Report on

CE673A - Instrumentation, laboratory and Field Practices in Geoinformatics

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1 ABSTRACT

As the part of lab report, the group of 4 student perform survey in chitrakoot at **Arogyadham**. We stayed there for 10 days and starting from 1st day with reconnaissance survey, then establishing control points, Performing GNSS survey to get precise coordinate of control point. Establish control network, total station traversing and adjustment is performed, mean sea level transfer using auto level, field detailing with total station, computation and quality checking is done. Following data help us to features map to prepare two-dimensional of the entire area allotted using ArcGIS pro software. Along with this we perform basic survey with JUNO 3B instrument in Chitrakoot city for 1 day. In that we went city area and collect important location in city.

2 OBJECTIVE

1. Know the Basic Surveying Equipment and handling procedure of each equipment.
2. Understanding the Surveying techniques including Control Points establishment, Computation and Adjustment of error.
3. Plotting details on UTM-WGS84 and Heights form BM
4. Learning GNSS and its working.
5. Establish a closed traverse.
6. Carry out leveling process of survey area.
7. Set Up total station and carry out measurements for each features in the area.
8. generate the map by collecting and processing all data.

3 Instrument/ Equipment Required

- Total station
- vertical Staff
- Tipod
- Trimble R10 GNSS Receiver
- Nikon AC-2S Auto Level
- Trimble Business Centre software
- MS- excel
- ARCGIS Pro

4 Techniques for Survey

4.1 Reconnaissance

In the survey, the first and most important part is reconnaissance survey. It includes the availability of infrastructures, site conditions, establishing control points where Back sight and fore sight is visible. These all comes under reconnaissance survey.

4.2 Total Station survey

The total station is used for measuring horizontal distance, slant distance, horizontal angle and vertical angle. As well as elevation in topographic and geodetic works, tacometric surveys and applications of geodetic surveys. For our survey in arogyadham we use **Trimble M3 total station** It is the semi automatic device. And it has software to manage the jobs. Job manager is an intelligent data management system of trimble total station. We create the job and record all survey points into the job.

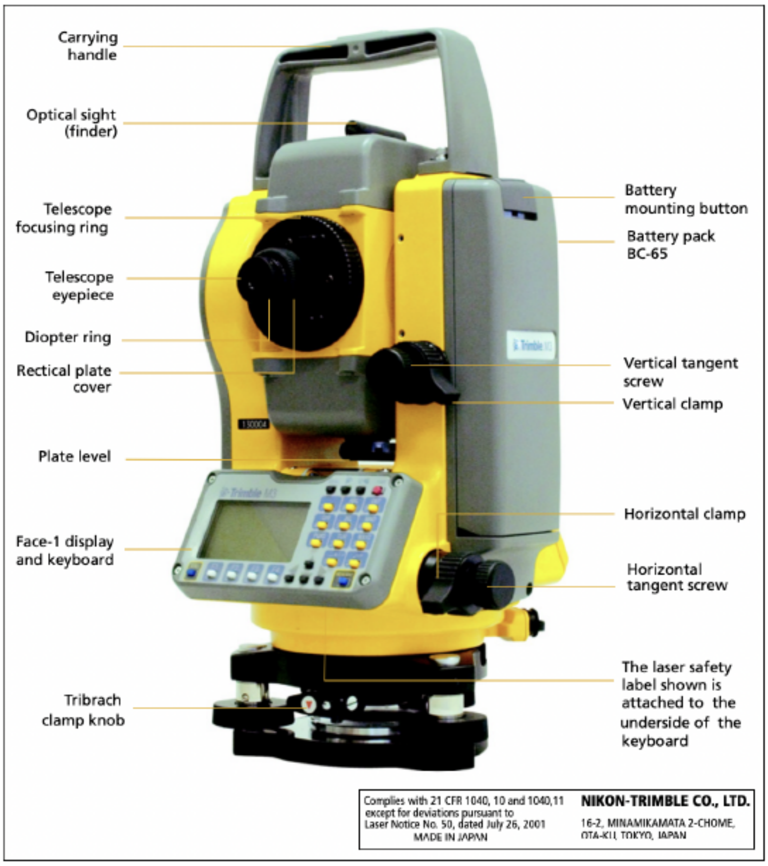

Figure 1: Total Station

The following methods are use for feature mapping.

4.2.1 Method of Back Sight (Two Point Problem)

- Setting up the Tripod: Open the tripod legs and set up on the control point. Check the tripod position by seeing through the center of optimal plummet. Level the top surface of tripod by pen or any other instrument. Centering and levelling of tripod is done roughly.
- Centering and levelling: This is an iterative process. start with levelling the instrument, There are three leveling two of them are assumed as on axis and perpendicular line passing through this axis and other leveling screw is assumed as one more axis. These two axes are for bubble in circular level. Adjust the leveling screws until the bubble in circular level comes to centre. Then,While centering the instrument align its central axis precisely over the station point. Centering is done using optical plummet. Adjust the legs until the station point is visible in optical plummet's cross hair.The process of centering and leveling is done continuously until both of them are achieved. Now, switch on the display to start the survey.
- Coarse Leveling: There are three leveling screws as shown in Figure 4, two of them are assumed as one axis and perpendicular line passing through this axis and other leveling screw is assumed as one more axis.These two axes are for bubble in circular level. Adjust the leveling screws until the bubble in circular level comes to centre.
- Trimble software - Select the correct program and Use the touch screen to select the program you want to use. The available programs include Survey, Stakeout, and Resection.Enter the project information such as the name, date, and location.Configure the settings such as the measurement units, the angular units, and the distance accuracy.
- Instrument coordinates: Go to Key-in > Points > Give name and code of the point accordingly > Give the coordinates of the instrument point which is already measured > Check control point > Store.
- north direction coordinates: Store the north direction point in the same way as above step. North direction is assumed as one of the control point which is visible from the instrument and its coordinates are known by observations of R10 receiver.

- Fine leveling/precision leveling: Go to instrument > Electronic bubble > Adjust the electronic bubble by the three leveling screws until it has reading less than 5" > Accept.

- Station Setup:
  -Go to measure > Station Setuup.
  – Option to enter instrument point will be appeared > Select the instrument point from the list (Which is fed in the instrument using key-in).
  – Measure the instrument height (in m) (station point to horizontal axis indication mark on the total station) using measuring tape and enter in the instrument.
  – Similarly enter the back sight point, other control point (Which is assumed as North direction).
  – Place the reflector/prism on prism rod/bipod and set it on the second control point and perform leveling of bipod.
  – Sight the reflector from the instrument: First sight the target by seeing through the optical sight to get approximate view of target, then see through telescope eyepiece and adjust the clarity using telescope focusing ring, now use vertical tangent screw and horizontal tangent screw to move telescope vertically and horizontally to align reflector and cross hair, now lock the telescope using vertical clamp and horizontal clamp to avoid movement of telescope.
  – Click on measure > It will show some error which should be less than 5 mm, our error is less than 5 mm > Store.

4.2.2 Basic Measurement by total station

The basic measurement by total station is Horizontal, Vertical angle and Distance. If we know coordinates of instrument (fed in the instrument, Known point), north direction (fed in the instrument, Known point) and basic measurements, Coordinates of the sighted point can be calculated.
Observation can be taken as,
- **PR Mode -** With the help of prism observation is taken. Prim is set at point at which we want to take observation, then by sighting the prim, we can take reading.
- **DR Mode -** In the Method prim is not used. With the help of laser beam we take reading. Direct beam is passed, the beam passing area is the crosshairs on the telescope reticle. This mode is used to measure inaccessible points.

4.2.3 Method of Resection by total station

The method of resection by total station is a surveying technique that involves using a total station instrument to determine the location of an unknown point by measuring angles and distances from known points. The known points are typically survey control points with known coordinates.
To perform resection using a total station, the following steps are typically followed:
- Set up the total station at a known control point and level it.
- Measure the angles and distances to at least two other known control points from the total station.
- Enter the coordinates of the known control points into the total station software. At-least three control points are needed to perform resection which are fed in instrument using key-in.
- Use the total station to measure the angles and distances to the unknown point.
- The software will then calculate the coordinates of the unknown point based on the measurements and the known coordinates of the control points.
- It is important to ensure that the total station is set up correctly and that all measurements are taken accurately in order to achieve accurate results.

