern surveying and geodesy, transforming distance measurement accuracy and efficiency. Unlike traditional methods relying on physical or optical means, EDMI employs electronic signals for precise distance determination. By transmitting a modulated electromagnetic beam from a master station's transmitter to a reflector at the remote station and measuring the phase difference between outgoing and incoming signals, EDMI accurately calculates slope distance. This technique, utilizing carrier wave modulation and the speed of light, ensures precise distance measurements, vital for surveying, construction, and geodesy applications.

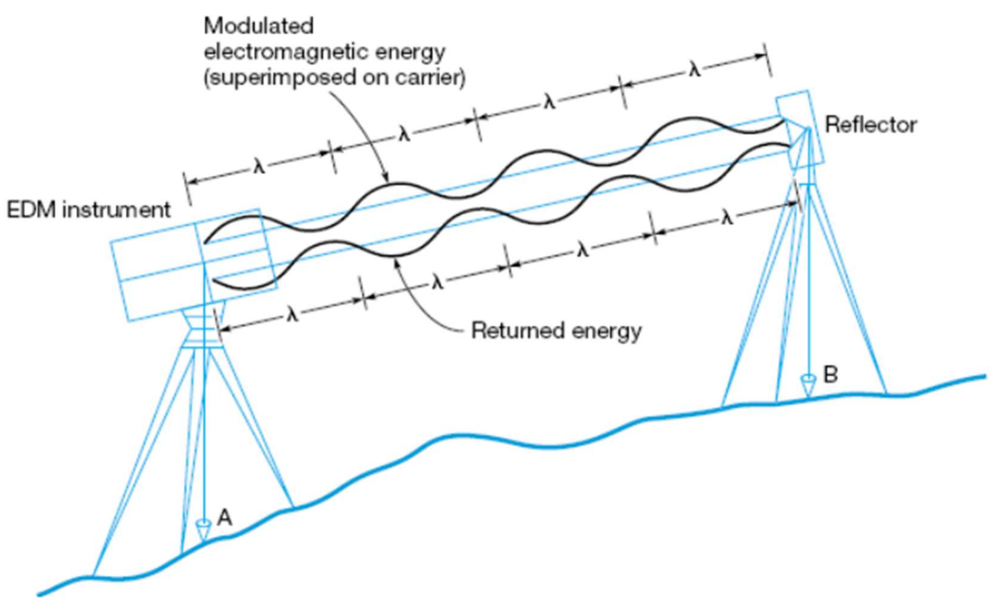


Figure 1: Principle of EDMI (Source: Wolf and Ghilani, 2002)

Precision: 1/1000000 to 1/500000.

Purpose:

- Used for the measurement of baseline for geodetic networks.
- Used for the measurement of baselines for precise engineering surveys.

Equipment Required: EDMI, Tape (2), Reflector, Tripod,

Objective

The objective of this laboratory exercise is to determine the cyclic error, reflector-instrument error and scale error for given EDMI.

Methodology

In this lab exercise we carried out the cyclic error, reflector-instrument error and scale error determination for the given EDMI.

Step1: First mounted the instrument over the tripod and approximately levelled the setup.

Step2: Now levelled the instrument by making the circular bubble at the centre. It can be done by using two levelling screws at a time, both screws should be rotated in same direction either inward or outwards at a time. Then kept the instrument approximately perpendicular to the previous position and used the other levelling screw to centre the bubble.

Step3: Switching ON the instrument, Opened Trimble Access and selected General survey in that and done electronic level by using principle of "three levelling screws".

Step4: Now press on Accept to initialize the instrument, then selected survey basic and entered appropriate values for pressure, temperature, etc.

Step5: Measured the instrument and reflector height and entered those values respectively.

Step6: Now Sighted the target/reflector and by pressing Measure button, measured Horizontal distance (HD).

Methodology for Error Determination

Cyclic Error

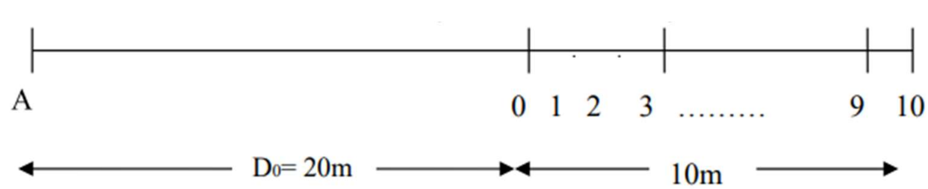
- Estimating the various calibration errors/corrections by comparing the distance measurement on a flat ground using the tape and EDMI.
- Assume the basic measuring unit as 10m (effective wavelength = λ/2).
- Set up an instrument at A.
- By using tape measured a straight line of 30m from A and divided that line into two segments of 20m and 10m.
- Now divided the last 10 m into 10 parts each of 1 m and measured each part carefully using the tape (d_i) as well as the EDMI (D_i) (D_i is measured from EDMI position A).
- Measure D_0 with EDM (Considered it as 20m).
- Now determine the error by using the formula:

$$e_i = D_i - (D_0 + \sum d_i)$$

- Correction is given by formula:

$$c_i = -e_i + \sum \frac{e_i}{10}$$

Where, $\sum \frac{e_i}{10}$ indicated the average error.

