CHAPTER FOUR

4.0 DATA DOWNLOADING, PROCESSING, ANALYSIS AND DISCUSSION

This chapter provides a detailed overview of the procedures involved in data download, data processing, correction, and data analysis conducted on the acquired data from the site and data presentation.

4.1 Data Download

All the recorded data was stored in the memory of the total station. To download the data, the total station was connected to a computer using a wired cable and downloading software. The software parameters were configured to match those of the instrument. The instrument's menu was accessed, and the memory manager was selected. From there, the "send data" option was chosen, and the file named "PRJT1" was located and downloaded to the computer through the software. The data was saved with a ".txt" file extension on the desktop of the laptop for further processing.

4.2 Data Editing

The downloaded geometric data were further processed to convert them into usable formats and improve their accuracy. The resulting coordinate data were edited using Notepad and Excel software. This file was then imported into AutoCAD2007 for additional processing.

4.3 Data Processing using Autocad 2007

Before using AutoCAD, we processed the coordinate data observed in the field by first transferring it into Notepad, then copying it into AutoCAD. The following steps outline the process for handling the data in AutoCAD:

1. Launch AutoCAD on the computer.
2. Click "New" from the application menu to start a new drawing.
3. Type UNITS in the command line and press Enter.
4. Select the desired unit type (e.g., decimal, architectural, engineering).
5. In the menu bar, select the "Polyline" tool.
6. Copy the data from Notepad and paste it into AutoCAD.
7. Type Z (for zoom) and press Enter, then type E (for extents) and press Enter to adjust the view.