4.2.4 Traversing by total station

Total station measures the angle and distance between the control points to form a traverse. The traverse can be open or closed and is used to establish a series of control points on the ground. To Measure we should know about whole circular bearing and Quadrant bearing.
Whole circle Bearing: It is used in prismatic compass surveying and was also used in this laboratory experiment. In this method, North Direction is taken as a reference direction and angles are measured in a clockwise sense. The measured angles can vary from 0^{o} to 360^{o}.
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 0^{o} to 90^{o}.

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

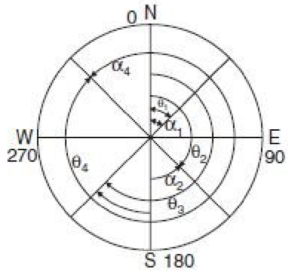

Fig. 13.4

Figure 2: Whole circle bearing and quadrant bearing formulae

4.2.5 Bowditch rule for closed traversing

The Bowditch Rule of Balance Traversing is a surveying technique used to establish the horizontal position of a point in a survey network. The rule states that the algebraic sum of the latitudes and departures of a closed traverse must be equal to zero. In other words, the sum of the eastward distances must be equal to the sum of the westward distances, and the sum of the northward distances must be equal to the sum of the southward distances.

This principle ensures that the traverse is closed, meaning that it starts and ends at the same point, and that the measurements are accurate. If the rule is not satisfied, it indicates that there is an error in the measurements or calculations, and the traverse needs to be retraced and corrected.

$$Corr\Delta E_{AB} = \Delta E\left(\frac{L_{AB}}{\sum L}\right)$$

$$Corr\Delta N_{AB} = \Delta N\left(\frac{L_{AB}}{\sum L}\right)$$

Corr = Correction
L_{AB} = Length of side (A-B)
ΣL = Sum of Lengths, Perimeter

Figure 3: bowditch/transit Rule of distributing corrections

4.3 Trimble R10 Receiver

R10 is dual frequency geodetic receiver. It receives L1, L2 frequencies. It uses relative positioning technique. Coordinates of reference station are precisely known. Coordinates of receiver are calculated with respect to reference station. Using R10 receiver ppm level of accuracy is achieved.

Figure 4: Trimble R10 Receiver

Figure 5: GNSS controller

In our survey we used method called rapid static. The rapid static method involves the following steps:
- Set up at least two GPS receivers at known control points with known coordinates.
- Set up a third GPS receiver at the unknown point to be measured.
- Collect data simultaneously for a period of time, typically at least 15 minutes, to allow for accurate measurements.
- Process the data using specialized software called Trimble to determine the distances between the GPS receivers and the satellites.
Use the distances to calculate the coordinates of the unknown point.

4.3.1 Post Processing of data

Post processing is done using Trimble Business Center software. TBC software is run and new project is created with blank template.
- Coordinate settings are set as follows:
1. System: Worldwide/UTM projection
2. Datum transformation: UTM 44 North
3. Horizontal datum: WGS 1984
4. No geoid model

- Go to baseline processing setting and click on satellite settings, then choose all GNSS constellation.
- Base station (IITK) is imported and control quality is selected under planar quality tag for more precise survey.
- Receiver's data of GCPs was imported in TBC. software.
- Session editor of baseline was used to do time edits. Blue line represents tracking by satellite at base station and green line represents tracking by satellite at rover station. Duration at which rover station was not able to track data while base station was able to track, was frozen to get better accuracy.
- After applying time edits, baseline was processed using "Process baselines" option. Baseline processing report and Point list (gives information about coordinates of base station and rover station) report was generated results.

4.4 Juno 3b Handheld

Juno 3B is a rugged handheld computer that is designed for field data collection, asset management, and inspection applications. It is manufactured by Trimble Navigation Limited, a company that specializes in GPS technology and other location-based products.
The Juno 3B runs on the Microsoft Windows Embedded Handheld 6.5 operating system and features a 3.5-inch sunlight-readable display, a 5-megapixel camera, and built-in GPS, Wi-Fi, and Bluetooth connectivity. It is also rated IP54 for water and dust resistance, and can withstand drops from up to four feet.

Figure 6: juno 3b handheld

Some common applications for the Juno 3B include GIS data collection, utility asset management, forestry, and environmental monitoring. It can also be used for mapping and navigation in outdoor environments. Overall, the Juno 3B is a versatile and durable handheld computer that is designed to meet the needs of professionals who work in challenging outdoor environments.

4.5 Auto-Level

An auto level is an optical instrument used in surveying and construction to measure height differences between points. It is a type of level that is equipped with a compensator mechanism that automatically levels the line of sight of the telescope, allowing for accurate measurements of vertical differences or elevations. The auto level

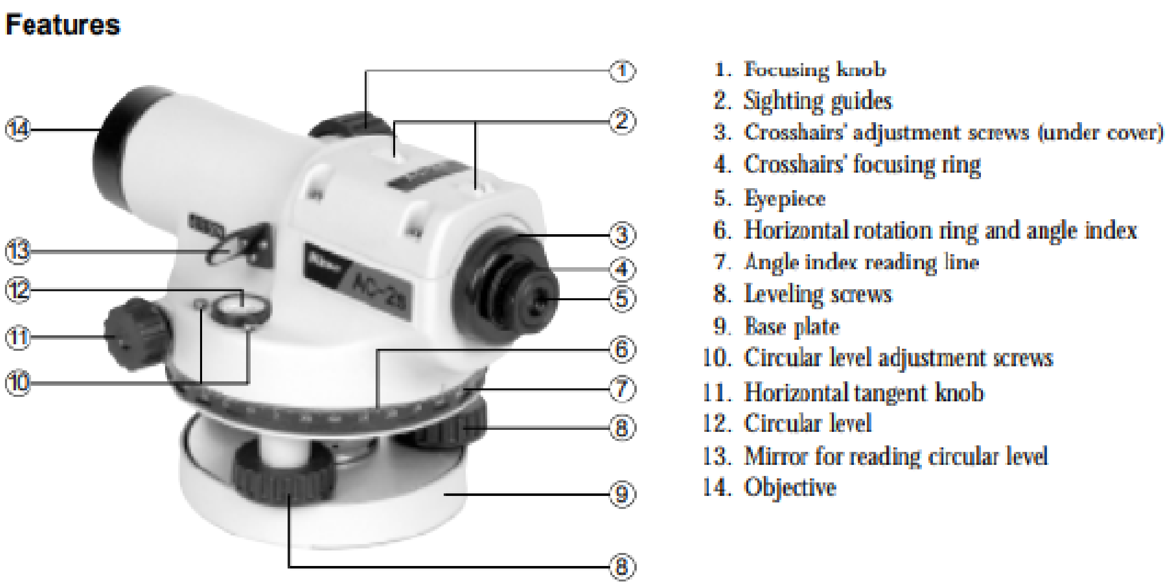

Figure 7: Auto Level

works by using a horizontal line of sight to observe a staff, which is a rod marked with measurements that is held vertically at a point of known or unknown elevation. The compensator mechanism within the auto level will automatically adjust the line of sight to be level, even if the instrument itself is not perfectly level. This ensures accurate measurements of vertical height differences.

4.5.1 Levelling Procedure

To use an auto level, the following steps are typically followed:

1. Set up the auto level on a tripod at a stable location.
   -Set up the tripod at a height appropriate for your use.
   - Attach the instrument to the tripod.
   - Level the instrument using the circular level as a reference.
   - Focus the telescope crosshairs by turning the crosshair's focusing ring

2. Take Measurements
   - Determining the Difference in Elevation: Set up the instrument half way between two points (A and B). Take a reading at point A and another one at point B. Subtract B from A to get the difference between the points.
   - Establishing an Elevation: Set the grade rod on a known point (B.M.) and take a grade rod reading. Add the grade rod reading to the known elevation to get the height of instrument or HI and then take the reading of the unknown foresight point and subtract it from the calculated height of instrument which give the reduce level of unknown point

   $$\text{Reduce level of Point} = \text{RL of BM} + \text{BS} \;\; \text{FS}$$

   - Making a Distance Measurement: To determine the distance between the instrument and the grade rod. Take readings at the upper stadia line(US) and the lower stadia line(LS) and apply the formula:

   $$\text{Distance} = (US - LS)100$$

   - Error Calculation: After completing the traverse by passing over all the control point and come back to the B.M. and measured the RL value of B.M and see the error between true value and measured value.

   $$\text{Closing error(e)} = \text{Measured value - true value}$$

   - Distribution of closing error in the Levelling process: Closing error (e) can be distributed to each station by this expression.

   $$\text{C} = -e(d/D)$$

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

3. Make table of all observations and perform Height of instrument method.
   - To use the height of instrument method, a level is typically set up on a tripod at a known elevation, such as a benchmark. The level is then adjusted so that it is level, and a horizontal line of sight is established. A rod or staff is then placed at the point to be measured, and the vertical distance from the horizontal line of sight to the rod is measured using a tape measure or a staff reading rod. The vertical distance is added to the elevation of the horizontal line of sight to determine the elevation of the point being measured.

