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Level : 3^{rd} year in civil engineering

LAB REPORT

For The Topography PW

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Contents

1 Introduction

This report documents the practical application of surveying techniques for measuring distances and elevations. Three methods were explored. Each method's procedure, results, and calculations are presented, focusing on practical application and data analysis.

2 Measurement of Distances

2.1 Objective

To calculate **horizontal distances** using the NIVEL device and a leveling rod based on staff readings.

2.2 Equipment :

- **NIVEL (Engineer's Level).**
- **Leveling rod (graduated staff)**
- **Tripod.**
- **Optional: Calculator or scale for computation.**

(A) Nivel

(B) Tripod

(C) Graduated Stuff

Procedure

1. **Set Up the NIVEL:**
    - Mount the NIVEL on the tripod and secure it in place.

- Adjust the leveling screws until the bubble is centered in the spirit level.

2. **Take Staff Readings:**
   - Align the device with the leveling rod held vertically.
   - Note the following readings from the staff:
     - **Top Reading (T)**: Highest visible graduation on the staff.
     - **Bottom Reading (B)**: Lowest visible graduation on the staff.
     - **Middle Reading (M)**: For elevation measurement (not used for distance calculation).
3. **Calculate the Distance:**
   - Using the formula, compute the horizontal distance D between the NIVEL and the staff.
4. **Repeat if Necessary:**
   - If measuring a long distance, repeat the process for successive positions.

2.3 Expression of results

Theory

The distance is determined by the difference between the top and bottom staff readings, scaled by a factor of 100 for metric graduations.

The formula for horizontal distance D is:

$$D = (T - B) \times 100$$

Where:

- T: Top reading (highest visible point on the staff)
- B: Bottom reading (lowest visible point on the staff)

Numerical substitution

- Top Reading (T): 1.50 m
- Bottom Reading (B): 1.45 m

$$D = (1.50 - 1.45) \times 100 = 5\,\text{m}$$

2.4 Conclusion

Using a nivel and leveling rod, the horizontal distance was determined to be 5 meters.

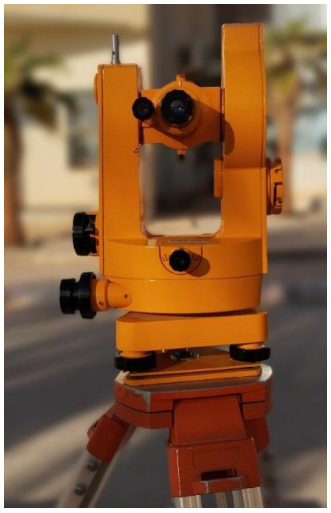
3 Measurement of Angles

3.1 Objective

This practical focuses on measuring distances indirectly using **vertical angles**. The method applies trigonometric principles to calculate horizontal and inclined distances based on angular observations and known height differences

3.2 Equipment :

- **Theodolite**
- **Leveling rod (graduated staff)**
- **Tripod.**
- **Optional: Calculator or scale for computation.**



(A) theodolite

(B) Tripod

(C) Graduated Stuff

3.3 Operating Procedure

1. **Set the Theodolite:**
   - Mount and level the instrument over the observation point.
2. **Take Vertical Angle Readings:**
   - Sight the target point with the telescope in the left circle position and record the vertical angle (V_L).

- Flip the telescope to the right circle position and record the vertical angle (V_R).

3. **Calculate the Vertical Angle (V_A):**
   - Use the formula:
   $$V_A = V_L + (400 - V_R)$$

4. **Proceed with Distance Calculations:**
   - Use the formula:
   $$D_h = (U - L) \cdot 100 \cdot \sin^2(V_A)$$

3.4 Expression of results

- $V_L = 100.68\,\text{gradians}$
- $V_R = 299.56\,\text{gradians}$
- $U = 1.465\,\text{m}$
- $L = 1.219\,\text{m}$

Calculating the Vertical Angle V_A

$$V_A = \frac{V_L + (400 - V_R)}{2}$$

Substituting the values:

$$V_A = \frac{100.68 + (400 - 299.56)}{2}$$

$$V_A = \frac{201.12}{2} = 100.56\,\text{gradians}$$

Calculating the Distance D_h

$$D_h = (U - L) \cdot 100 \cdot \sin^2(V_A)$$

$$D_h = (1.465 - 1.219) \cdot 100 \cdot \sin^2(100.56)$$

$$D_h = 24.6\,\text{m}$$

3.5 Conclusion

Using a theodolite and trigonometric calculations, the horizontal distance (Dh) to the target point was determined to be 24.6 meters. This was achieved by measuring vertical angles (VL = 100.68g, VR = 299.56g) and the upper (U = 1.465m) and lower (L = 1.219m) staff readings. The calculated vertical angle (VA) used in the distance calculation was 100.56 gradians.

