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THE UTILIZATION OF STADIA MEASUREMENTS FOR DIFFERENT CONSTRUCTIONS WORKS

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Abstract— **Tachoetry is used to measure the lengths of traverse sides, to check the more accurate taped distances in order to uncover gross errors or mistakes and to determine differences of elevation between points. It's most general use is found in the compilation of planimetric and topographic maps by field methods alone, by which distances, elevations and directions to points are to be determined from field control points whose positions have been established by a higher order of accuracy.**

The principles of stadia measurement by use of the transit or theodolite or total station is one of the main method of tacheometry. This paper presents the principles of stadia measurement and a computer program will be formulated and written by using MICROSOFT AXEL. This version of the language is objecting oriented provided with comprehensive tools to simplify the task of programming and to provide the programmer with wide range of options for design of the user interface system.

Keywords- **Stadia Measurements, Stadia Leveling, Stadia Surveying, Horizontal Measurements Distances and Tacheometry.**

I. INTRODUCTION

Tachometric surveys the branch of surveying in which the horizontal and vertical distances with the angular measurements can be determined. It is not so accurate method of finding the horizontal distances as the Chaining is, but it is most suitable for carrying out the surveys to find the distances in the hilly area where other methods are quite difficult being carried out.

It is generally used to locate contours, hydrographic surveys and laying out routes of highways, railways and other applications for civil engineering. There are several different types of system, including the stadia, sub tense bar, and optical wedge systems. The stadia tachometry method is the most commonly used, stadia method, is used to quickly measure distances with an engineer's transit, theodolites, or auto-level and a graduated rod. This Stadia range finding is good for locating topographic details such as fields, rivers, bridges, buildings, and roads.

II. TACHEOMETRIC OR OPTICAL METHOD

In stadia tacheometry the line of sight of the tachometer may be kept horizontal or inclined depending upon the field conditions. In the case of horizontal line of sight (Fig.1), the horizontal distance between the instrument at A and the staff at B is

$D = k\, s + c$ ………………………..... (1.1) Where

K and c = the multiplying and additive constants of the tachometer, and

s = the staff intercept, = $ST – SB$,

Where ST and SB are the top hair and bottom hair readings, respectively.

Generally, the value of k and c are kept equal to 100 and 0 (zero), respectively, for making the computations simpler. Thus

$D = 100\, s$ ……………………………….. (1.2)

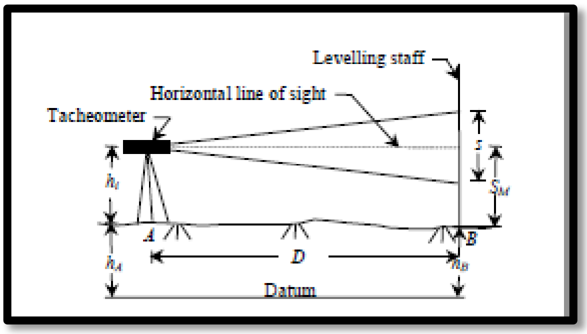


Figure1: Horizontal line

In the case of inclined line of sight as shown in Fig. 2 the vertical angle α is measured, and the horizontal and vertical distances, D and V, respectively, are determined from the following expressions

$D = ks \cos 2\alpha$ ……………………….(1.3)

$V = ks\cos \alpha \sin \alpha$........................... (1.4)

The elevation of B is computed as below.

$hB= hA + hi + V – SM$ …………….(1.5)

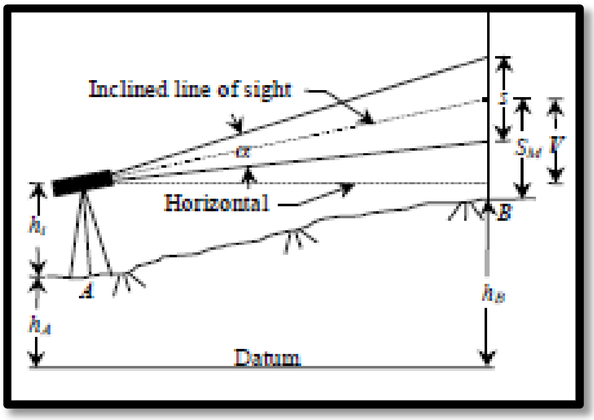


Figure2: Inclined Distance

III. MODERN INSTRUMENTS OF TACHEOMETRY

A. Total Station

A total station, which is shown in figure (1), is a theodolite that incorporates distance measuring using a laser or infrared beam, along with internal/external electronic data logging These devices save the surveyor from collecting multiple measurements for each point location whose position needs to be known, as triangles can be constructed trigonometrically once you know one internal angle (between baseline and unknown point) and two edge lengths (the baseline and measured distance to unknown point).