5 Methodology

- DAY 1

  1. **JUNO Survey -** For first day our team perform juno survey. Total about 15 km walk in city of chitrakoot covering every important feature like bank, Dharamshala, temple, School, Public Office,Hotels, Bus stand, Hospital, Road, etc. This survey we perform with the help of JUNO 3B. It is small pocket size device by which we can collect features in the form of Point, Line and Polygon. In our survey school, hospital, temple we record in point feature. Road, Bridge, etc we cover in line feature. And if the feature is having large area we can collect it in polygon. In our survey there was one mountain surrounded by parikrama, we cover whole area in polygon.

- DAY 2

  1. From 2nd day we start main survey in Arogyadham. First we start with Reconnaissance survey. In this we fix total 10 control points at different place by which we can get traversing. Considering inter-visibility of previous ans next point as well as distribution of control point all over the area to get maximum number of features.

2. So we established a total 10 control points for entire area to be mapped, marking them with paint for future reference.

3. After that we start TS traversing. With the help of total station we do traversing with all 10 control points. We measure fore bearing and back bearing at each station as well as interior angle at each control station.

- DAY 3
    1. Mean sea level transfer is done using auto level through "height of instrument" method. We find elevation of control point.
    2. Set one temporary datum near to control point. From there we find elevation for each control point.
    3. A major use of this process is to draw contour lines on the map. Adjustment of levelled surface is done using Bowditch adjustment. After field work, MS-Excel is used for calculating reduce levels and corrections are applied using Bowditch's rule to get adjusted heights.
    4. After levelling, detailing using total station is performed at 2 control points by generating coordinate of all feature which we need to plot in our map.
- DAY 4
    1. R10 Receiver and R10 controller are used to receive observation of control points in rover mode and static mode.
    2. we take observation at each point for at least 15- 0 minutes.
    3. If the control point is surrounded by trees or high rise building then there might be chance the signal get obstruct so we have to take readings for more minutes.
- DAY 5 and 6
    1. After getting global coordinates of all control points, first we feed the coordinates in the total station and we start feature mapping.
    2. We start with gaushala and take reading of each corner of building, trees, electric pole, foothpath, road etc.
    3. We also take readings of contour points of open ground.
- DAY 7
    1. Last day we did Road profiling of 300 m road in arogyadham.
    2. We take 5 readings at each cross section. 2 at ends 1 at center and other 2 at middle of center and end.
    3. mark each cross section at 5m gap from 0 m to 315 m.

6 Discussion and Result

6.1 Rough network of traverse

By starting reconnaissance survey in given Arogyadham area, we select control points such that two consecutive points are visible from each other.

Figure 8: Traverse by Control Points

In above figure we can see, We select total 10 CPs by which we form closed traverse.

6.2 Observation table for traverse

As we collect Distance between consecative control point and angle between them, We apply some checks,

- Apply the check: Sum of Interior angle = (2n-4)*90
- In our case, n = 10 so the sum of exterior angle should be = 1440
- Observed sum of interior angle = 1440.01227
- As the total error = 0.01227
- Distribute the error in all 10 angles equally.

Station	Line	Length (m)	Interior Angle	Corrections	Corrected Angles
p1			92.48972222	0.001277777	92.488444443
	p12	129.433			
p2			242.2238889	0.001277777	242.222611123
	p23	53.511			
p3			209.4175	0.001277777	209.416222223
	p34	58.736			
p4			111.1177778	0.001277777	111.116500023
	p45	45.644			
p5			93.28138889	0.001277777	93.280111113
	p56	101.645			
p6			93.12611111	0.001277777	93.124833333
	p67	105.803			
p7			144.5325	0.001277777	144.531222223
	p78	20.9515			
p8			270.0958333	0.001277777	270.094555523
	p89	69.2945			
p9			97.48472222	0.001277777	97.483444443
	p910	122.582			
p10			86.24333333	0.001277777	86.242055553
	p101	88.5395			
p1					
		Sum	1440.012778		
		should be =	1440		
		Total Error =	0.01277777		
Apply correction to each angle =			0.001277777		

Figure 9: Traverse Check

As the Angle is adjusted, Length is also have to adjust by Bowditch rule.

- Find Whole circular bearing of each line.
- As we already observed Length of each line, use both to find Latitude and departure of each control points.
- Find sum of all Latitude and departure, as we know it is closed loop the sum should be zero.
- But we get some error, so distribute the error by Bowditch rule.
- correction for latitude find as per transit rule
- Same, Correction for departure, find as per transit rule.
- Make table to show all corrected values,

									Consecutive Coordinates				Corrections (Transit Rule)		Corrected Consecutive Coordinates	
									Latitude		Departure		Latitude	Departure	Latitude	Departure
Station	Line	Length (m)	Interior Angle	Corrections	Corrected Angles	Whole Circle Bearings	Quadrantal Bearings	Quadrant	N(+)	S(-)	E(+)	W(-)			N(+)/S(-)	E(+)/W(-)
p1			92.4897	0.0013	92.4884											
	p12	129.433				2.4884	2.4884	NE	129.311		5.620		-0.005	-0.003	129.316	5.623
p2			242.2239	0.0013	242.2226											
	p23	53.511				64.7111	64.7111	NE	22.859		48.383		-0.002	-0.001	22.861	48.384
p3			209.4175	0.0013	209.4162											
	p34	58.736				94.1273	85.8727	SE		4.227	58.584		-0.002	-0.001	-4.225	58.585
p4			111.1178	0.0013	111.1165											
	p45	45.644				25.2438	25.2438	NE	41.285		19.466		-0.002	-0.001	41.287	19.467
p5			93.2814	0.0013	93.2801											
	p56	101.645				298.5239	61.4761	NW	48.538			89.307	-0.004	-0.002	48.542	-89.305
p6			93.1261	0.0013	93.1248											
	p67	105.803				211.6487	31.6487	SW		90.068		55.516	-0.004	-0.002	-90.064	-55.514
p7			144.5325	0.0013	144.5312											
	p78	20.952				176.1799	3.8201	SE		20.905	1.396		-0.001	0.000	-20.904	1.396
p8			270.0958	0.0013	270.0946											
	p89	69.295				266.2745	86.2745	SW		4.503		69.148	-0.002	-0.002	-4.500	-69.147
p9			97.4847	0.0013	97.4834											
	p910	122.582				183.7579	3.7579	SW		122.318		8.034	-0.004	-0.003	-122.314	-8.031
p10			86.2433	0.0013	86.2421											
	p101	88.540				90.0000	90.0000	NE	0.000	0.000	88.540		-0.003	-0.002	0.003	88.541
p1								**summation>**	**-0.028**		**-0.018**					
		796.140														

Figure 10: Corrected Traverse table

6.3 check for Quality of work

Quality of the traversed network

Quality	Permissible limit of closing error
First order	$6''\sqrt{N}$
Second order	$15''\sqrt{N}$
Third order	$30''\sqrt{N}$

N is the number of sides in the traverse.

Quality	Permissible limit of closing error
First order	1: 25000
Second order	1: 10000
Third order	1: 5000

e/p is reported in 1: X format.

Figure 11: Quality check

In our work,
Closing error in distance = 33.28 mm
closing error in angle = 44.2"
As the N = 10, Permissible limit = 47.43 > 33.28 mm hence 2nd order.
and e/p = 1:23922.475 , hence 2nd order.