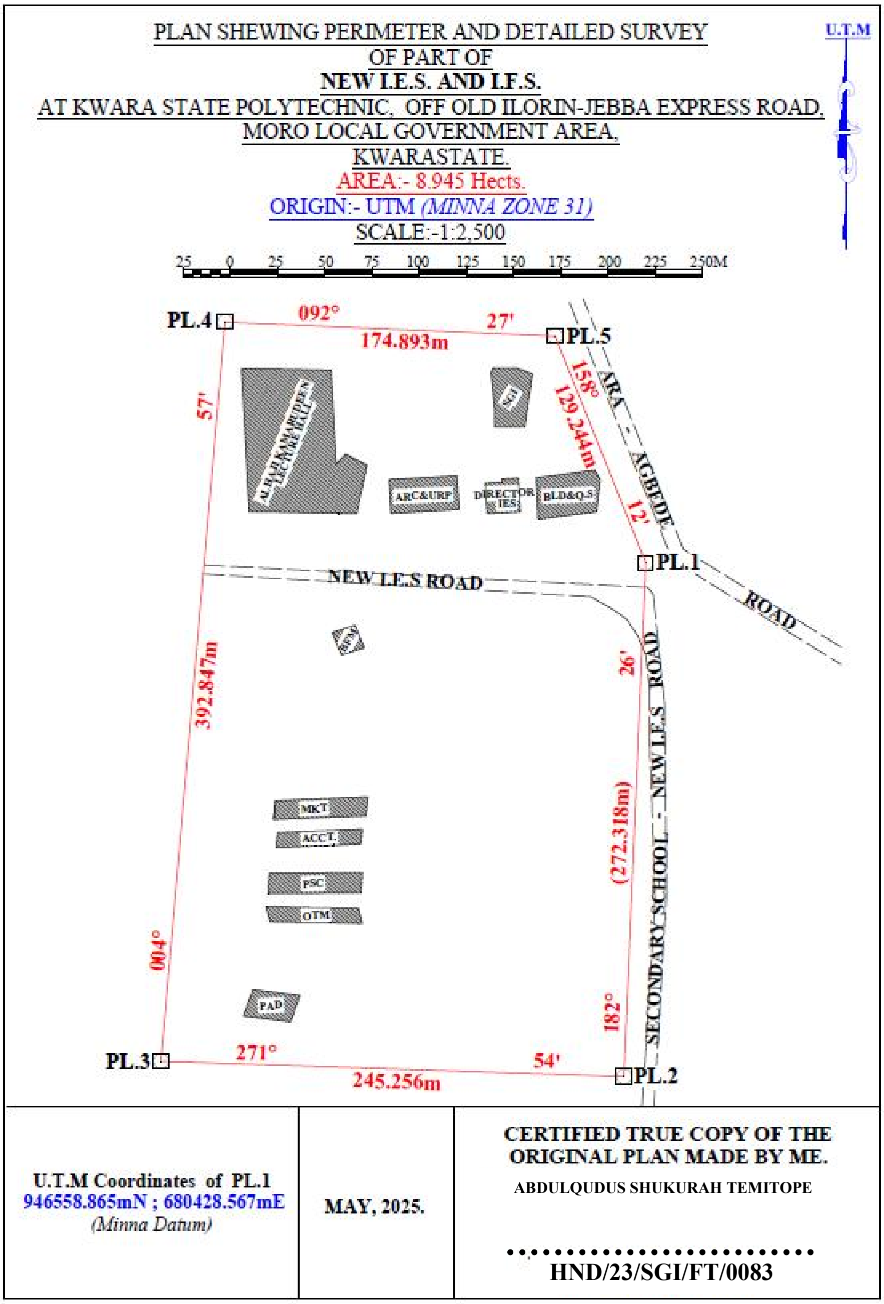

Figure 3.7: *Plan showing Perimeter and Detailed Survey.*

Area Computation using Cross Multiply Coordinates

E1 N1

E2 N2

E3 N3

E4 N4

E5 N5

E1 N6

680428.567	946558.865
680417.004	946286.792
680171.885	946294.956
680205.833	946686.334
680380.567	946678.865
680428.567	946558.865

$$\frac{\sum \quad - \quad \sum}{2}$$

$$\frac{460{,}787{,}138{,}011.03 - 460{,}786{,}959{,}116.36}{2}$$

$$\frac{178{,}894.67}{2}$$

Area = 89,447.335 sqft

Area = 8.945 hect.

4.4 Results and Discussion

Table 4.4: *Total station and Digital level Spot height Readings and their differences*

STATIONS	EASTING	NORTHING	HEIGHT		DIFF.
			T.S	LEVEL	
PT1	680272.275	946497.781	355.749	355.715	0.034
PT2	680267.717	946479.907	356.403	356.362	0.041
PT3	680273.327	946450.469	354.811	354.772	0.039
PT4	680287.358	946434.349	354.268	354.208	0.060
PT5	680317.873	946433.648	355.036	354.984	0.052
PT6	680304.544	946455.727	355.710	355.668	0.042
PT7	680337.867	946463.436	355.448	355.386	0.062
PT8	680342.774	946441.708	356.295	356.240	0.055
PT9	680342.774	946441.708	356.736	356.680	0.056
PT10	680348.740	946443.460	355.971	355.931	0.040
PT11	680377.262	946451.836	355.725	355.673	0.052
PT12	680382.060	946482.711	355.318	355.277	0.041
PT13	680381.009	946518.108	354.819	354.766	0.053
PT14	680350.494	946509.345	355.174	355.128	0.046
PT15	680356.104	946484.813	355.033	355.005	0.028
PT16	680332.603	946480.960	355.228	355.188	0.040
PT17	680308.051	946470.796	355.517	355.464	0.053

PT18	680298.581	946490.422	355.834	355.802	0.032
PT19	680318.222	946506.191	355.726	355.678	0.048
PT20	680308.753	946526.168	356.148	356.096	0.052
Mean			**355.8163**	**355.7726**	**0.0437**
Variance			**2.5758**	**2.5881**	**0.0123**
Standard Deviation			**1.6049**	**1.6088**	**0.0039**

Working Formulas for Mean, Variance and Standard Deviation Calculation

The mean is calculated as:

$$\mu = \frac{\sum x_i}{n}$$

μ= mean

$x_i =$ each point height

$n =$ number of points

The variance is calculated as:

$${}^{2} = \frac{\sum (x_i - \mu)^2}{n}$$

$^{2} =$ variance

$x_i =$ each point height

μ= mean

$n =$ number of points

The Standard Deviation is calculated as:

$$= \sqrt{\quad {}^{2}}$$

= standard deviation

^{2}= variance

Mean calculation for Total Station Height readings

$$\mu = \frac{\sum xi}{n}$$

$$\mu = \frac{355.749+356.403+354.811+354.268+355.036+355.710+355.448+356.295+356.736+355.971+355.725+355.318+354.819+355.174+355.033+355.228+355.517+355.834+355.726+356.148}{20}$$