Figure3**:** Total station

It is a combination electronic transit and electronic distance measuring device (EDM) types of total station surveying slope Staking, topographic surveys, construction project layout , leveling, traverse surveys and adjustments ,building face surveys , resections , areas , intersections, point projections, taping from baseline, road (Highway) surveys, accuracy is highly dependent on leveling the instrument. Thus two leveling bubbles are provided on the instrument and are referred to the circular level and the plate level. Circular level is located on the tribrack while plate level is on horizontal axis of instrument just below scope of the total station.

B. 2GPS Instrument

This device has become a standard surveying technique in most surveying practices advantage of GPS surveys

Figure 4: GPS instrument.

- Three Dimensional • Site Indivisibility Not Needed • Weather Independent • Day or Night Operation • Common Reference System • Rapid Data Processing with Quality Control • High Precision • Less Labor Intensive/Cost Effective • Very Few Skilled Personnel Needed

GPS eliminates the need for establishing control before a survey

GPS can establish control as and when need Most GPS survey projects consist of multiple baselines or networks, and the baselines can be measured individually using only two receivers or several at a time using multiple receivers d and establish points at strategic locations to start and close conventional traverses The GPS survey technique used in a given project depends on

- Accuracy requirements • Urgency of the project • Local terrain conditions • Available equipment,

C. EDM instrument

Modern EDM equipment contains hard-wired algorithms for reducing the slope distance to its horizontal and vertical equivalent. For most engineering surveys, Total stations combined with electronic data loggers are now virtually standard equipment on site. Basic theodolites can be transformed into total stations by add-on, top- mounted EDM modules. The development of EDM has produced fundamental changes in surveying procedures.

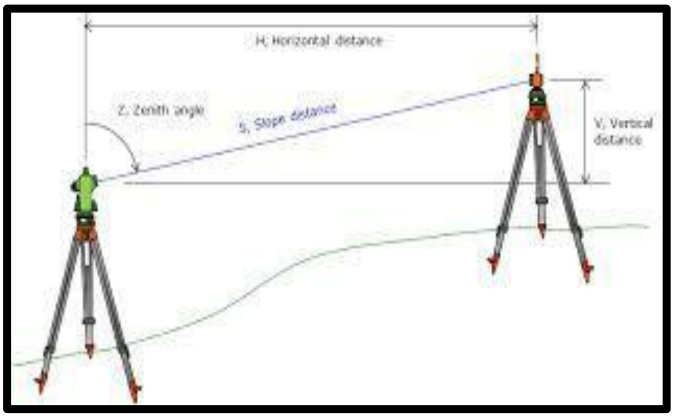


Figure 3**:** EDM process

An EDM measures the line of sight distance between the instrument and reflector. This is a slope distance and not horizontal unless the EDM and reflector are at the same elevation. When EDMs were first affordable a typical procedure a surveyor used would be: (1) measure a zenith angle with a theodolite, (2) remove the theodolite from the tripod and mount the EDM (often using the same tribrach to maintain the same setup) and measure the slope distance, and, finally (3) manually reduce the slope distance to horizontal. Electronic Distance Measurements (EDM) can be divided into:

1. Infrared wave instruments
2. Light wave instruments
3. Micro wave instruments

D. Infrared Wave Instruments

These instruments measure distances by using amplitude modulated infrared waves. Prisms mounted on target are used to reflect the waves. These instruments are light and economical and can be mounted on theodolites for angular measurements. Also the range of such an instrument will be 3 km and the accuracy achieved is ± 10 mm.

Figure 4: Infrared Wave Instruments

E. Light Wave Instruments

These are the instruments which measures distances based on propagation of modulated light waves. The accuracy of such an instrument varies from 0.5 to 5 mm / km distance and has a range of nearly 3 km.

Figure 5: Light Wave Instruments

F. Microwave Instruments

These instruments make use of high frequency radio waves. Thee instruments were invented as early as 1950 in South Africa by Dr. T.L. Wadley. Also The range of these instruments is up to 100 km and can be used both during day and might.