6.4 Levelling

After carrying out levelling for whole network, perform levelling method to get RLs of each control point. As there are 2 methods for Levelling adjustment i.e. Height of instrument method and Rise and fall method. We use Height of instrument method for our our levelling adjustment. We assume the RL of Bm = 100 m. Here is the observation table for loop.

station	BS			FS			IS			HI	RL	Remerk	Distance(meter)
	US	MS	LS	US	MS	LS	US	MS	LS				
BM	0.110	0.990	0.880							100.990	100.000	Benchmerk	
P2	1.561	1.408	1.246	2.436	2.288	2.140				100.110	98.702	CP	61.100
I12	1.882	1.722	1.581	1.206	1.063	0.917				100.769	99.702	IP(btw P1 and P2	58.980
P1	1.256	1.141	1.025	0.665	0.475	0.285				101.435	100.294	CP	61.100
I110	1.792	1.692	1.592	1.482	1.380	1.278				101.747	100.055	IP(btw P1 and P10)	40.400
P10	0.226	0.133	0.042	1.190	1.062	0.938				100.818	100.685	CP	43.600
I910(1)	0.725	0.611	0.497	2.122	2.039	1.956				99.390	98.779	IP(btw P9 and P10)	39.400
I910(2)	0.316	0.229	0.143	2.171	2.031	0.189				97.588	97.359	IP(btw P9 and P10)	215.510
P9	0.780	0.671	0.563	1.694	1.598	1.500				96.661	95.990	CP	41.100
I89	2.194	2.094	1.094	1.498	1.373	1.248				97.382	95.288	IP(btw P9 and P8)	135.000
P8	1.520	1.468	1.415	0.392	0.331	0.271				98.519	97.051	CP	22.600
P7	0.982	0.886	0.789	1.892	1.812	1.763				97.593	96.707	CP	32.200
IP67	1.145	1.012	0.881	1.892	1.782	1.673				96.823	95.811	IP(btw P6 and P7)	48.300
P6	0.906	0.706	0.506	0.780	0.588	0.398				96.941	96.235	CP	78.200
I65(1)	2.093	1.984	1.913	1.414	1.229	1.043				97.696	95.712	IP(btw P6 and P5)	55.100
I65(2)	0.290	0.171	0.052	1.107	1.040	0.917				96.827	96.656	IP(btw p6 and P5)	42.800
P5	1.616	1.589	1.563	3.167	3.055	2.943				95.361	93.772	CP	27.700
I54(1)	2.377	2.333	2.287	0.750	0.717	0.684				96.977	94.644	IP(btw P5 and P4)	15.600
I54(2)	2.451	2.412	2.374	0.167	0.120	0.072				99.269	96.857	IP(btw P5 and P4)	17.200
P4	1.604	1.509	1.413	0.467	0.423	0.380				100.355	98.846	CP	27.800
I43	1.379	1.305	1.232	1.532	1.447	1.361				100.213	98.908	IP(btw P4 and P3)	31.750
P3							0.928	0.857	0.786	100.213		CP	14.250
BM				0.348	0.208	0.081				100.213	100.005	Benchmerk	26.700
	TOTAL	26.066			26.061								1136.39

Figure 12: Levelling network

Arithmetic Check for levelling :

$$\sum BS - \sum FS = LastRL - FirstRL$$
26.066 - 26.061 = 10.005 - 100 = 0.05

6.5 Quality of level Work

As the closing error = 5 mm
Permissible Error in Levelling is given by E = c$\sqrt{n}$ where n = no. of setups of auto-level and c is constant which depends on, given following table.

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: Table for constant

By checking, n = 21 i.e. no. of setups, $5 < 4\sqrt{21} = 18.33$
hence the quality of work comes under **precise levelling**

6.6 GNSS Survey

We collect accurate coordinates of all control points by Trimble R10 Receiver. Collecting data for each coordinate for 10 to 15 mins and post processing the data, we get exact coordinates of Control points.

Control point name	Easting	Northing	Ellipsoidal ht.
CP1	486380.031	2781721.353	90.926
CP2	486257.749	2781763.685	89.341
CP3	486249.681	2781816.564	90.034
CP4	486270.484	2781871.454	89.512
CP5	486236.519	2781901.897	84.456
CP6	486164.506	2781830.234	86.916
CP7	486234.905	2781751.323	87.376
CP8	486255.312	2781746.691	87.733
CP9	486239.86	2781679.197	86.693
CP10	486354.747	2781636.56	91.339

Figure 14: Data after Post Processing

In above table we can see, We get Easting, Northing and Ellipsoidal height of each control point.

6.7 final map

After collecting and processing all data and use it together in ARC GIS pro, generate the Map of Arogyadham area.

- We digitize Map in ARC GIS pro
- Create separate shape file for each feature.
- Merged them into one map.
- Shape files can be polygon, line, Point.
- Provide contours of Contour interval = 0.5 m
- Provide Legends, Grids, scale and title to map.

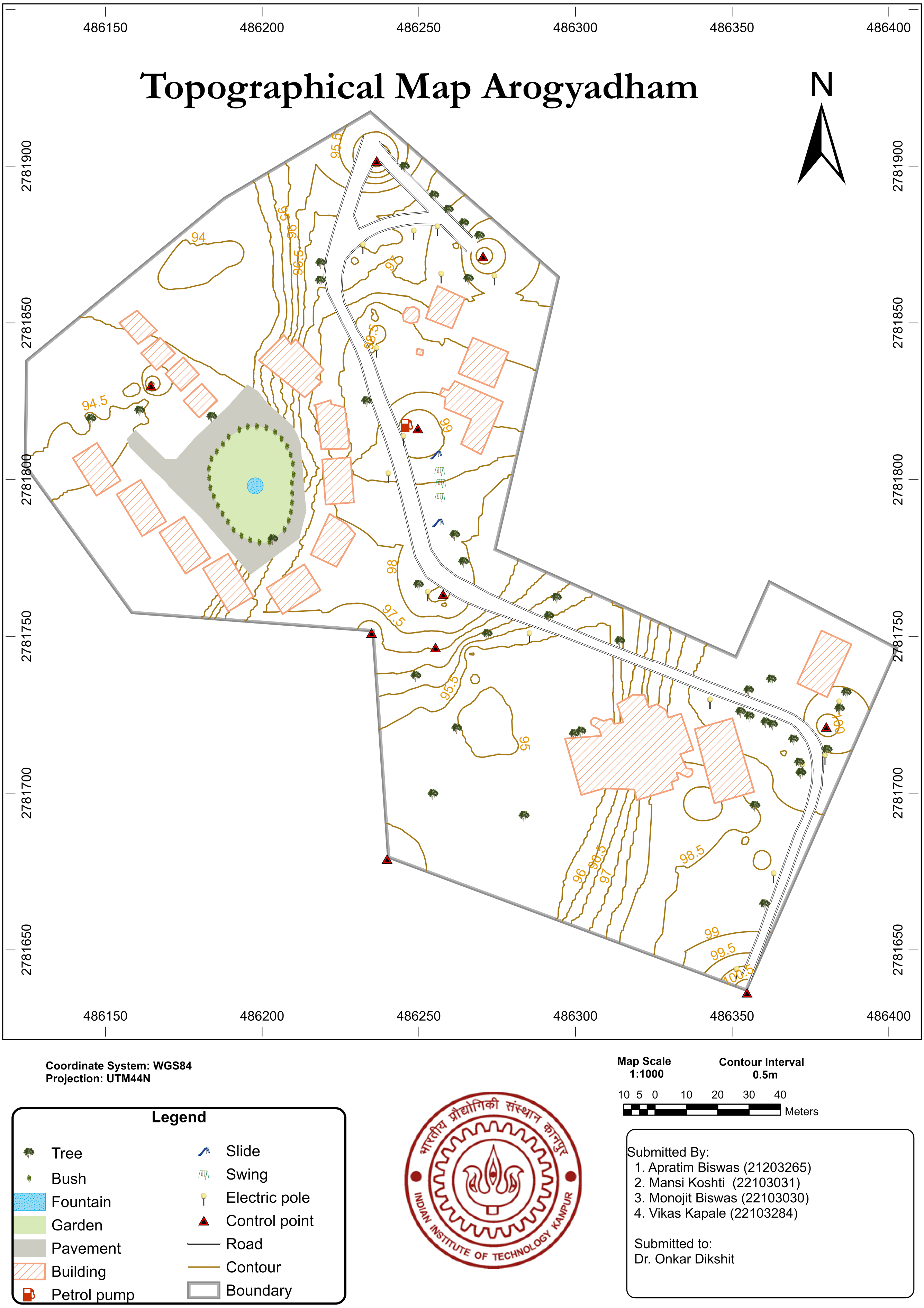

Figure 15: Feature Map

6.8 Juno map

We collect data by Juno 3b hand held device.