$$\mu = \frac{7116.326}{20}$$

μ=**355.8163**

Mean calculation for Reduced Level Height readings

$$\mu = \frac{355.715+356.362+354.772+354.208+354.984+355.668+355.386+356.240+356.680+355.931+355.673+355.277+354.766+355.128+355.005+355.188+355.464+355.802+355.678+356.096}{20}$$

$$\mu = \frac{7115.452}{20}$$

μ = **355.7726**

Mean calculation for Total Station Height readings - Mean calculation for level height readings 355.8163 – 355.7726 = 0.0437

$$^{2}=\frac{\sum(xi-\mu)^2}{n}$$

$$^{2}=\frac{\sum(xi-\mu)^2}{n}$$

$$\frac{0.0673^2+0.5867^2+1.0053^2+1.5483^2+0.5327^2+0.2521^2+0.1582^2+0.4126^2+0.9284^2+0.0992^2+0.1104^2+0.1327^2+1.0217^2+0.6184^2+0.7834^2+0.4926^2+0.2581^2+0.0164^2+0.0428^2+0.3317}{20}$$

$$^{2}=\frac{51.516}{20}$$

$$^{2}=\mathbf{2.5758}$$

Variance calculation for Reduced Level Height readings

$$\frac{0.576^2+0.5894^2+1.006^2+1.5686^2+0.5285^2+0.2375^2+0.1382^2+0.4103^2+0.9126^2+0.0821^2+0.1013+0.1104^2+1.0102^2+0.6014^2+0.7695^2+0.4818^2+0.2443^2+0.0071^2+0.0289^2+0.32047}{20}$$

$$^{2}=\frac{51.762}{20}$$

$$^{2}=\mathbf{2.5881}$$

Variance calculation for total station – variance calculation for level height readings 2.5758 – 2.5881 = 0.0123

The Standard Deviation for Total Station Height readings:

$= \sqrt{\quad}^{2}$

$= \sqrt{2.5758}$

$=$ **1.6049**

The Standard Deviation for Reduced Level Height readings:

$= \sqrt{2.5881}$

$=$ **1.6088**

The standard deviation for total station – standard deviation for level height reading 1.6049 – 1.6088 = 0.0039

The table above shows the station Id, eastings, northings, total station height, digital level reduced level and the difference between the total station height and the digital level reduced level.

The comparison of the two pieces of equipment revealed variations within a specific range. The differences observed between the two pieces of equipment were found to be in the range of 0.028 to 0.062 meters. These differences indicate slight disparities in the measurements obtained from each instrument. Statistical analysis was performed to evaluate the mean, variance, and standard deviations of the observed differences. The mean difference was calculated to be 0.0437, indicating an average deviation between the measurements obtained by the two equipment. The variance, which quantifies the spread of the differences, was found to be 0.0123.

This value suggests that the variations in the measurements obtained by the two pieces of equipment were relatively consistent. The standard deviation, which provides a measure of the dispersion of the data, was determined to be 0.0039. This indicates that the differences between the measurements obtained from the two pieces of equipment had a moderate level of variability.

Overall, the results of the analysis demonstrate that there were slight variations between the measurements obtained from the two pieces of equipment. The mean, variance, and standard deviations provide insights into the magnitude and consistency of these differences, offering valuable information for assessing the accuracy and reliability of the equipment in question.