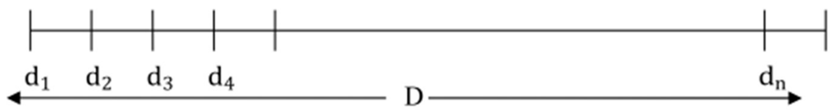


Reflector-instrument constant

Divided the distance (D) of 10m into 10 number of segments of 1m length. Use the same set of EDMI & reflector set for entire set of measurements. Measured length of line (D) using EDMI and length of each of n segments (d1, d2, d3, d4….)

Reflector constant can be calculated by the formula:

$$K = \frac{D - \sum d_i}{n-1}$$



Scale error

Scale error can be determined by the formula:

Scale error $(ppm) = \left(\frac{D_k - D_m}{D_k}\right) * 10^6 = n\ ppm$

Corrected Distance = D_m + n * D_m

Were,

D_k = Known distance of calibrated line.

D_m = Measured distance of calibrated line.

n = Scale error in ppm.

Results and Discussion

Cyclic Error

Case I: When Instrument is placed at point A.

Station	Taped dist. d_i (m)	EDMI dist. D_i (m)	$(D_0 + \sum d_i)$ (m)	$e_i = D_i - (D_0 + \sum d_i)$ (m)	$c_i = -e_i + \sum\frac{e_i}{10}$ (m)
0	0	20	20	0	0
1	1	20.998	21	-0.002	-0.0055
2	2	21.992	22	-0.008	0.0005
3	3	22.991	23	-0.009	0.0015
4	4	23.995	24	-0.005	-0.0025
5	5	24.99	25	-0.01	0.0025
6	6	25.987	26	-0.013	0.0055
7	7	26.987	27	-0.013	0.0055
8	8	27.993	28	-0.007	-0.0005
9	9	28.993	29	-0.007	-0.0005
10	10	29.999	30	-0.001	-0.0065
				$\sum e_i$ = -0.075	$\sum c_i$ = 0

Case II: When Instrument is placed at a distance of 17m from point A.

Station	Taped dist. d_i (m)	EDMI dist. D_i (m)	$(D_0 + \sum d_i)$ (m)	$e_i = D_i - (D_0 + \sum d_i)$ (m)	$c_i = -e_i + \sum\frac{e_i}{10}$ (m)
0	3	3.010	3	0.01	-0.0014
1	4	4.024	4	0.024	-0.0154
2	5	5.000	5	0	0.0086
3	6	6.017	6	0.017	-0.0084
4	7	7.008	7	0.008	0.0006
5	8	8.019	8	0.019	-0.0104
6	9	9.010	9	0.01	-0.0014
7	10	10.002	10	0.002	0.0066
8	11	11.009	11	0.009	-0.0004
9	12	11.984	12	-0.016	0.0246
10	13	13.012	13	0.012	-0.0034
				$\sum e_i = 0.095$	$\sum c_i = 0$

Reflector-instrument constant

Measured length of line (D) = 29.999 – 20 = 9.999

$\sum d_i = 1 + 1 + \ldots = 10$

$K = \frac{D - \sum d_i}{n-1} = \frac{9.999 - 10}{10-1} = \frac{-0.001}{9} = -0.0001$

This reflector-instrument constant -0.0001, indicating a negligible offset between the measured length using the EDMI and the actual distance of the line. This shows the EDMI's capability to provide precise distance measurements with minimal instrumental bias.

Scale error

Scale error $(ppm) = (\frac{30.000 - 29.999}{30.000}) * 10^6 = 33.33\ ppm$

Corrected Distance = $29.999 + 33.33 * \frac{29.999}{10^6} = 30.00$

Conclusions

This laboratory evaluation of the Electronic Distance Measurement Instrument (EDMI) alongside a traditional tape measure provided valuable insights into its accuracy and error characteristics. Despite minor differences compared to the tape measure, the EDMI demonstrated overall precision, particularly suitable for surveying and engineering projects. Regular calibration is essential to maintain its accuracy. This exercise demonstrates the EDMI's utility and reliability in precisely measuring distances, emphasizing its significance in various practical applications.

Reference

1. Wolf, P.R. and Ghilani, C.D., 2002, Elementary surveying, an introduction to geomatics, X edition, Prentice Hall: NJ.
2. Schofield, W. and Breach, M., 2007, Engineering surveying, VI edition, Butterworth: Oxford.
3. Anderson, J.M. and Mikhail, E.M., 1998, Surveying theory and practice, WCB McGraw: Boston.

Name: Pramod B Gandugade Roll No: 231030405

Laboratory Exercise -III Traverse Survey

Objective

To establish a close traverse using Total Station and adjust the closing error to get the adjusted interior angles.

Introduction

Traverse consists of series of straight lines connecting successive established points along the route of survey. These points are called Traverse points.

There are two types of traverses:

- **Open traverse:** In an open traverse, the starting and ending points are not the same, creating a line that does not form a closed loop. Open traverses are commonly used for linear features like roads, pipelines, or property boundaries.
- **Closed traverse:** A closed traverse begins and ends at the same point, forming a closed loop. This method is often employed for mapping areas with irregular boundaries or when precise accuracy is required.

In our laboratory exercise we performed the closed traverse with 4 stations in the IITK convocation ground.

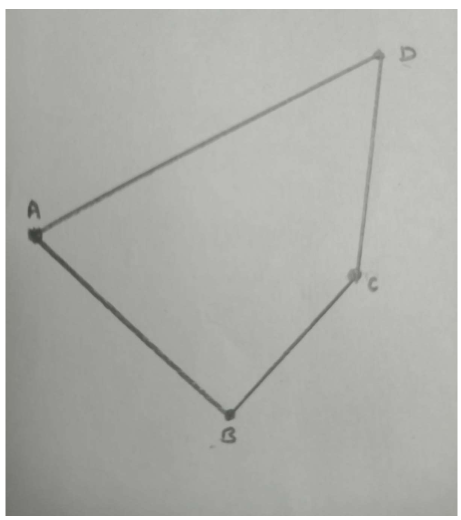


Figure 2: Rough sketch of location of stations.