Figure 6: Microwave Instruments

G. *Digital Level* is the process of measuring, by direct or indirect methods, vertical distances in order to determine elevations. To establish heights relative to a benchmark a device with a sighting telescope called a level The advantages of digital levels are that observations are takenwithout the need to read a staff or record anything by hand. Introducing this automationremoves two of the most common errors when leveling, reading the staff incorrectly and writing down the wrong value in the field book.

Figure 7: Digital level

H. *Digital Theodolite* A surveying instrument and precision instrument for measuring angles in the horizontal and vertical plane the se of theodolite, Mapping applications and in the construction industry, Measurement of Horizontal and vertical angle , Measurement of magnetic bearing of lines , Locating points on line, Prolonging survey lines , Determining difference in elevation, Setting out curves , Aligning tunnels, Mining works in digital theodolite all the parameters required to be observed during surveying can be obtained, the value of observation gets displayed in a viewing panel , the precision of this type of instrument varies in the order of 0.1" to 10″.

Figure 8 : Digital Theodolite

IV. MODELING STADIA MEASURMENT (MSM) OF TACHEOMETRY IN CIVIL ENGINEERING APPLICATION

Stadia tachymetry is mainly used in surveying details in selected areas. Adequate horizontal and vertical control, supplied by traversing and leveling is required to orientate the survey and to provide station levels. It is best suited to open ground where few hard levels are required. Infield practice, the transit is set on a point for which the horizontal location and elevation have been determined**,** so we design a simple programming (MSM) MODELING STADIA MEASURMENT, This method is easy to apply in the field, but unless a direct-reading tachymeter is used, the resultant computation for many ‘spot-shots’ can be extremely tedious, even with the use of a computer program. The very low order of accuracy and its short range limit its application to detail surveys in rural areas or contouring.

V. PROGRAM DESIGN

Computers of various types and sizes are now widely used in surveying and are particularly convenient for making traverse computations. Small programmable handheld units, data collectors, and laptop computers are commonly taken into the field and used to verify data for acceptable misclosures before returning to the office. In the office, personal computers are widely used. A variety of software is available for use by surveyors. Some manufacturers supply standard programs, which include traverse computations, with the purchase of their equipment. Various software are also available for purchase from a number of suppliers. Spreadsheet software can also be conveniently used with personal computers to calculate and adjust traverses. Of course, surveying and engineering firms frequently write programs specifically for their own use. Standard programming languages employed include Fortran, Pascal, BASIC, C, and others. In this research the Microsoft Excel program used to programming the equation of traverse into table of input data and the Excel calculate the output data.

A. Maine Page of (MSM) Program Design

We designed a program by Microsoft Excel and used its equation facility to produce a full Modeling Stadia Measurement for all applications in civil engineer, it contain two

part plotting traverse and plotting profile. The cases of the traverse are classified into eight cases (number of sides =(3), number of sides= (4), number of sides= (5), number of sides= (6), number of sides= (7), number of sides= (8)), the main page framework shown in figure 9.

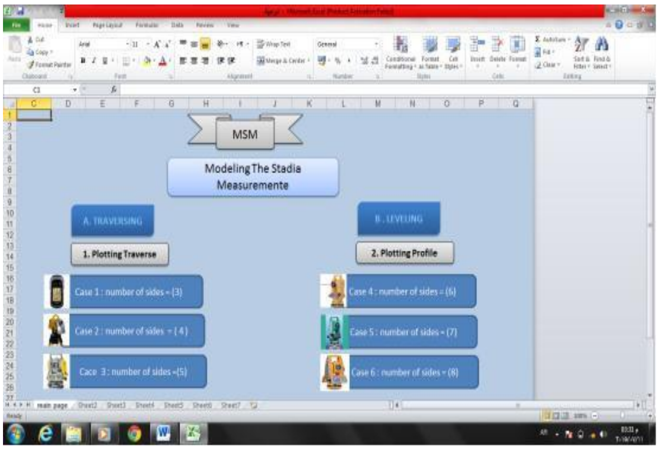


Figure9: MSM framework

These menu items are described in the following sections.

1. Case1: number of sides = (3).
2. Case2: number of sides = (4).
3. Case3: number of sides = (5).
4. Case4: number of sides = (6).
5. Case5: number of sides = (7).

Case6: number of sides = (8).