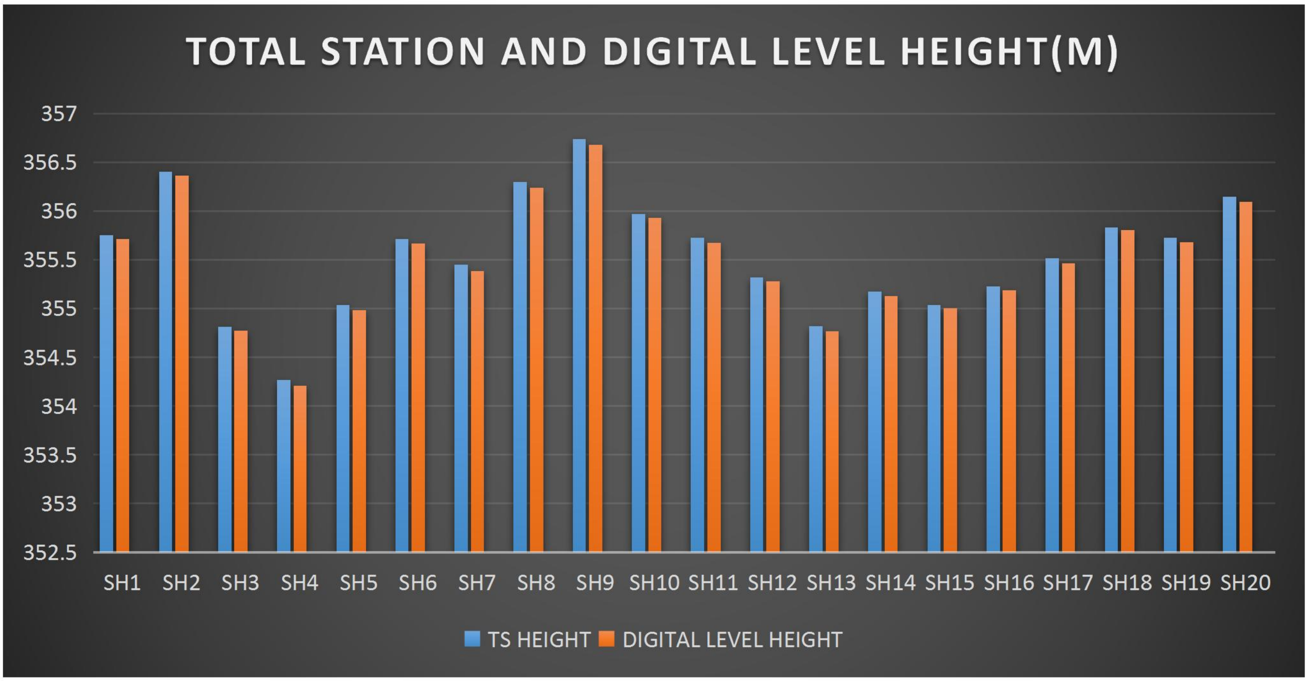

Figure 1:*Bar chart showing heights obtained from the total station and level instrument*