4 Direct leveling by closed traverse

4.1 Objective

The purpose of this practical is to perform direct leveling by a closed traverse to determine **the elevation differences** between various points within a closed loop.

4.2 Equipment :

- **NIVEL (Engineer's Level)**
- **Leveling rod (graduated staff)**
- **Tripod**
- **Measuring tape (for distances between points)**
- **Optional: Calculator or scale for computation**

(A) Nivel

(B) Tripod

(C) Graduated Stuff

Procedure

- **Set up the leveling instrument:**
  - Position the leveling instrument on a stable tripod at the first station.
  - Ensure the instrument is properly leveled.
- **Place the leveling staff:**
  - Place the leveling staff at the first measurement point.
  - Ensure the staff is vertical and correctly positioned.
- **Take a staff reading:**
  - Observe the staff reading through the instrument at the first station.
  - Record the reading in the field notebook.
- **Move to the next station:**
  - Move the leveling staff to the next station.
  - Take the reading and record the measurement.
- **Repeat for all stations:**
  - Continue the process for all stations in the closed traverse loop.
  - Ensure staff readings are taken at each point.
- **Check for closing error:**
  - After completing the loop, return to the starting station.
  - Take a final staff reading to check for any closing error.

4.3 Expression of results

N Points	**Readings**		ΔH		**Altitude**
	AR	**AV**	**+**	**-**	
R1	1.363		0.044		112
A	1.312	1.319			112.044
B	1.286	1.064	0.248		112.292
C	1.299	1.359		0.073	112.219
D	1.350	1.572		0.273	111.946
R1		1.338		0.012	111.958
SUM	**6.61**	**6.652**	**0.304**	**0.346**	
DIFFERENCE	**-0.042**		**-0.042**		**111.958**
TOLERANCE	**0.791**				

4.4 Conclusion

This closed traverse leveling survey aimed to determine elevation differences between points A, B, C, and D, starting and ending at benchmark R1 (elevation 112). The survey resulted in a small closure error of -0.042, which is well within the acceptable tolerance of 0.791, indicating acceptable accuracy for the survey. The final calculated elevation of R1 after the traverse was 111.958,m.

5 Direct leveling by radiation

5.1 Objective

The primary objective of leveling by radiation is **to determine the elevation of points within a defined area relative to a reference point**, which may be provided or assumed. This method allows for efficient surveying of point levels in a single space.

5.2 Equipment :

- **NIVEL (Engineer's Level)**
- **Leveling rod (graduated staff)**
- **Tripod**
- **Optional: Calculator or scale for computation**

(A) Nivel

(B) Tripod

(C) Graduated Stuff

Procedure

1. **Determine the Leveling Station Location:**

- Select the point where the leveling device will be placed, ensuring clear visibility of all measurement points.

2. **Identify the Reference Point:**
    - Choose a reference point for taking readings, which will serve as the starting point for settlement calculations.
3. **Mark the Measurement Points:**
    - Mark each point on the floor with chalk. Label each point with an "X" and number them (e.g., 1, 2, 3, ..., 10).
4. **Install the Leveling Station:**
    - Position the leveling instrument on the tripod at the center of the survey area, ensuring it is level and stable.
5. **Take and Record Readings:**
    - For each measurement point, record three readings:
        - Upper Reading: The reading at the top of the leveling staff.
        - Middle Reading: The central reading.
        - Lower Reading: The reading at the bottom of the staff.
6. **Rotate the Leveling Station:**
    - After each measurement, rotate the leveling instrument to the next point to take additional readings.