1. **Case 1: Travers number of sides = (3).**

If the user selects any option, the form shown in figure (9) is displayed on the screen. First the user input information's is listed below:

2. H.A is a horizontal angle.
3. H.I height of instrument
4. Z is a vertical angle
5. U is upper hair
6. L is lower hair
7. M is middle hair
8. α Is 90-Z

When the user input this required data, the program begins the calculation of the elements (Horizontal Distance for each side, Vertical Distance for each side, Difference in Elevation for each side, Adjusted Elevation of the Traverse Stations

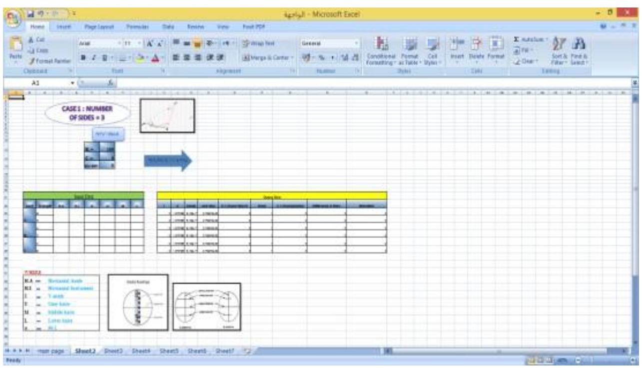


Figure10: traverse 3 node

Following that the transition traverse design process is considered completed the program enabled the user to go to the design of the next traverse in the alignment irrespective of its case (3 sides or 4sides or 5 sides or 6 sides or 7 sides or 8 sides or 9 sides or 10 sides) or can exit the traverse design if it is the last traverse in the alignment as shown in figure 11

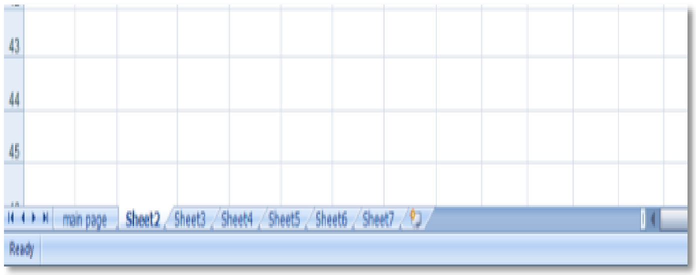


Figure11: selected any cases of traverse

B. Menu

Start your traverse at known height of instrument on one corner find the true vertical angle to your first leg. Follow the same procedure of inverting and repeating it to determine the upper, lower, and middle hair on input data table.
The user can select another case of traverse by click on sheet or can return to main page as shown in figure 9 to select cases in every case the different page appeared as shown in figure 12, 13, 14, 15, 16

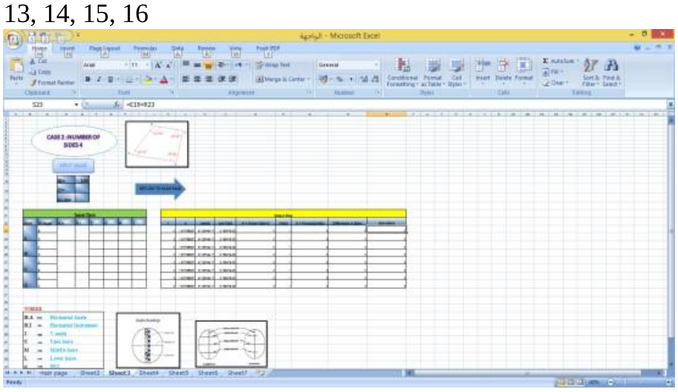


Figure12: Traverse 4 node

Each different type of survey will have its unique requirements concerning traverse station placement. On property surveys, for example, traverse stations are placed at each corner if the actual boundary lines are not obstructed and can be occupied. If offset lines are necessary, a stake is located near each corner to simplify the observations and computations. Long lines and rolling terrain may necessitate extra stations, stations are set at each angle point and at other locations where necessary to obtain topographic data or extend the survey