Instruments Used: Total Station, Compass, plumb bob, Peg, Hammer.

Methodology

Following steps are adopted to do traversing of a closed loop:

Step 1: Four stations were established on the IITK Convocation Ground, with each group setting up one station.

Step 2: Now, we performed the initial settings for the total station.

Step 3: Levelled the instrument and centred the instrument by using plumb bob.

Step 4: Now sight the station immediate left to our station by focusing on the bob suspended to the total station of that station and set the horizontal angle as zero as initial reading and measured the angle of the station which is at our immediate right with respect to the previous station by sighting the bob of that station.

Step 5: We recorded observations for both face-right and face-left orientations.

Step 6: Now moved to the next station, repeated the same procedure as described above, recording the interior angle corresponding to each station for both face-right and face-left positions and took the mean of interior angles obtained from both the faces.

Step 7: Now summed up all the interior angles and whatever the closing error comes we adjusted that error.

Step 8: Balanced the angular error by using method-1 given in 'Wolf and Ghilani'. For this what we have done is first divided the closing error by the number of stations i.e., 4 to get a average correction.

Step 9: Multiple of these average corrections are tabulated in column format and then rounded off these corrections to 2 decimal places and took the successive difference of the corrections for adjustment of each angles. This successive difference is done by subtracting the preceding value from the one being considered and tabulated in a new column. Checked this calculation by doing the sum of the values of this new column, it should be equal to the angular misclosure of traverse.

Step 10: Now, we found the adjusted interior angle for each station by subtracting this correction from the measured interior angle and the sum of this adjusted interior angle at each station should be equals to true geometric value i.e., for our case it should be equal to 360^0.

Step 11: Now we specified our order of traversing based on the traversing specifications.

Specifications in Traversing

S. No.	Type of Item	Angular error of closure	Linear error of closure
1	First order traverse for horizontal control	6″√N	1 in 25,000
2	Second order traverse for horizontal control and for important and accurate work.	15″√N	1 in 10,000
3	Third order traverse for survey of important boundaries.	30″√N	1 in 5,000
4	Minor theodolite traverse for detailing	1′√N	1 in 3,000
5	Compass traverse	15′√N	1 in 300 to 1 in 600

Figure 3: Traversing specifications.

Results and Discussion

Traverse Survey

Sl No.	Station Observed	Face (L/R)	Horizontal Angle				Succesive difference	Succesive difference (deg.)	Adjusted angle
			Reading (Degrees)	Mean of interior angle	Multiples of average corrections	Correction rounded			
1	D	L	0	75.197248	3.82455	3.82	3.82	0.001061111	75.1961869
	B		75.196846						
	D'		0.0025						
	Error		-0.0025						
	D	R	180						
	B		255.19765						
	D'		179.9991						
	Error		0.0009						
2	A	L	0	49.2095975	7.6491	7.65	3.83	0.001063889	49.2085336
	C		49.204649						
	A'		0.0011						
	Error		-0.0011						
	A	R	180						
	C		229.214546						
	A'		180.01694						
	Error		-0.01694						
3	B	L	0	144.153421	11.47365	11.47	3.82	0.001061111	144.15236
	D		144.153877						
	B'		0.0025						
	Error		-0.0025						
	B	R	180						
	D		324.152965						
	B'		180.00111						
	Error		0.00111						
4	C	L	0	91.443983	15.2982	15.3	3.83	0.001063889	91.4429191
	A		91.448987						
	C'		0.003888						
	Error		0.003888						
	C	R	180						
	A		271.438979						
	C'		180.03888						
	Error		0.03888						
									360.000000

Total interior angle	360.0042495
Error	-0.0042495

Figure 4: Observation table.

From the above table we can see that our closing error comes out to be 0.0042495 degrees i.e., 15.2982’’ and after doing the adjustment and balancing the errors we get the adjusted interior angles, sum of which comes to be 360^0.

From the specifications of traversing shown in the figure above, we can say that our traverse falls into the third-order as we are getting the closing error of 15.2982’’.

Conclusions

We performed traversing at the IITK Convocation Ground with the help of Total Station, compass, and plumb bob resulted in a closing error of 15.2982". This error places our traverse in the third order category according to traversing specifications. To mitigate this error, we implemented a systematic approach to balance the angular discrepancy by dividing the closing error by the number of stations, and subsequently adjusted each angle accordingly. By doing calculation and adjustment, we ensured that the sum of adjusted interior angles at each station becomes the true geometric value of 360 degrees, thereby enhancing the accuracy and reliability of our surveying. This traverse provided us with hands-on experience in practical surveying techniques, reinforced fundamental principles of accuracy and precision, and underscored the critical importance of attention to detail in surveying.