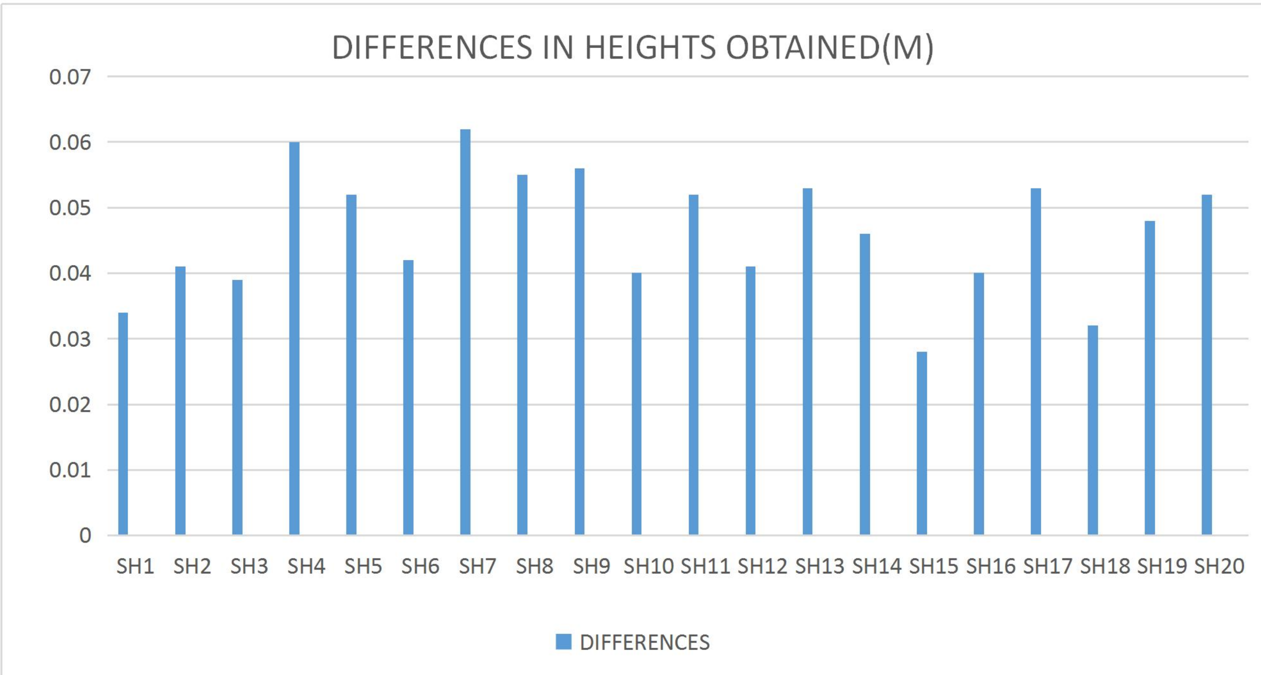

Figure 2:*Histogram showing the difference in the two instrument's result*

The histogram presented above illustrates the distribution of deviations between the two methods being compared. The deviations are depicted in centimeter, showcasing the level of accuracy achieved by both methods. The histogram highlights that the deviations are tightly clustered and exhibit a consistent pattern.

