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COMPARATIVE STUDY FOR DETERMINING ALTITUDES

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Abstract

Levelling or terrestrial elevation is the part of the topography that studies the tools and methods for determining the point's altitude on the terrain surface and representation in plan. With these measurements will be obtaining the third coordinate of a point H - altitude.
The article aims to determine rates using three surveying instruments (classical level, total station and digital level) and two survey methods: closed geometrical levelling traverse and trigonometric levelling.
Measured points are inside the University of Agronomic Sciences and Veterinary Medicine, Bucharest.

Key words*: comparative study, altitude, levelling, surveying instruments*

INTRODUCTION

Levelling or terrestrial elevation is the part of the topography that aims to determine altitudes (quotas) points on the topographic surface and relief representation on plans and maps.
Levelling is performed with specifically instruments and is eligible for use mainly in surveying and construction.
Any point on the earth's surface must be determined by the three coordinates X, Y, H.
The odds are absolute if determined from surface-level or if it is determined relative to a reference surface set arbitrarily. Figure 1 can be seen in absolute and relative shares of the points A and B :

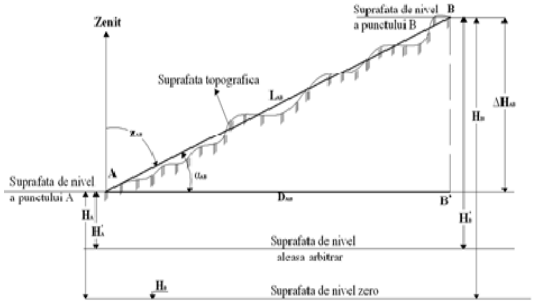

Figure 1. Defining altitudes

H_A si H_B absolute altitudes;

H'_A si H'_B relative altitudes

MATERIALS AND METHODS

For comparative study, we used: Leica RUNNER 20/24, Leica TC407 total station and Leica Sprinter 100M.
1) RUNNER 20/24 is a member of the new generation of automatic levels for manufacturers. Its innovative technology makes the measurement easier to achieve.
The instrument is ideal for all applications of a reliable and robust levels. The easy operation of the instrument can be easily learned, even by non-initiates.

Figure 2. Leica grade level RUNNER 20

Important parts:

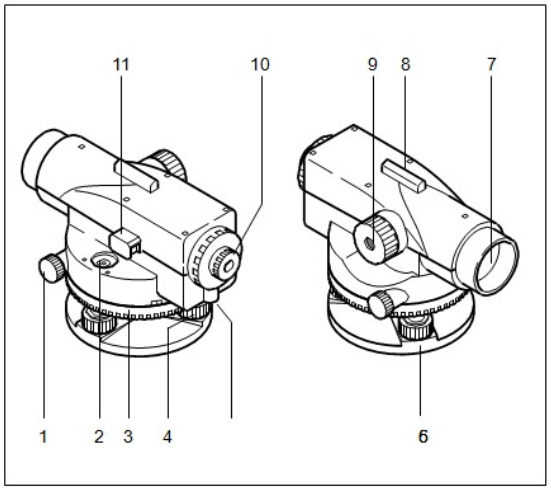

Figure 3. Instrument components

1. Endless drive (both sides)
2. Circular level
3. Knurled ring of adjustable horizontal circle
4. Footscrew
5. Compensator test knob
6. Base plate
7. Objective
8. Optical sight with point marking
9. Focusing knob
10. Eyepiece
11. Level prism

Figure 4. Leica TC407 total station

2) The Leica Geosystems TC407 is a high-quality electronic total station designed for the construction site.
Its innovative technology makes the daily surveying jobs easier.
The product is ideally suited for simple construction surveys and setting out tasks.
The easy operation of the product functions can be learned without problems in no time.