Figure: Batch of 2023-2024 Survey Camp

Sr No.	Location	B.S(m)	I.S	F.S(m)	H.I(m)	R.L(m)	L.S(m)	U.S(m)	Length(m)	Remarks
1	Bench Mark	0.998			100.998	100.000	0.888	1.106	21.80	
2	CP 1			1.463		99.535	1.405	1.519	11.40	RHS road edge
3	CI 1	0.422			99.957		0.315	0.530	21.50	
4	CI 1			2.799		97.158	2.710	2.885	17.50	
5	CI 2	0.753			97.911		0.569	0.947	37.80	
6	CP 2			2.760		95.151	2.490	3.030	54.00	Behind fountain
7	CI 3	1.931			97.082		1.849	2.020	17.10	
8	CP 3			1.220		95.862	1.151	1.291	14.00	Corner of resort entance
9	CI 4	1.269			97.131		1.182	1.355	17.30	
10	CP 4			3.530		93.601	3.360	3.700	34.00	Hospital road
11	CI 5	0.450			94.051		0.322	0.580	25.80	
12	CP 5			2.522		91.529	2.370	2.680	31.00	Start of valley
13	CI 6	2.080			93.609		1.965	2.199	23.40	
14	CI 6			0.219		93.390	0.151	0.285	13.40	
15	CI 7	2.451			95.841		2.339	2.509	17.00	
16	CI 7			0.667		95.174	0.628	0.705	7.70	
17	CI 8	2.889			98.063		2.829	2.948	11.90	
18	CI 8			0.503		97.560	0.465	0.543	7.80	
19	CI 9	2.251			99.811		2.219	2.284	6.50	
20	CP 6			0.791		99.020	0.744	0.839	9.50	Canteen Gate
21	CI 10	1.330			100.350		1.200	1.461	26.10	
22	CP 7			1.089		99.261	0.955	1.220	26.50	Frount of Pertol pump
23	CI 11	1.449			100.710		1.423	1.478	5.50	
24	BM			0.712		99.998	Total Length		458.50	Permenant Benchmark
	SUM	18.273		18.275						

Checks	Σ BS - Σ FS	-0.002	m
	Last RL -First RL	-0.002	m
Closing Error		-2	mm
	Number of CP	7	
	Correction	0.000285714	m
	E= C sqrt(K)	C = E / sqrt(K)	2.95366	Precise Levelling

Note: As the correction at forth decimal place it will not impact the RL measurments much so correction was not carried out.

City Map: CHITRAKOOT , MADHYA PRADESH (SHEET NO. S7)

Legend

Features

Type

- ATM
- BANK
- BUILDING
- BUS STAND
- CANTEEN
- CIVIL COURT
- HOTEL
- MEDICAL STORE
- OFFICE
- POLICE STATION
- POND
- POST OFFICE
- RESTAURANT
- ROAPWAY
- SCHOOL
- SHOP
- TEMPLE
- WATER TANK
- WELL
- Route

Instrument used to carry out this city survey was JUNO-3B.