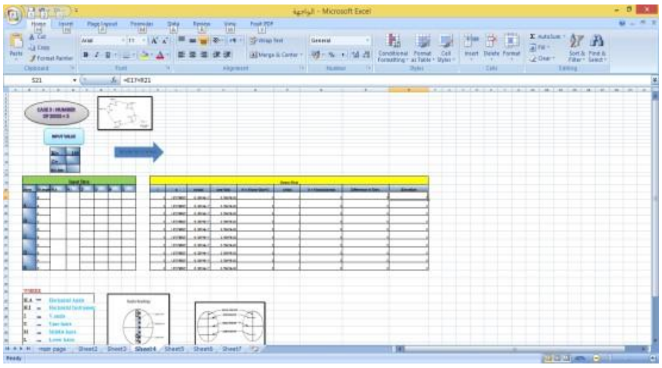


Figure13: Traverse of 5 node

Measured angles or directions of closed traverses are readily investigated before leaving the field. Linear measurements, even though repeated, are more likely a source of error, and must also be checked. Although the calculations are lengthier than angle checks, with today's programmable calculators and portable computers they can also be done in the field to determine, before leaving, whether a traverse meets the required precision

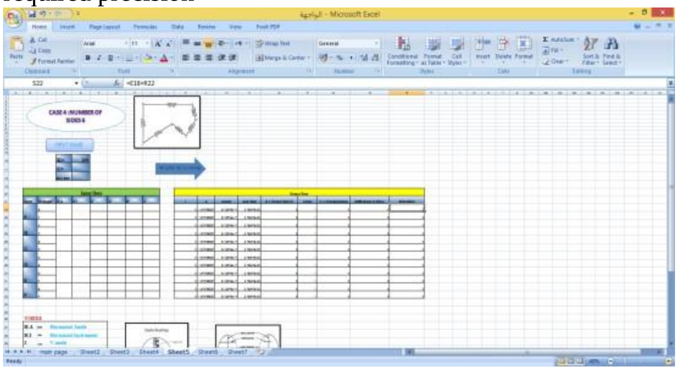


Figure14: Traverse 6 node

In this case we designed a Travers has seven sides and its elements that we added which observed by the observer was the vertical angle and reading staff.

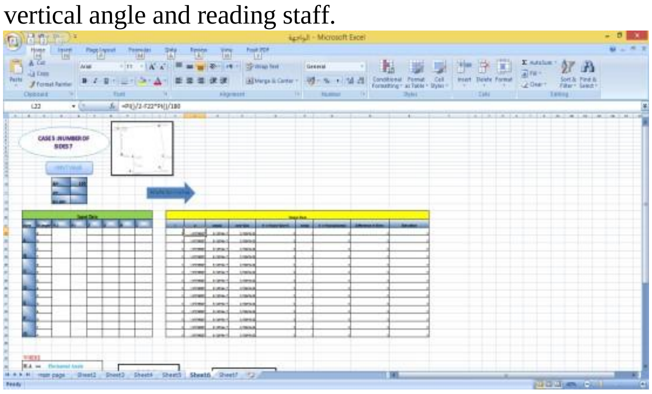


Figure15: traverse 7 node

In this case we designed a Travers has eight sides and its elements that we added which observed by the observer was the vertical angle and reading staff.