Important parts:

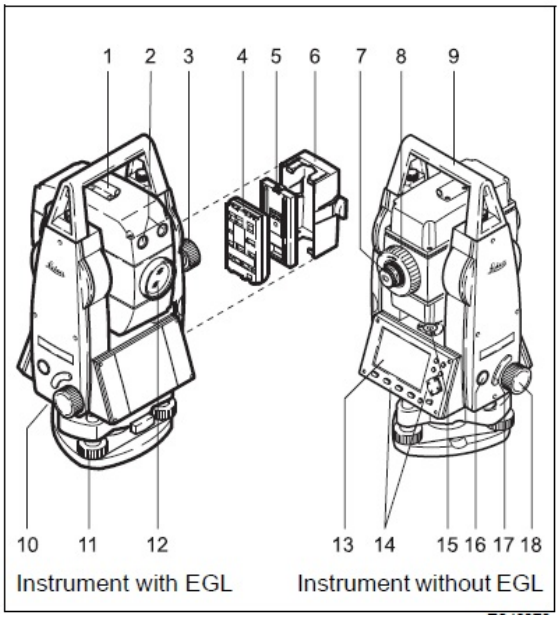

Figure 5. Instrument components

1) Optical sight
2) Integrated guide light EGL (optional)
3) Vertical drive
4) Battery
5) Battery stand for GEB111
6) Battery cover
7) Eyepiece; focusing graticule
8) Focussing telescope image
9) Detachable carrying handle with mounting screws
10) Serial interface RS232
11) Foot screw
12) Objective with integrated Electronic Distance Measurement (EDM); Beam exit
13) Display
14) Keyboard
15) Circular level
16) On/Off key
17) Trigger key
18) Horizontal drive

3) SPRINTER 100M is the new high quality electronic digital level produced by Leica Geosystems. It is designed to make levelling easier and quicker in any construction site. It employs techniques that electronically read the special bar-coded staff and the gathered data is displayed on the screen almost instantly. Its innovative technology makes the daily surveying jobs easier.

Figures 6, 7. Leica Sprinter 100M digital level

Instrument components:

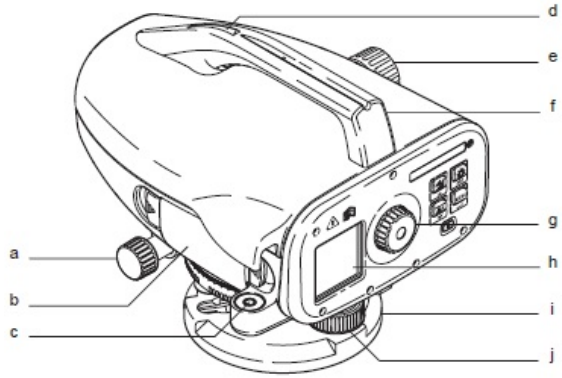

Figure 8. Instrument components

a) Horizontal fine motion screw
b) Battery compartment
c) Circular level
d) Gunsight
e) Focusing knob
f) Handle
g) Eyepiece
h) LCD display
i) Base plate
j) Levelling foot screw

M*ethods used*:

Traverse levelling method applies when we want to determine the odds of several points that can not be measured from a single point of station. By making their support network will thicken altimetry or there will be a network where there are no points in the studied area known quota.

Levelling classification can be based on the measurement tools used and depending on the methods of measurement and processing adopted in the following categories:

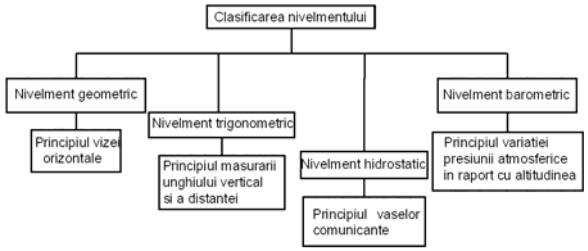

Figure 9. Classification levelling

1) Levelling traverse closed circuit - starts from a known point share (RN1) and closes on the same point of share known (RN1).