Scale 1:15000

Projection - UTM Datum -WGS 84

UTM ZONE : 44 N

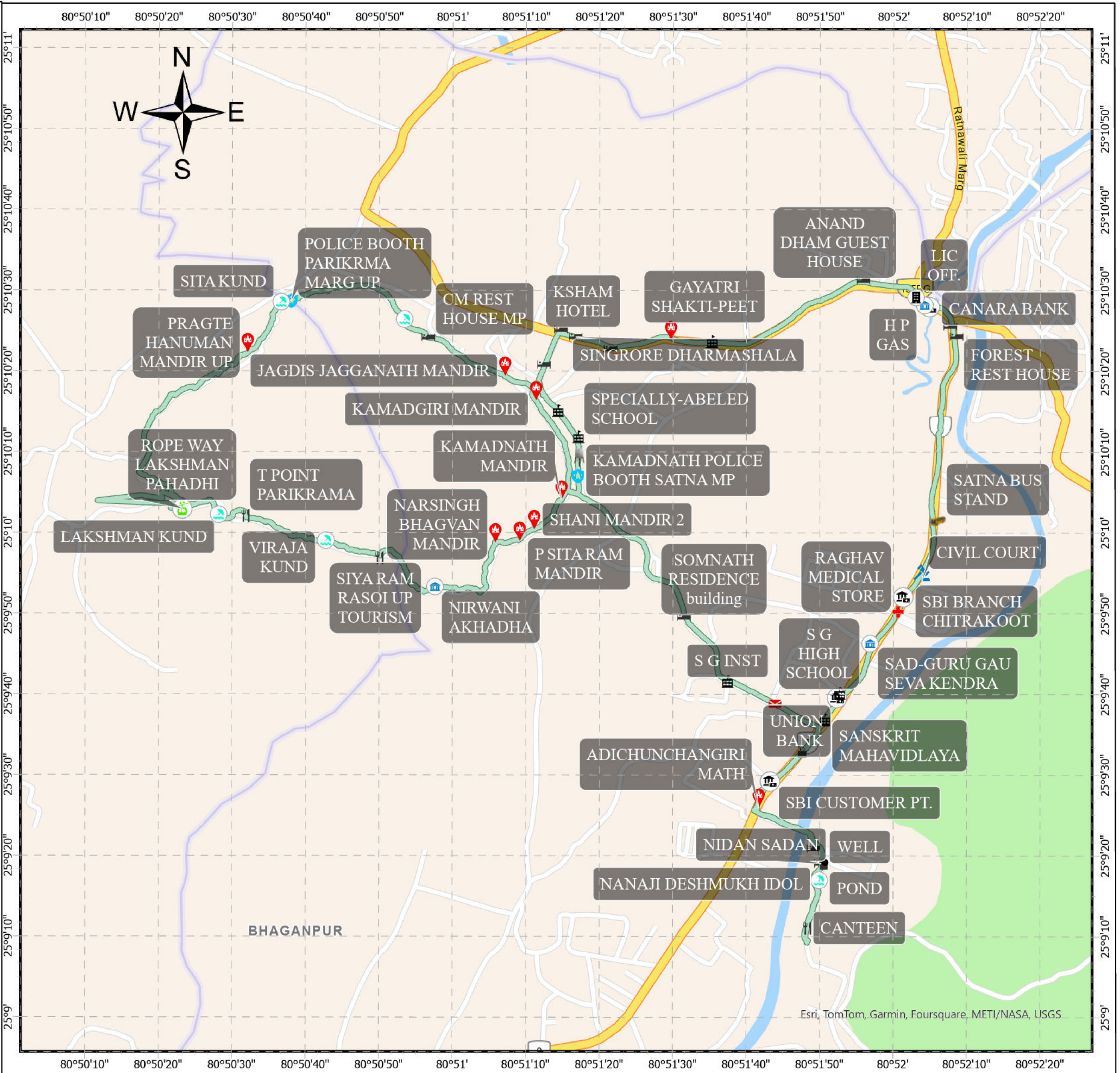
CE 673: INSTRUMENTATION LABOURATORY AND FIELD PRACTICES IN GEOINFOMATICS

Department of Civil Engineering, IIT Kanpur.
Course Instructor: Dr. Onkar Dikshit

Group Number 7:
Anukul - 231030402
Pramod - 231030405
Satyam - 231030406
Shubham - 231030407
Sreekanth- 231030409

19- April-2024

500 0 500 1,000 Meters



Topological Map :ARROGHYADHAM, CHITRAKOOT, MADHYA PRADESH (SHEET NO. S7)

Legend

- Fountain
- Borewell
- CP
- Man_Hole
- Petrol_Pump
- Tree
- Street_Light
- Water_Tank
- Boundary Walls
- Building
- Garden
- Paved Way
- Road
- Drainage
- Contour
- Farm Land
- Boundary

Scale 1:1000

Projection - UTM
Datum -WGS 84

UTM ZONE: 44N

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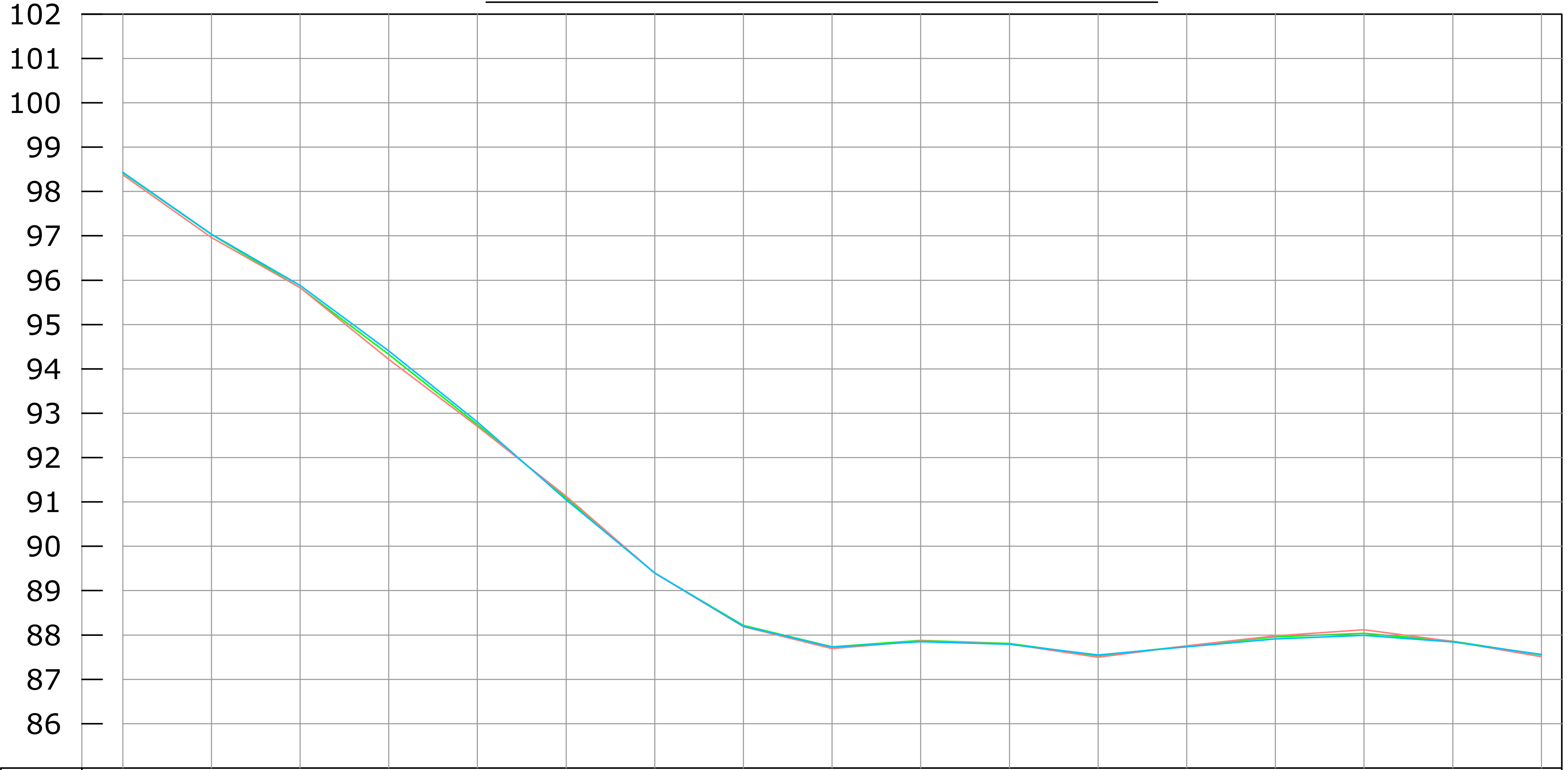
Sreekanth- 231030409

Feature mapping was done using Total Station.