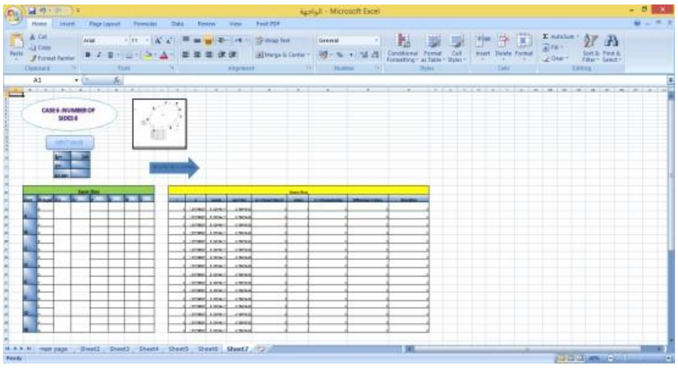


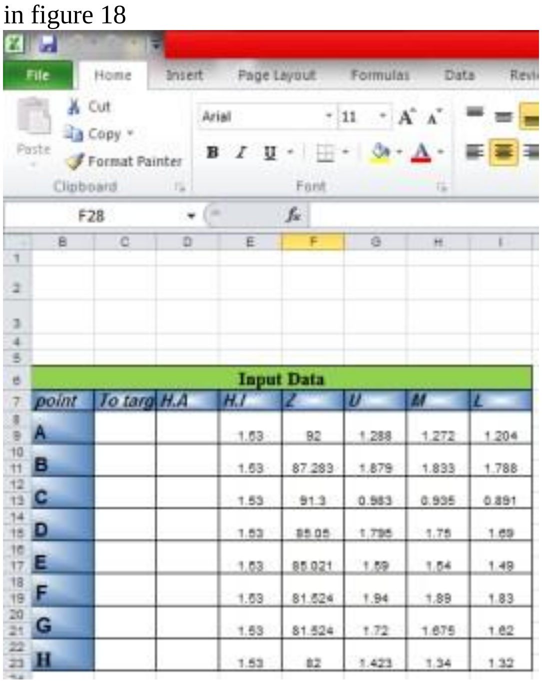
FIGURE16: TRAVERSE 8 NODE

C. TRAVERSING PRACTICING

We practice Tachometry in field to ensure the program. By selected several points separated in college laboratory and took some of them on stairs, as shown in figure 17

Figure 17: Laboratory Stairs Case Study

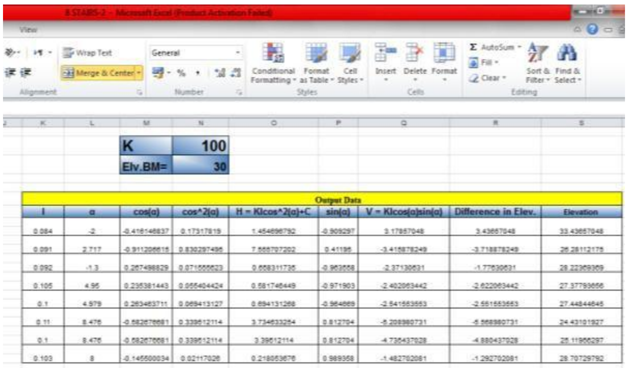
The Input Data was prepared by the height of the instrument using digital theodolite and the staff reading as shown in figure 18



Input Data							
point	To targ	H.A	H.I	Z	U	M	L
A			1.53	92	1.288	1.272	1.204
B			1.53	87.283	1.879	1.833	1.788
C			1.53	91.3	0.983	0.935	0.891
D			1.53	85.05	1.795	1.75	1.69
E			1.53	85.021	1.59	1.54	1.49
F			1.53	81.524	1.94	1.89	1.83
G			1.53	81.524	1.72	1.675	1.62
H			1.53	82	1.423	1.34	1.32

Figure18: Input Data

So if we run the program the output data Measurements find all the horizontal, vertical and their elevations see figure 19.



K	100
Elv.BM=	30

Output Data								
I	α	cos(α)	cos^2(α)	H = Klcos^2(α)+C	sin(α)	V = Klcos(α)sin(α)	Difference in Elev.	Elevation
0.084	-2	-0.416146837	0.17317819	1.454696792	-0.909297	3.17857048	3.43657048	33.43657048
0.091	2.717	-0.911206615	0.830297496	7.555707202	0.41195	-3.415878249	-3.718878249	26.28112175
0.092	-1.3	0.267498829	0.071555623	0.658311736	-0.963558	-2.37130631	-1.77630631	28.22369369
0.105	4.95	0.235381443	0.055404424	0.581746449	-0.971903	-2.402063442	-2.622063442	27.37793656
0.1	4.979	0.263463711	0.069413127	0.694131268	-0.964669	-2.541563563	-2.551563563	27.44844645
0.11	8.476	-0.582676681	0.339512114	3.734633254	0.812704	-5.208980731	-5.568980731	24.43101927
0.1	8.476	-0.582676681	0.339512114	3.39512114	0.812704	-4.735437928	-4.880437928	25.11956297
0.103	8	-0.145500034	0.02117026	0.218053676	0.989358	-1.482702081	-1.292702081	28.70729792

Figure 19: the output data and computation

D. PLOTTING THE PROFILE

Drawing the profile, it is first necessary to compute elevations along the reference line from the field notes. However, this cannot be done until an adjustment has been made to distribute any misclosure in the level circuit, as shown in figure 20.