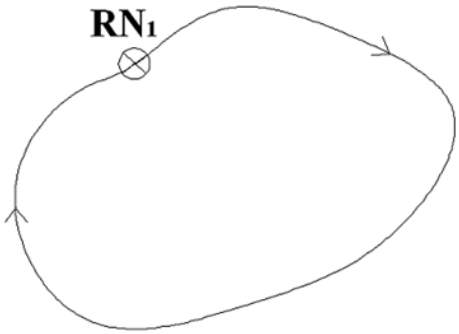

Figure 10. Scheme levelling traverse closed circuit

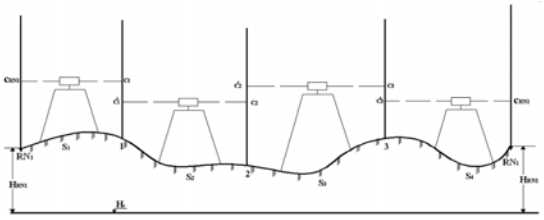

Figure 11. Traverse levelling geometric middle closed circuit

Stage field:
Measurements on the field will follow the same rules as to traverse the geometric levelling supported at the ends. The difference that arises is that will turn on the landmark know RN1 share and close measurements on the same landmark as it is the only point of time share. All measurements will be centralized in the book field.
Checking measurements:
Since the mark is the same departure and destination, the difference between the average readings back and average readings before the amount should be zero.

$$\sum a - \sum b = H_{RN1} - H_{RN1} = 0$$

$$e_h = (\sum a - \sum b)$$

The condition is: $e_h \le T_h$ Where tolerance is calculated using:

$$T_h = 3\sigma_h \sqrt{\sum D_{ij}(km)}$$

Verification:
HRN1 calculated by transmission rates equals HRN1 known data of the problem.

2) Trigonometric levelling
Trigonometric levelling method is applied in special circumstances when the terrain is rugged (steep slopes), and distances between points can reach up to several kilometres. It is recommended to apply only in such situations because they are more complex measurements, angles and distances are measured, which leads to decreased accuracy of determining the differences in level. Depending on the evolution of the field and measured distances between points, we have several situations:
• trigonometric levelling visas spaced upward (Figure 12) - the angle of slope is positive and the distance between points is small, the focus might be surprised at the height of the device;

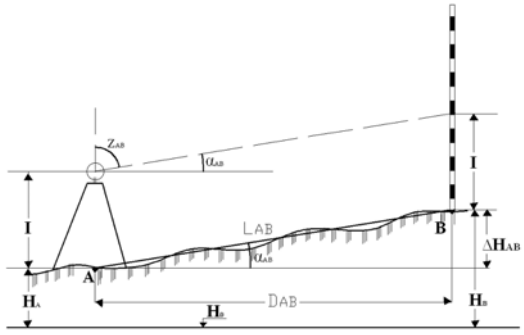

Figure 12. Trigonometric levelling visas spaced upward

• trigonometric levelling upward visas great distances (Figure 13) - the angle of slope is positive, but the distance between points is great, it can not be targeted to wonder at the height of the device;

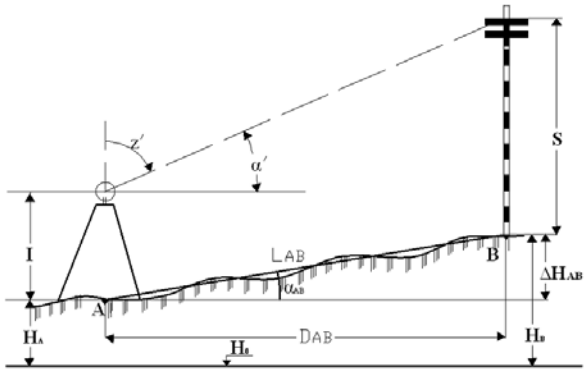

Figure 13. Trigonometric levelling upward visas great distances

• trigonometric levelling downward visas (Figure 14) - the angle of slope is negative.