25 12.5 0 25 50 Meters

L-Section from Ch. 0 to 320



Ht.																	
Slope			1:13.65(-)					1:30.48(-)						1:462.43(-)			
R.H.S.	98.435	97.035	95.880	94.405	92.805	91.050	89.400	88.200	87.730	87.850	87.790	87.550	87.735	87.910	87.990	87.845	87.560
R.T.L.	98.420	97.030	95.830	94.325	92.750	91.090	89.395	88.215	87.735	87.875	87.810	87.535	87.750	87.960	88.040	87.860	87.550
L.H.S.	98.375	96.960	95.830	94.215	92.705	91.125	89.395	88.185	87.695	87.865	87.795	87.500	87.755	87.980	88.120	87.855	87.510
Ch.	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320

PROJECT: CE673 SURVEY CAMP ROAD C/S

CLIENT: IIT KANPUR

LOCATION: AROGHYADHAM,CHITRAKOOT

TITLE: L-SECTION CH 0 TO 320

GROUP NUMBER 7:

- ANUKUL DWIVEDI - 231030402
- PRAMOD GANDUGADE - 231030405
- SATYAM AGNIHOTRI - 231030406
- SHUBHAM MISHRA 231030407
- SREEKANTH KS-231030409

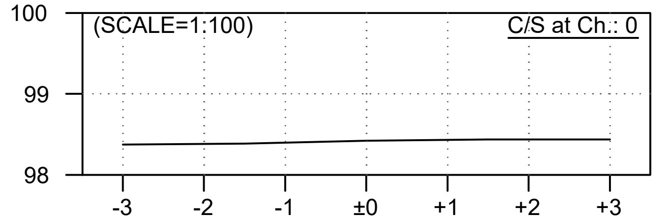
MENTOR: Dr. ONKAR DIKSHIT

DRG NO: 01

SCALE :

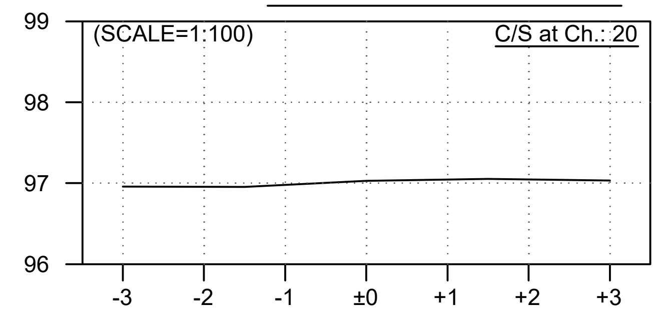
DATE : 19-04-2024

Name of Road :-C.C. Road



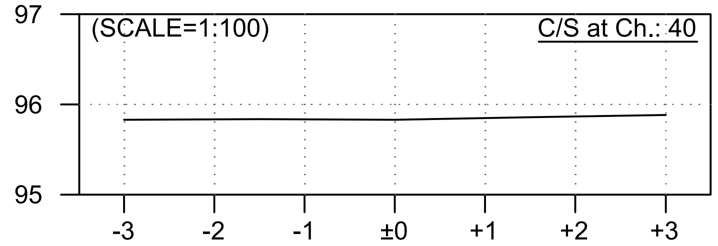
OGL	98.375	98.385	98.420	98.435	98.435
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



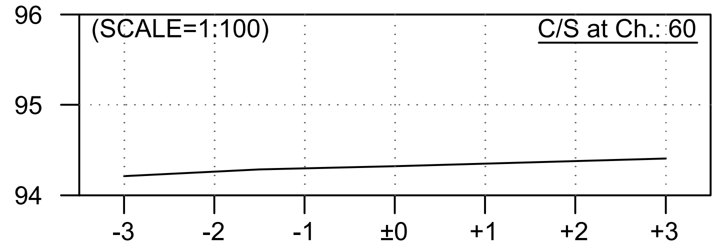
OGL	96.960	96.955	97.030	97.055	97.035
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



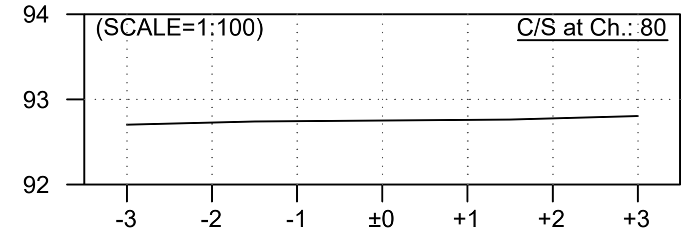
OGL	95.830	95.835	95.830	95.855	95.880
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