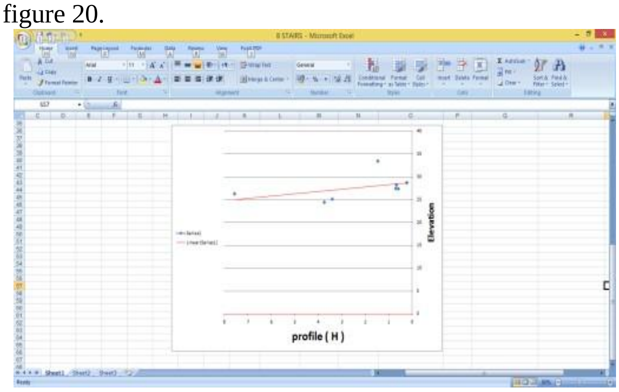
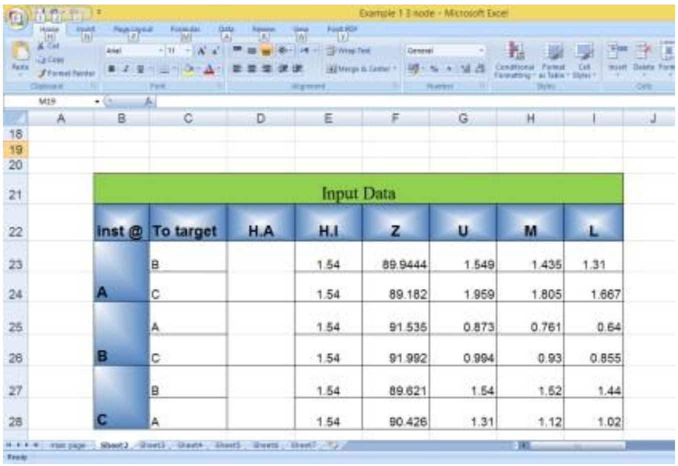


Figure 20: plotting the profile

E. Traverse by stadia measurement

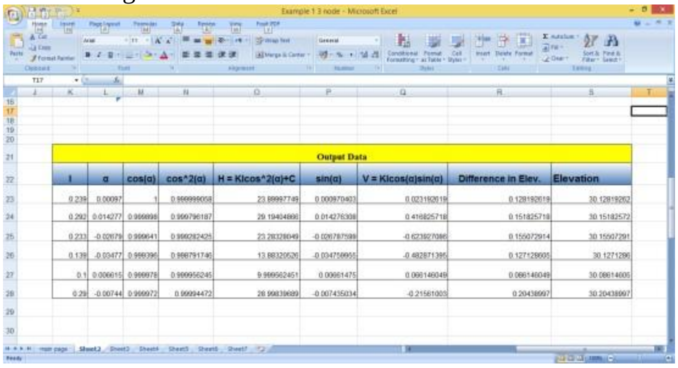
We practice stadia in field to ensure the program. By selected several points separated in college around the laboratory and took some of them on garden. The Input Data was prepared by the height of the instrument using digital theodolite



Input Data							
Inst @	To target	H.A	H.I	Z	U	M	L
	B		1.54	89.9444	1.549	1.435	1.31
A	C		1.54	89.182	1.959	1.805	1.667
	A		1.54	91.535	0.873	0.761	0.64
B	C		1.54	91.992	0.994	0.93	0.855
	B		1.54	89.621	1.54	1.52	1.44
C	A		1.54	90.426	1.31	1.12	1.02

Figure21: Input Data

So if we run the program, the output data Measurements find the entire horizontal, vertical and their elevations as it is shown in figure 22



Output Data								
I	α	cos(α)	cos^2(α)	H = Klcos^2(α)+C	sin(α)	V = Klcos(α)sin(α)	Difference in Elev.	Elevation
0.239	0.00097	1	0.999999058	23.89997749	0.000970403	0.023192619	0.128192619	30.12819262
0.292	0.014277	0.999898	0.999796187	29.19404866	0.014276308	0.416825718	0.151825718	30.15182572
0.233	-0.02679	0.999641	0.999282425	23.28328049	-0.026787589	-0.623927086	0.155072914	30.15507291
0.139	-0.03477	0.999396	0.998791746	13.88320526	-0.034759955	-0.482871395	0.127128605	30.1271286
0.1	0.006615	0.999978	0.999956245	9.999562451	0.00661475	0.066146049	0.066146049	30.06614605
0.29	-0.00744	0.999972	0.99994472	28.99839689	-0.007435034	-0.21561003	0.20438997	30.20438997

Figure 22: the output data

VI. CONCLUSIONS

To know and understand the basic concepts of distance measurement, the solution problems of traversing by manual method are more complex if compared to the solution by Microsoft EXCEL programming of the same problem. Identify and select instruments and procedures are necessary to reduce errors that result from measuring distances and angles with the stadia principal.

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