CONTOUR MAP USING AUTO LEVEL **CONTOUR MAP USING TOTAL STATION**

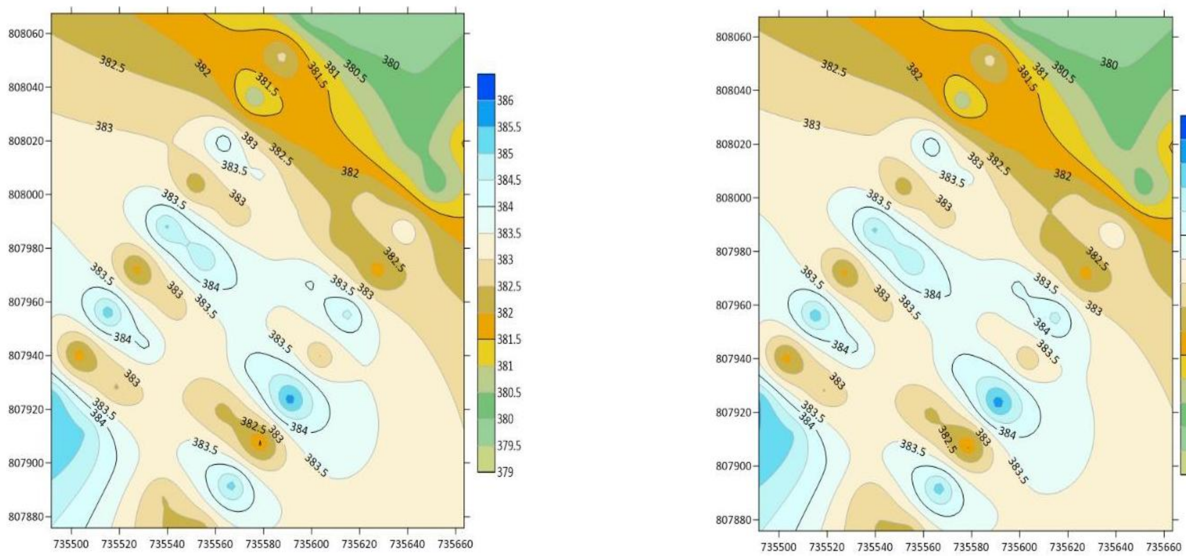

Figure 3: *Showing the contour map obtained from the two instrume*

3-D SURFACE MODEL USING AUTO LEVEL **3-D SURFACE MODEL USING TOTAL STATION**

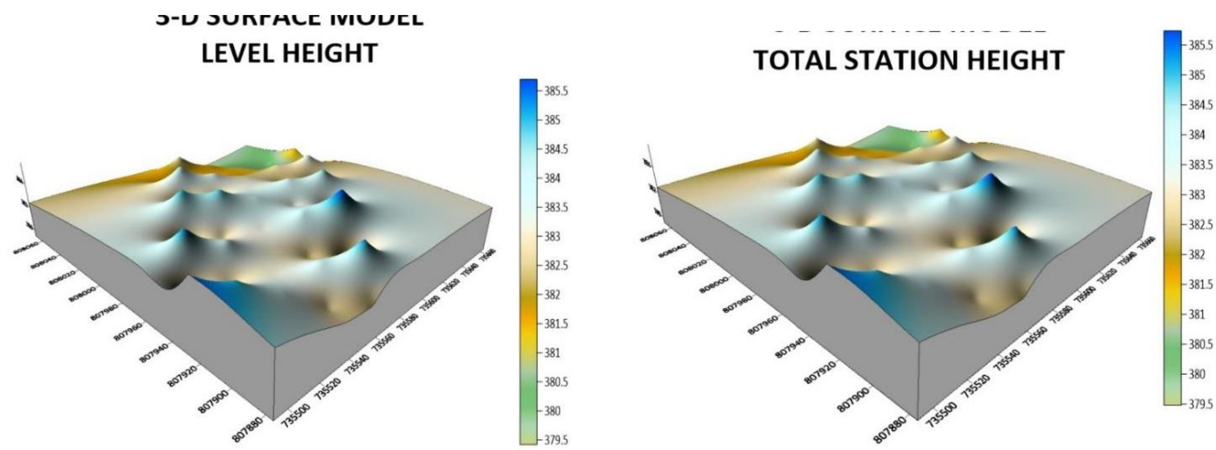

Figure 4: *Showing the 3D surface map obtained from the two instruments*

The mean of the deviations, calculated to be 0.0437m, provides an indication of the average difference between the measurements obtained from the two methods. This value signifies a small average deviation, suggesting that the two methods generally yield similar results with minimal variation.

The histogram provides a visual representation of the data, allowing for a comprehensive understanding of the distribution of deviations. By examining the histogram, one can observe the concentration of deviations around the mean value, indicating a central tendency in the measurements obtained by the two methods.

The centimeter-level accuracy exhibited by the deviations underscores the precision of the measurement techniques employed. This level of accuracy is crucial, particularly in applications that require high precision, such as engineering, construction, or geospatial analysis. The contour maps presented above exhibit strikingly similar patterns, which serve as a testament to the high degree of precision achieved by the instruments used. The consistent and replicated patterns observed on the maps reinforce the reliability and accuracy of the measurements obtained.

The similarity in the contour patterns indicates that the instruments employed in the surveying process were able to capture the subtle variations in elevation with great precision.

This level of accuracy is crucial in applications such as topographic mapping, land surveying, and engineering, where even minor deviations can have significant implications. By displaying the contours of the surveyed area, the maps provide a visual representation of the landscape's topography and elevation changes.

The congruity in the contour lines across the maps signifies that the instruments effectively captured and recorded the elevation data, resulting in a reliable representation of the terrain

4.5 Statistical Analysis

A statistical investigation was carried out using Paired Two Samples as Means to test whether there is any significant difference in the performance of the two instruments for terrain height determination. The independent sample t-test is a member of the t-test family, which consists of tests that compare mean value(s) of continuous-level (interval or ratio data), normally distributed data (Hinton, 2004). The independent-sample t-test evaluates the difference between the means of two independent or unrelated groups. That is, we evaluate whether the means for the two independent groups are significantly different from each other.

Hypothesis

A hypothesis was set up and tested using an Independent – sample T-Test:

1. Null Hypothesis: H0: There is no difference between the terrain height obtained from the total station and digital level instrument.

2. Alternative Hypothesis: H1: There is a difference between terrain height obtained from total station and digital levelling instrument.

The null hypothesis is rejected if the calculated t value has a probability sig. (p) greater than the chosen significance level. An Independent sample T-Test was used in testing the hypothesis at a significance level of 0.05. Data analysis Package extension in Excel was activated and used in running the T-Test.

Table 4.5: *T-Test: Two-Sample Assuming Unequal Variances*

	Digital Level	**Total Station**
Mean	355.77262	355.81628
Variance	2.588092118	2.575687471
Observations	20	20
Pearson Correlation	0.032104369	0.031950494

Hypothesized Mean Difference	0.001605218	0.001597525
t Stat	0.056215684	0.056208782
P(T<=t) one-tail	0.145413689	0.144776257
P(T<=t) two-tail	0.290982737	0.289552551
Sum	7096.631	7095.814
Kurtosis	2.049052417	2.0403051292
Skewness	0.612867732	0.5907755549
Median	354.772	354.811
Maximum	356.680	356.736
Minimum	354.208	354.268
Range	2. 472	2.468

The statistical data provided supports our discussion by indicating a high degree of agreement and consistency between the digital level and total station measurements. The mean values are very close, the variances are similar, and the Pearson correlation coefficient indicates a strong linear relationship. The t-test results suggest that any observed difference between the two instruments' means is likely due to random variation rather than a significant discrepancy. After carrying out the project, we observe that digital level is more accurate than total station, although the different can be quite small.