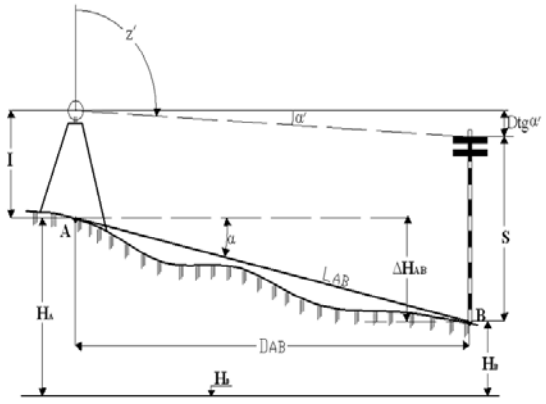

Figure 14. Trigonometric levelling downward visas

RESULTS AND DISCUSSIONS

Table 1. Study results

Comparative study								
Classic level Leica RUNNER20 			Digital level Leica Sprinter 150M 			Total station -Leica TC407 		
Precision: • Standard deviation per km double run RUNNER 20 - 2,4 mm			**Precision:** Standard deviation per km double run (ISO 17123-2): Electronic measurement with SPRINTER aluminium barcode staff: 2.0mm (SPRINTER 100/150M)			**Precision:** • Accuracy standard deviation Hz, V (acc. to ISO 17123-3) - TC(R)407 -7" (2 mgon)		
Nr Pct	ΔH	H	Nr pct	ΔH	H	Nr Pct	ΔH	H
GPS1	0	87.631	GPS1	0	87.631	GPS1	0	87.631
1	0.009	87.640	1	0.007	87.648	1	0.011	87.656
P5.1	-0.157	87.581	P5.1	-0.156	87.582	P5.1	-0.159	87.594
GPS1	0.051	87.637	GPS1	0.050	87.633	GPS1	0.053	87.643
e_h	0.006		e_h	0.002		e_h	0.012	
T	0.0061		**T**	0.005		**T**	0.016	

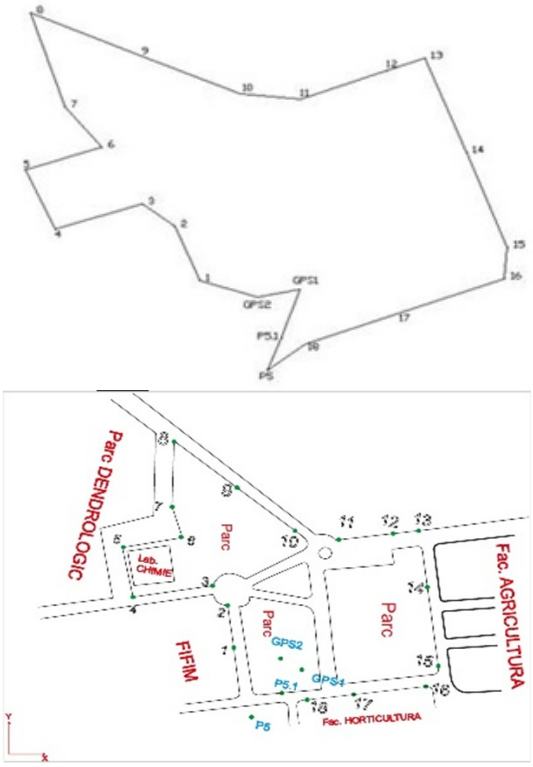

Figure 15. Drawing support network

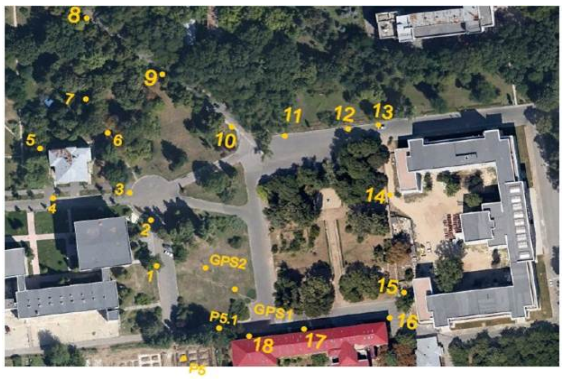

Figure 16. Catch the framing in Google Earth

CONCLUSIONS

Using measurements made with different surveying instruments we obtained H-altitude.
The paper was aimed to determining the altitudes of several points situated in the U.A.S.V.M Bucharest campus with three different surveying instruments (classical level, digital level and total station), demonstrating their capabilities and accuracy.

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User manual Leica TC407