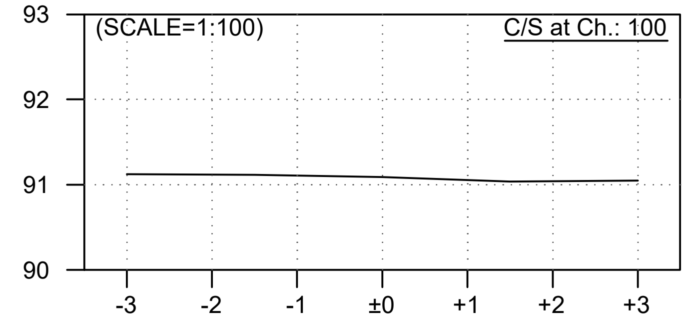
OGL	94.215	94.285	94.325	94.365	94.405
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



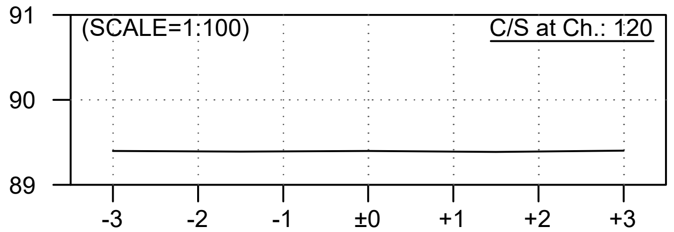
OGL	92.705	92.740	92.750	92.765	92.805
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



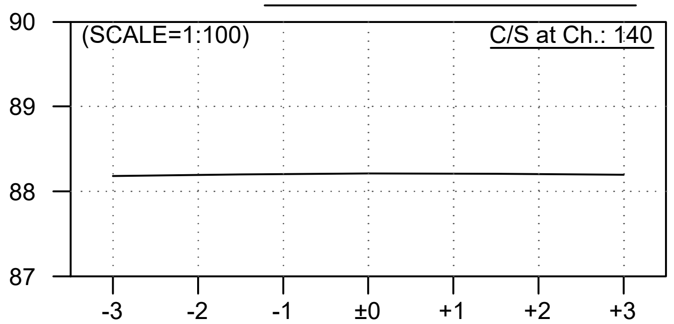
OGL	91.125	91.115	91.090	91.040	91.050
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



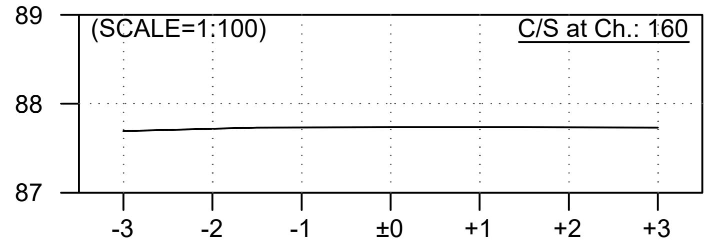
OGL	89.395	89.390	89.395	89.385	89.400
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



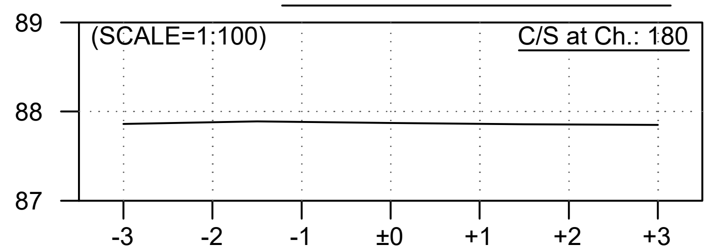
OGL	88.185	88.205	88.215	88.205	88.200
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



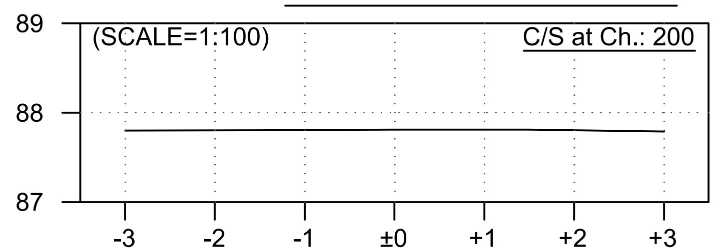
OGL	87.695	87.725	87.735	87.730	87.730
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



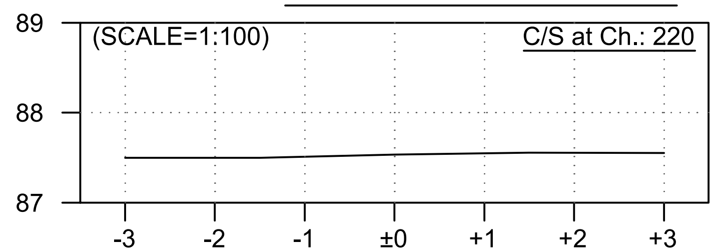
OGL	87.865	87.885	87.875	87.855	87.850
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



OGL	87.795	87.805	87.810	87.810	87.790
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



OGL	87.500	87.500	87.535	87.555	87.550
Distances	3.000	1.500	0.000	1.500	3.000

PROJECT: CE673 SURVEY CAMP ROAD C/S

CLIENT: IIT KANPUR

LOCATION: AROGHYADHAM,CHITRAKOOT

TITLE: CROSS-SECTION CH 0 TO 220

GROUP NUMBER 7:

- ANUKUL DWIVEDI - 231030402
- PRAMOD GANDUGADE - 231030405
- SATYAM AGNIHOTRI - 231030406
- SHUBHAM MISHRA 231030407
- SREEKANTH KS-231030409