- By Importing all data into ARC GIS pro, classify all data by different categories such as, Hospital, school, temple, hotel, etc. into shape file
- Provide symbol for each shape file.
- generate Map.

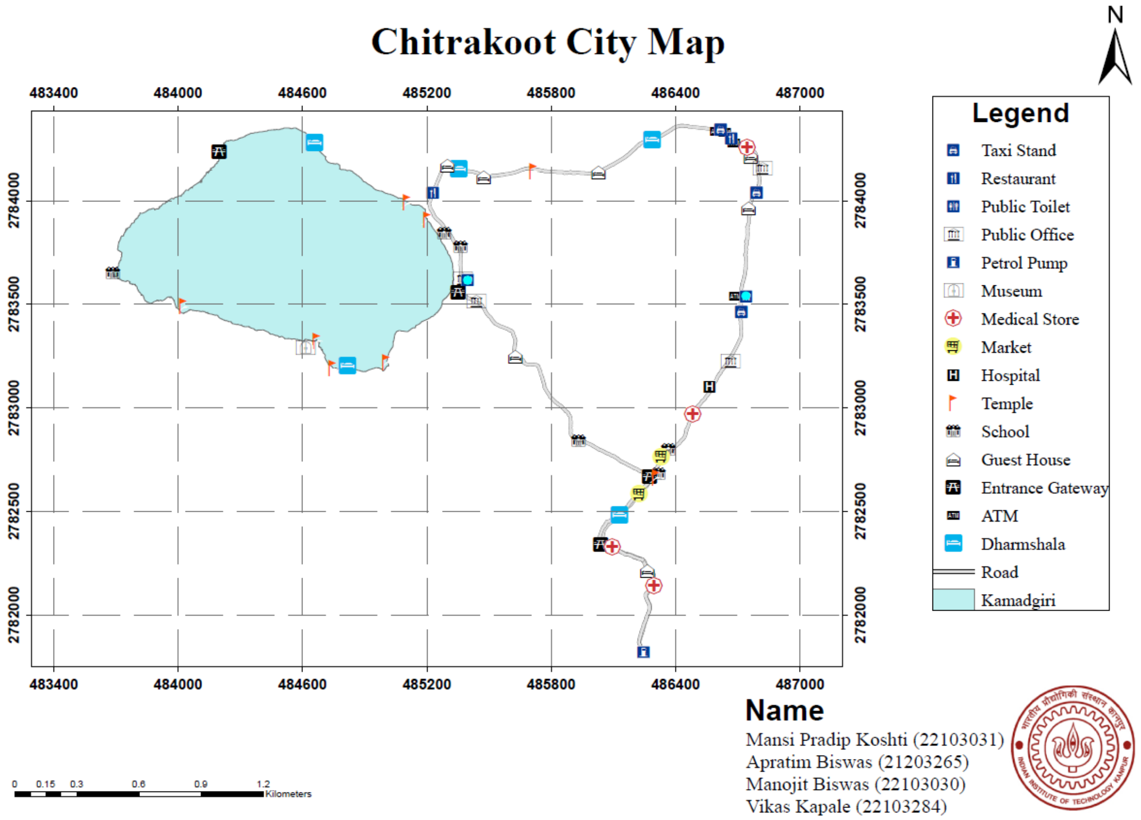

Figure 16: Map by JUNO 3b

6.8.1 Error Measurement

Estimated accuracies for 32909 corrected positions	
Range	Percentage
1-2m	9.20%
2-5m	48.24%
>5m	42.56%

Figure 17: Map by JUNO 3b

Here we can see many points are having accuracy greater than 2 m. The main reason of getting less accuracy is type of Receiver, as we are using navigational Receiver of this, we could not maintain high accuracy.

6.9 Road Profile

As we collect data for making road profile of main road of Arogyadham. We plot the data in Matlab, We get the results as,

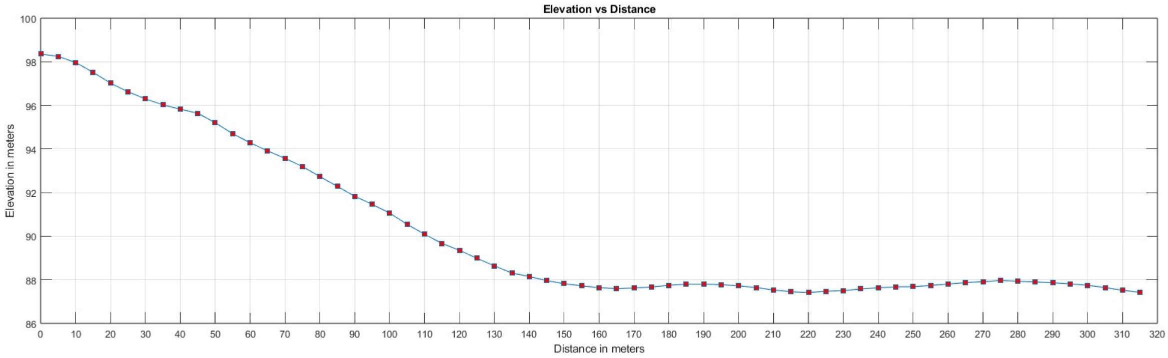

Figure 18: Road Profile

The road has 350 m length. We plot section at each 5m of length.