5.3 Expression of results

N Points	Lecture		ΔH		Altitude
	AR	AV	+	-	
R1	1.24			0.047	112
1		1.287			111.953
2		1.351		0.111	111.889
3		1.348		0.108	111.892
4		1.295		0.055	111.945
5		1.268		0.028	111.972
6		1.227	0.013		112.013
7		1.530		0.29	111.71
8		0.965	0.275		112.275
9		0.960	0.28		112.28
10		1.527		0.287	111.713
11		0.955	0.285		112.285
12		1.232	0.008		112.008
13		1.525		0.285	111.715
14		1.247		0.007	111.993
15		0.965	0.275		112.275
16		0.841	0.399		112.399
17		1.220	0.02		112.02
18		1.507		0.267	111.733
19		1.535		0.295	111.705
20		1.459		0.219	111.781
SOMME	**24.8**	**25.244**	**1.555**	**1.999**	
ECART	**-0.444**		**-0.444**		**-0.444**

5.4 Conclusion

This radial leveling survey determined the elevations of 20 points relative to a benchmark (R1) with a known elevation of 112. The measured elevations ranged from approximately 111.705 to 112.399. A discrepancy (closure error) of -0.444 was observed.

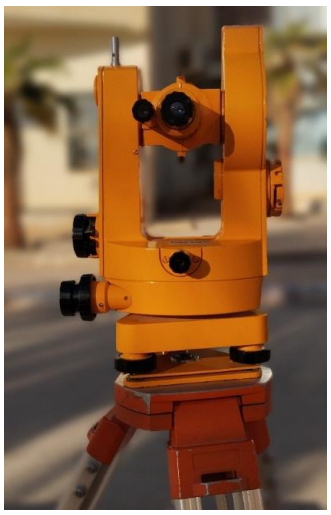
6 Indirect Leveling

6.1 Objective

Indirect leveling is a surveying method used **to determine the relative elevations of points when direct leveling is not feasible**. This technique is based on measuring angles and distances, typically with a theodolite or total station, and applying trigonometric calculations to compute the elevation differences. It is particularly useful for inaccessible points, steep terrains, or areas with obstacles.

6.2 Equipment :

- **Theodolite**
- **Leveling rod (graduated staff)**
- **Tripod**
- **Measuring tape (if needed for distances)**
- **Optional: Calculator or scale for computation.**



(A) level

(B) Tripod

(C) Graduated Stuff

Procedure

- **Set up the Instrument:**

  - Position the leveling instrument on a stable tripod at a central location within the survey area.
  - Ensure the instrument is securely fixed and horizontally leveled.
- **Position the Staff:**
  - Place the leveling staff at the first measurement point.
  - Ensure the staff is held vertically and properly positioned relative to the survey area.
- **Take Readings:**
  - Observe the staff reading through the instrument.
  - Record the reading in the field notebook (representing the elevation difference between the instrument and the point on the staff).
- **Move to Next Points:**
  - Without moving the instrument, reposition the leveling staff to the next measurement point.
  - Repeat the reading process for each new point.
- **Record Data:**
  - Record the staff readings for all survey points in the field notebook.

6.3 Expression of results

Equations

Parameter	Above Altitude	Below Altitude
V_a	$V_a = \frac{V_l + (400 - V_r)}{2}$	$V_a = \frac{V_l - (400 - V_r)}{2}$
Dh	$Dh = (U - L) \cdot 100 \cdot \sin^2(V)$	$Dh = (U - L) \cdot 100 \cdot \sin^2(V)$
ΔH	$\Delta H = \frac{Dh}{\tan(V_z)}$	$\tan(V_i) \cdot Dh$
H_B	$H_B = H_A + \Delta H$	$H_B = H_A - \Delta H$

Results

Station	Hi	L		V		Vz	Dh	Δh	Hb
		L_{sup}	L_{inf}	V_g	V_d				
A	1.425	1.495	1.472	97.6	302.64	97.48	12.80	0.54	113.97
B	1.425	1.458	1.379	101.73	298.17	101.78	9.29	0.33	113.68

6.4 Conclusion

This indirect leveling survey used trigonometric principles to determine the elevations of points A and B relative to a known benchmark. Point A was found to have an elevation of approximately 113.97, while point B's elevation was determined to be approximately 113.68. The results incorporate measurements of vertical angles and the staff readings to calculate elevation differences.

7 Conclusion

This practical work successfully demonstrated the application and comparative advantages of various surveying techniques. Direct and indirect distance measurements provided accurate results, while traverse and radiation leveling highlighted elevation determination. The exercise enhanced understanding of surveying methods, data processing, and potential error sources. Further work could explore the methods' comparative efficiency and accuracy under diverse conditions.