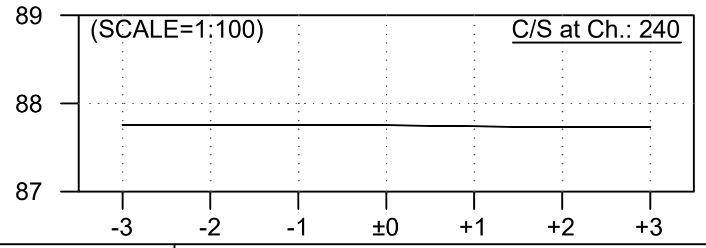
MENTOR: Dr. ONKAR DIKSHIT

DRG NO: 02

SCALE :

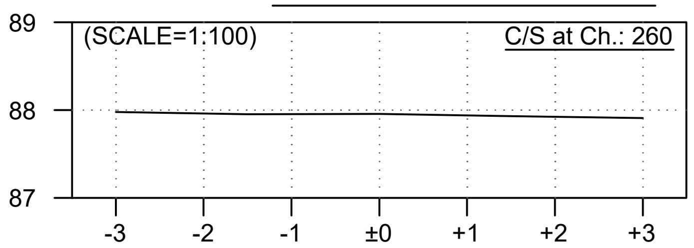
DATE : 19-04-2024

Name of Road :-C.C. Road



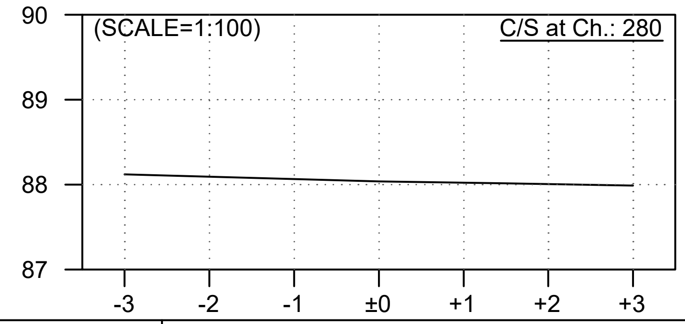
OGL	87.755	87.755	87.750	87.735	87.735
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



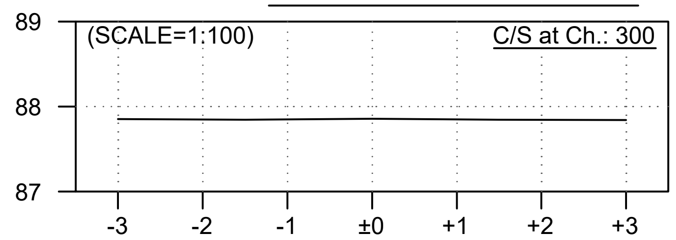
OGL	87.980	87.955	87.960	87.935	87.910
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



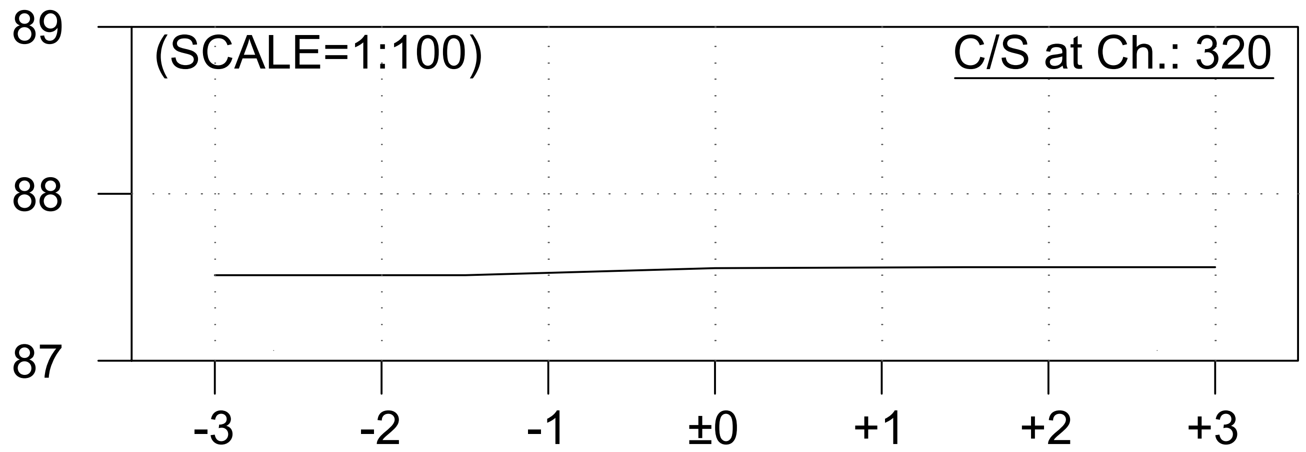
OGL	88.120	88.080	88.040	88.015	87.990
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



OGL	87.855	87.850	87.860	87.850	87.845
Distances	3.000	1.500	0.000	1.500	3.000

Name of Road :-C.C. Road



OGL	87.510	87.510	87.550	87.560	87.560
Distances	3.000	1.500	0.000	1.500	3.000

PROJECT: CE673 SURVEY CAMP ROAD C/S

CLIENT: IIT KANPUR

LOCATION: AROGHYADHAM,CHITRAKOOT

TITLE: CROSS-SECTION CH 240 TO 320

GROUP NUMBER 7:

- ANUKUL DWIVEDI - 231030402
- PRAMOD GANDUGADE - 231030405
- SATYAM AGNIHOTRI - 231030406
- SHUBHAM MISHRA 231030407
- SREEKANTH KS-231030409

MENTOR: Dr. ONKAR DIKSHIT

DRG NO: 01

SCALE :

DATE : 19-04-2024