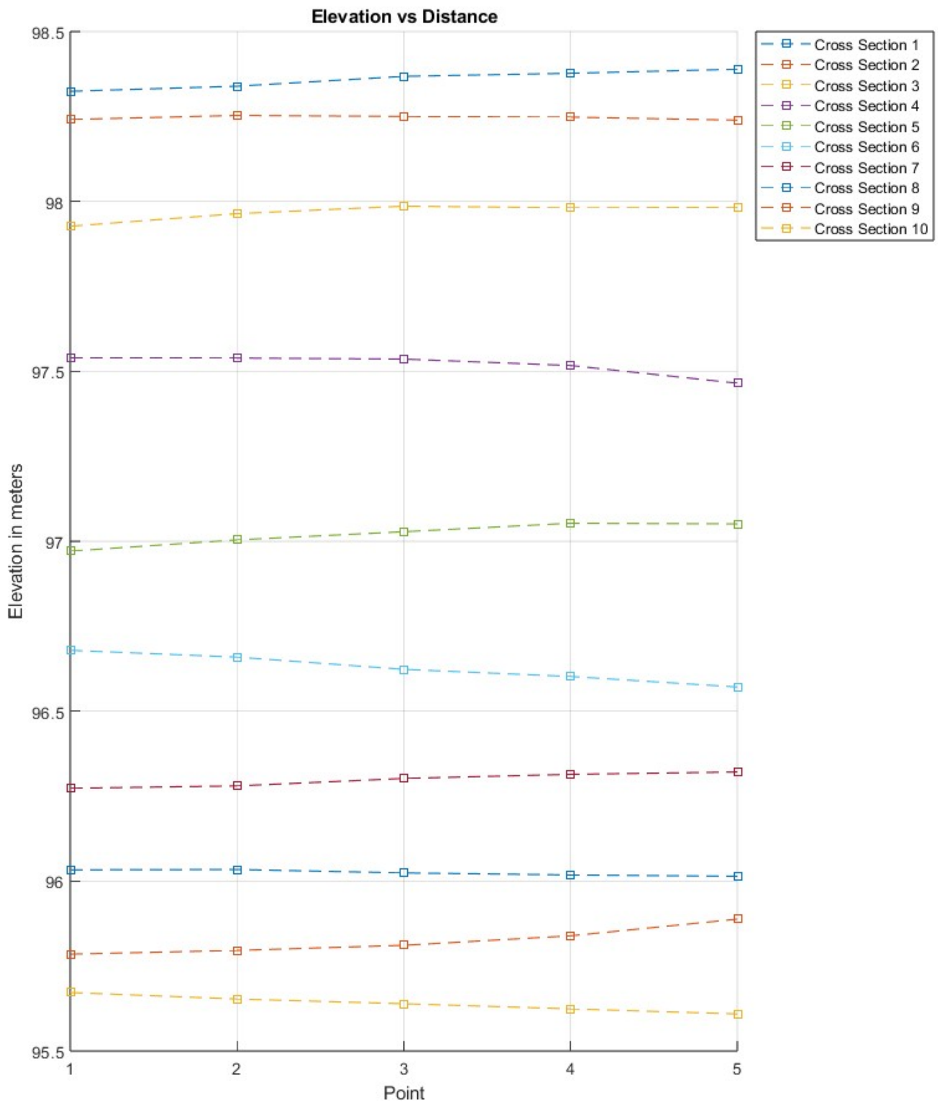

Figure 19: section of road

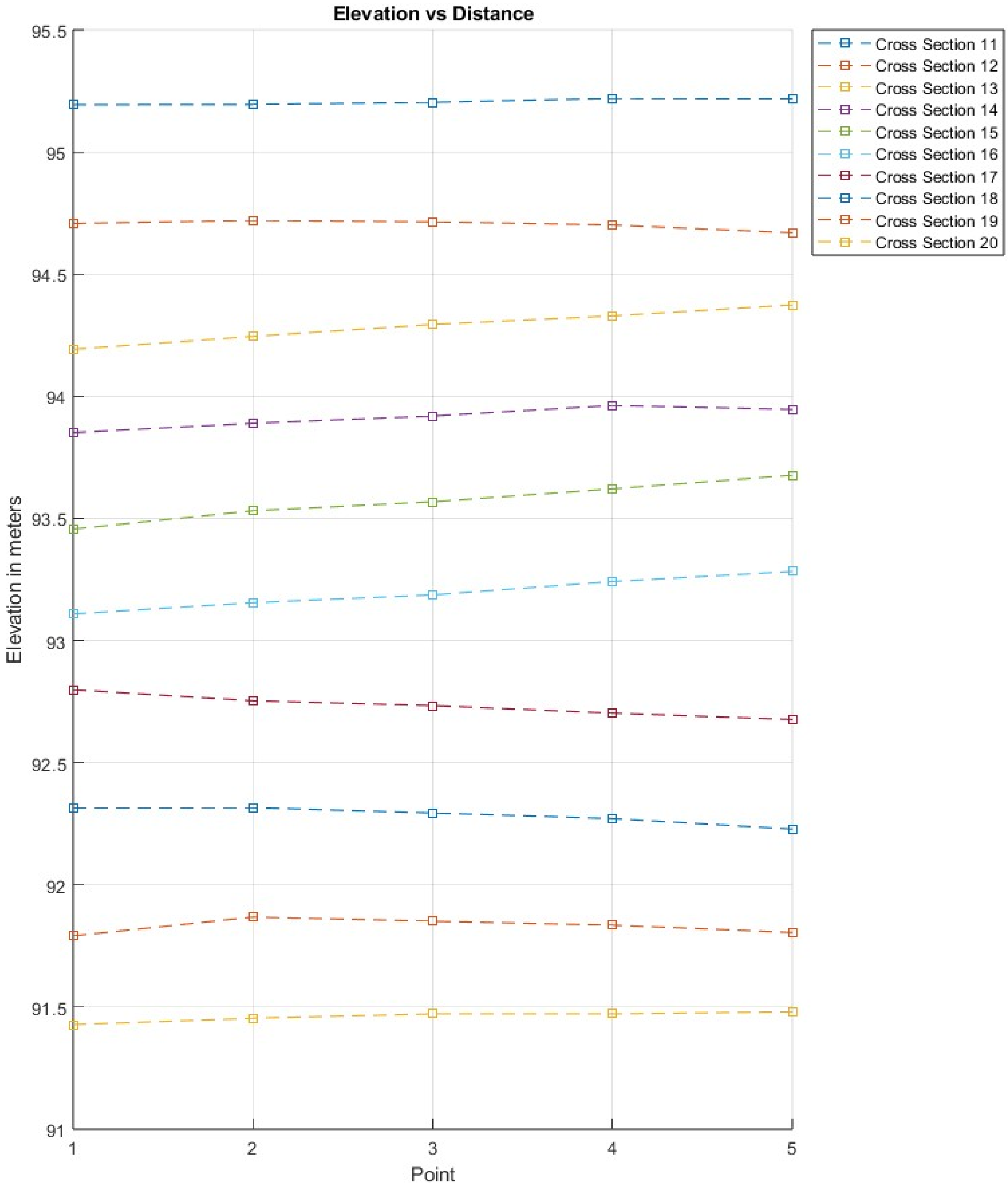

Figure 20: Section of road

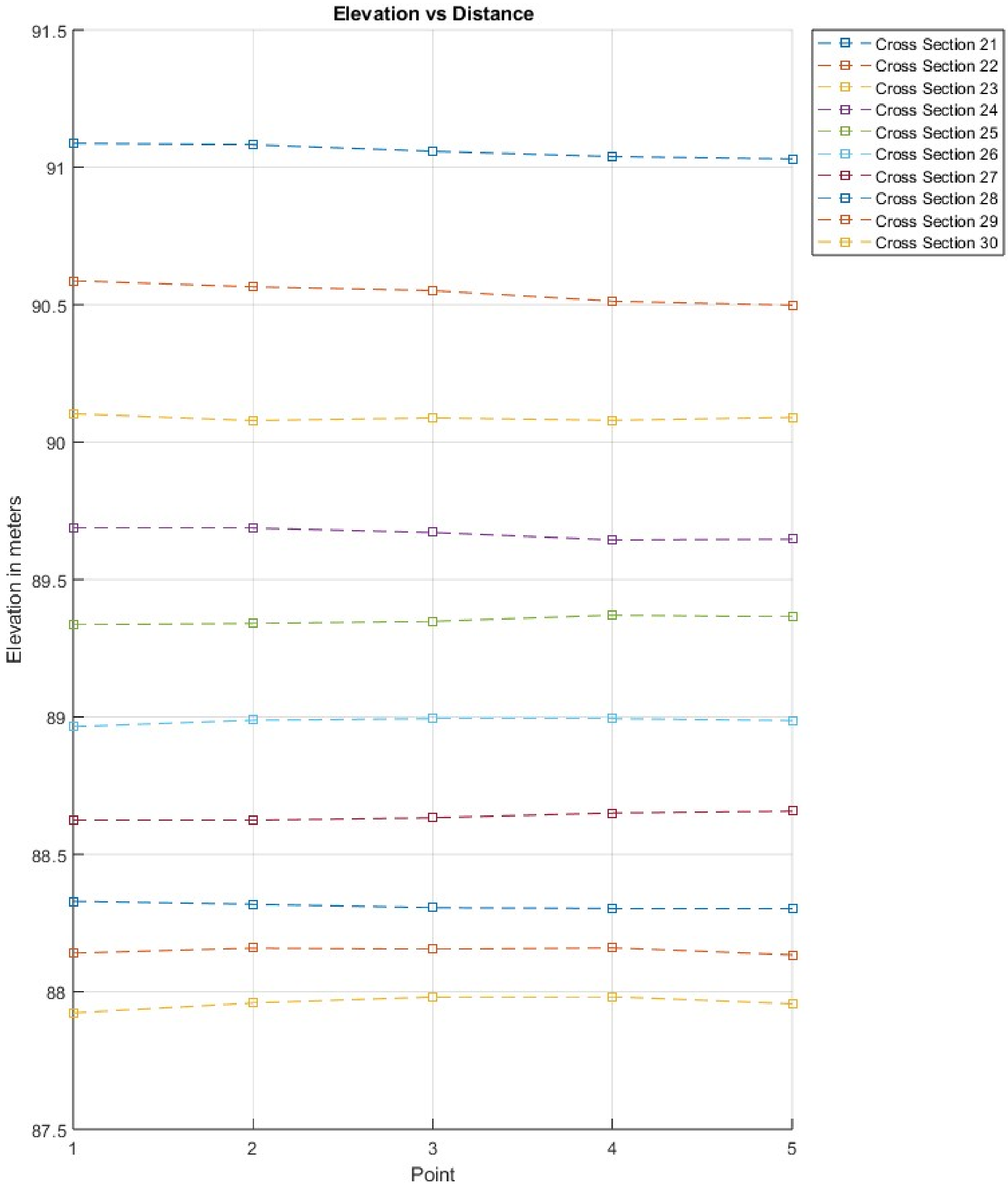

Figure 21: section of road

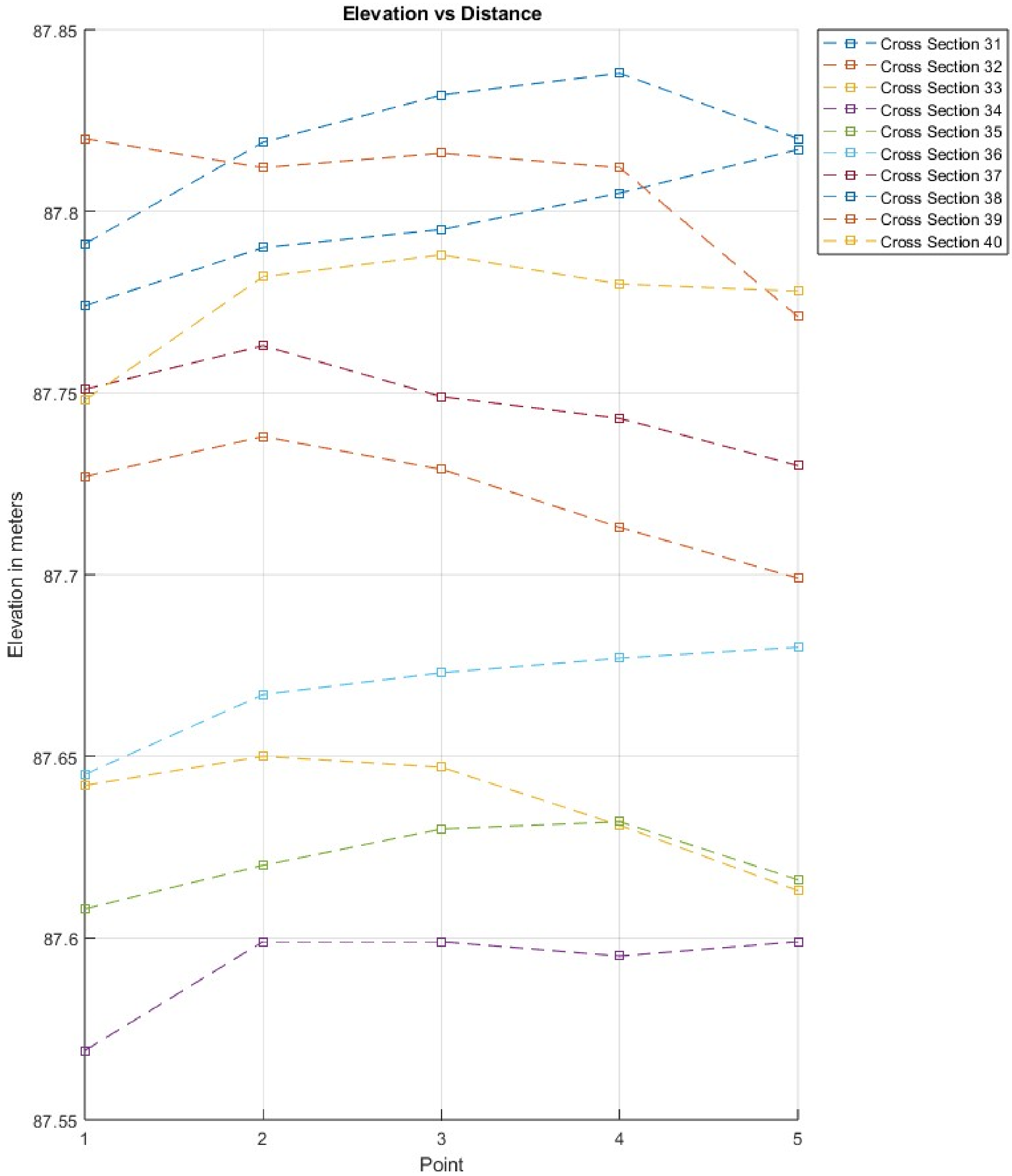

Figure 22: section of road

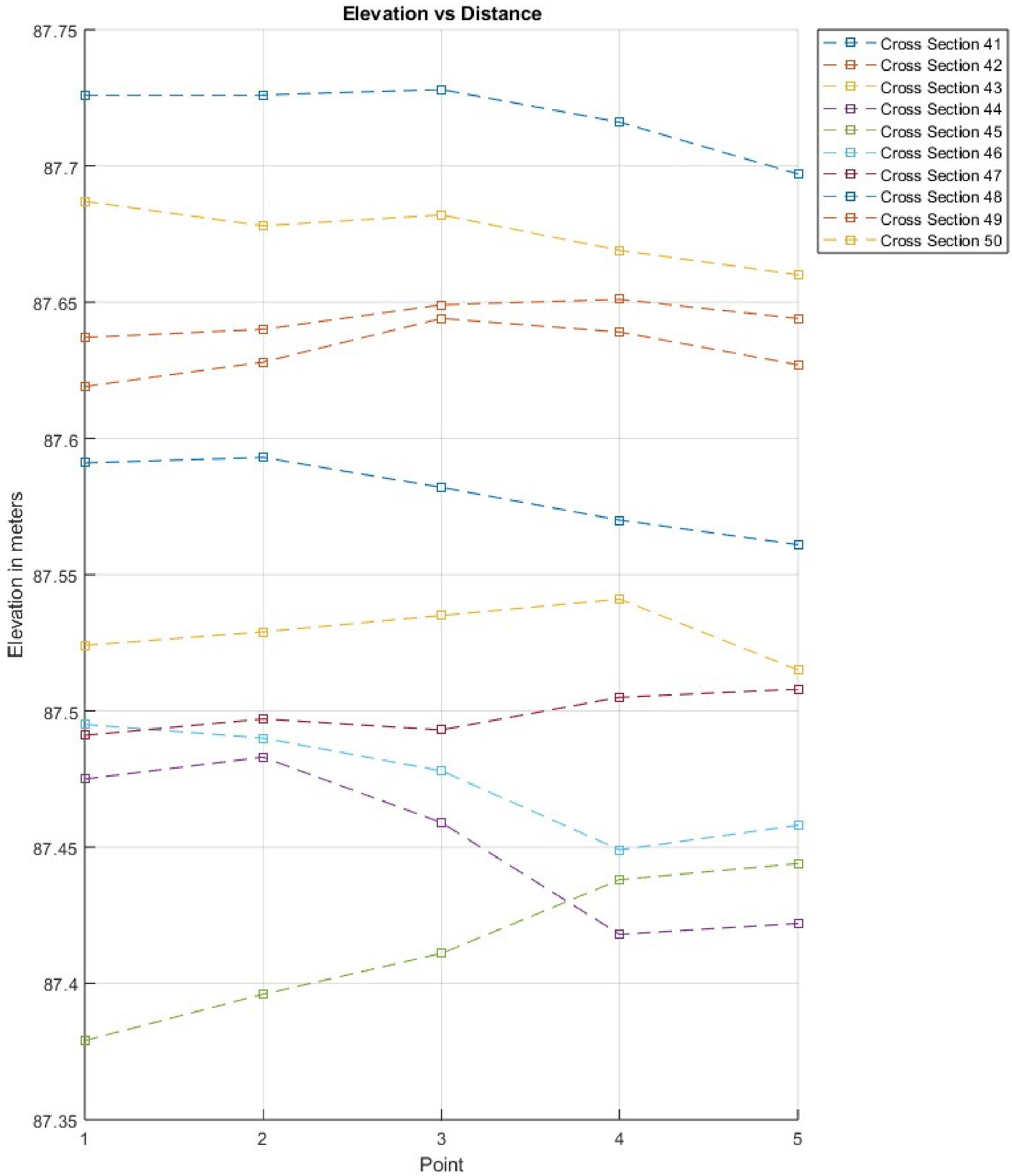

Figure 23: section of road

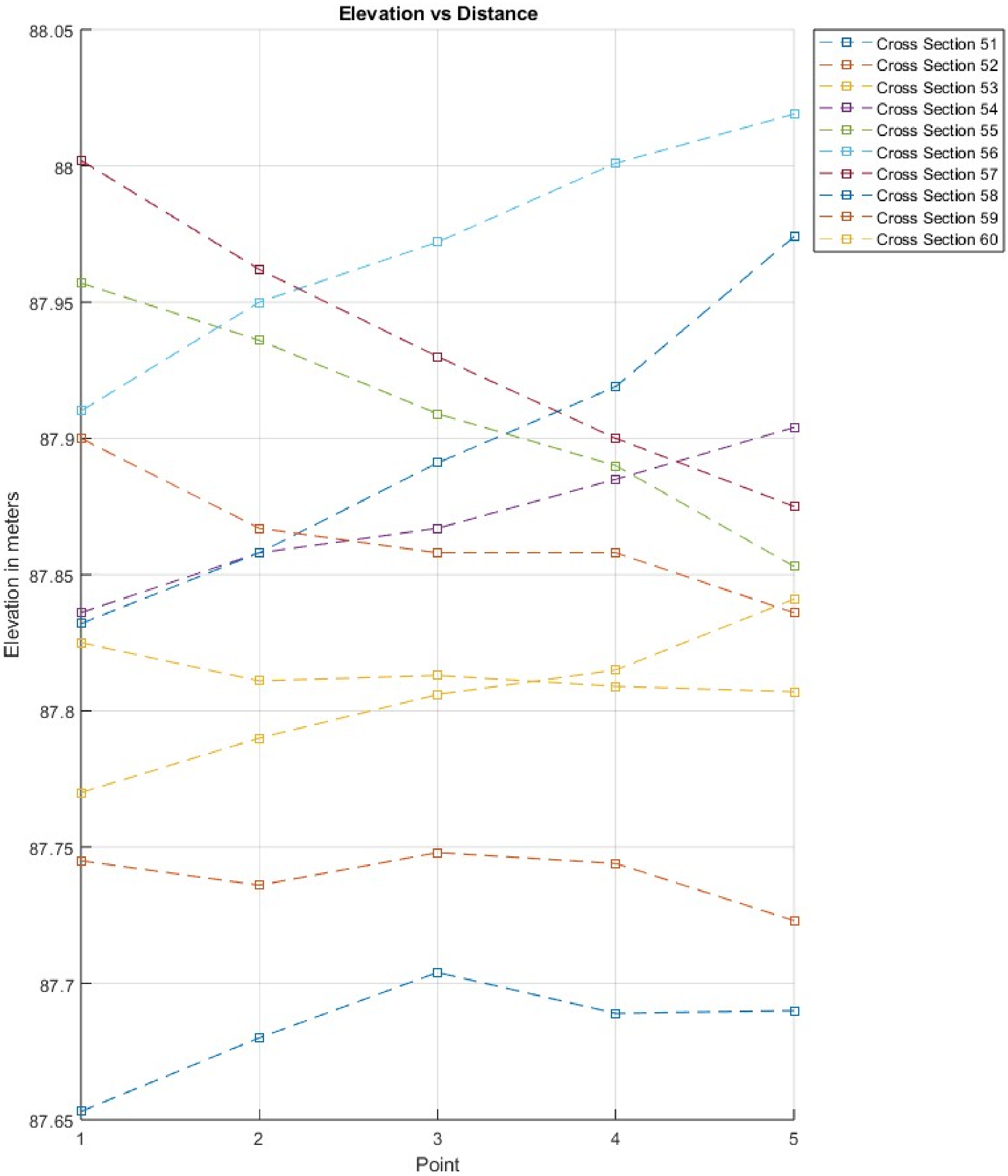

Figure 24: section of road

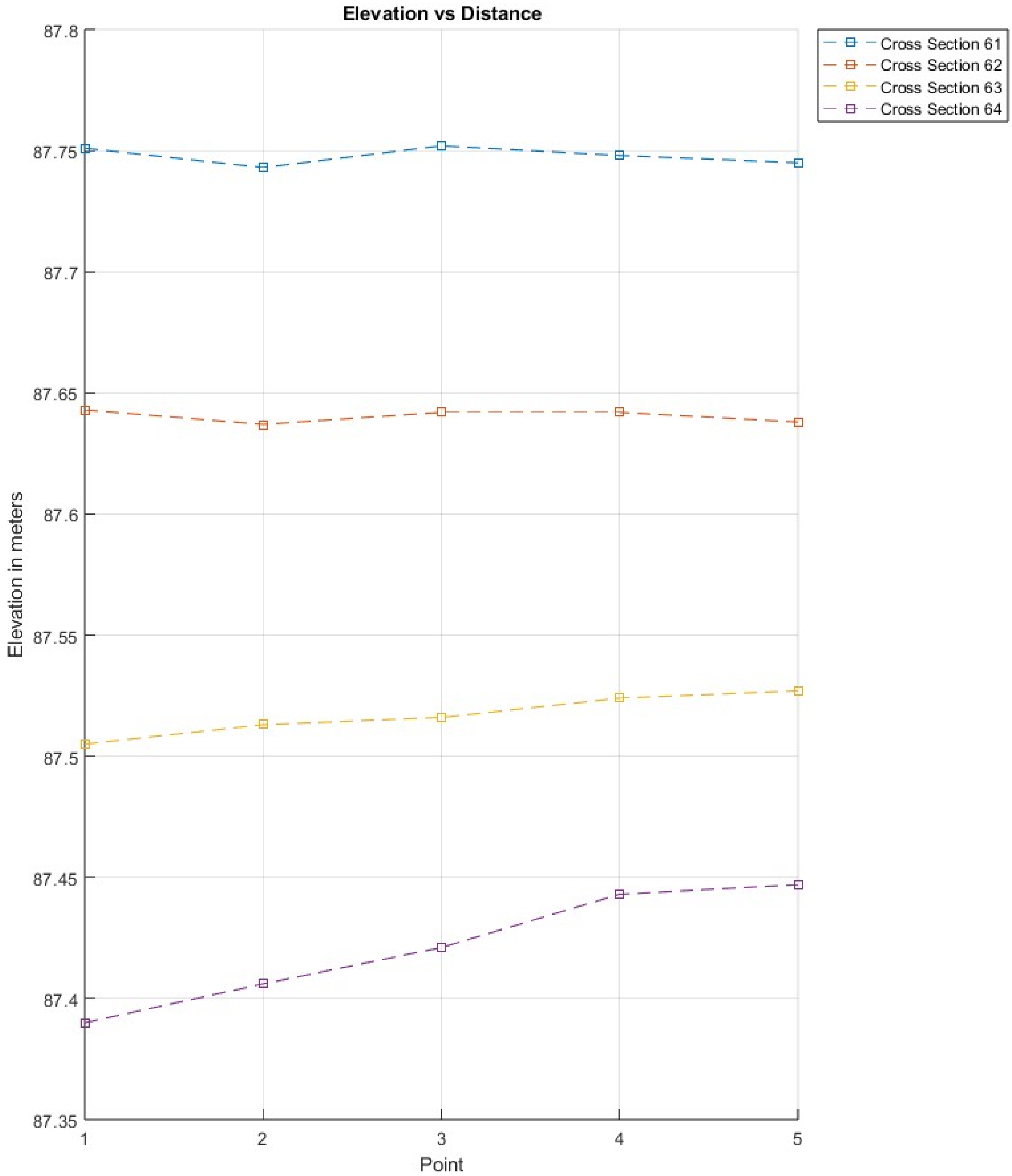

Figure 25: section of road

7 Conclusion

We can see, the map we make by Juno 3b handheld device is not that much accurate, as we are using navigation GNSS receiver, which is less accurate than Geodetic receivers. The accuracy of navigation GNSS receivers are in order of few meters. So, these Receiver is good for small scale maps or for big areas. As the cost of juno 3b handheld device is less compare to geodetic receiver. We can prefer it over Geodetic for mapping of large areas. In Feature mapping we collect all data i.e. coordinates in cartesian coordinates system for this we use Total station for traversing, auto level to get heights, GNSS survey to get coordinates in WGS- 84. For this we use Geodetic GNSS Receiver. AS we know Geodetic Receiver has more accurcy than Navigational Receiver. This receivers are used for large scale mapping where we have to show small features accurately. Other than GNSS Receiver, we also use Total station, Auto level for taking reading. By total station we form traverse of control points. By finding Accurate coordinates of CPs, It is easy to get all features near by area. By auto level we got height data which we use for feature mapping. As we have to submit the map into A3 size, and the area to be mapped was about 200 by 200 m we took scale of 1:1000.
In this course we learn about handling all survey instruments which we use in precise survey work. As well we learn digitizing the map into ARC GIS pro.